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NOTES, MEDICAL AND SURGICAL, TAKEN DURING THE LATE SIEGE OF LUCKNOW.

By H. M. Greenhow, Esq.

BENGAL MEDICAL SERVICE.

In the following notes, taken during the late siege of Lucknow, some of the principal Medical facts of interest are enumerated, and the diseases which prevailed are commented on. A list of the wounded admitted into the Native Hospital, in joint medical charge of which I was placed, is also given; and I have ventured to add another of a few cases,—about forty, of European Officers and others, whom I was called upon to see in the course of my duties. These lists give a fair idea of the kind of wounds met with throughout the siege; and I leave it to others to publish their notes of the sick and wounded admitted into the European Hospital. I should mention that many of the Europeans in my list of wounded were sent to the European Hospital for treatment, as they could be better attended to there, than elsewhere in the Garrison.

The siege of Lucknow commenced on the morning of the 30th June 1857, and lasted till the 25th September, when Generals Outram and Havelock entered the intrenchment at the head of 2,500 men. Though the presence of these troops was a great relief, and probably the saving of the beleaguered Garrison, yet the final and complete relief took place only on the 17th November, when the Commander-in-Chief himself opened up the communication with Alum Bagh. The following notes however are more particularly drawn from my experience during the period previous to the 25th September,—except those on the wounded, which extend to the 20th October.

For several weeks before the actual siege commenced, many Officers and other Europeans,—Serjeants of mutious Native Corps, and others, with their wives and children, had been arriving at the city, and were received into the various houses round about the Residency. These persons had escaped from the districts near, for the most part simply with their lives. They had had to fly from the stations of Oude at a moment's notice, and often on foot, to avoid the bullets and bayonets of their own Regiments and their own Sepoys. Many were not so fortunate as to escape at all, and were burnt to death or cut up,—men, women and children, in their bungalows or on their own parade grounds. Many were shot down and exterminated, while being conveyed towards Lucknow by the very men who had undertaken to guard them and had sworn the most solemn oaths to see them safely to their journey's end. Many again,—delicate women and young children,—had been exposed to the full heat of a tropical sun, in June, and compelled, in some instances, to walk miles without food, and in constant dread of pursuit by a relentless foe; while others, less fortunate, fled to the jungle and then lay down to die; or, possibly, met a worse fate at the hands of the armed ruffians who infested the country. Those who were fortunate enough to reach Lucknow and were lodged, as I have mentioned, in the immediate vicinity of the Residency were, for the most part, without clothes, except what they had on at the time of their flight.

The Residency, at this time, was filled with ladies and children who, for the most part, had come there before the Mutiny in Cantonments. The Judicial and Financial Commissioner's houses were opened to the strangers from the districts; while the Offices of those gentlemen, the Post Office, various musjids and other edifices, and, in short, every available building whatever were converted into dwellings for the European and Eurasian population of Lucknow, and it may be said of Oude generally. Of course the crowding was great, and exercised, as will presently be seen, an injurious effect on the health of the Garrison.

The entrenchment, though not thoroughly completed when the siege began, was in a forward state and embraced a space of raised plateau round the Residency, of some 2 miles in circumference,—the river flowing at a short distance on its North Eastern side.

There was, up to the last moment, a small camp at Cantonments, so that, till the actual shutting-up of the Garrison, communication was kept up with the districts around; and the Commissariat arrangements were carried on so vigorously that, at the time the siege began, above 4 months' provisions of meat and grain had been laid in. Still, when the siege commenced on the 28th June, it was scarcely expected; and many persons found that they had not stored up little luxuries and even necessaries, the want of which they severely felt after the lapse of a short time.

On that memorable morning, when the small force which had gone out to meet the enemy was driven in, after having suffered very severely in an engagement at Chinhut, a place about six miles from the city,—the Garrison of Lucknow found itself hemmed in on every side by a force of certainly twelve to fifteen thousand men,—which, subsequently, was fully doubled, who had with them from 30 to 40 guns, including many heavy pieces.

The numbers of the Garrison at this time appear as follows :—

Strength of the Lucknow Garrison on 30th June, 1857.

EUROPEANS.

Chaplains.	Officers.	N. C. Officers.	Drummers.	Privates.	Non-Mily. Combatants.	Total.	Women.	Children.	Grand total.	
2	130	63	20	567	147	929	257	281	1,467	

NATIVES.

Fighting men.	Public Camp followers.	Private Camp followers.	Total.		Grand total of Garrison.
611	162	742	1,515		2,982

Of the fighting-men, to oppose the large force outside, it will thus be seen that there were but 1,538; and this included, besides a good many wounded, a considerable number of Natives who thought our star was on the decline, and who, therefore, could hardly be depended on. It included many too, who had never seen a shot fired, and some who had hardly used a gun,—men however who felt that they were about to fight for very life and all most dear to them, and who knew their wives and children were watching their every movement and praying for success to crown their arms. Men and women were in an extraordinary position, and it required a great effort on the part of both to sustain them in it. Notwithstanding however the check at Chinput, and the loss experienced there; notwithstanding the overpowering numbers of the enemy and their rapid advance on the city, and in spite of the jaded condition of those who had previously come in from the neighbouring stations, and the generally crowded condition of each house in the intrenchment,—the besiegers were repulsed in the fierce attack they made during the first three days of the siege, with a loss to the besieged, insignificant indeed as regarded numbers. Their beloved Chief,—Sir Henry Lawrence, was, however, mortally struck by a shell on the third day, and this circumstance tended not only to depress their spirits, but to make them feel, in an intenser degree, the difficulties and dangers of their position.

After the closing in of the enemy and the cessation of communication with the surrounding country, people began to feel the hardships as well as the perils incident to their situation. At the first alarm, most of the servants,—thinking the Garrison doomed, had fled, leaving their masters to find for themselves. To ladies particularly, this was a great loss; and, subsequently, when arrowroot and sago, sugar and port-wine were not to be had; when milk was very scarce, and eggs sold at 2 Rupees a piece, and whenever soojee was not abundant,—it may be imagined that people put on grave faces and looked anxiously for "The Relief." As will be seen presently, children especially were the sufferers, for broth and soojee and rice were, literally, their only food. There was certainly porter for those persons who urgently required it; but beer was not to be had after the early days of the siege. Meat and attah were the staple food of adults; but ladies,—especially the sick, could with difficulty eat or digest chuppaties, and no bread was seen during the whole siege.

The Sanitary arrangements were carried out before the besieging army arrived in a very vigorous manner, and the whole area of the entrenchment was cleared of filth to an amazing extent. When however, the siege began, the establishment of the Sanitary Officer vanished, and he was left comparatively powerless. The Garrison then had to bury dead horses and other animals of all kinds; and some difficulty was experienced in getting these, and the bodies of Natives and others, disposed of in the proper manner. Europeans were interred in the Church-yard, which had been included in the intrenchment; but it is believed that the enemy have not allowed the bodies to rest in their graves.

But, spite of every effort, where persons are crowded together as in a Garrison, and are under a Tropical sun, and where servants, so particularly necessary in India, are few and far between,—filth and nuisances will collect; and it may be conceived that, after a few weeks, the air of the entrenched enclosure became tainted, and disease became prevalent. Perhaps it was well that the season was comparatively a dry one. At the beginning, the heat was great; but after the first two or three weeks, rain fell in some quantity and the air became cooler,—the thermometer generally ranging from 85° to 90°.

Whether the women and children, who were for the most part shut up in the houses and consequently unable to enjoy what fresh air there was,—or the Officers and Soldiers, who often slept out in the damp trenches or were exposed to great exertions in alternate sun and rain, suffered most in health, it is not easy to say; but undoubtedly all were severely tried, and the trial proved too much for many. It may be mentioned that the women and children of H. M. 32nd Foot,—which Regiment formed the staple of the Lucknow Garrison, had nearly all perished miserably at Cawnpore; their fate foreshadowing, as it were, that of Lucknow, should it fall before the arrival of relief.

No building in the intrenchment was safe from shot, shell and bullets, but the European and Native Hospitals were chosen in spots as free as possible from fire; and though, in the former, several men were wounded by balls that penetrated; and, though the upper story was riddled by round shot, yet the arrangements were good, and every thing was carried on in a regular and systematic manner. The Medical Staff lived in the Hospital; women were allowed to nurse their husbands; boys from the Martinière College acted as help mates to the nurses, and made themselves useful in cooling the patients with hand-punkahs, &c.; while, for several weeks, certain benevolent ladies lent their aid to smooth the pillows and dress the wounds of the poor fellows,—both Officers and men who lay in the different wards.

All luxuries that could be procured, as jellies, port-wine, arrow-root and sago, were made over to the Hospital soon after the commencement of the siege; and, for the sick throughout the Garrison, indents for these things were sent in by Medical Officers, as they were required. But, as already mentioned, the supply was not equal to the demand, especially towards the end of the siege.

In the Native Hospital also, matters were carried on in a regular manner. The stock of servants was but very limited, most having fled at the first alarm. But the Hospital, though greatly crowded at times, answered its purpose sufficiently well, and the patients received there every attention.

Taking all the above mentioned circumstances into consideration; remembering the disheartening condition of affairs in the Garrison at the commencement of the siege; the effect of the loss of dear relations during its continuance,—for women sometimes saw their husbands shot before their very eyes; the hard work in the heat and wet, of the men,—the anxiety, close confinement, and insufficiency of suitable food of the women and children; the almost necessarily defective Sanitary arrangements and over-crowding of the whole Garrison; taking all these things into the account, can it be wondered at that cholera, diarrhœa, dysentery and fever found their victims,—and that, besides those who died of their wounds, many met their death through disease?

I now propose to notice these and a few other diseases, and begin with

CHOLERA.

Cholera prevailed among both Europeans and Natives, especially during the first two months of the siege, but could never be called epidemic. It was reported to be raging in the city, and the chances are there was truth in the report, as, unquestionably, during the month of June, many deaths from it took place. I believe indeed that Lucknow, like other large cities of India, is never wholly free from Cholera.

In the intrenchment, many cases of Diarrhœa ran on into Cholera, while, in others, such was not the case; and, as I have often known, the former were more manageable than those instances in which Cholera came on suddenly. Among the latter, the symptoms were often of a severe type from the first, and treatment seemed of little avail.

In my experience, Natives recovered better than Europeans; but of the latter I have no statistics. Of Natives, nearly half the cases admitted into the Native Hospital recovered. Of those Natives whom I saw out of Hospital, the majority recovered. Of Europeans I did not attend very many, but several recovered. Those whom I saw, were many of them children, but they, for the most part, did badly. The prognosis was more favorable in the case of adults.

At the causes of this complaint, happening as it did in a close entrenchment, it is hardly necessary to glance. The real cause of Cholera has yet, indeed, to be further investigated, but that certain conditions prepare the way for its action, is undoubted, and these conditions were present at Lucknow. They were, probably, of the same nature as those which produced the Diarrhœa subsequently described and may, therefore, be omitted here. I may mention however, that, in several cases of Europeans attacked by Cholera, *inordinate appetite* was previously observable. I myself noticed this in one or two instances of convalescence from wounds, and I believe it was not an uncommon case.

It is quite unnecessary to notice here the symptoms of this disease. They were the usual and well-known symptoms of Cholera. Sometimes there was premonitory Diarrhœa, sometimes not. As a general rule, the intensity of the complaint was over in 24 hours and signs of either amendment or death had set in. Collapse, in those cases where it occurred, came on quickly. Subsequent fever I did not observe in any instance that I can call to mind, but in one, that of a boy, decided head-symptoms appeared and ushered in death.

With Natives, the treatment I pursued was that which I commonly employ. No stimulants were given. I gave the same pills as are mentioned by me in a former number, (III), of the "Indian Annals" except that of opium one grain was given in each pill, instead of half a grain. Creasote and water to allay vomiting, I found most useful. Turpentine frictions and garters tied round the legs, relieved cramp. Congee-water and dilute sulphuric acid made useful drinks. With Europeans, in consequence of not seeing cases often for some hours, I could not prevent stimulants being given. Nor, as most persons were living rather under fear, did they seem to be so much contra-indicated as they would otherwise have been. But, when I allowed a stimulant at all, it was in small quantity and consisted of weak brandy and water. Judging however from my own experience and that of the European Hospital, where stimulants were in most instances given in profusion, I am led to conclude that in very few cases is brandy, (the best stimulant,) advisable even when Cholera and any other diseases that may prevail, as at Lucknow, are of an asthenic character. With Natives this is, undoubtedly, the case, and so I think also with Europeans; though, the latter, being more accustomed to stimulants, are more likely to tolerate them. Calomel treatment was tried in the European Hospital with a favorable result in one or two cases; but it was perhaps doubtful whether the Calomel was the cause of that result. Bleeding, *even during collapse*, seemed to answer well in several cases. I am not aware that this plan has been practised of late years in Cholera. In several instances however, 4 ounces of blood were obtained from the arm of patients in collapse. The pulse returned, and though the effect often passed off, the bleeding was sometimes repeated, after a few hours, and with apparent success. In the European Hospital, opium appears to have proved hurtful, and its use was discontinued in a great measure; but I cannot say my experience, among the Natives at least, agreed with this.

DIARRHŒA.

From the commencement of the siege, this complaint prevailed. Those who had ever had it before were sure to suffer from it now; and several cases of old Hill Diarrhœa which I observed were so augmented as to end fatally. Strong European Soldiers too began to be ill; and,—though medicines, with directions, were placed in the hands of Pay-Serjeants of Companies, so that at the first moment of attack the men might have relief,—there were very many admitted into Hospital and many sunk under the disease. Among women and particularly children, Diarrhœa was very common; indeed the latter may be said to have been visited by it almost in an epidemic form. Of the Natives, but few were affected with Diarrhœa, though many, as will be again noticed, had attacks of Dysentery.

The causes that produced Diarrhœa have been already glanced at.

The time of year, with its alternations of heat and wet, was unfavorable; especially for those who had, as was the case with all, to remain on the *qui vive* night and day, ready to "turn out" at a moment's notice. The anxiety of mind and want of proper rest, were alone sufficient to weaken and predispose even the strongest to disease; and added to this were the hard work in the trenches, in digging mines, in raising traverses, and in all fatigue-duties, as well as in the actual serving of guns and mortars, and general fighting. Again, the Sanitary state of the Garrison, though, at first, well enough, became, after a time, any thing but satisfactory. The drains and necessaries became foul; the different houses were, as indeed was inevitable, over-crowded; water in consequence of the flight of the servants, was but sparingly used by many people; while, for the same reason, clean clothes were at a premium, and punkahs at a stand-still.

The food, as already noticed, disagreed with most people. Luxuries, for the sick even, as sago, arrow-root port-wine, sugar, milk, eggs, &c., &c., were scarce; and, for the healthy, chuppaties would not always supply the place of bread, nor rice that of potatoes and other vegetables. The cooking pots moreover were not "kullaied" during the siege; and as they were not, in most cases, kept particularly clean, I suspect the actual food eaten contained numerous particles of deleterious matter.

Super-added to these causes, may be noticed the voracious appetite which numbers of people seemed to have,—especially those recovering from wounds or illness. Many, I feel certain, made themselves ill by yielding too much to this tendency, which led them often,—not content with plain rice or chuppaties and meat,—to indulge in chocolate, hermetically sealed salmon, herrings, sardines, and other rich things, of which they would partake liberally, thinking to make up in this way for the loss of their accustomed good bread, vegetables and puddings.

The symptoms of languor and lassitude generally preceded the actual complaint; and uneasiness, even amounting to pain, was generally felt across the abdomen, especially in the course of the colon. A copious evacuation was speedily followed by others of the same description; generally these motions were watery in consistence, light in color, but fœculent in odor. They continued till the patient was worn out, till they were checked by medicine, or till they degenerated into rice-water, as in certain cases where Cholera ensued.

They were accompanied not by fever, but by a great feeling of nausea; and were succeeded by a sense of weakness and general prostration. This diarrhœa was indeed of that asthenic form which might be expected to result from the causes already enumerated as producing it. It seized men, women and children, and proved fatal in many cases. Women, and particularly children, suffered from it most frequently and severely,—no doubt because by them especially were the change of food and its unsuitable character felt.

In many cases, this diarrhœa was difficult to shake off, and very liable to return, as indeed might be anticipated from the circumstances of the Garrison. Of the men however, though all suffered more or less from looseness of the bowels, most improved as the siege continued; for diarrhœa was very common at first, and less so after a time,—no doubt in consequence of men's stomachs becoming accustomed to the chuppaties, which formed the staple of their food.

For those afflicted with diarrhœa, rest was indispensable, but not easily procured. A few nights in bed,—for by day the flies would not allow of sleep,—did more in most cases than all medicine; and men came to Hospital often, and, after a couple of days' rest there, departed sound and well, having required but the simplest medicines. Regulation of the diet was, in nearly all instances, a thing difficult to carry out. The indications were to avoid greasy cookery, meat and chuppaties; while rice, soojee, arrow-root, sago and tea, and subsequently broth, minced-meat and portwine were allowed. For children, port-wine, soojee or milk and ground rice, with some sugar added, were found to constitute the best diet; and, after a time, minced meat and rice could be borne and were relished.

The medicines I found most useful were the following, *viz.*, the Pil hydrarg. c. opio et zingiber, which had a most excellent effect, particularly when the motions were light colored,—a thing of frequent occurrence. Sometimes, especially in cases of chronic diarrhœa, the following pills were useful: ℞ Pil, hydrarg. ʒss, cupri sulph. pulv. opii. a. a. gr. vi *m* ft. pil xij; one pill to be taken every 3 hours.

Chalk mixture, as a general rule, I did not find useful. Mixtures of mucilage and tinct kino, often with quinine disulph. and acid. sulph. dil. conjoined, checked the diarrhœa, acting most favorably on the mucous membrane of the bowels, and exercising a tonic effect on the system generally.

With children, small doses of Dover's powder and hydrarg. c̄ cret. were sometimes sufficient to check the complaint. But with irritable stomachs, either in children or adults, these did not answer; and then a mucilage mix ure with laudanum and tinct. kino, or mistura cretæ with tinct. kino, or catechu seemed to be retained and to act very beneficially; creasote too I found invaluable in cases where nausea was a troublesome symptom. Enemata of mucilage and laudanum, or in the latter stages of the complaint, of mucilage and port-wine, and of beef-tea or arrowroot and port-wine, were very soothing and supporting; and in many cases being retained for several hours, really were instrumental in promoting recoveries which otherwise had been but doubtful.

Dysentery.

The form of Dysentery which affected the Garrison was acute, but somewhat asthenic; and, while the Europeans were attacked most by diarrhœa, the Natives, in my experience, suffered, in a greater degree from Dysentery. At the same time the complaint in the Natives, as is generally the case, was milder in form than that of the Europeans; and, on the whole, the disease was of a very manageable character, and nothing like that inflammatory and ulcerative Dysentery which is met with in Bengal Proper. There was, however, a great tendency to relapse, even after an entire recovery. Towards the termination of the siege, the type of Dysentery somewhat changed. It became more asthenic even than before, and was evidently of scorbutic origin. The same causes that produced diarrhœa, doubtless led to Dysentery. It is therefore unnecessary to re-enumerate them. Feelings of lassitude and fatigue, with uneasy griping sensations in the abdomen, generally ushered in an attack of Dysentery. Then came, in many cases, a full watery motion; or sometimes, straining and inability to pass more than a small lumpy stool, or a quantity of watery, mucous fluid. However this might be, after a few hours, tenesmus, frequent straining and bearing down pains in the rectum became marked; the latter more especially on the patient's standing up, and particularly on his making any exertion. The prostration indeed, was, in many instances, very considerable; nausea too was a prominent symptom; fever generally absent. The motions were small in quantity; sometimes dark, but generally, after a little time, light-brown or whitish in color; degenerating into mucous and then bloody stools, and having little or no fœculent odor connected with them. Blood was not passed in large quantities in more than two of the cases I saw; but pure blood was, undoubtedly, discharged in many instances, showing how great a degree of congestion, at least, existed in the mucous membrane of the large intestines. That ulceration did not take place, was, I think, shown by the rapid recoveries which most patients made when they once began to take care of themselves; for they very soon, as a general rule, ceased to have bloody motions, even though the tendency to looseness and straining might, and did often, remain for some time. There was indeed in this complaint, as in the diarrhœa, the same difficulty to shake off thoroughly the disease,—the same tendency to relapse. All classes of persons suffered more or less from Dysentery; but, as I have mentioned, it appeared to affect a greater portion of Natives than of Europeans. Of the latter, the men suffered more than the women and children; probably on account of their greater exposure to damp and the night air, and to their unwontedly hard work.

The treatment and general management of this Dysentery was very much the same as that required in the diarrhœa already described. Both arose from the same causes; both were asthenic in form, and accompanied by general weakness. In both, therefore, rest was indispensable, and slight nourishing food was required. In the Dysentery, as in the diarrhœa, meat, curries, chuppaties, &c., were prohibited; while soojee and port-wine, or arrowroot or sago and port, and sometimes jelly or ground-rice were allowed. Subsequently, soup and minced-meat, with port-wine or sherry were relished, and the patient soon recovered his ordinary appetite. Eggs, (when procurable), were very useful in cases where great nausea existed; and I often found that a boiled egg mashed up with a little rice, was relished when other things could not be taken.

I generally commenced the treatment with a pill of pil. hydrarg, opium and ginger, as in cases of diarrhœa, followed by one ounce of castor oil with xv. or xx. minims of laudanum, after three or four hours. Sulphate of copper, I did not find so useful as in diarrhœa; and indeed the above-mentioned pills answered every purpose in the great majority of cases. I may here remark that opiates, as a general rule, seem to me to exercise a better effect in most forms of

Dysentery in this country, when given alone than when joined to astringents. The latter act for a time in a favorable manner; but their effect seems to pass off leaving the patient but little relieved,—while that of opium or morphia is more lasting, at the same time that, especially when joined to pil. hydrarg, it appears to allow of the natural function of the bowels being carried on.

At the same time, when the stomach was irritable, a mixture with mucilage and tinct. kino. was very useful, and was retained when opium or laudanum, or, with children, Dover's powder and Grey powder, were rejected. In such cases too, chalk mixture with tinct. kino. or catechu proved successful; and creasote, when every thing else failed, was a sure remedy for nausea. Enemata of mucilage and laudanum were most useful; while, in the advanced stages of the complaint, mucilage and port-wine, or beef-tea, or arrowroot and port-wine enemata, were almost indispensable.

Small-Pox.

At the commencement of the siege, there were many cases of Small-pox among the children of the Garrison. In the city, this disease had been prevailing for some time, and hence, probably, its extension to the Europeans. After the first month or six weeks of the siege, it entirely disappeared from among the latter; whereas, had communication been kept up with the city, the chances are it would have continued its ravages among them. The interruption of communication therefore no doubt acted favorably in this instance for those confined within the intrenchment. The disease was, as far as I observed it, of a severe type, both in children and adults. I saw many fatal cases; though some, especially of adults, were mild and accompanied by but little constitutional disturbance. Instances in which the eruption became confluent, were not rare; and the majority of these proved fatal, head symptoms generally setting in about the eighth or ninth day.

Fever.

From genuine miasmatic fevers the Lucknow Garrison was peculiarly free. Shut up in a confined space for many months during the hot and rainy season, with but indifferent Sanitary arrangements, and encumbered by a large collection of animals of various kinds, a daily increase of filth and a consequent pollution of the atmosphere, necessarily, took place. It was to be expected, therefore, that Fever would prevail. Yet it was almost absent; and indeed, speaking generally, I should say that the latter weeks of the siege,—curious as it may seem, were more healthy than the first. This may be partly accounted for by the supposition that the weak and unhealthy part of the Garrison fell victims early to disease, while the strong and healthy remained; but the fact that Fever was comparatively of rare occurrence is a curious one.

While, however, Miasmatic Fevers were seldom met with, a low kind of Typhus Fever,—I believe the true Typhus,—was not infrequent. I saw several cases of this disease among Europeans, generally terminating fatally, and of which the subjoined is a good example; and I may be permitted to add that, among Natives also, I believe I have met this complaint in its true form. I had some records of cases observed formerly, but these have been lost with my other papers.

Case.—Lieut. ——, ætat. 24, of sanguine temperament; during July and the beginning of August, had suffered from repeated attacks of diarrhœa and Fever. About the middle of August, he became affected by a low Fever, resembling, in many of its features, the true typhus.

The digestive organs were greatly disturbed; the tongue was foul, the saliva thick and gummy; the bowels were opened at irregular intervals, with motions loose, peculiarly offensive in odor, and in appearance resembling coffee-grounds. The stomach was irritable, nausea was almost constant, and but very little food could be digested. That the circulation was deranged was shown by the pulse, which was constantly weak and irritable, ranging from 120 to 150 in frequency, and easily excited by slight causes. The respiration too was quickened, particularly towards the close of the case; and, indeed, there were, throughout, frequent dyspnœa and sense of suffocation. The urine was high colored, but no minute examination was made of it. The skin was generally moist and clammy, and latterly exhaled an indescribable odor. After about the third week of the Fever, an eruption appeared on the skin of the abdomen, which gradually spread to the chest and arms and then to the lower limbs. This eruption resembled that of typhus, and continued to increase till the 5th or 6th day, after which it faded slowly away. The spots were tolerably bright in

color, disappearing on pressure, but immediately returning on its removal. Headache was never complained of, but there were, throughout, a tendency to sleep and great lassitude and inability to exertion. During sleep, I observed twitching of the muscles of the face and limbs, and this increased as the case proceeded. The patient, at one time, though much emaciated, appeared about to rally. The eruption disappeared, the bowels became more regular, the head more collected, the pulse less irritable, and a favorable change seemed to have set in. Still the respiration and pulse were too quick, and great weakness remained. A change of locality was tried, but soon it became apparent that the system was giving way; and, in the beginning of October, death took place. The treatment consisted of astringents and opiates to check the diarrhœa, and subsequently tonics,—as quinine and iron, and the mineral acids; while stimulants, particularly port-wine and rum, (because others could not be procured,) and a supporting diet were prescribed.

The want of the necessary comforts for sick men, proved a source of serious inconvenience during this siege; and, in consequence of it, many cases, not in themselves dangerous, became so, and too often terminated fatally. Diarrhœa and Dysentery became chronic, or were succeeded by low Fever; and in other instances, constitutions naturally strong were undermined, and became the ready recipients of Typhus and Cholera.

Child Births.

A good many births took place during the siege. As might be anticipated, many were premature, for what a position was it for ladies and women to be in! Round shot frequently crashing into the houses, shells bursting in the roads and open spaces, and in the very verandahs; bullets constantly whistling through the air, or "thudding" against the walls; and mines occasionally shaking the very earth! Such were the sights and sounds which met one on every hand; while our own heavy guns, morning and evening, replied to the enemy's fire and shook the air with reverberations. At the commencement of the siege, it was especially remarked how all the children, of every age, felt the confinement. The weakly gave way at once. The strong alone survived; while new-born children almost invariably pined and died.

SUICIDE.

It has been remarked, I believe, during sieges generally, that suicide and that depressed state of mind leading to it, is not uncommon. Nor is this more than one would expect, considering the numerous and pressing causes of anxiety that must be present to the minds of nearly all those, who are surrounded and cut off, as it were, from the outer world. At Lucknow, this was peculiarly the case; for, with the example of Cawnpore before them, and the knowledge that theirs might be a similar fate, the garrison had cause for deep solicitude, more especially as their wives and all they held most dear were so intimately concerned. Sometimes, indeed, men's spirits were good, and they held up bravely; but, occasionally, when weeks had passed over and no news from outside was received; when well-loved comrades or valuable officers, for there were many such, fell by the enemy's bullets or by disease, which might have been perhaps successfully combated under more favorable circumstances; they were apt to despond, and to feel the reality of their dangerous position. But, though the thought of it was too much for the minds of one or two, we must rejoice that these cases were rare; and, while gently drawing a veil over them, can but feel proud that so much privation and so great a trial were endured with a cheerful spirit by the great mass of the garrison.

Besides irritation and depression of mind, several cases of irritability of the bladder occurred. In some instances this irritability constituted a disease in itself; in others, it was grafted on to other complaints; and, in all, it formed a most serious indication, and was not unfrequently the precursor of death. It presented itself in persons of nervous temperament; and, as might be expected, was almost as difficult to combat as its kindred disease of the mind.

SCURVY.

TOWARDS the termination of the siege, scorbutic eruptions, swellings of the limbs and joints, and scorbutic dysentery, became of frequent occurrence. I never observed the true scurvy,—the bleeding gums and loosened teeth; but patches on the skin appeared in many cases, in children particularly; while asthenic dysentery, no doubt of scorbutic origin, presented itself; and swellings of the knees and ankles were not unfrequent. Considering the total want of vegetables, with the exception of a very little "sagh," and the absence also of lime juice and vinegar, the wonder is that more persons did not suffer in this way. Rice was served out, latterly, of course, in very reduced quantity; but rice cannot be considered a good substitute for good vegetables, a fact proved indeed by the experience of this siege. The best treatment for the complaint, and an evidence too, if such were needed, of its real origin, was the partaking again of fresh vegetables. When the supply of these was opened up, scorbutic diseases began to disappear; and, as the appetite for vegetables was satisfied, the result of being deprived of them became less and less manifest.

Having thus reviewed the principal Diseases which prevailed in the garrison, I propose to give a few notes of my experience of the Wounded during the siege. First however, it may be well to subjoin a return of the killed and dead of the garrison during the period preceding Sir James Outram's arrival. Here is the return.

RETURN OF KILLED AND DEAD OF THE LUCKNOW GARRISON, FROM 30TH JUNE TO 25TH SEPTEMBER 1857.

EUROPEANS.

Chaplains.	Officers.	N. C. Officers.	Drummers.	Privates.	Non-Military Combatants.	Total.	Women.	Children.	Grand Total.	
1	28	43	6	248	23	349	15	41	405	

NATIVES.

Fighting-men.	Public camp followers.	Private camp followers.	Total.		Grand Total of deaths exclusive of Private camp followers.
133	19	Loss unknown.	152		557

The total loss of the garrison during the three months, may, therefore, be set down with tolerable correctness at one fourth of their original number. But many desertions took place among the fighting Natives and Public Camp Followers, so that, before the termination of the siege, their numbers were reduced to about one-half from that cause alone; and this must be considered in noting the mortality among them, as it appears in the above return.

Of Europeans, it seems that the Private Soldiers, (as might be expected), suffered most severely, their loss being not very far short of one-half; next to them the Non-Commissioned officers; then the Drummers, (who performed the duties of private soldiers); then the officers; and lastly the Non-Military combatants. Among the women and children the mortality was, considering all things, wonderfully small.

I now proceed to consider the wounds and injuries of which I had experience during this siege. In order to render this easy, I cannot do better than give the lists in the exact form in which I made them out during my observation of the cases.

Here then they are.

(I).—List of Wounded, admitted into the Native Hospital, Lucknow, between the 30th June and 20th October 1857.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
1	25	Bullet-wound through abdominal walls and peritoneum, and into bladder, ...	Bullet not extracted, though attempted, ...	Death from irritation, ...	Wounded in garrison, lived 3 days.
2	25	Bullet-wound close to spine, ball passing into belly, ...	Bullet not extracted, ...	Ditto ditto, ...	Ditto ditto.
3	18	Round-shot-wound just above knee, smashing thigh, ...	Amputation of the thigh, primary, ...	Recovery, ...	Ditto (1) a good recovery.
4	34	Bullet through and above shoulder, bone not broken, ...	Bullet passed out, ...	Ditto, ...	Ditto.
5	34	Bullet graze of foot, ...	....	Ditto, ...	Ditto
6	66	Bullet through arm, just above wrist, bone uninjured, ...	Bullet escaped, ...	Ditto, ...	Wounded at Chinhut.
7	60	Bullet through thigh, bone unbroken, ...	Ditto, ...	Ditto, ...	Wounded in garrison.
8	25	Bullet through mouth, producing bad compound fracture of lower jaw, ...	Ditto, ...	Death from irritation and exhaustion, ...	Ditto, lived 5 days.
9	50	Bullet through upper third of thigh, no fracture, ...	Bullet extracted, ...	Recovery, ...	Ditto.
10	40	Bullet-wound of skin of side, ...	Bullet passed out, ...	Ditto, ...	Ditto.
11	25	Bullet through thigh, bone untouched, ...	Ditto, ...	Ditto, ...	Ditto.
12	30	Round-shot-wound of foot and compound fracture of leg, ...	Amputation of leg primary, ...	Death from irritation and exhaustion.	Wounded at Chinhut, (2) lived 6 weeks.
13	30	Round-shot-wound, smashing thigh, ...	Amputation of thigh, primary, ...	Death from tetanus, ...	Wounded in garrison, (3), ... Lived 10 days, operation not performed at Hospital.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
14	35	Bullet-wound of arm below shoulder, and compound fracture of humerus, ...	Bullet extracted, ...	Recovery, ...	Wounded in garrison.
15	50	Bullet-graze of side, ...	....	Ditto, ...	Ditto.
16	60	Bullet through chest, ...	Bullet passed out, ...	Death from irritation and exhaustion, ...	Ditto, lived 15 days.
17	30	Bullet through nape of neck, ...	Ditto, ...	Recovery, ...	Ditto.
18	40	Bullet-graze of side, ...	....	Ditto, ...	Ditto.
19	20	Shell-wound of foot, and smash of bones, ...	Hey's operation,—primary	Ditto, ...	Ditto, (4), ... A beautiful stump, and healed in 6 weeks.
20	50	Bullet-graze of thigh, ...	....	Ditto, ...	Ditto.
21	35	Bullet-wound of thigh, without fracture, ball deeply buried among muscles, ...	Bullet not extracted, ...	Ditto, ...	Ditto.
22	25	Bullet-wound through thigh, no fracture, ...	Bullet passed out, ...	Ditto, ...	Ditto.
23	30	Round-shot-wound of leg, tearing off integuments, but producing no fracture, ...	....	Ditto, ...	Ditto.
24	50	Bullet through thigh, and compound fracture, ...	Bullet extracted, ...	Ditto, ...	Ditto.
25	30	Bullet-wound through forearm, bone escaping, ...	Bullet passed out, ...	Ditto, ...	Ditto.
26	25	Bullet through occipital bone, passing upwards and fracturing it, escape of brain, ...	Bullet extracted, ...	Death from irritation, ..	Wounded in Chinhut, lived 2 months.
27	30	Bullet-wound under skin of forearm, ...	Bullet passed out, ...	Recovery, ...	Ditto.

28	40	Bullet-wound of leg, and fracture of both bones, ...	Ditto, ...	Ditto, ...	Wounded in garrison.
29	25	Bullet-graze of arm, ...	....	Ditto, ...	Ditto.
30	40	Bullet-wound and fracture of arm, also bullet-wound of thigh, bone unbroken, ...	Bullet not extracted from arm. Ball extracted from thigh, ...	Ditto, ...	Wounded at Chinhut.
31	30	Bullet-wound of shoulder, no bone broken, ...	Bullet passed out, ...	Ditto, ...	Wounded in garrison.
32	30	Three flesh-wounds from tulwar, in thigh, shoulder and head......	....	Ditto, ...	Wounded at Chinhut.
33	30	Bullet-wound of leg, bone unbroken, ...	Bullet passed out, ...	Ditto, ...	Ditto.
34	70	Bullet-wound through cheek, no bone broken, ...	Bullet spit out, ...	Ditto, ...	Wounded in garrison.
35	65	Bullet-wound of left side, in spleen, region, much hæmorrhage, ...	Bullet not extracted, ...	Death from irritation and exhaustion, ...	Ditto, lived a month.
36	26	Bullet-graze of neck, ...	....	Recovery, ...	Ditto.
37	30	Bullet-wound of lower third of thigh, no fracture, ...	Bullet passed out, ...	Ditto, ...	Wounded at Chinhut.
38	37	Tulwar wounds of neck and shoulder, ...	....	Ditto, ...	Ditto.
39	45	Bullet-wound of foot, no fracture,	Bullet passed out, ...	Ditto, ...	Ditto.
40	60	Bullet-graze of back, ...	....	Ditto, ...	Ditto.
41	50	Bullet-wound of thigh, bone escaping, ...	Bullet lodged, ...	Ditto, ...	Ditto.
42	55	Bullet-wound of upper third of thigh bone untouched, ...	Bullet escaped, ...	Death from irritation & sloughing of wound,...	Ditto, lived 15 days.
43	45	Bullet-wound of side, ...	Bullet extracted, ...	Recovery, ...	Wounded in garrison.
44	30	Bullet-wound of arm just below shoulder, bone escaping, ...	Bullet escaped, ...	Ditto, ...	Wounded at Chinhut.
45	32	Bullet-wound under skin of buttock,	Ditto, ...	Ditto, ...	Wounded in garrison.
46	30	Bullet-wound under left clavicle, producing fracture, ...	Bullet not extracted, ...	Death from irritation and suppuration, ...	Ditto, lived 25 days.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
47	26	Bullet-graze of side, ...	....	Recovery, ...	Wounded in garrison.
48	24	Shell-wound, a graze of thigh, ...	....	Ditto, ...	Ditto.
49	30	Bullet-wound of side, breaking ribs, much hæmorrhage, ...	Bullet extracted, ...	Ditto, ...	Ditto.
50	30	Bullet-wound of arm, smashing bone and producing great laceration, ...	Primary amputation at shoulder-joint, ...	Death from irritation and exhaustion	Wounded in garrison, (5) ...... lived 15 days.
51	20	Bullet through inner corner of orbit, lodging in brain and then escaping, ...	Bullet escaped, ...	Death from shock, ...	Ditto, lived 10 hours.
52	30	Bullet-wound through thigh, bone broken, ...	Bullet extracted, ...	Recovery, ...	Wounded in garrison.
53	25	Bullet wound of buttock, ...	Bullet lodged, ...	Ditto, ...	Ditto.
54	30	Bullet-wound through thigh, bone unbroken, ...	Bullet extracted, ...	Ditto, ...	Ditto.
55	60	Bullet through abdomen, wounding bowels and spleen, and producing great hæmorrhage, ...	Bullet passed out, ...	Death from shock, ...	Ditto, lived 6 hours.
56	55	Bullet-wound through hand, bones broken, ...	Ditto, ...	Recovery, ...	Ditto.
57	50	Bullet-wound through thigh, bone unbroken, ...	Ditto, ...	Ditto, ...	Ditto.
58	20	Bullet-wound of temple, into brain,	Bullet lodged, ...	Death immediate, ...	Ditto.
59	60	Bullet-wound of shoulder, ball breaking clavicle and entering chest, ...	Ditto, ...	Death from irritation and exhaustion, ...	Ditto, lived 3 days.
60	25	Bullet-wound of thigh, just above and behind knee, ...	Bullet extracted, ...	Recovery, ...	Ditto.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
61	35	Bullet-wound of head, ball entering at inner canthus of left eye, and passing out in front of left ear, fracturing temple, ...	Bullet passed out, ...	Death from irritation and exhaustion, ...	Ditto, lived 12 days.
62	30	Bullet-wound of forearm; bones unbroken. The same ball then passed into left side, below ribs, through stomach and so out right side, 4-inches below nipple.	Ditto, ...	Death from exhaustion and shock, ...	Ditto, lived 2 days.
63	20	Bullet-wound of leg, bones unbroken, ...	Ditto, ...	Recovery, ...	Ditto.
64	25	Round-shot carried off right arm near shoulder. No hæmorrhage.	....	Death from shock, ...	Ditto, Wounded while serving a gun. lived 24 hours.
65	23	Bullet-wound of thigh. No fracture, ...	Bullet escaped, ...	Recovery, ...	Ditto.
66	30	Bullet-wound of left cheek; also, a flesh-wound of chest, ...	Ditto, ...	Ditto, ...	Ditto.
67	25	Bullet-wound through cheek, breaking jaw, ...	Bullet escaped, ...	Ditto, ...	Wounded in garrison.
68	40	Bullet-wound of wrist, breaking it; the same ball then passing into thigh and producing a flesh-wound near the scrotum, ...	Ditto, ...	Ditto, ...	Ditto, This man's hand was resting on his scrotum, when he was struck by the ball.
69	25	Bullet-wound of fore-arm, with fracture of both bones, ...	Ditto, ...	Ditto, ...	Ditto.
70	20	Bullet-wound of upper third of fore-arm, with fracture, ...	Bullet not extracted, but probably escaped, ...	Ditto, ...	Ditto.
71	30	Bullet-wound of upper third of humerus, with comminuted fracture, ...	Bullet escaped, ...	Ditto, ...	Ditto,
72	50	Bullet-wound of fore-arm, without fracture, ...	Ditto, ...	Ditto, ...	Ditto,

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
73	30	Bullet-wound of temple, with fracture and driving in of inner table, ...	Bullet extracted, ...	Death from irritation, ...	Wounded in garrison, lived 10 days.
74	25	Bullet-wound, the ball passing in at right clavicle, down through the trunk, and out near the left hip, ...	Bullet escaped, ...	Death from shock, ...	Ditto, lived 12 hours, Probably shot from abovedownwards.
75	18	Bullet passed into abdomen, above pubes; and was extracted close to the clavicle, where it lay under the skin, ...	Bullet extracted, ...	Death from irritation, ...	Ditto, lived 10 days.
76	23	Bullet-wound through both thighs, bones untouched, ...	Ditto, ...	Recovery, ...	Ditto.
77	45	Bullet-wound of thigh, bone escaping, ...	Bullet escaped, ...	Ditto, ...	Ditto.
78	30	Bullet-wound of right testicle, ...	Ditto, ...	Ditto, ...	Ditto.
79	40	Bullet-wound of right thigh, bone escaping, ...	Ditto, ...	Ditto, ...	Ditto.
80	28	Bullet-wound of leg, producing compound comminuted fracture of tibia,—fibula escaping, ...	Mortification, and secondary amputation of thigh, ...	Death from shock of operation, ...	Ditto, (6) The amputation was secondary, and he sunk from exhaustion 12 hours after the operation.
81	25	Bullet-wound of leg above ankle, ball passing upwards into calf. No fracture, ...	Bullet not extracted, ...	Recovery, ...	Ditto, Wounded while lying down.
82	16	Bullet-wound of abdomen, from the front; the ball wounding the bowels, and being extracted near spine, ...	Bullet extracted, ...	Death from shock, ...	Ditto, lived 3 hours.

83	20	Bullet-wound of left thigh, producing compound comminuted fracture, close below neck of bone, but not opening joint, ...	Bullet passed out, ...	Death from irritation, ...	Ditto, lived a week. A woman.
84	27	Bullet-wound of arm, bone untouched, ...	Ditto, ...	Recovery, ...	Ditto.
85	25	Bullet-graze of head, ...	....	Ditto, ...	Ditto.
86	22	Bullet-wound of forehead, with fracture of skull and escape of brain, ...	Bullet lodged, ...	Death, ...	Ditto, death in 6 hours.
87	27	Bullet-wound of arm,—a flesh wound, ...	Bullet escaped, ...	Recovery, ...	Ditto.
88	20	Bullet-graze of arm, ...	Ditto, ...	Ditto, ...	Ditto.
89	20	Bullet-wound of left fore-arm, producing compound fracture of radius. Same ball passed into left side of abdomen and lodged in stomach region. No blood vomited, ...	Bullet lodged. Subsequent mortification, & secondary amputation below shoulder, ...	Death from exhaustion,...	Ditto, (7) When mortification set in, amputation was not permitted. Two days after, the patient agreed to amputation, and it was performed as a last resource. Death took place on the following day.
90	19	Bullet-wound of abdomen, ...	Bullet escaped, ...	Death from shock, ...	Ditto, lived 4 hours.
91	60	Wound of abdomen from a portion of brick entering it, ...	Portion of brick extracted,	Recovery, ...	Ditto, Wounded while behind a wall.
92	55	Bullet-wound of skin over knee,....	Bullet escaped, ...	Ditto, ...	Ditto.
93	25	Bullet-graze of knee, ...	....	Ditto, ...	Ditto.
94	20	Bullet-graze of forehead, ...	....	Ditto, ...	Ditto.
95	22	Bullet-wound of arm, with compound fracture just below shoulder. Also two bullet-wounds of fore-arm, without fracture, ...	Primary amputation at shoulder joint, ...	Death from irritation and exhaustion, ...	Ditto. (8) lived a month.
96	25	Bullet-graze of arm, ...	....	Recovery, ...	Ditto.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
97	23	Bullet-wound of head; ball entering forehead, passing through brain, and out at occiput, ...	Bullet escaped, ...	Death, ...	Wounded, in garrison, death in 2 hours.
98	20	Smash of foot from a shell, ...	Primary amputation of leg, ...	Death from tetanus, ...	Ditto, (9) lived 10 days.
99	15	Bullet-wound of foot and great laceration of soft parts. No fracture, ...	Bullet escaped, ...	Recovery, ...	Ditto.
100	25	Bullet-wound of knee, ball not penetrating, ...	Ditto, ...	Ditto, ...	Ditto.
101	24	Bullet graze of cheek, ...	....	Ditto, ...	Ditto.
102	17	Bullet-wound of head, ball entering behind right ear, and passing out at malar bone of right side, ...	Bullet extracted, ...	Ditto, ...	Ditto.
103	15	Bullet-wound of foot, shattering the astragalus, ...	Bullet lodged, ...	Death from irritation and exhaustion, ...	Ditto, ... Brought to Hospital on 8th day after infliction of wound, but would not consent to amputation, lived 10 days.
104	30	Compound comminuted fracture of thigh, from a round shot striking it, ...	Primary amputation of thigh, ...	Death from shock, ...	Ditto, (10) death in 12 hours.
105	30	Bullet-wound of foot, a flesh-wound, ...	Bullet escaped, ...	Recovery, ...	Ditto.
106	20	Bullet-wound of shoulder, a flesh-wound, ...	Bullet extracted, ...	Ditto, ...	Ditto.
107	50	Bullet-wound of back between shoulders, ...	Bullet escaped, ...	Ditto, ...	Ditto.
108	24	Bullet-wound of head, and fracture of temporal bone, ...	Ditto, ...	Death from irritation, ...	Ditto, lived 20 days.
109	20	Bullet graze of penis and thigh, ..	Ditto, ...	Recovery, ...	Ditto.
110	30	Bullet-wound of arm, and compound fracture, ...	Ditto, ...	Death from irritation, ...	Ditto, lived 6 weeks.
111	25	Bullet-wound of leg, and fracture of upper end of tibia, ...	Ditto, ...	Ditto, ...	Ditto, lived a month.
112	26	Bullet-wound of leg, and compound fracture of tibia, ...	Ditto, ...	Ditto, ...	Ditto, lived 6 weeks. A woman.
113	20	Bullet-wound of leg. No fracture,	Bullet escaped, ...	Recovery, ...	Ditto.
114	25	Bullet-wound of temple, ball entering, ...	Bullet lodged, ...	Death, ...	Ditto, lived 12 hours.
115	20	Brick (splintered) wound of wrist, and fracture of bones, ...	....	Death from mortification,	Ditto, lived 2 days.
116	50	Bullet-wound of neck, ball entering at top of sternum, passing across shoulder and into right arm, ...	Bullet extracted, ...	Recovery, ...	Ditto, a woman.
117	35	Bullet-wound, causing fracture of fore-finger, ...	Bullet escaped, ...	Ditto, ...	Ditto.
118	25	Bullet-wound of abdomen, through liver, great hæmorrhage, ...	Bullet lodged, ...	Death from shock and hæmorrhage, ...	Ditto, lived 3 hours.
119	23	Shell-wound of gluteal-region, laying bare the muscles deeply,	....	Death from shock and mortification, ...	Ditto, lived 2 days.
120	24	Shell-wound of arm, and compound fracture, ...	....	Recovery, ...	Ditto.
121	20	Two flesh wounds of each arm and leg, and wounds of face; also a flesh wound of abdomen, all from a shell, ...	....	Death from shock, ...	Ditto, lived 24 hours.
122	25	Shell-wound of hand, carrying away the three middle fingers ..	Amputation of 3 fingers,	Recovery, ...	Ditto.
123	30	Shell wound of wrist, a flesh wound,	....	Ditto, ...	Ditto.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
124	23	Bullet-wound of thigh. Bone unbroken, ...	Bullet lodged, ...	Recovery.	Wounded in garrison.
125	54	Bullet-wound of arm just below shoulder; ball entering in front, breaking the bone, wounding a small artery, passing through scapula, and so out, ...	Bullet escaped, ...	Death from irritation and exhaustion, ...	Ditto, lived a week.
126	25	Bullet-wound of pelvis and abdomen; ball passing in at buttock through abdomen, wounding bladder, and so out at anterior surface of belly, ...	Ditto, ...	Death from shock and exhaustion, ...	Ditto, lived 3 days.
127	20	Bullet-graze of back, ...	Ditto, ...	Recovery, ...	Ditto
128	20	Arm torn off at shoulder by round-shot, scapula implicated,	....	Death from shock, ...	Ditto, lived 2 days.
129	19	Bullet-wound of leg, producing compound fracture, ...	Primary amputation of leg, ...	Death from irritation, ...	Wounded outside garrison, (11).– { Amputation performed in field, lived 10 days.
130	25	Round-shot wound of knee, smashing it, ...	....	Death from shock, ...	Ditto, lived 3 hours.
131	30	Bullet-wound of thigh. No fracture,	Bullet escaped, ...	Recovery, ...	Ditto.
132	27	Bullet-wound of arm, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
133	31	Bullet-wound of shoulder, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
134	35	Bullet-wound of thigh, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
135	30	Bullet-wound of fore finger and thumb, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
136	58	Bullet-wound of thigh, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
137	30	Bullet-wound of side, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
138	25	Bullet-wound of thigh, ditto, ...	Ditto, ...	Ditto, ...	Ditto.

139	25	Bullet-wound of arm, and compound fracture, ...	Ditto, ...	Ditto, ...	Ditto.
140	24	Bullet-wound of thigh, no fracture,	Ditto, ...	Ditto, ...	Ditto.
141	45	Cuts of face, neck, and flesh-wound of face from a bullet, ...	Ditto, ...	Ditto, ...	Ditto.
142	34	Bullet-wound of thigh, no fracture,	Ditto, ...	Ditto, ...	Ditto.
143	20	Bullet-wound of arm and side, no fracture, ...	Bullet escaped, ...	Ditto, ...	Ditto,
144	23	Round-shot-wound of leg, smashing it, ...	Primary amputation of thigh, ...	Death from shock, ...	Ditto, (12) lived 2 days.
145	30	Ditto, ditto, ...	Primary amputation of leg, ...	Death from shock, ...	Ditto, (13) lived 2 days.
146	25	Round-shot-wound of foot, smashing its anterior portion, ...	Chopart's operation,—primary, ...	Nearly healed after 2 months, ...	Ditto, (14) { Secondary hæmorrhage 3rd day after operation, from carelessness in removing ligature. Wound subsequently attacked by worms. Afterwards, an abscess opened over inner ankle.
147	40	Bullet-wound of foot. Bones untouched, ...	Bullet escaped, ...	Ditto, ...	Ditto.
148	26	Grape-shot-wound of leg, ditto, ...	....	Ditto, ...	Ditto.
149	35	Bullet-wound through back, ball lodging in chest, ...	Bullet lodged, ...	Death from irritation, ...	Ditto, lived 10 days.
150	30	Bullet-wounds of arm and abdomen, flesh-wounds, ...	Bullet escaped, ...	Recovery, ...	Ditto.
151	30	Bullet-wound of chest, breaking 2 ribs, ...	Ditto, ...	Death from irritation and exhaustion, ...	Ditto, lived 15 days.
152	27	Bullet-wound of leg, and compound fracture, ...	Ditto, ...	Recovery, ...	Ditto.
153	25	Bullet-wound of thigh, no fracture,	Ditto, ...	Ditto, ...	Ditto.
154	30	Bullet-wound of leg just below knee, slightly fracturing tibia,	Bullet extracted, ...	Death from irritation and exhaustion, ...	Ditto, lived 10 days.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
155	20	Bullet-wound of thigh, bone untouched, ...	Bullet escaped, ...	Recovery, ...	Wounded outside garrison.
156	22	Bullet-wound of leg, and compound fracture, ...	Ditto, ...	Death from tetanus, ...	Ditto, lived 12 days.
157	23	Bullet-wound of knee, external to joint, ...	Bullet lodged, ...	Recovery, ...	Ditto.
158	24	Bullet-wounds of chin and arm, —flesh-wounds, ...	Bullet escaped, ...	Ditto, ...	Ditto.
159	30	Bullet-wound of chin, breaking a portion of lower jaw, ...	Ditto, ...	Death from irritation, ...	Ditto, lived 5 weeks.
160	25	Bullet-wound of thigh, no fracture, ...	Ditto, ...	Recovery, ...	Ditto.
161	20	Bullet-wound of ditto, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
162	20	Bullet-wound of shoulder, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
163	20	Contused wound of leg, from bricks falling on it, ...	....	Ditto, ...	Ditto.
164	21	Bullet-wound of leg, and compound fracture, ...	Bullet escaped, ...	Ditto, ...	Ditto.
165	40	Bullet-wound of both legs, ball lodging in right, no fracture, ...	Bullet lodged, ...	Ditto, ...	Ditto.
166	45	Bullet-wound of thigh, no fracture, ...	Bullet escaped, ...	Ditto, ...	Ditto.
167	20	Bullet-wound of ditto, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
168	45	Bullet-wounds of knee and breast, —flesh-wounds, ...	Ditto, ...	Ditto, ...	Ditto.
169	20	Bullet-wound of calf, no fracture, ...	Ditto, ...	Ditto, ...	Ditto.
170	20	Bullet-wound of thigh, ditto, ...	Bullet lodged, ...	Ditto, ...	Ditto.
171	25	Bullet-wound of neck in 2 places, —flesh-wounds.	Bullet escaped, ...	Ditto, ...	Ditto.

172	30	Bullet-wound of side,—a flesh wound, ...	Bullet extracted, ...	Ditto, ...	Ditto,
173	20	Bullet-wound of elbow,—ditto, ...	Bullet escaped, ...	Ditto, ...	Ditto.
174	20	Bullet-wound of arm and thigh,—a flesh wound, ...	Bullet extracted, ...	Ditto, ...	Ditto.
175	25	Bullet wound of leg, ditto, ...	Ditto, ...	Death from mortification,	Ditto, lived 5 days.
176	30	Bayonet-wound of abdomen, just avoiding stomach, ...	....	Recovery, ...	Ditto.
177	20	Shell-wound of cheek, and fracture of malar bone and loss of eye, ...	....	Death from shock, ...	Wounded in garrison, lived 2 days.
178	20	Round-shot wound of head, smashing it, ...	....	Death instantaneous, ...	Ditto, in Hospital, as a waiting man.
179	22	Ditto ditto, ...	....	Death from shock, ...	Ditto, lived 2 hours.
180	15	Bullet-wound of thigh, no fracture, ...	Bullet escaped, ...	Recovery, ...	Ditto.
181	20	Bullet-wound of thigh and leg; fracture of leg, ...	Ditto, ...	Death from mortification,	Ditto, lived 8 days.
182	20	Bullet-wound of hand, and fracture of all the bones, ...	Primary amputation of fore-arm, ...	Nearly healed after a month, ...	Wounded outside garrison, (15.)
183	20	Bullet-wound of thigh, bone escaping, ...	Bullet lodged, ...	Recovery, ...	Ditto.
184	30	Bullet-wound of finger, ditto, ...	Bullet escaped, ...	Ditto, ...	Wounded in garrison.
185	20	Bullet-wound of neck, ditto, ...	Bullet extracted, ...	Ditto, ...	Ditto.
186	35	Bullet-wound of chest, passing backwards through lung and scapula, ...	Ditto, ...	Death from irritation, ...	Ditto, lived 6 days.
187	30	Bullet-wound of knee joint, ...	Ball escaped, ...	Death from irritation and exhaustion, ...	Wounded outside garrison, ... Admitted 8th day after the reception of injury. Would not submit to amputation.
188	25	Bullet-wound of toes, without fracture, ...	Ditto, ...	Recovery, ...	Ditto.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
189	30	Bullet-wound of head, no fracture, ...	Bullet extracted, ...	Recovery, ...	Wounded in garrison.
190	25	Bullet-wound of head, with fracture, ...	Ditto, ...	Death, ...	Wounded outside garrison, lived 2 days.
191	33	Bullet-wound of arm, without fracture, ...	Bullet escaped, ...	Recovery, ...	Ditto.
192	25	Bullet-wound of thigh, ditto, ...	Bullet extracted, ...	Ditto, ...	Wounded in garrison.
193	30	Bullet-wound of shoulder, passing near joint, ...	Ditto.	Death for irritation and exhaustion, ...	Ditto, lived 8 days.
194	20	Bullet-wound of arm, without fracture, ...	Bullet escaped, ...	Recovery, ...	Ditto.
195	20	Bullet-wound of leg, ditto, ...	Ditto, ...	Death from tetanus, ...	Ditto, lived 10 days.
196	25	Bullet-wound of hand, ditto, ...	Ditto, ...	Recovery, ...	Ditto.
197	30	Bullet-wound of hand, and fracture of fingers, ...	Amputation of 3 fingers,	Death from mortification,	Wounded outside garrison, ... { Amputation performed outside; lived a week.
198	20	Bullet-wound of head, ball entering forehead and passing out at occiput, ...	Bullet escaped, ...	Death, ...	Wounded in garrison, lived 2 hours.
199	10	Bullet-wound of chest, through lungs, ...	Bullet lodged, ...	Death from irritation and exhaustion, ...	Ditto, lived 5 days.
200	25	Bullet-wound of arm, and compound fracture, ...	Bullet escaped, ...	Doing well, ...	Ditto.
201	28	Bullet-wound of face and hand, flesh wounds, ...	Ditto, ...	Recovery, ...	Ditto.
202	25	Bullet-wound of abdomen implicating the stomach and kidneys,	Bullet extracted from back, ...	Death from shock, ...	Ditto, lived 15 hours.
203	21	Bullet-wound of abdomen, near navel, ...	Bullet lodged, ...	Ditto, ...	Ditto, lived 12 hours.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
204	26	Bullet wound of arm, and compound fracture, ...	Bullet escaped, ...	Death from mortification,	Ditto, lived 14 days.
205	20	Bullet-wound of thigh, without fracture, ...	Bullet escaped, ...	Recovery, ...	Ditto.
206	30	Bullet-wound of malar-bone,—a severe wound, ...	Bullet lodged, ...	Doing well, ...	Ditto.
207	50	Bullet-wound through scapula, ball lodging in chest, ...	Ditto, ...	Death from irritation and exhaustion, ...	Ditto, lived 3 weeks.
208	25	Bullet-wound of leg, no fracture, ...	Bullet escaped.	Recovery, ...	Ditto.
209	30	Bullet-wound of little finger, ...	Amputation of little finger,	Ditto, ...	Ditto.
210	25	Bullet-wound of calf, a flesh-wound,	Bullet escaped, ...	Ditto, ...	Ditto.
211	20	Bullet-wound of arm, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
212	35	Bullet-wound of sole of foot, ditto,	Ditto, ...	Ditto, ...	Ditto.
213	25	Bullet-wound of leg and back, ditto,	Ditto, ...	Ditto, ...	Ditto.
214	35	Bullet-wound of hand, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
215	50	Round shot-wound of thigh, carrying it away, ...	Primary amputation of thigh, ...	Death from shock of operation, ...	Ditto, (16),... { Lived 24 hours after operation.
216	26	Bullet-wound of side and fracture of ribs, ...	Bullet extracted, ...	Doing well, ...	Ditto.
217	20	Bullet-wound of head, and bad fracture of skull, ...	Bullet escaped, ...	Death from shock, ...	Ditto, lived 24 hours.
218	30	Wound of neck from a splinter of wood, laying open the deeper parts, ...	....	Death from pydmia, ...	Ditto, ... { At first, much hæmorrhage, subsequently irritation and pydmia.
219	20	Bullet-wound of arm and compound fracture; ball subsequently lodging in chest, ...	Bullet lodged, ...	Death from irritation, ...	Ditto, lived 15 days.
220	25	Bullet-wound of arms, no fracture, ...	Bullet escaped, ...	Recovery, ...	Ditto.
221	20	Bullet-wound of hand, ball passing through it, ...	Ditto, ...	Ditto, ...	Ditto.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
222	30	Bullet-wound of elbow,—a flesh wound, ...	Bullet escaped, ...	Recovery, ...	Wounded in garrison.
223	25	Bullet-wound of head, and fracture of skull, ...	Ditto, ...	Death, ...	Ditto, Death occurred 10 days after receipt of injury. He came to Hospital in a dying state.
224	20	Horse-bite of foot, no fracture, ...	....	Recovery, ...	Ditto.
225	24	Bullet-wound of shoulder, ditto, ...	Bullet escaped, ...	Ditto, ...	Ditto.
226	20	Bullet-wound of thigh, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
227	26	Bullet-wound of lower jaw, and compound fracture, ...	Ditto, ...	Doing well, ...	Ditto.
228	20	Bullet-wound of left leg, no fracture, ...	Ditto, ...	Recovery, ...	Ditto.
229	30	Round-shot wound of right foot, smashing it, ...	Primary amputation of leg, ...	Death from mortification,	Ditto, (17) lived 10 days.
230	27	Shell-wound of foot,—a flesh wound, ...	....	Recovery, ...	Ditto.
231	25	Shell-wound of buttock, laying it open and tearing skin off penis &c.; a very severe injury, ...	....	Death from shock, ...	Ditto, lived 12 hours.
232	50	Bullet-wound of thigh, and compound fracture, ...	....	Death from irritation, ...	Ditto, lived 8 days.
233	24	Bullet-wound of finger, no fracture, ...	Bullet escaped, ...	Recovery, ...	Ditto.
234	30	Bullet-wound of abdomen, tearing out a portion of bowel, ...	Ditto, ...	Death from shock, ...	Ditto.
235	30	Bullet-wound of shoulder, through fleshy part of axilla, ...	Ditto, ...	Recovery, ...	Ditto.
236	27	Bullet-wound of knee, and slight compound fracture of tibia, ...	Ditto, ...	Ditto, ...	Ditto.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
237	30	Bullet-wound of hand, no fracture, ...	Ditto, ...	Ditto, ...	Ditto.
238	27	Bullet-wound of foot, ...	Ditto, ...	Ditto, ...	Ditto.
239	27	Bullet-wound of arm, ditto, ...	Ditto, ...	Ditto, ...	Ditto.
240	30	Bullet-wound of side, ball lodging in loin, ...	Bullet lodged, ...	Death from shock, ...	Ditto, lived 6 hours.
241	30	Bullet-wound of shoulder, a flesh wound, ...	Bullet extracted, ...	Recovery, ...	Ditto.
242	26	Bullet-wound of wrist,—a flesh-wound, ...	Bullet escaped, ...	Ditto, ...	Ditto.
243	28	Bullet-wound of hand,—ditto, ...	Ditto, ...	Ditto, ...	Ditto.
244	27	Bullet-wound of side,—ditto, ...	Ditto, ...	Ditto, ...	Ditto.
245	20	Bullet-wound of arm,—ditto, ...	Ditto, ...	Ditto, ...	Ditto.
246	25	Bullet-wound of side, ball lodging in abdomen, ...	Bullet lodged, ...	Death from irritation and exhaustion, ...	Ditto, lived 10 days.
247	30	Bullet-wound of arm, fracturing condyle of ulna, ...	Bullet escaped, ...	Recovery, ...	Ditto.
248	45	Bullet-wound of head, ball entering at ear and passing out at neck, ...	Bullet extracted, ...	Ditto, ...	Ditto.
249	34	Bullet-wound of foot and hand. No fracture, ...	Bullet escaped, ...	Ditto, ...	Ditto.
250	20	Round-shot-wound of buttock, tearing it open. Also fracture of leg, ...	....	Death from shock, ...	Ditto, lived 3 hours.
251	20	Round-shot-wound of knee, smashing it, ...	Primary amputation of thigh, ...	Ditto, ...	Ditto, (18) lived an hour.
252	22	Round-shot-wound of elbow, ditto, ...	Primary amputation of arm, ...	Doing well, ...	Ditto, (19) Sloughing ulceration at first attacked the stump, but it afterwards did well.
253	21	Round-shot-wound of arm, ditto,	Primary amputation at shoulder-joint, ...	Ditto, ...	Ditto, (20.)

Nos.	Age.	How Wounded.	Treatment.	Results, including cause of death.	Remarks.
254	15	Bullet-wound of arm, and compound fracture. Also, wound of side, but no fracture, ...	Amputation of arm after 6 days, ...	Doing well, ...	Wounded in garrison, (21.)
255	35	Round-shot-wound of leg, smashing it, ...	Primary amputation of leg, ...	Mortification and death,	Ditto, (22) lived 6 days.
256	32	Round-shot-wound of leg, smashing knee, ...	Primary amputation of thigh, ...	Death from exhaustion consequent on operation, ...	Ditto, (23) lived 4 days.
257	32	Round-shot-wound of arm, smashing it, ...	Amputation of arm after 8 days, ...	Doing well, ...	Ditto, (24.)
258	20	Bullet-wound of thigh, fracturing femur and femoral artery, ...	Primary amputation of thigh, ...	Death from shock, ...	Ditto, (25) lived 12 hours.
259	50	Round-shot-wound of leg, smashing it, ...	Primary amputation of leg, ...	Doing well, ...	Ditto, (26.)
260	30	Round-shot-wound of leg, smashing it, ...	Primary amputation of thigh, ...	Ditto, ...	Ditto, (27.)

(II).—List of wounded Europeans, (principally Officers and Civilians), and Eurasians, who came under my observation during the Siege of Lucknow, between the 30th June and 25th September 1857.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
1	28	Bullet-wound of left jaw, smashing it and producing great hæmorrhage and shock, ...	Bullet extracted, ...	Death from shock, ...	Wounded in garrison, Standing behind loop-hole. Lived 10 minutes.
2	30	Bullet-wound of back, ball breaking edge of right scapula, then passing over shoulder and out in front of it, ...	Bullet passed out, ...	Death from irritation and exhaustion, ...	Ditto, Lived 5 days.
3	50	Bullet-wound of face, the ball entering at angle of left jaw, passing upwards through palate bone and making its exit at right orbit, carrying away the eye ball with it, much hæmorrhage, ...	Ditto, ...	Ditto, ...	Ditto, Standing behind parapet. Lived 3 weeks.
4	33	Bullet-wound of temple, ...	Bullet lodged, ...	Immediate death, ...	Ditto. Working behind parapet.
5	25	Bullet-wound of scalp, this wound was healing when another bullet, a week after, tore open the old wound, ...	Bullet passed out, ...	Recovery, ...	Ditto, Behind parapet. Subsequently shot again through the head, and killed.
6	24	Bullet-wound of left chest, ball passing over surface of ribs,—not through cavity of chest, and so out at back, ...	Ditto, ...	Ditto, ...	Ditto.
7	7	Round-shot wound of face and head, smashing them.	....	Immediate death, ...	Ditto, Struck while at play.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
8	32	Bullet-wound of thigh, ball passing in at lower part of middle third and lodging somewhere behind knee, ...	Bullet lodged, ...	Doing well, ...	Wounded at Chinhut.
9	28	Bayonet-wound of groin, ...	....	Recovery, ...	Ditto.
10	23	Bullet-graze of right side, ...	....	Ditto, ...	Ditto, ... Subsequently again wounded.
11	35	Brick (splintered) wound of left orbit, ...	....	Ditto, ...	Wounded in garrison,.................. Behind parapet.
12	28	Brick (splintered) wounds of face and of knee, flesh wounds, ...	....	Ditto, ...	Ditto.
13	27	Brick (splintered) wounds of chest and abdomen, all flesh wounds,	....	Ditto, ...	Ditto, Subsequently died of cholera.
14	38	Severe contusion of fore-finger of right hand, from a bullet striking it while in the act of firing a rifle, ...	....	Recovery, ...	Ditto, ... The rifle was broken to pieces, subsequently died of dysentery, &c.
15	27	Bullet-wound of shoulder, ball passing over scapula, and producing no fracture, ...	Bullet passed out, ...	Ditto, ...	Ditto,
16	25	Bullet-wound of shoulder, ball passing close to joint, and probably touching head of humerus,	Bullet lodged, ...	Doing well, ...	Ditto,
17	25	Bullet-wound of thigh, no fracture, ...	Bullet passed out, ...	Recovery, ...	Ditto, subsequently died of cholera.
18	30	Burns of arms, chest and face,... ...	....	Ditto, ...	Ditto, While loading a mortar, subsequently killed by round-shot.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
19	35	Bullet-wound of foot, and bad fracture of bones, ...	Primary amputation of foot, ...	Death from shock, ...	Ditto, (1) Lived 3 days.
20	25	Bullet-wound in centre of forehead,	Bullet lodged, ...	Death, ...	Ditto, Looking over parapet—lived 20 minutes.
21	37	Bullet-wound of thigh, no fracture, ...	Bullet passed out, ...	Recovery, ...	Ditto.
22	45	Bullet-wound of lumbar region, a flesh wound, ...	Ditto, ...	Ditto, ...	Ditto.
23	47	Bullet-wound of arm, near shoulder, no fracture, ...	Ditto, ...	Ditto, ...	Ditto, Subsequently died of cholera.
24	23	Bullet-wound of head, and slight fracture of skull, ...	Ditto, ...	Ditto, ...	Ditto, A portion of parietal-bone discharged.
25	28	Bullet-wound of hand, a severe wound, ...	Ditto, ...	Ditto, ...	Ditto.
26	28	Bullet-wound of thigh, no fracture, ...	Bullet lodged, ...	Ditto, ...	Ditto, Subsequently killed by round-shot.
27	21	Bullet-wound of mouth, breaking jaw. Ball swallowed, and after three weeks, passed per anum, ...	Bullet passed per anum,...	Ditto, ...	Wounded at Chinhut
28	29	Bullet-wound of arm, and compound fracture, ...	Secondary amputation of arm, ...	Death from irritation and exhaustion, ...	Wounded in garrison, (2) ...... Lived a fortnight.
29	27	Hand blown off while throwing a hand-grenade, ...	Primary amputation of fore-arm, ...	Death from irritation and exhaustion, ...	Ditto, lived 9 days.
30	21	Fracture of arm, and injury to chest, from a round-shot striking it, ...	Primary amputation of arm, ...	Death from mortification,	Ditto, lived 48 hours.
31	22	Bullet-wound of chest, ball entering below clavicle passing over ribs, and out near pit of stomach,	Bullet passed out, ...	Death from irritation and exhaustion, ...	Ditto, Wounded while stooping, lived 15 days.
32	35	Bullet-wound of lumbar region. No fracture, also bullet-wound of fore-arm. No fracture, ...	Both bullets passed out,	Death from irritation and diarrhœa, ...	Wounded at Chinhut, lived 2½ months.

Nos.	Age.	How Wounded.	Treatment.	Result, including cause of death.	Remarks.
33	30	Bullet-wound through spine, ball entering stomach, ...	Bullet lodged, ...	Death from shock, ...	Wounded in garrison, lived 12 hours.
34	32	Flesh-wound of arm, from splinter of shell, ...	....	Recovery, ...	Ditto.
35	24	Dislocation of wrist, from brick striking it, ...	....	Ditto, ...	Ditto, from explosion of mine.
36	26	Compound comminuted fracture of humerus, with rupture of an artery. Much hæmorrhage a bullet-wound, ...	Bullet in part lodged, in part escaped, having split on the bone, ...	Doing well, ...	Ditto.
37	27	Contusion of side, and wound of calf, from fragments of a shell,..	....	Recovery, ...	Ditto.
38	23	Bullet-wound of neck, and slight splintering of upper end of sternum, ...	Bullet extracted, ...	Ditto, ...	Ditto.
39	28	Bullet-wound of head, ...	Bullet lodged, ...	Death, ...	Ditto, lived 12 hours.
40	38	Bullet-wound of face, in which malar-bone was broken and forced back, and the articulations of upper and lower jaw, on one side, broken, ...	Bullet escaped by neck, just behind temporal bone, ...	Death from pyæmia, ...	Ditto, Lived 5 weeks, bone was discharged freely from the wound.

In considering the large proportion of the above cases which proved fatal, the unfavorable circumstances under which the patients labored, must be remembered. Of the first list, Nos. 83, 112 and 116 were women.

By far the greater number of the Natives wounded were poorly nourished camp-followers; and it is well known that the vast majority of the Europeans and Eurasians had suffered more or less in health from exposure, &c., and could but feebly resist the effects of a severe wound.

The following is a Summary of the injuries contained in the lists.

LIST I.

Nature of injuries.	Recoveries.	Deaths.	Total.
Bullet wounds, ...	153	63	216
Round shot wounds, ...	9	15	24
Shell wounds, ...	6	5	11
Grape shot wounds, ...	1	0	1
Splinter wounds (of brick or wood,)	2	2	4
Bayonet wounds, ...	1	0	1
Tulwar wounds, ...	2	0	2
Horse bite, ...	1	0	1
Total, ...	175	85	260

LIST II.

Nature of injuries.	Recoveries.	Deaths.	Total.
Bullet wounds, ...	17	12	29
Round shot wounds, ...	0	2	2
Shell wounds, ...	2	0	2
Splinter wounds, (of brick or wood,)	4	0	4
Bayonet wounds,...	1	0	1
Wound from bursting of hand grenade, ...	0	1	1
Burns, ...	1	0	1
Total, ...	25	15	40

Out of a total, therefore, of 300 cases, 100, or exactly one-third were fatal.

The large proportion of 245 out of the whole number, were bullet-wounds, of which 75 proved fatal. Next in number came those from round-shot,—26, of which 17 were fatal; then shell-wounds,—13, of which 5 were fatal; while splinter-wounds,—(2 deaths), and others, complete the list. As there was necessarily but little hand-to-hand fighting, there were but few bayonet and tulwar-wounds. The premature bursting of a hand-grenade, and the accidental ignition of some powder in a mortar, occasioned severe injuries to two Officers,—the former proving fatal.

The small number of shell-wounds appears, at first sight, curious; for it might be supposed that shells, bursting in such a confined space as the Lucknow entrenchment, would be certain to do great damage. But such was not the case, partly because the enemy had probably but a small supply of large shells, even though they were in the habit of returning any "dummies," (unexploded shells), we might send them; and partly because they had not sufficiently mustered the art of cutting their fuses. Sharpnell they used frequently to send in; but the cover was pretty good, and people were so much on the look out for it morning and evening,—when the enemy were most active,—that they generally managed to avoid it successfully.

The round-shot wounds were more numerous than those from shells, and they were too of a very serious nature. As might be expected, a round-shot makes so complete a smash of whatever it strikes, produces so great a contusion of neighbouring parts, and occasions such a shock to the system at large, that its effects cannot be other than most serious.

Of course, in such a large number of bullet-wounds as is here recorded, every variety of case was met with,—from mere graze, up to a wound of some vital part, or bad fracture of limb. It is hardly necessary to remark that the gravity of a bullet-wound depends almost entirely on the part struck,—the bullet flesh-wound only differing from a common flesh-wound inasmuch as that its track sloughs. In a healthy subject, this is a very simple process, and does not occupy any great length of time. When a bullet, on the other hand, strikes a vital part, of course the prognosis is most unfavorable; but I know of a remarkable case,—not entered in my lists, in which a bullet lodged in the brain of

the patient, and he feels but the least possible inconvenience from it. The ball, in this instance, entered at the occiput.

The first point in the *treatment* of bullet-wounds is, of course, the possibility or not of extracting the ball, should it have lodged. This is frequently a difficult matter, and should be performed carefully. There is no operation, in certain instances, requiring more tact and judgment and knowledge of the parts, than this. I have seen that M. Baudens, late Chief Surgeon of the French Army in the Crimea, (Vide "*Lancet* of Sept. 12th 1857), says, the enlargement of the external wound was *entirely* abandoned by the French Surgeons in the late war, in the extraction of bullets. I confess to having found it useful and even necessary sometimes, though oftener perhaps the division of a ridge of fascia, or as M. Baudens says, of an "envelope of cellular tissue" removed all difficulty.

I now proceed to consider, briefly and by themselves, the injuries of limbs, as involving their treatment, and the question of amputation. Generally speaking, in Lucknow, compound fractures from bullet-wounds and round-shot could not be saved; though there were exceptions in the case of bullet-wounds. But the facilities for nursing and giving the proper care to compound fractures were not present; and, consequently, amputations were sometimes performed, when, under other circumstances, limbs might have been preserved.

Resections were practised in certain cases, but were not very successful. I have no doubt, however, that, under more favorable circumstances, they would do well, as they probably occasion less shock than amputations.

Judging from the experience gained during this siege, I come to the following conclusions as to certain points of practice.

1st. I agree with M. Baudens, that fracture of the femur by a bullet does not necessarily involve amputation. But, if complicated with wound of the femoral or other large artery, or with extensive laceration of the soft parts, or with great splintering of the bone and consequent destruction of the periosteum,—then amputation is advisable.

2nd. Penetrating wounds of the knee,—even in Natives, and when at first they appear to be going on well, necessitate amputation, which had much best be performed primarily.

3rd. Wounds of the feet implicating the bones to any considerable extent, call for amputation ; but partial are better than entire amputations, even when the injury is produced by round-shot or shell, as giving less shock to the patient and preserving to him a more useful limb.

4th. Fracture of the humerus by a bullet, even if complicated by wound of a large artery, does not necessarily demand amputation ; but I suspect it is best, as a general rule, to amputate, in the field, or when there is not good Hospital accommodation, or when the periosteum is extensively destroyed.

Amputations too often were unsuccessful during the siege of Lucknow. Of those of which I have records, among Natives, out of 27 cases, 17 were fatal ; while among Europeans, the only two cases in my list,—one of which was primary, the other secondary, were unsuccessful. I have not obtained the statistics of amputations among the Europeans generally, but have understood that about one case in every 3½ terminated favorably. Thus the success among Natives was greater than that among Europeans.

Below is given a

Tabular Statement of the Cases of Amputation performed at the Native Hospital.

Number.	Nature of amputation.	Primary or Secondary.	Result.	Cause of death.
1	Amputation of thigh,	P	Recovery.	
2	Ditto leg, ...	P	Death, ...	Irritation and exhaustion.
3	Ditto thigh, ...	P	Ditto, ..	Tetanus.
4	Hay's operation on foot,	P	Recovery.	
5	Amputation at shoulder joint,...	P	Death, ...	Irritation and exhaustion.
6	Ditto of thigh, · ...	S	Ditto, ...	Shock of operation.
7	Ditto arm, ...	S	Ditto, ...	Ditto.
8	Ditto at shoulder joint,	P	Ditto, ...	Irritation and exhaustion.
9	Ditto of leg, ...	P	Ditto, ...	Tetanus.
10	Ditto thigh, ...	P	Ditto, ...	Shock of operation.
11	Ditto leg, ...	P	Ditto, ...	Irritation.
12	Ditto thigh, ...	P	Ditto, ...	Shock of operation.
13	Ditto leg, ...	P	Ditto, ...	Ditto.
14	Chopart's operation on foot, ...	P	Recovery.	
15	Amputation of fore-arm, ...	P	Ditto.	
16	Ditto thigh, ...	P	Death, ...	Shock of operation.
17	Ditto leg, ...	P	Ditto, ...	Mortification.
18	Ditto thigh, ...	P	Ditto, ..	Shock of operation.
19	Ditto arm, ...	P	Recovery.	
20	Ditto at shoulder joint,	P	Ditto.	
21	Ditto of arm, ...	S	Ditto.	
22	Ditto leg, ...	P	Death, ..	Mortification.
23	Ditto thigh, ...	P	Ditto, ..	Exhaustion after operation.
24	Ditto arm, ...	S	Recovery.	
25	Ditto thigh, ...	P	Death, ..	Shock of operation.
26	Ditto leg, ...	P	Recovery.	
27	Ditto thigh, ...	P	Ditto.	

It will be remarked that two of these amputations were partial,—Hay's and Chopart's of the foot.

These cases both recovered well.

Of the thigh there were 10 amputations ; of which 2 recovered.

Of the leg, seven ; of which one recovered.

Of the shoulder-joint, three ; of which one recovered.
Of the arm, four ; of which three recovered.
Of the forearm, one, which recovered.

All the amputations were primary except four,—three of the arm, and one of the thigh, two of the four recovered

There were also three cases of amputation of fingers, two of which did well ; while one was followed by mortification and death.

The causes of death among amputations, as in other cases, may be divided under four heads,—viz: shock, nine cases; irritation and exhaustion, four ; mortification, (moist gangrene), two ; and tetanus, two. In certain cases of bullet-wounds, sloughing ulceration, excessive suppuration and pyemia were the proximate causes of death ; and, in many instances, worms proved most troublesome.

For the removal of the latter, I found lotions of turpentine, creasote, camphor, or nitric acid, very effectual.

The shock of the operation, in many cases, was, no doubt increased in consequence of there being little or no chloroform ; while the degenerated atmosphere of the entrenchment, the want of many necessary comforts, and the generally depressing circumstances of the garrison, made the patients an easy prey to the other causes of mortality.

It is a curious fact, that the operations performed on the wounded of the Force which, under Generals Outram and Havelock, so gloriously relieved Lucknow on the 25th Sept. were even more unsuccessful than those performed among the old garrison. At Alum Bagh, a healthy and open spot 4 miles distant from Lucknow, a much larger proportion of recoveries took place.

CAMP, ALUM BAGH,
25th January, 1858.

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REPORT

ON THE

STATE OF THE BLOOD

AND THE

BLOOD-VESSELS IN INFLAMMATION.

REPORT

ON THE

STATE OF THE BLOOD

AND THE

BLOOD-VESSELS IN INFLAMMATION,

And on other points relating to the Circulation in the Extreme Vessels:

TOGETHER WITH

A REPORT

ON LYMPHATIC HEARTS AND ON THE PROPULSION OF LYMPH FROM THEM, THROUGH A PROPER DUCT, INTO THEIR RESPECTIVE VEINS.

BY

T. WHARTON JONES, F.R.S.

"IN YONDER WORLD, I DO BELIEVE,
THAT TRUTH THEY STILL MAINTAIN;
BUT WITH THE LIES THAT HERE PREVAIL,
OUR MARSHAL FIGHTS IN VAIN."
Bismarck.

"SHAM FAILS,
TRUTH PREVAILS."
Moltke.

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THE following pages are respectfully addressed to the General Council of Medical Education—Universities and their Colleges—Colleges of Physicians, Colleges of Surgeons, and all other Authorities, who may consider the faithful instruction of Students of Medicine in a real knowledge of the phenomena of the Circulation of the Blood to be of paramount importance.

THE AUTHOR.

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REPORT ON THE STATE OF THE BLOOD

AND THE

BLOOD-VESSELS IN INFLAMMATION.

INTRODUCTION.

I TAKE it to be the object of Mechanics to describe the phenomena of Nature—to describe them completely, and in the simplest manner. I mean that it will be our task to state what the phenomena are, but not to find out the causes. See 'Introduction to Lectures on Mechanics,' by the late Gustav Robert Kirchoff, Professor of Physics in the University of Berlin.

> "Thus Harvey sought the truth, in truth's own book, Creation,
> Which by the hand of God Himself was writ,
> And wisely thought 'twas fit,
> Not to read comments only, upon it,
> But on the original itself to look."—*Cowley.*

About fifty years ago I contributed to the 'British and Foreign Medical Review' certain 'Reports on Inflammation,' and in 1850, there appeared in the October number of 'Guy's Hospital Reports' my Astley-Cooper Prize Essay, "On the State of the Blood and the Blood-Vessels in Inflammation, as ascertained by experiments, injections, and observations by the microscope." This Essay was supplemented with a Paper (published in the 'Medico-Chirurgical Transactions' for 1852), describing the phenomena of inflammation as it occurs in the web of the bat's wing, my previous observations having been confined to the web of the frog's foot.

Prefacing the Paper "On Inflammation in the Web of the

Bat's Wing," I observed:—"It has not unfrequently been objected to the results obtained from microscopical observations on the web of the frog in the inflamed state, that we cannot safely argue from them as to the nature of the inflammatory process in man.

"This, however, like many other general objections, is well or ill-founded according to the sense in which the terms are employed. If, in the objector's mind, the word 'inflammation' conjures up the idea of a pleurisy or pneumonia, of a meningitis or encephalitis; nay, even of a conjunctivitis or iritis, with all the attendant symptoms (subjective as well as objective), functional disturbance and terminations, I admit that the objection is well founded. But if, on the contrary, all that we venture to deduce from our microscopical observations on the web of the frog in the inflamed state be merely something concerning the general nature of the inflammatory process, something of the state of the blood and the blood-vessels in the inflamed part, something, in short, in elucidation of the question as to the *proximate cause* of inflammation, so much agitated by the pathologists of the last century, then, I apprehend that the objection is ill-founded.

"Still, there can be no doubt that, even as regards the simple elucidation of the state of the blood and the blood-vessels in an inflamed part of the human body, microscopical observations made on a transparent part of a warm-blooded mammal would be more satisfactory than similar observations on the cold-blooded reptile, especially when we take into consideration the marked peculiarity of character which the red blood-corpuscles of the mammifera present.

"Accordingly, in pursuing my researches into the nature of the inflammatory process, I have not failed to direct attention to the microscopical study of the effect of wounds on the state of the blood and the blood-vessels in the web of the bat's wing; the bat being the only mammiferous animal which presents an external part of the body thin and transparent enough for microscopical examination."

Of late years I have contributed various papers on the physio-pathology of the circulation to the 'Lancet' and the

'American Journal of the Medical Sciences.' More recently still, in a series of communications to the 'Lancet,'* in the course of the last ten years, I have commented on the misrepresentation of facts, and on the blundering excogitations relating to the subject, too often found in the text-books put into the hands of students of medicine. The aim of the present Report is to insist further on this, and to show that in the study of a science of observation, such as physio-pathology, we must scrupulously direct attention to the phenomena of Nature in their sequence and correlations; while we as scrupulously refrain from excogitations. Too commonly, would-be investigators build up some plausible excogitation on what they see or think they see, nay, wish to see, and then excogitate experiments to prove this excogitation. "Nil fingendum, nil excogitandum, sed inveniendum quod Natura ferat, quod Natura faciat," is a precept which has ceased to find much acceptance among them, except when read backwards.

The State of the Blood and the Blood-Vessels in Inflammation.

§ 1. "The experimental inquiry respecting the contractile power of the blood-vessels and the Nature of Inflammation," prefixed to the Treatise on "Inflammation of the mucous membrane of the Lungs," which the late Sir Charles Hastings published in 1820, was, in my Report, No. XXXIV. of the 'British and Foreign Medical Review' (July, 1844), signalised as a valuable contribution to medical science. In it Sir Charles remarked that at the commencement of inflammation in a frog's web, the corpuscles of the blood within the vessels of the affected part appear, under microscopical observation, as if fused together into a uniform red mass which moved sluggishly along, and at last became stagnant, a condition which had been indicated by older writers in the expression of "*lentor* and *remora*." The vessels themselves,

* For a list of these communications, see Appendix.

he conceived to be "debilitated in their action," and that to this, the alteration in the condition of the blood on entering them from the vessels of the adjacent healthy part, is owing. Herein, however, Sir Charles committed himself to an excogitation in the attempt to define the cause of the phenomenon instead of tracing it out in its sequence and correlations. The expression "debilitated action," seems to be a relic of the jargon of Brunonianism.

§ 2. One kind of "debilitated action" of the arteries is exemplified in paralytic relaxation of their walls, and this is manifested by dilatation of their calibre from distension with blood now flowing freely on under the full operation of *vis a tergo*, permitted by the loss of tension; the force of the heart remaining unaltered. In a case of such *debilitated* action of arteries there is thus, associated with the dilatation of calibre, *increased* activity of the flow of blood and *not a retardation leading to stasis*. On the other hand, "increased action" of the arteries is exemplified in tonic contraction of their muscular coat, and this is manifested by more or less persistent constriction of their calibre *with impediment to the flow of blood*. Let it be asked, therefore, in which of the two cases do we find "debilitated action"? Herein is a dilemma, between the horns of which John Hunter thought he had slipped through by remarking that dilatation is as much an evidence of power as constriction of calibre from contraction of the arterial wall. If John Hunter assumed, as the late M. Paul Bert erroneously thought he had proved by experimental researches,* that dilatation of the calibre of arteries is owing to direct muscular action, he was over-hasty in his assumption. A dilemma, therefore, still remained. The rapid flow of blood in arteries, relaxed and dilated by distension, is, however, an evidence of unaltered power of the heart.

§ 3. Such dilemmata are to be guarded against by simply

* M. Paul Bert's blunders have been taken up as facts and adduced as a standard outcome of experimental research. Notably, see 'The Advancement of Science by Experimental Research': being the Harveian Oration, delivered before the Royal College of Physicians of London on June 27, 1883. By S. O. Habershon, M.D., F.R.C.P., late Senior Physician to, and Lecturer on Medicine at, Guy's Hospital.

observing and describing phenomena in their sequence and correlations, as Kirchoff advised, instead of inventing causes to account for them. Inflammation is a morbid process, the phenomena attending which have their initial seat in the blood and blood-vessels of the part affected. In studying its course, therefore, we have to direct attention to the sequence and correlations of the phenomena which present themselves in connexion with the state and action of the said blood and blood-vessels.

§ 4. In my Report on the Nature of Inflammation in No. XXXIV. of the 'British and Foreign Medical Review' (1844), I accepted the doctrine that to suspension of nervous influence from the arterioles, the accumulation and aggregation of blood-corpuscles in the extreme vessels of a part, constituting inflammatory congestion, are owing. This excogitation, however, I formally renounced in my Essay on the state of the blood and the blood-vessels in inflammation ('Guy's Hospital Reports,' October, 1850), for the reason which I proceed to explain: After directing my attention to the mechanism of the establishment of vascular congestion in a wounded part, I turned to the study of the mechanism of a vascular congestion which had become established in the web of a frog, independently of any solution of continuity of vessels by a wound. In such a case when the walls of the arteries of the limb were paralysed by section of the ischiatic nerve, I found that the congestion was rapidly dispersed by the free flow of blood which ensued under the full influence of *vis a tergo*—the force of the heart continuing unchanged—which came into operation. This, it may be observed, showed that "debilitated action" of arteries, even to actual paralysis, was a condition *antidotal to*, not *a cause of*, the idiopathic inflammatory congestion of the character under notice.

§ 5. In the case of inflammatory congestion *around a wound*, a similar resolvent effect was *not* produced. On the contrary, congestion was not only increased,* but continued

* See *infra*, and also the description of my preparations of wounded and inflamed webs of the frog, injected with their own blood, and the illustrative drawings in 'Guy's Hospital Reports,' before cited.

so, especially on the further side of the wound, and declined only as healing took place and a freer circulation of blood in the part was re-established.

§ 6. To return to non-traumatic vascular congestion :—In such a case (having its seat in the web of a frog), the application of an irritating collyrium did, indeed, cause an aggravation of the congestion by exciting the muscular walls of the arterioles to increased contraction with corresponding constriction of their calibre, but this was only temporary, being superseded by relaxation of walls with dilatation of calibre from distension with the full stream of blood now permitted to enter them, and to flow freely under the influence of *vis a tergo*. The effect of this, again, I found was dispersion of the congestion in a manner similar to that above described as taking place in a case of non-traumatic congestion, when the walls of the arteries were paralysed by section of the ischiatic nerve.

§ 7. Irritating collyria dropped into the eye for catarrhal ophthalmia cause dispersion of the congestion in like manner by promoting eventual relaxation of the walls of the constricted arteries, though aggravation of the symptoms is temporarily induced by the increased constriction at first excited, but which is superseded by dilatation from distension when the muscular walls become relaxed. Herein, it is to be remarked that the *modus operandi* of the remedy indicates at the same time the nature of the *proximate cause* of the congestion.

§ 8. Arteries which have their walls relaxed, become, as just observed, *dilated* by *distension* with the blood stream, which is full and rapid on account of the free operation of *vis a tergo*. The capillaries and venules to which the arterioles in question lead are also distended, and the flow of blood onwards in them is full and rapid likewise. Such is simple hyperæmia or vascular fulness with heat which may be well observed in a rabbit's ear, while the great central artery of the organ is in a state of relaxation; but which may be seen to become superseded by an anæmic condition with coldness, when constriction of the said artery supervenes, as it does occasionally. For details, see below.

§ 9. Idiopathic vascular congestion begins with constriction of the arterioles of the affected part, the effect of which constriction is retardation of the flow of blood in them, while regurgitation from various neighbouring anastomosing vessels, in which the circulation is still going on, takes place into the capillaries and venous radicles to which the constricted arterioles lead. The blood, being thus retarded in its course, red corpuscles are retained and aggregate together, while the saline constituent of the plasma, by virtue of its nature as a crystalloid, exudes by dialysis. The result of this separation of the saline constituent of the serum is that the red corpuscles with the fibrinous and albuminous elements of the plasma become so fused together, by virtue of their nature as colloids, that the appearance of a uniform viscous-looking red mass indicated by Sir Charles Hastings, as above mentioned, is produced. Flowing sluggishly along, this mass tends to become stagnant in the small vessels of the affected part—arterioles, capillaries, and venules. It is subsequently to the escape of the crystalloid constituent of the serum by dialysis that exudation of the colloid lymph takes place, as was shown by the late Professor Graham, Master of the Mint, in his researches on Colloids and Crystalloids. At the commencement of a nasal catarrh, the discharge from the nose is a clear saline solution ; subsequently the discharge is a thick mucus.

§ 10. Though hyperæmia or simple vascular fulness from increased freedom of the flow of blood in a part owing to relaxation or actual paralysis of the arterial walls is, in its mechanism, the very opposite of inflammatory congestion which supervenes in the manner just mentioned on constriction of the arterioles of the affected part, the state of the blood and the blood-vessels in the two different cases is very generally confounded.* Accompanying inflammatory con-

* See my article in the 'Lancet' propounding the question :—"Is Dilatation of the Calibre of small Arteries a fact in Nature disclosed by experimental research to be owing to an active expansion of their walls under the influence of special *vaso-dilator nerves?*" and the remark on M. Paul Bert's experimental researches in § 2.

gestion with *stasis sanguinis*, there is, indeed, also more or less hyperæmia or simple vascular fulness in the parts adjacent to the focus of the inflammation, as I explained in my Essay in 'Guy's Hospital Reports,' in correction of the assumption that an increased quantity of blood flows in the vessels of the part which is the focus of the inflammation, whereas *stasis sanguinis* actually exists in them.

§ 11. It is to the cardiac impulses on the blood, flowing in the said relaxed arteries, dilated by distension, against the focus of inflammatory congestion, that throbbing is owing. This throbbing used to be considered a manifestation of a supposed heart-like propulsive action of the arteries. Coincident with the throbbing, and owing to the same cause, is the microscopically observable phenomenon of oscillation of the yielding but otherwise stationary mass of agglomerated and stagnant red corpuscles within the vessels. Though so obvious in respect to its incidental nature, this oscillation is often spoken of as something special in the inflammatory process. It is to be noted that the cardiac impulses under notice are not so strong as commonly supposed they should be under the influence of the degree of *vis a tergo* in operation, because much of this force is already expended on streams in branches that arise from the arterial trunk higher up and pour blood into extreme vessels in which the circulation is as yet free.

§ 12. The mistake that the flow of blood becomes slower in dilated arteries arose from confounding the dilated artery under observation as a channel receiving the stream from a narrower one, whereas, in the case in question, the flow is still from a wider channel, though into one become less narrow than before and, therefore, merely offering a less degree of impediment to the stream. We sometimes, indeed, see in the course of our observations on the phenomena of the circulation in the web of a frog, an artery with its calibre wide at one place and narrow at another alternately, in which very obvious retardation of the flow takes place when the blood is received into the wider from the narrower parts of the channel, while acceleration of the flow is seen when the

blood again enters a narrower part. This, it will be observed, is simply an exemplification of phenomena to be expected under the circumstances, in accordance with the principles of hydraulics.

Microscopical Examination of a Drop of Healthy Blood withdrawn from the Body.

§ 13. Examining microscopically a small drop of healthy blood disposed on a slide and covered with a thin plate of glass, immediately on being drawn, we see at first the red discs dispersed without order in the plasma, but in a minute or so arranged like coins in rouleaux. The steps of the transition to this orderly arrangement, in their sequence and correlations, are observed to be something in this wise: adjacent discs coming into direct contact overlap each other in files, and then slipping up on edge, become applied surface to surface. Herein, the phenomena would appear to indicate, in the first place, a slipperiness of the discs on each other, through the medium of the plasma; in the second place, a reciprocal attraction whereby they come into actual contact, surface to surface; and in the third place, direct adhesion. In my "Observations on the Blood," in No. XXVIII. of the 'British and Foreign Medical Review,' 1842, I offered it as my conclusion that the reciprocal attraction and adhesion of the red discs is of a special character, but whether of a vital or physical nature I did not stop to inquire, only observing that the phenomenon appears to be very much influenced by the state of the corpuscles, on the one hand, and the composition of the fluid in which they are surrounded, on the other. The phenomenon of the approach of the red discs to each other and the adhesion which takes place between them, subsequently to their coming into contact, it may now be stated, thanks to the valuable observations and experiments of my much esteemed friend, the late Professor Graham, Master of the Mint, depend on the peculiar nature as *colloids* of the red discs, on the one hand, and of the fibrinous constituents of the plasma in which they are suspended, on the other.

§ 14. As leading to the orderly arrangement of the red discs in aggregating above described, there is no indication of its being due to a stickiness of their surface, such as Sir Joseph Lister has vaunted to be a crucial *fact discovered by himself*, though it is really nothing more than an excogitation for the *nonce*, on his part. If there had been any stickiness, would the discs, let it be asked, not have adhered at once promiscuously, and so have become irregularly aggregated in the manner observed to take place in Professor Nasse's experiment of adding mucilage of gum containing a little salt in solution, to a drop of blood?

§ 15. The rouleaux, into which were seen to aggregate the red corpuscles in a drop of healthy blood newly drawn, and immediately examined under the microscope, exhibit, after a minute or two, a tendency to break up. Coincident with this disruption, the fibrin of the plasma is found to have become separated by coagulation and deposited on the glass slide in the form of minute granules, and extremely delicate pale fibrils shooting out from them in various radiating directions.

Microscopical Examination of the Blood within the Living Vessels.

§ 16. In regard to the correlations of the constituents of the blood in the living state within the vessels, it might be said that, owing to the proportion in which the colloid fibrin and the serum considered as a crystalloid solution, are mixed in the plasma, this constituent acts as a neutral medium for the suspension of the corpuscles; the red corpuscles being checked in the tendency they have as colloids to aggregate, on the one hand, and on the other, from floating in a loose and disorderly manner.

§ 17. In blood withdrawn from the conditions in which it is when flowing within the vessels of the living body, the correlations of the plasma and corpuscles become different, as above mentioned, thus: The red corpuscles aggregate into rouleaux, and so far separate themselves from the plasma. This is followed by resolution of the plasma into fibrin and

serum—the fibrin, as a colloid, undergoing pectization or coagulation; while the serum, being a crystalloid solution, is pressed out in a fluid state by the increasing contraction of the coagulating fibrin. In the fluid serum thus become free, the rouleaux of red corpuscles are left immersed. Supervening on this, the arrangement in rouleaux tends to be broken up.

§ 18. These phenomena may be taken to indicate that the presence of the fibrinous element in the fluid state is a condition favourable to the aggregation of the red corpuscles into rouleaux; while, on the other hand, immersion in the serum, which is a crystalloid saline solution in an albuminous colloid, set free when the colloid fibrin has been separated by pectization or coagulation, is unfavourable to the continuance of the said aggregation.*

§ 19. Conversely, it is here, in passing, worthy of being noted that, as we have above seen, and as we shall again see more particularly below, on the establishment of vascular congestion, as seen in the web of the frog's foot under microscopical examination, the red corpuscles and the fibrinous element of the plasma being left together in direct contact by the dialytic exudation of the crystalloid saline of the serum which takes place, become, owing to their nature as colloids, interfused and form the uniform viscous-looking red mass within the vessels of the affected part which is seen moving sluggishly along, and at last becoming stagnant, as above described in the quotation from Sir Charles Hastings, and which was spoken of by older writers under the expression of *lentor* and *remora* of the blood.

§ 20. But to return to the behaviour of our drop of blood, which was withdrawn from the living body. After the pre-

* In No. XXVIII. of the 'British and Foreign Medical Review' (July, 1842), the fact was stated that aggregation of the red corpuscles of blood into rouleaux does still take place in the serum after the fibrin of the plasma has been withdrawn by coagulation. It was, however, shown that the inference that the fibrin exerts no essential action in causing the aggregation must be taken with some degree of qualification.

cipitation of the fibrin of the plasma by coagulation, and the disruption of the rouleaux as above described, disaggregated red corpuscles are seen floating about, in the field of the microscope, singly and confusedly in the serum; some here and there also, perhaps, adherent at a single point to the glass slide through the medium of coagulated fibrin. In such a case, if a slight agitation be communicated to the preparation, so that a current of the serum with disaggregated red corpuscles suspended in it, is produced, those at anchor here and there, are by the stream bearing on them pressed into a pear-shape. Here it may be mentioned in passing that in a case before disruption of the rouleaux had actually taken place, I subjected the preparation to galvanic influence, and found that the albumen of the serum which remained after the precipitation of the fibrin, around the rouleaux, was coagulated so that the red corpuscles were so glued together in their aggregated state that no disruption took place.

Microscopical Examination of a Drop of Blood Newly Drawn in a Case of Inflammation.

§ 21. Turning from our microscopical examination of a drop of healthy blood, let us now direct attention to the phenomena which present themselves in a drop of blood newly drawn from a person labouring under an acute inflammation of some important organ. But first, it is to be remembered that, as was particularly shown by MM. Andral and Gavarret some fifty years ago, an inflammation may commence and run its course without any change in the state of the general mass of blood in the body; but that on the supervention of inflammatory fever the fibrinous material of the plasma becomes much increased in quantity, and the number of red corpuscles diminished.

§ 22. In exemplification of this, and the peculiar phenomena attendant on it, the following cases are quoted in abstract from my "Observations on the Blood," in No. xxviii. of the 'British and Foreign Medical Review,' 1842:—

"Case I. *Blood from a young man labouring under pericarditis.*—By the time that a small drop of blood could be transferred to the microscope and examined, the red corpuscles had already aggregated together into rouleaux. These rouleaux were seen to become quickly broken up again; this was followed, however, not by disaggregation of the discs as above described in healthy blood, but by their collection into isolated masses, dispersed in wide intervening spaces of plasma. So close was this aggregation that the red corpuscles appeared almost as if fused together.

"Case II. *Blood from a young man, aged eighteen, labouring under peritonitis.*—On immediate examination of a small drop under the microscope, the red corpuscles were seen already aggregated into rouleaux, leaving in the field wide spaces of plasma. The corpuscles appeared thinner, and as if softer than in healthy blood. Disruption of the rouleaux soon followed, and the corpuscles became collected into irregular viscous-looking red masses, as if fused into each other. To the naked eye, the drop of blood, as spread out on the glass slide, exhibited the aspect referred to below, as having been described by John Hunter to be characteristic of blood drawn from a person labouring under severe inflammation.

"Case III. *Blood from a man with pneumonia of two days' standing.*—The red corpuscles, viscid-looking on the surface, quickly ran together into rouleaux, and then, as if fused into each other, became closely aggregated into irregular masses."

§ 23. On the surface of a cupful of blood, soon after being drawn by venesection in such cases, what is called a buffy coat is formed by a separation of the plasma together with the colourless from the red corpuscles. The latter remaining at the bottom of the cup in the form of crassamentum, while the plasma with the colourless corpuscles collects at the top, and, coagulating, forms the buffy coat. In the morbid condition of the blood under notice, there is, as above mentioned, an increased quantity of fibrinous matter in the plasma, while the red corpuscles are diminished in number. At the same time, the red corpuscles aggregate with unusual celerity and closeness. Owing to this, the operation of their greater specific gravity is increased, so that they sink before coagulation of the plasma takes place. Independently, however, of their specific gravity, a separation of the red corpuscles will take place laterally, as above mentioned, in passing, and which I here proceed to notice more in detail. A drop of inflammatory blood thinly spread out on a glass slide, or even on the blade of the lancet which has been used in performing the venesection, exhibits to the naked eye a mottled aspect—red patches on a transparent ground—owing, as seen under a microscope, to collections of rouleaux of closely-aggregated red corpuscles, dispersed about in spaces occupied with plasma alone. This fact, so far as regards the naked-eye appearance, was pointed out by John Hunter, and subsequently by the late Professor van der Kolk, of Utrecht, by whom it was signalised to be as characteristic of that state of the blood on which the formation of the buffy coat depends as the buffy coat itself when formed. The reason why, as I remarked in 1842, is that the appearance is owing to the same cause. As the blood is, in the case in question, spread out in a thin film, there is of course no sinking of the aggregated red corpuscles involved, seeing that they necessarily remain on the same level surface with the plasma from which they have separated laterally.*

§ 24. Coagulation of healthy blood is found to be retarded by the addition of a crystalloid in solution, either simple, or as it exists mixed with albumen in the form of serum which has become separated from a coagulated mass. The red corpuscles, therefore, have time to subside by gravity. But to return to the changed state of the blood drawn from a person labouring under inflammation of some important organ. In the blood, as it circulates within the vessels of the living body, the red corpuscles, which are solid colloids, and the fibrinous element of the plasma, also a

* For further particulars on this and other points above noticed, see the volumes of the 'British and Foreign Medical Review' for the years 1842, 1843, and 1844.

colloid but in a fluid state, seem to react on each other in the manner peculiar to their nature. As an indication of the effect of such reciprocal action, we may accept the fused-like condition of the surface of the red corpuscles, the unusual celerity and closeness with which they aggregate into rouleaux and other peculiarities of the phenomena observed in buffy blood, on the one hand, and on the other, the increased quantity of the fibrinous constituent in the plasma; that is, if we máy accept also, as I did forty-eight years ago, the teaching of the late eminent Professors of Göttingen, my friends Doctors Wagner and Henle, viz., to quote the words of the former, that "the red corpuscles might be presumed to bear the same relation to the plasma and its normal composition as the cells of secreting glands do to the secreted fluids;" and to quote the designation applied by the latter to the red corpuscles of "swimming glandular cells."

§ 25. In my "Observations on the Blood," in No. XXVIII. of the 'British and Foreign Medical Review,' the fact was dwelt on that the red corpuscles of blood drawn from a person labouring under acute inflammation aggregate, as above mentioned, more rapidly and closely into rouleaux than is to be observed in healthy blood. Misinterpreting my words on the subject, the late Dr. Williams, in his 'Principles of Medicine,' published in 1843, attributed to me a statement "that it is a similarly rapid and close aggregation of the red discs within the vessels which is the cause of the obstruction in the capillaries in inflammation and other cases of impeded circulation." This, Dr. Williams called an "assumption" on my part, and then proceeded to refute the statement with which he had credited me by an *ignoratio elenchi*. On this, I remarked*: "How much soever the author of this Report believes that the greatly increased tendency of the red corpuscles of buffy blood to aggregate, would promote the action of the exciting cause of inflammatory stasis, it was never for a moment his opinion that such increased tendency was a necessary condition for inflammatory stasis, knowing

* Report "On the Nature of Inflammation" in No. XXXIV. of the 'British and Foreign Medical Review,' § 19, 1844.

that this may arise from a slight injury, and when the mass of blood is still quite healthy."

§ 26. In a Paper in the 'Philosophical Transactions' for 1858, entitled "On the Early Stages of Inflammation," by Joseph Lister, Esq., F.R.C.S., Eng. and Edin., Assistant Surgeon to the Royal Infirmary, Edinburgh: communicated by Dr. Sharpey, Secretary, R.S., that author too generously credited me with having been the first to explain the mode of formation of the buffy coat, thereby indirectly exposing me to the reproach of having appropriated what was due to Professors Nasse and Henle, which any one who had not seen my paper in the original, might have brought against me. In my "Observations on the Blood" in the 'British and Foreign Medical Review,' above cited, I expressed myself to the effect that the nature of the process leading to the formation of the buffy coat in inflammatory blood was first explained by Professor Hermann Nasse, of Marburg, and subsequently by Professor Henle. "More recently," it was added, "I have made some observations on the point." Here follow the observations. My claim hath this extent—no more.

§ 27. The late Dr. Williams, in his 'Principles of Medicine' (§ 205, p. 96, published in 1843), in representing and objecting to my account of the minute process leading to the buffy coat, fell into an error which I exposed in my "Report on the Changes in the Blood in Inflammation, &c.," in the 'British and Foreign Medical Review' for July, 1844. On the other hand, Sir Joseph Lister, in his paper above referred to, credited Dr. Williams with having first described and accurately figured the appearance of white corpuscles in large numbers on the inside of the walls of arterioles, capillaries, and veins. Dr. Williams's 'Principles of Medicine,' from which Lister quotes, was published in 1843. In my "Observations on some points on the Anatomy, Physiology, and Pathology of the Blood," which appeared in the 'British and Foreign Medical Review' (October, 1842)—a year before the publication of Dr. Williams's book—a detailed account of the subject is given under the heading of "Condition of the Colourless Corpuscles in, and their passage through, the minute arteries, capillaries, and radicles of the veins." This account was drawn up from the microscopical observations I had been making at the time, but unaccompanied by any expression claiming them as a discovery on my part. On the contrary, the account was given as what I believed to be already phenomena of common observation at the time.

§ 28. To this I would invite Sir Joseph Lister's attention. Moreover, I would invite his attention to the succeeding paragraph, in which I refer to M. Poiseuille's previously published suggestion, that the indication of attraction between the colourless corpuscles and the walls of the vessels might be owing to the less rapidity of the current of blood next the vascular wall, such as was shown by M. Girard to take place when a liquid flows through a tube of small diameter.

§ 29. As to Dr. Williams's conjecture that the colourless corpuscles which we see accumulated in unusual number on the inner surface of the walls of the small blood-vessels at the commencement of inflammatory congestion in the web of a frog, and which he suggested to be the chief cause of the obstruction leading to the stagnation of the red corpuscles, are actually new formations, I remarked in my "Report on the Present State of Knowledge of the Nature of Inflammation," in No. XXXIV. of the 'British and Foreign Medical Review' for April, 1844:—"Having directed attention particularly to the point, the author of this Report can venture to maintain that the colourless corpuscles which are seen under microscopical observation, accumulated on the inner surface of the walls of the vessels, are no new formations, but that, as stated in a former number of this 'Review' (1842), they already exist in the blood,—that when the velocity of the stream is great, the colourless are carried along mingled with the red corpuscles, but that when the stream is retarded from any cause, they are seen to become disengaged from among the red corpuscles, and fall into contact with the walls of the vessels when the stream is less rapid, and rolling slowly along or actually remaining at rest, they accumulate in great numbers," lining the wall like an epithelium. The same view of the matter, I added, had been taken by Emmert ('Beiträge zur Pathologie und Therapie,' Heft I., s. 48, Bern, 1842). Here the question suggests itself: could Professor Virchow, in formulating his view that "proliferation" is the essential characteristic of incipient inflammation, have adopted Dr. Williams's view, that the colourless corpuscles, seen accumulated within the vessels as just described, are actually new formations, and have taken them to be the manifestation of his "proliferation?"

§ 30. In my 'Observations,' in No. XXVIII. of the 'British and Foreign Medical Review,' 1842, under the heading of "Attractions and Repulsions of the red and colourless corpuscles," it is remarked:—"From the facts stated in the preceding part of this paper, it may be admitted that the red corpuscles have an attraction for each other, but little or none for the colourless corpuscles. The accumulation of the colourless corpuscles, at the inner surface of the vascular wall, was taken by Ascherson and Weber* to indicate the existence of some kind of attraction between them and these walls." Again, in my Report on the "Nature of Inflammation," in No. XXXIV., op. cit., I remarked: "When the circulation in the web of the hind foot of a frog is attentively observed under the microscope, the colourless corpuscles of the blood are seen, if the stream be slow, to accumulate on the inner surface of the wall of the vessels—principally radicles of veins—along which they slide or roll over and over, whereas the red corpuscles, which occupy the axis of the stream, are carried directly onwards. From the differences in the position, and in the mode and rapidity of progression exhibited in the case of these two kinds of blood-corpuscles, it appears that there is something of the nature of an attraction between the colourless corpuscles and the walls of the vessels, but an absence of attraction between the red corpuscles and these walls, as also between the red and colourless corpuscles themselves. Though the red corpuscles keep together in the axis of the stream, sliding on each other, there is not apparent among them any actual tendency to

* Müller's Archiv.

aggregate, such as that which is observed in blood drawn from the body and at rest, as above described.

§ 31. In very small capillaries, colourless corpuscles may be observed passing, one after the other, but a red corpuscle, only now and then—a peculiarity which suggests the idea that the phenomenon is owing, not to the difference in size (for the red corpuscles readily yield, so as to be accommodated to vessels of a width less than their own diameter), but to an absence of attraction, if not the existence of a positive repulsion, between the red corpuscles and the walls of the vessels. I have seen colourless corpuscles readily enter very small capillaries; but a red corpuscle, when it would have followed, has been as if warded off, unless accidentally pushed in by the passing stream.

§ 32. Sir Joseph Lister, as above mentioned, has excogitated the cause of the aggregation of the red corpuscles into rouleaux, which we see take place in a drop of blood newly drawn from the body and displayed under a microscope. This discovery of his, as he claims it to be, he would have us accept as a fact in nature affording the true explanation of the process of inflammation, thus:—"The essential feature," says he, "of the inflammatory process is a more or less complete suspension of a functional activity in the affected tissues (the consequence of some injurious influence acting on them) owing to which the red corpuscles of the blood in the vessels of the part acquire increased adhesiveness or stickiness of surface, and so aggregate together and block up the vessels, causing *stasis sanguinis*." The late Sir Charles Hastings' account of the phenomenon observed at the commencement of inflammation in a frog's web displayed under a microscope, viz., "the corpuscles of the blood within the vessels of the affected part, as if fused together into a uniform red mass, which is moved sluggishly along and at last becomes stagnant," is above quoted (§ 1) as a simple enunciation of what can be observed in nature; but Sir Charles' *obiter dictum* that the vessels themselves are debilitated in their action, and that to this the alteration in the state of the blood on entering them from the vessels of the adjacent healthy part is owing, can be considered only as an excogitation.

§ 33. Sir Joseph Lister's *discovery*, so far as regards a stickiness of the surface of red corpuscles is concerned, which he considers to be the true explanation of the inflammatory process, is all his own; but excluding this excogitation, his view of the essential feature of the inflammatory process appears something like a *reproduction* of Sir Charles Hastings' account. In excogitating that the red corpuscles of the blood in the vessels of an inflamed part acquire increased stickiness of surface, Lister displays a misconception of the phenomenon of aggregation in its sequence and correlations. The adhesion and fusion into each other which take place between the disks are subsequent to their coming into contact by attraction, and are, we have seen, owing to their nature as colloids.

§ 34. The idea that the red corpuscles of the blood aggregate into rouleaux by virtue of a stickiness of their surface, and not on account of any kind of attraction bringing them together, has been strenuously combated by Professor Richard Norris of Queen's College, Birmingham. In illustration of his argument, Dr. Norris prepared a number of cork disks, loaded at one side of the circumference, so that they might float perpendicularly in a liquid he placed them in. The disks, thus suspended, ran together into rouleaux after the manner of the red disks of blood. This phenomenon, he justly concluded, must be owing to the operation of an attractive force and not to any stickiness of surface—a property which cork disks do not possess.

§ 35. It has been above shown that in a drop of healthy blood examined under the microscope immediately on being drawn, the phenomenon of the aggregation of red corpuscles into rouleaux does not indicate anything that we could admit to be the effect of a "stickiness" of their surface. The phenomenon of the aggregation of red corpuscles within the vessels, as we have seen, and shall see more particularly below, when discussing vascular congestion and the fusion of the said corpuscles into a uniform viscous-looking red mass, is still further from indicating anything like the effect of mere stickiness. The reciprocal attraction of the red corpuscles and disposition to melt into each other at their surfaces when, by the abstraction of surrounding serum, they have been in direct contact for a time, depends on their colloid nature, as we have seen reason to conclude from the late Professor Graham's observations on Colloids and Crystalloids.

§ 36. As to the accumulation of colourless corpuscles on the inner surface of the vascular walls, all that can be said by way of description of the phenomenon has been stated above, and in my Reports in the 'British and Foreign Medical Review.' Here I would call to mind how that, in the small vessels, we see the red corpuscles keep together in the axis of the stream of plasma, *though they do not adhere to each other;* while next the walls, where the stream is slower, the colourless corpuscles tend to accumulate. This tendency of the colourless corpuscles to accumulate depends, as above suggested, on an attraction between them and the vascular walls, the operation of which is favoured, partly by the slowness of the stream next the walls and partly by an attraction between them and the plasma, such as we see manifested by their continuing mingled therewith in the formation of the buffy coat. We shall see below that red corpuscles acted on by solution of salt applied to the web show an attraction for the wall of a vessel which they do not exhibit under normal conditions.

§ 37. At the commencement of the establishment of inflammatory congestion, colourless corpuscles accumulate, in the manner just mentioned, on the inner surface of the walls of the vessels, while the red corpuscles, which are retained, aggregate. Hereupon the crystalloid element of the serum in solution separates and is exuded by dialysis. The fibrinous element of the plasma which is left, and what of the albuminous element of the serum which has not exuded along with the crystalloid solution, coalesce, by virtue of their colloid nature, with the colloid red corpuscles, and thus there is produced the well known aspect of a viscous-looking red mass which moves sluggishly along in the vessels, and at length, becoming stagnant, blocks them up. It is subsequently to the dialysis of the crystalloid saline in solution that the exudation of the colloid in the form of lymph takes place, as was shown by Mr. Graham.

§ 38. The colloid fusion of the red corpuscles into each other in the stagnant blood increases in degree the longer the stasis exists. If the conditions for the resolution of vascular congestion come into operation before stasis has existed long, re-establishment of the circulation in the vessels concerned I observed to take place in the following manner:—At every stroke of the heart, the mass of aggregated red corpuscles was pushed onwards, and what of it was forced into neighbouring anastomosing vessels in which the circulation was going on was quickly disaggregated and carried away in the stream. When, however, the stasis had already existed for some time, the tenacity with which the red corpuscles were held together by the fusion was so great that it was only after repeated impulses that the stagnant mass was moved on in portions into the neighbouring vessels and carried away in the stream.

Coagulation of the Blood.

§ 39. The colloid fusion of the red corpuscles in *stasis sanguinis* just spoken of is not an example of coagulation similar to that which we see the blood undergo a few minutes after being drawn from the body. In my observations on some points in the "Anatomy, Physiology and Pathology of the Blood," in No. XXVIII. of the 'British and Foreign Medical Review,' 1842, it is stated that, as well known, the blood, a few minutes after being drawn from the body, coagulates into a red jelly-like mass, and that, by the slow shrinking in volume which this mass undergoes, a yellowish liquor is gradually squeezed out.

§ 40. The crassamentum and serum into which the mass of coagulated blood thus becomes resolved, consist, it is to be noted, of the components of the blood while circulating in the vessels, and for a short time subsequently to its being

drawn, but altered as regards condition, combination and arrangement. The transition of the blood from the liquid state into that of a red jelly-like mass is owing to the pectization or coagulation which the fibrinous material of the plasma comes to undergo by virtue of its colloid nature. From this pectization or coagulation, there results a felt-work of fibres, in the meshes of which the corpuscles (both red and colourless), together with the serum (left separate when the fibrinous material of the plasma underwent pectization), are retained. If it is by virtue of its colloid nature that this fibrinous material of the plasma undergoes pectization, how is it, it will be asked, does pectization not take place in the blood within the vessels of the living body?

§ 41. Within a time as short as that during which blood continues uncoagulated after abstraction, the blood within the vessels of the living body has already made two or three circuits, in the course of each of which it has become impregnated with carbonic acid gas on the one hand, and deprived of oxygen gas on the other while passing through the capillaries of the system; to be, conversely, in its passage through the capillaries of the lungs, impregnated anew with oxygen gas and freed from the carbonic acid gas with which it had become loaded in passing through the capillaries of the system. Furthermore, the blood, in its course through the body, receives the renovating lymph, but gives out various matters for nutrition and secretion, while in exchange certain decomposed old matters are returned, to be eventually eliminated from the system in various processes.

§ 42. The blood in its course within the vessels of the living body is thus in a state of constant change as regards composition, like the tissues themselves which it nourishes, while it is itself object and agent of its own nutritive changes. Indeed, it has been aptly compared by a French Physiologist to a tissue under the name of *Chair coulante*. The blood in fact, though fluid, contains in suspension (as remarked in my "Observations" in the 'British and Foreign Medical Review,' No. XXVIII., 1842), innumerable organized and living corpuscles, endowed with properties by virtue of which the oxygen and lymph which are being constantly received into the blood are elaborated, with generation of heat, into material fitted to supply what is lost in the waste of the body. While the blood is thus the medium of nutrition for the body, it is the agent by which it is itself maintained in the state and condition fitted for the purpose; the state of fluidity, for example, which depends on a constant renewal of its composition, whereby the tendency to pectization of the fibrinous material of the plasma is constantly superseded.

Coagulation of the Blood within the Vessels.

§ 43. Having thus traced the phenomena attending the coagulation of the blood after abstraction from the body, in their sequence and correlations, and endeavoured to explain how it is that the blood in its normal state within the vessels of the living body maintains its fluidity, it is now to be stated that under certain abnormal conditions, local intravascular deposits of coagulated fibrin do take place from the blood. This, therefore, remains a subject of study.

§ 44. The following is a description of the beginnings of the internal clot which came to be formed in the case of a wound of the web of a bat's wing dividing an artery, as represented in a drawing before me which I made at the time. Haemorrhage having become arrested by the formation of an external clot, the upper segment of the divided artery from its mouth thus closed to some distance above was seen filled with blood. The red corpuscles of this blood having become aggregated, formed a deposit of crassamentum in the part of the interior of the arterial stump in question, next the orifice now stopped up by the external clot, chiefly on one side of the wall, while on the other side of the wall and extending higher up to where the stream passed off from the trunk of the vessel, under the influence of *vis a tergo* by the first considerable branch above the wound, plasma collected. Herein was exemplified a separation of the blood collected

within the upper segment of the vessel into crassamentum and plasma, something like what occurs in the formation of the buffy coat. It may be mentioned, in passing, that the internal clot thus formed received successive additions of plasma by deposit from the stream passing off from the trunk of the vessel by the first considerable branch above the wound.

§ 45. The blood, though within a living vessel, thus undergoes coagulation in consequence of being at rest, and, therefore, excluded from the changes which normally take place in its composition while circulating through the body. Sometimes in the course of my observations, I have seen the part of the upper segment of the divided artery containing the internal clot suddenly become constricted, whereupon, the crassamentum and the plasma composing it, as above mentioned, were regurgitated into the stream passing off from the trunk by the considerable branch above and carried away.

§ 46. From blood within a vessel in full stream, a local deposit of fibrinous matter is found where there may happen to be a lesion of the inner coat of the vessel. This cannot be compared to the coagulation exemplified in the formation of the internal clot just described. It may, however, be compared to the coagulation exemplified in the formation of the external clot; thus, when an artery is divided, the cut ends retract within its sheath, the inner surface of which at the place is thereby left ragged by the laceration and stretching of the cellular tissue. The blood escaping from the mouth (the *upper* let us say) of the cut vessel, encounters this ragged inner surface of the sheath, and thereon fibrinous matter from the plasma is deposited by coagulation, and forms the external clot whereby further haemorrhage is arrested, and the condition established for the accumulation of the blood which comes to form the internal clot as above described. The deposit of fibrin from blood just drawn from the body on being whipped or stirred may be compared, in one respect, to the deposit just described on the ragged inner surface of the sheath of a divided artery.

§ 47. In frogs, of which one of the feet was the seat of ulceration and slough, I have frequently seen while examining under the microscope the circulation going on in the other foot, which was healthy, agglomerations of red corpuscles, followed by fibrinous floccules, intermixed with leucocytes, suddenly present themselves in an artery, in the form of an embolon. After an instant or two, these embola becoming more or less disintegrated and reduced in size, were forced onwards by *vis a tergo*. Such embola appear to be internal clots which have formed in small arteries leading to parts where congestions of blood were seated, and which, being regurgitated by the contraction of these vessels in the direction of their trunks, were received into the torrent of the circulation and carried away. They seem to be of a nature similar to that of the embola met with in the human body after operations; but different from that of a thrombus arising from fibrinous deposit in cases of lesion of the inner coat of an artery. By making pressure with a blunt point over an artery or vein in the web of a frog or bat displayed under the microscope, the inner coat of the vessel is bruised, the effect of which injury we see to be a deposit, at the place of the lesion inside the vessel, of a grayish granular floccule, consisting of white corpuscles held together by a fibrinous-looking viscid substance. By this thrombus the calibre of the vessel, which has at the same time undergone constriction from contraction of the muscular wall excited by the pressure, is further obstructed. See below, § 72.

§ 48. Hewson pointed out that by dissolving sulphate of soda in blood as it flows from a vein, coagulation is prevented, so that the red corpuscles readily subside; but that if the plasma thus left at the top in a fluid state be poured off and mixed with water, it is found to coagulate. This is owing to the dilution of the sulphate of soda solution. In a similar manner, ammonia mixed with blood as it flows from a vein prevents coagulation, but by-and-by the volatile alkali escaping, coagulation takes place. Again, admixture with serum, which has separated from a cupful of blood, interferes with coagulation, the serum in such a case, it is

to be noted, acts merely as a saline solution. Though blood may be thus kept fluid, after being abstracted from the body, it cannot be compared, in respect to composition, to blood actually circulating within the vessels.

Phenomena Attending the Establishment of Vascular Congestion as Excited by Different Causes.

1. *Phenomena attending the establishment of vascular congestion in a wounded part of the web of a frog's foot or bat's wing.*

§ 49. In my Essay on "The State of the Blood and Blood-Vessels in Inflammation" ('Guy's Hospital Report,' for October, 1850), I described and illustrated by drawings from the life the phenomena attending the establishment of vascular congestion in a wounded part of a frog's web, as observed under the microscope. Subsequently, in a paper in the 'Medico-Chirurgical Transactions,' for 1852, I described the corresponding phenomena in the web of a bat's wing.

§ 50. In a wound of the web of a frog's foot or bat's wing, involving division of a small artery, this vessel was seen to become constricted on either side of the section for some distance beyond, so that the blood was driven *centrad* in the upper segment and squeezed onward *distad* in the lower. In a few seconds, the constriction of the vessel ceasing, in consequence of relaxation of its muscular wall, which had become contracted at the place under the stimulus of the wound, *vis a tergo* came freely into operation, and haemorrhage took place from the upper segment in a direct course. On the stoppage of this haemorrhage by the formation of an external clot, the upper segment of the divided artery, from its mouth thus closed to some distance above, was seen filled with blood, which came to be the nucleus of an internal clot, as above explained. What haemorrhage took place from the lower segment of the divided artery was by reflux. After its cessation, blood, of which the red corpuscles had separated from the plasma, remained filling the interior of the vessel down to the origin of a branch in which a retrograde stream was sluggishly moving. This collection of blood, though analogous to the nucleus of an internal clot, as just described in the upper segment, differed somewhat in the mechanism of its formation.

§ 51. The mouths of the capillaries and venous radicles actually divided in the wound became stopped up with aggregated red corpuscles. In passing, it may be remarked that under none of the conditions now described was any migration of white corpuscles outwards seen, notwithstanding that the mouths of the divided vessels were otherwise open.

§ 52. The capillaries and venous radicles previously fed by the extreme ramifications of the divided artery, gradually became gorged and dilated by distension with blood corpuscles in consequence of regurgitation into them from anastomosing capillaries and venous radicles to which collateral arterial channels unimplicated in the wound directly led, such, for example, as the arterioles from the considerable branch above the wound by which the stream of blood was passing off from the trunk.

§ 53. Into the extreme ramifications of the divided artery themselves below the wound, a reflux of blood took place from the capillaries previously fed by them, but now, as stated, supplied by regurgitation, so that the said extreme arterial ramifications likewise became gorged and dilated by distension, this being permitted by the relaxation of their muscular walls which had ensued.

§ 54. The blood thus regurgitated into the extreme vessels of the part not being driven on freely in this retrograde course, the red corpuscles accumulated by retention and aggregated together, by virtue of their colloid nature, into a uniform viscous-looking red mass (in the manner above explained, § 37), which came to block up the capillaries, the arterioles leading to them, and the venules proceeding from them.

§ 55. In a drawing before me (which I made from nature) of the state of the blood in the capillaries of the bat's wing at

the beginning of arrestment of its free flow, the red corpuscles are represented as aggregated in a manner similar to what we see in blood newly drawn from the human body, viz., some in a linear series overlapping each other, in one vessel, and, in another vessel, some arranged in a single long roll, occupying the lumen of the capillary vessel.*

§ 56. From the description now given of the mechanism of the establishment of vascular congestion in a wounded part of the frog's web, it will be understood how it is that on the further side of the wound, chiefly, the accumulation of the blood in the capillary network, the arterioles leading to it, and the venules proceeding from it, commences ; this being due, not to any increased afflux of blood directly to the place, but to a retention of the blood corpuscles slowly received into the vessels by reflux from adjacent anastomosing vessels in which the circulation was going on. Hence it is that when the arterial trunk higher up is relaxed and the flow of blood in it is accelerated by the freer operation of *vis a tergo*, the congestion by regurgitation from the neighbouring vessels fed by it, in which the circulation is free, becomes augmented.

§ 57. Considering the great quantity of blood which thus becomes accumulated in the vessels on the further side of a wound, we may comprehend how it is that haemorrhage by reflux is so liable to take place from the mouth of the lower segment of divided vessels, and how, in consequence of its retrograde and sluggish flow, the blood escapes without any rhythmical impulse. In haemoptysis, the haemorrhage is owing to some such state of matters. In a case of chronic bronchitis aggravated now and then by weather influences, the sputa after coughing are streaked with blood. On one occasion, after a violent fit of coughing, a great mouthful of blood was expectorated. Such occasional aggravations of the symptoms I interpret as owing to an increased constriction of bronchial arterioles with increased congestion of the small

* For delineations of the red corpuscles within the small vessels of the frog's web tending to aggregate and become fused into each other, when there was more or less impediment to the flow of blood, see Plates IV., VI., and VII., in my Essay in 'Guy's Hospital Reports,' October, 1850.

vessels by reflux. Some of these vessels giving way under the strain of coughing, blood escaped in the quantity mentioned. By this, irritation was for the time relieved, and resumption of a freer circulation took place. In cases of actual lesion implicating arterioles, congestion by reflux takes place in a somewhat similar manner, as will be understood from the descriptions of vascular congestion here being given. In the case of the proximal segment of a divided artery, the direct stream, as before said, passes off by the first considerable branch above the wound; hence, *vis a tergo* now extends but comparatively little to the mouth of the segment, so that the formation of an external clot is the less resisted.

2. *Phenomena attending the establishment of vascular congestion as observed in a part cauterised by being touched with a point of nitrate of silver or blue-stone.*

§ 58. In 'Guy's Hospital Reports,' so frequently cited, I showed that when the web of a frog, displayed under a microscope, was slightly touched with a point of lunar caustic or blue-stone (the latter by preference, as nitrate of silver causes opacity at the place) over an artery, contraction of the muscular wall of the vessel was excited and constriction of its calibre thereby induced, with the effect that a check was given to the free flow of blood. The contracted state of the muscular coat of the artery, however, quickly ceasing, constriction gave way to enlargement of calibre by distension with blood in a full stream. This dilatation of the artery by distension with blood in a full stream was not of long continuance, however, but was superseded by a new constriction, this time to gradual obliteration of the calibre of the vessel at the place, which proved to be permanent—an effect which was owing to degeneration of the structure of the wall of the artery to a mere cord, occasioned by the caustic in solution having at last penetrated thereto. With the dilatation by distension of the artery in the first instance from relaxation of its muscular wall, there was an accelerated flow of blood, causing general vascular fulness of the part,

but when the artery thus became slowly constricted to obliteration at the cauterised spot, the blood, no longer finding a passage onwards, flowed off freely by the first considerable branch above from the trunk, as in the case of stoppage of the passage by section of an artery.

§ 59. As in this case of stoppage of an arterial passage by section of the vessel, there also took place reflux of blood into the capillaries and venous radicles, as well as into the arterioles opening into the capillaries of the region to which the now obliterated artery had led. The corpuscles of the blood, thus regurgitated, were seen to become aggregated and stagnant. Neighbouring arteries which had not come under the caustic action of the bluestone, but which were merely irritated by the weak solution of it which had reached them by diffusion around, having their walls subsequently relaxed, became dilated by distension with the full streams of blood now freely entering them. From these rapidly flowing currents, the vessels, on the *distal* side of the obliterated part of the cauterised artery, received the blood by regurgitation; but the corpuscles of this regurgitated blood becoming aggregated and stagnant, the freedom of the streams in the relaxed and distended arteries adjacent was diminished owing to diversion of the flow into other channels higher up. And thus was established in a circumscribed spot intense vascular congestion from stasis of red corpuscles, owing to arrest of the flow of blood to the spot, in consequence of the obliteration of the artery leading to it. The mechanism of this congestion, it will be observed, is substantially similar to that of the congestion before described as taking place in a wounded part in which an artery is divided.

§ 60. The flow of blood in full stream causing vascular fulness in the first instance, which was owing to the enlargement of the calibre of the artery by distension with blood as before described, it is to be observed, had nothing to do with the establishment of the subsequent circumscribed congestion, and much less had any imaginary primary active dilatation of the artery.

§ 61. The explanation here given of the phenomena observed in the experiment of touching the web of a frog with bluestone over an artery, is, in all essential particulars, applicable to the late Professor Cohnheim's experiment of cauterising the tongue of a frog or toad with a small crystal of the nitrate of silver. The account, however, which he gives of the phenomena and mechanism of the establishment of the vascular congestion thereby excited, betrays very imperfect observation of the effects of the cauterisation of the vessels of the part and the flow of blood therein, in their sequence and correlations. Although Cohnheim suspected that the caustic gives rise to some alteration in the structure of the wall of an artery, he did not ascertain the nature of the supposed alteration, his observation of the sequence and correlations of the attendant phenomena being defective, and his experiments aimless and inconclusive.

§ 62. The experiment of cauterising the tongue of the frog or toad has been elaborately repeated by Mr. F. Darwin, among others of Cohnheim's numerous followers; but I have no hesitation in applying to him the same strictures which I have just made on Cohnheim's own work, and would here, again, declare the alleged primary dilatation of the small arteries to be a mere fancy excogitated from imperfect observation, and, of course, also the allegation that such constitutes the first step towards the establishment of the focus of vascular congestion in acute inflammation.

3. *Phenomena attending the establishment of inflammation in a non-vascular structure, as exemplified in Keratitis.*

§ 63. In my Report in the 'British and Foreign Medical Review,' No. XXXIV., April, 1844, on the present state of knowledge of the nature of inflammation, I devoted a section (No. VIII.) to the consideration of the inflammatory process in non-vascular structures. In such parts, morbid actions may go on, I remarked, in all respects similar to those which attend or result from inflammation of ordinary vascular parts. The cornea, for example, though it is vascular while being developed, is, in its fully formed and healthy state, non-vascular, and yet inflammation of it is spoken of under the name of Corneitis, or 'Keratitis.'

§ 64. The cornea derives the materials necessary for its nutrition by exudation from the blood circulating in the vessels of the adjoining conjunctiva and sclerotica. Let us, therefore, inquire what takes place in the cornea when it suffers such an injury as would excite inflammatory congestion in a vascular part. First of all, then, the vessels of the adjoining parts of the conjunctiva and sclerotica, though not directly implicated in the injury, become the seat of congestion; and secondly, the cornea becomes more or less opaque in consequence of exudation of lymph into the interstices of its substance. Thus, the cornea when wounded, though it does not itself become the seat of vascular congestion, becomes the seat of another and most important part of the inflammatory process, viz. exudation of lymph. The only peculiarity in respect to the cornea, as compared with vascular structures, being that the vascular congestion on which the exudation of lymph depends, is seated—not in it—but in parts adjacent to it; hence, instead of the old formula, "*ubi stimulus, ibi fluxus*," it would, strictly speaking, be more appropriate to say, in respect to Keratitis, "*hic stimulus, ibi fluxus*."

§ 65. In the course of a *Keratitis*, the cornea may, indeed, become vascular itself also, but such an event is secondary, and is owing to the development of new vessels shooting out in the exuded lymph from those of the conjunctiva and sclerotica which became primarily congested. Such supervening vascularity in the cornea, however, does not always occur, even in the healing process. Ordinarily, the incision of the cornea for the extraction of a cataract unites by the first intention without the development of new vessels in its substance, and we sometimes see an ulcer of the cornea become filled up with non-vascular granulations.

§ 66. In Keratitis, we have thus a natural analysis of the phenomena of the inflammatory process in its two great initiatory stages—the congestion in one place, and the supervening exudation in another. Moreover, we have a well-defined example of the mode in which irritation may be communicated to the vessels of the conjunctiva and the sclerotica, independently of any direct lesion. In a vascular part the irritation might operate directly on the vessels themselves or on the blood, but in the case of the cornea there is neither vessel nor blood to be directly acted on.

§ 67. The mode in which the vessels of the conjunctiva and sclerotica are affected in consequence of irritation applied to the cornea alone, is this: the excitement of the sensitive nerves of the cornea is transmitted to their centre, and thence by reflex action to the vaso-motor nerves of the arterioles of the adjoining part of the conjunctiva and sclerotica, so that contraction of the muscular walls of those vessels with corresponding constriction of their calibre is induced, and the consequence of this is impediment to the free flow of blood, followed by retention of red corpuscles, which become aggregated and stagnant in the manner above described as taking place in the establishment of congestion, in an ordinary vascular structure.

§ 68. Morbid action may, however, commence in the substance of the cornea itself independently of any injury from without, or of any preceding congestion of the vessels in the adjacent conjunctiva and sclerotica, though, subsequently, the irritation to which the sensitive nerves of the idiopathically affected corneal substance are thereby subjected, will be transmitted, as in the case of a wound, to the vaso-motor nerves of the arterioles of the neighbouring conjunctiva and sclerotica, whereby congestion in the vessels of these structures will be induced. A similar process may no doubt take place in a vascular structure without any primary implication of the vessels.

§ 69. In the Report in the 'British and Foreign Medical Review,' from which the statements just made are quoted, I accepted the doctrine that excitement of the sensitive nerves of the cornea by the irritation of a wound of the corneal substance, called forth "*antagonistically*," according to the late Professor Henle's view, a state of depression or temporary paralysis of the vaso-motor nerves of the muscular walls of the arterioles opening into the capillary network of the conjunctiva and sclerotica adjoining the cornea, and that the consequence of this was relaxation of the muscular walls of the arterioles permitting dilatation of their calibre by distension, owing to the increased afflux of blood directly into it. This view, however, I subsequently renounced as above mentioned and explained (§ 4).

§ 70. In conclusion of these remarks on the vascular congestion attending Keratitis, I beg to repeat what I have elsewhere insisted on, that it is a mere excogitation to say that white corpuscles migrate from vessels of the conjunctiva or sclerotica, by boring through their walls, into the interstices of the corneal substance. It is impossible to examine the parts concerned during life. Having, however, displayed a minute section of a detached piece of healthy cornea under a microscope armed with a one-eighth of an inch object-glass, no corpuscles were at first seen on examination; but after a brief interval of time I observed white cells begin to protrude as if from interstices at the edge of the section. Such corneal corpuscles are, no doubt, the objects which Cohnheim appears to have imagined to be colourless corpuscles of the blood which had emigrated from the vessels in the adjacent parts of the conjunctiva and sclerotica, and which, as he supposed, made their way into and through the interstices of the cornea by means of amœboid movements.*

4. *Phenomena attending the establishment of vascular congestion independently of any lesion of structure.*

§ 71. In my Essay, "On the State of the Blood and Blood-Vessels in Inflammation" ('Guy's Hospital Reports' for

* In my Articles in the 'Lancet,' "On the alleged Escape of White Corpuscles from the small Vessels," I have sufficiently shown the unsatisfactory characters of the observations of Cohnheim, his predecessors, and followers, on the subject. In a reproduction of Lister's "theory" of inflammation, in a valuable text-book on Surgery, it is stated (to the bewilderment, I fear, rather than the enlightenment of the students) that the said "theory" was not received until Cohnheim's discovery of migration in 1867. I do not know if Lister has yet observed the phenomenon which at one time he had failed to see, though not to doubt. Failing his attestation, however, Mr. Victor Horsley describes emigration from a vein in the mesentery of the frog which had been exposed for *seven hours!*

October, 1850), it is mentioned that in the frog's web displayed under a microscope, we sometimes see in the course of our observations a case in which arterioles are much constricted at some particular spot, so that the current of blood in them is impeded or altogether arrested. The capillaries, previously supplied by the said arterioles, however, are seen to receive blood by reflux from neighbouring anastomosing vessels in which the circulation is going on. Interruption to the direct passage of blood in the extreme vessels of a part, thus resulting from constriction of arterioles, operates in a manner similar to that which we have found to be occasioned by actual division of an arteriole in a wound. In the web of a bat's wing I have seen a state of congestion arise under similar conditions.

§ 72. Constriction of the calibre of an arteriole for the purpose of demonstration may be at once excited by making pressure over the vessel by means of a blunt point, so as to induce contraction of its muscular coat. In connection with this, it is to be mentioned that besides the constriction of the calibre of the vessel thus occasioned, a grayish granular floccule, consisting of white corpuscles held together by a viscid fibrinous-looking substance, was deposited inside the vessel at the place of lesion by the bruise of its inner coat. The thrombus thus produced added still further to the obstruction of the calibre of the vessel.* The double effect of bruise over an artery in the forms of constriction of its calibre and of the grayish lymphy-looking deposit on the inner surface of the wall at the place pressed upon, I pointed out, firstly, in the frog in 1850, and, secondly,

* In a bat's wing, the artery being closely accompanied by a vein, both vessels suffered from the pressure, and in the interior of each a similar grayish, lymphy-looking deposit was thereby caused. It is to be noted, however, that while the artery became constricted at the place, as before described in the frog, the vein did not. In regard to this, the question arises: Did the absence of constriction of the vein depend on the difference in respect to the character of the irritability of the muscular coat of the walls of the two kinds of vessels as manifested by the difference in the phenomena of their contractility, and in respect to the difference in the microscopical characters of the fibres of their muscular coat?

in the bat in 1852, by pictorial delineation as well as verbal description.

§ 73. In the mechanism of the establishment of vascular congestion independently of any solution of continuity of vessels, simple arterial obstruction operates, as above said, in one respect like the division of vessels in a wound. Different, however, from the congestion, hereby occasioned, congestion from simple arterial obstruction, in what manner soever excited, may become resolved in the early stage by the supervention of relaxation of the contracted walls of the arteries, so that the full stream of blood which ensues under the influence of *vis a tergo*, distends the calibre of the arterioles and drives onward the aggregated mass of red corpuscles stagnant in the extreme vessels. In exemplification of this, it has been above shown (in §§ 5, 6, and 7) that in catarrhal conjunctivitis, the small arteries are constricted, while the capillary network and venules leading therefrom are the chief seat of engorgement with red corpuscles. On the other hand, it was shown that stimulating collyria in the treatment of catarrhal ophthalmia act by the relaxation of the arterial walls and re-establishment of the free flow of blood, superinduced on the cessation of the contraction of the muscular wall at first excited. The nature of the condition of the vessels implicated in the inflammation in question and the *modus operandi* of the stimulating collyrium applied in the treatment are thus reciprocally illustrative. In respect to this *modus operandi* of stimulating collyria in the treatment of catarrhal ophthalmia, it is to be noted that, as will be seen below, the vascular injection produced by a lesion—even such as is made by a thorn or the stitch of a suture—instead of being dispersed, is increased by the application of an irritant to the interdigital web of a frog or by section of the sciatic nerve, because direct *vis a tergo* in the arteries, which have been implicated, cannot be re-established while the reflux from adjacent anastomosing vessels is augmented.

5. *Phenomena attending the establishment of vascular congestion and stasis in the web of a frog's foot, excited by the application of a strong solution of common salt thereto.*

§ 74. This effect depends partly on the state of the blood-vessels thereby induced, viz. contraction of the muscular coat of the arterioles with constriction of their calibre, followed by relaxation with supervening dilatation by distension with blood; but chiefly on the action of the salt on the blood itself, through endosmose. In my Essay, "On the State of the Blood and Blood-Vessels in Inflammation" (already repeatedly cited), I described and delineated how a red corpuscle was here and there seen to strike against the wall of a capillary, whereupon others joined it, so that the vessel became obstructed by an accumulation of red corpuscles. Herein the red corpuscles and the wall of the vessel had become altered by the salt in respect to the non-attraction which, as a rule, subsists between them.

§ 75. It has been above mentioned that in a case of congestion in the frog's web, unaccompanied by any wound of the vessels, if the ischiatic nerve be cut so that the walls of the arteries of the foot are relaxed by paralysis of their muscular coat, the congestion is rapidly dispersed by the force of the fuller stream of blood in them which ensues. On the other hand, I referred to the experiment of a German physiologist,* which I had repeated, that in a frog's web congestion and stasis could not be so readily induced as usual in the extreme vessels by the application of a strong solution of salt when the ischiatic nerve had been previously divided, as when the limb is uninjured, and the circulation is going on naturally. In such a case as the former, in which the ischiatic nerve has been previously divided, so that the muscular walls of the arteries of the part have become paralysed and cannot contract under the stimulus of the salt solution, their calibre remains dilated by distension with blood which flows so rapidly in full stream that it escapes the action of the salt.

* I regret that I cannot here give the name of this observer. I have, however, mentioned it elsewhere on a previous occasion. At present, I have no opportunity of refreshing my memory.

§ 76. In a case in which the ischiatic nerve has not been interfered with, and in which, therefore, the arteries of the web retain their contractility, the application of a strong solution of salt excites contraction of their muscular coat with corresponding constriction of their calibre, the effect of which is an impeded flow of blood. This is, however, quickly superseded by a free flow owing to the relaxation of the arterial walls with dilatation of their calibre by distension which supervenes. As the impediment from the temporary contraction is not great in the larger arteries, the full stream of blood passes on and escapes any strong action of the salt, but in arterioles, capillaries, and venules, the stream of blood, in consequence of its tenuity, is readily affected by the salt, so that here and there accumulation of red corpuscles with *stasis sanguinis* becomes established, and resists the impulse of the stream in larger arteries leading to them which have recovered from the constriction primarily excited by the stimulus of the saline solution, and in which, therefore, the flow is free. In the arterioles leading to the capillaries, thus first obstructed, stasis by-and-by becomes established also, while the streams which lead to them pass off by considerable branches above. We thus see that under the conditions now described, stasis is propagated backwards from the capillaries to the arterioles, and resists *vis a tergo* in arteries higher up, in which the blood is flowing in full streams. This, it is to be particularly noted, is no indication that congestion under other conditions, such as those which I have specially described, is not owing to constriction of arterioles, and cannot co-exist with a free circulation higher up. This and such-like blundering strictures which Sir Joseph Lister (under the misguiding auspices of his Professor of Physiology, the late Dr. Sharpey, who was at the same time Physiological Secretary of the Royal Society) has levelled against my Essay, "On the State of the Blood and the Blood-Vessels in

Inflammation," * betrays a neglect of research by observation of phenomena in their sequence and correlations and an illogical proclivity to hasty excogitation. Lister had been a pupil of my class in University College, and had served temporarily as my ophthalmic assistant at the hospital, having, at his own request, obtained permission from me to do so. That Sir Joseph had been studying my Papers on Inflammation with great diligence was evident from the pertinence of his inquiries in conversation with me respecting my observations, in order to obtain by word of mouth further elucidations of the subject. So intent, indeed, was he in his inquiries that he, one day, accompanied me in my walk to the Regent's Park after the hospital visit, *cross-examining* me all the way!

§ 77. In preparing the specimens for the microscope of frogs' webs injected with their own blood to illustrate the state of the blood and the blood-vessels in inflammation which accompanied my Essay,† I applied a saturated solution of common salt on both the dorsal and plantar surfaces of the webs. The first effect of this was constriction of the calibre of the arteries—from branches to trunk—with retardation of the flow of blood in them. Relaxation of their muscular walls quickly supervening, however, the arteries became dilated by distension with the full streams of blood entering them under the influence of the now unimpeded *vis a tergo*. Notwithstanding this free flow of blood in the large arteries, the blood in the extreme vessels of the part to which they led was acted on so strongly and completely by a continued application of the salt, that the red corpuscles at

* I am not sure that Lister quotes in full the title of this Essay, which is: "On the State of the Blood and the Blood-Vessels in Inflammation, as ascertained by experiments, injections, and observations by the microscope." This title, I have been given to understand, was the original dictation of Sir Astley Cooper himself. It defines exactly what it may be considered necessary to know on the subject. In working out the various points for my Essay I kept closely to the requirements indicated; indulging in no excogitations.

† The specimens were deposited in Guy's Hospital Museum, and the special description of them given in the 'Reports' for October, 1850.

length agglomerated together into a mass, which became stagnant and filled the said vessels like an injection of red wax, as above elucidated in the two preceding paragraphs, §§ 75 and 76.

§ 78. Here, it is now to be stated, that when the blood thus became stagnant in the extreme vessels of the part, the further flow in the trunk was so impeded that the stream in it deviated and passed off by a considerable branch arising from it still higher up. In the trunk between this branch and the place where the stasis in the small vessels existed, a collection of plasma was seen with some corpuscles suspended in it, oscillating forwards and backwards. This collection of plasma I recognised as the result of a process similar to that on which the formation of the *coagulum internum* above described, in the proximal segment of a divided artery, depends. By continuing the application of the salt, the web became at last completely injected and fit to be dried and prepared for mounting on slides for the miscroscope.*

§ 79. Here the remark is to be repeated that the inflammatory injection around a lesion of the web in which vessels have been implicated is increased by the application of the salt and continues so. Certain of the preparations above referred in my Essay in 'Guy's Hospital Reports,' represents cases of such increased inflammatory congestion around a wound.

§ 80. In my Essay, "On the State of the Blood and the Blood-Vessels in Inflammation," an exposition of the phenomena attending the establishment of inflammatory congestion in a wounded part of a frog's web, illustrated by drawings from life, constituted the very groundwork on which my further researches were based. Without tracing out, in their sequence and correlations the phenomena in question, no adequate comprehension of the subject could have been obtained. Subsequent observations on a wounded

* See the special description of all this in my Essay in 'Guy's Hospital Reports.'

part of a bat's wing supplied what it was desirable to know regarding the phenomena as they present themselves in a mammiferous animal.

§ 81. In his paper in the 'Philosophical Transactions' for 1858, p. 659, Lister says:—"The effect of arterial *contraction* in producing accumulation and stagnation of corpuscles in the capillaries has been described by Mr. Wharton Jones as occurring in the web of a frog in a state of health, and concludes this allegation of his by excogitating that it was perfectly clear that stagnation of the blood depended on something more than mere contraction of the arteries," omitting, however, a description of the phenomena of that "something more." I do not understand what is here meant by "the arterial contraction" which I am made to say "produces accumulation and stagnation of corpuscles in the capillaries"—whether "*an act of contraction*" or "a state of contraction" of the muscular walls of the arteries with constriction of their calibre. Surely Lister did not mean to say that "an act of contraction of the muscular walls of small arteries of the web of a frog has been indicated by me as exciting a special operation by which stagnation of blood in the capillaries is occasioned." If he did, I must denounce the allegation as an *ignoratio elenchi*. If, however, he meant a state of *contraction* of the *muscular walls of arterioles* with corresponding *constriction of their calibre*, he does not say so, and much less does he specify the phenomena which I describe and delineate as supervening on the constriction—such, for example, as the mode in which the direct flow of blood in the capillaries and venous radicles to which the constricted arterioles lead, is obstructed and replaced by reflux from adjacent vessels in which the circulation is still free. By this omission, therefore, Lister still remains open to the charge of attributing to me what I never said.

§ 82. Since renouncing the excogitation that suspension of nervous influence from the small vessels of a part constitutes a condition for the establishment of inflammatory congestion (§§ 4, 69), I have all along contended that when the calibre of a minute artery of the frog's web or bàt's wing becomes

constricted by the contraction of its muscular wall, by what cause soever excited, so that the current of blood is retarded, we observe that red corpuscles accumulate by retention and, aggregating, come at last to block up the capillaries and venous radicles to which the constricted arterioles lead. The accumulation thus arising is augmented by the addition of corpuscles derived by reflux from neighbouring vessels in which the circulation is still free owing to their origin being higher up, as explained in detail, §§ 52–56.

§ 83. Lister, it is above mentioned, excogitates that it was perfectly clear that stagnation of the blood depended on "something more" than mere contraction of the arteries. What that "something more" is, he, however, leaves a mystery under the name of "suspension of animation." He does not even explain what he means by the vague expression of "contraction of the arteries" which he attributes to me, though I never used it. Nay, more, as if to fix a charge of error on me, he adduces an observation of his own to show that accumulation and stasis of corpuscles took place in two or three capillaries unaccompanied by any change in the vascular dimensions—meaning by this that there was no "contraction of the arteries." Perfectly true, but the stasis in this case was owing to a change in the condition of the corpuscles themselves by the action of the morsel of capsicum which Lister himself applied to the web in his experiment; though, in consequence of his inadequate observation, he overlooked the sequence and correlations of the phenomenon.

§ 84. It has been above shown (§ 76), and let it be here repeated, that under the action of a solution of salt dropped on the web of a frog, the full stream of blood in the larger arteries at first escapes, in a great measure, being affected, but that in consequence of the tenuity of the stream in the capillaries, the red corpuscles of the blood flowing therein readily become acted on by the salt which is imbibed into it, so that here and there we may see them aggregated and stagnant. This effect of the imbibition of salt in solution through the capillary wall on the red corpuscles is described and delineated in my Essay in 'Guy's Hospital Reports,' so often referred to. The direct action of the salt on the red corpuscles was indicated by their becoming of a darker tint and more flattened form. In exemplification of a change in the state of the red corpuscles of the nature just indicated, operating as a cause of stasis, it may be here added that, the effect of carbonic acid gas directed in a minute stream on a spot of the outside of a lung of the frog,* is to cause arrestment of the flow of blood in the capillaries at the place, independently of any change in the vascular dimensions. The pulmonary arteries, it may be here remarked, have only a weak muscular coat, so that they are not liable to undergo any material degree of constriction of calibre.

Notwithstanding this, and the peculiar abrupt ending of the arterioles in the capillaries, Dr. George Johnson maintains his excogitation that the entrance of blood into the lungs in cholera collapse is shut out by an increase of contractile power, generated, we must suppose, for the nonce, whereby the calibre of the vessels is constricted.

§ 85. Besides his excogitation that it was perfectly clear that stagnation of the blood depended on a "something more than mere contraction of the arteries," Lister adds that it also appeared impossible to account for it satisfactorily as a result of the dilatation of the arteries. No doubt, but it is to be added that it could not be accounted for *at all* as a result of dilatation, as I have already shown, except around a wound. But why talk about accounting for anything without observing the phenomena in their sequence and correlations whereby we may come to understand what it is necessary for us to know. By his inadequate observation, Lister necessarily fails to account for what he has before his eyes.

§ 86. We have above seen that, according to Sir Charles Hastings, the appearance presented by the red corpuscles within the vessels of the affected part at the commencement of inflammation in a frog's web, as if fused together into a uniform red mass which is moved sluggishly along, depends

* 'Observations on the Blood' in No. XXVIII. of the 'British and Foreign Medical Review,' published in 1842.

on a debilitated action of the vessels themselves. This *obiter dictum* of Sir Charles Hastings, though merely a rag of the Brunonian theory, has been (it is above mentioned, § 36) adopted by Sir Joseph Lister, and amplified by him into "a suspension of functional activity in the affected tissues, from some injurious influence acting on them, the result of which on the blood therein, is that the red corpuscles acquire a *stickiness* of their surface, owing to which they aggregate together and block up the vessels."

§ 87. This meaningless excogitation of his, Sir Joseph Lister claims to be a scientific discovery by himself of the true cause of the commencement of inflammatory congestion, and boasts that it has received independent confirmation from his subsequent inquiry into the nature of coagulation (Croonian Lecture, Royal Society, 1863, 'Proceedings,' pp. 30–1), which is also no more than an excogitation. We have thus presented to us one meaningless excogitation in support of another, in explanation of phenomena which ought to have been observed and described in their sequence and correlations.

Structure and Functions of the Blood-Vessels.

§ 88. Under this heading Sir Joseph Lister introduces an episode into his paper on Inflammation in the 'Philosophical Transactions' which we have been examining, but for what purpose it is difficult to imagine, seeing that it does not really bear on inflammation, and seeing that he manifests no just comprehension of what he pretends to discuss—a remark, I have above shown, to be applicable to the main subject of his paper. Certainly, whatever the purpose or intention was, the effect of Lister's *would-be criticism*, under the encouraging but misguiding auspices of his Professor, Dr. Sharpey, virtually amounts to slander of my work, in which I traced crucial facts, elucidating vital points in Medical Science. But to return, Lister says: "The minute veins sometimes exhibit great contractility" in the higher animals, as in the irregular constrictions often seen in the mesentery of the mouse and in the remarkable rhythmical variations in calibre"—("rhythmical variations in calibre," let it be noted, is no expression of mine)—"discovered by Mr. Wharton Jones, in those of the bat's wing" ('Philosophical Transactions,' 1852). Herein nothing is said of the "structure and functions" of the minute veins of the mesentery of the mouse nor of the veins in the bat's wing, whilst the accounts given in reference to the minute veins of the mesentery of the mouse and to the veins of the bat's wing are meaningless or short of the truth.

§ 89. The minute veins in the mesentery of the mouse can be seen under microscopical examination, only when the animal is in a moribund state, and the contractions which their muscular wall is observed to undergo here and there while the intervening parts swell out into varicose dilatations, are indications not of normal function, but only of beginning *rigor mortis*. Constriction of a small vein in the mesentery of a moribund mouse, as I saw it thus taking place, is represented in a figure at p. 556 of the last edition of my 'Ophthalmic Medicine and Surgery.' Herein, certainly, it may be remarked, there could be no doubt of the existence of suspension of "functional activity"—not, however, in a *greater or less degree*, merely, but to a lethal extent. Sir Joseph Lister, in speaking as he does, omits to describe the conditions under which he observed the phenomena, nay, he does not describe the phenomena themselves, either in their sequence or correlations. Surely, *Biologists*, in their experimental researches, do not "often" subject the mesentery of a mouse to microscopical examination, and when they do, it certainly is not with the expectation of finding the vessels acting normally.

§ 90. Sir Joseph Lister couples the muscular contractions which cause the "irregular constrictions" of minute veins in the mesentery of a moribund mouse with the normal rhythmical or heart-like contractions of the veins in the wings of a healthy bat, designating the latter merely under the name of "rhythmical variations in calibre" (an expression, which is physiologically *illiterate*), without any reference to the rhythmical heart-like contractions of the muscular walls of

the veins causing the constrictions in calibre, which alternate with dilatations, whereby the onward course of the blood is promoted, regurgitation being prevented by valves. The dilatations of calibre depend on ensuing muscular relaxation of the walls of the veins, with elastic reaction of adjacent parts and entrance of blood. According to his own incidental mention, Lister had, in his possession, bats for examination; but he seems not to have studied the phenomena of the circulation in their sequence and correlations. It might have been supposed that Lister, who had previously occupied himself with success in teazing out and disposing for examination under the microscope, the muscular fibres of the tonically contractile walls of vessels generally, would have been curious to ascertain the microscopical characters of the muscular fibres of the walls of vessels, the calibre of which undergoes rhythmical variations! But no! He does not even specially recognise rhythmical contractions of the muscular walls of the veins as the cause of the rhythmical variations of their calibre, much less the propulsive force exerted on the stream of blood.

§ 91. The title of my Paper in the 'Philosophical Transactions' for 1852 is this: "Discovery that the Veins of the Bat's wing, which are furnished with valves, are endowed with rhythmical contractility, and that the onward flow of blood is accelerated at each contraction." This title, though brief, indicates something more than rhythmical variations in calibre, but Sir Joseph does not quote it, so that all his remarks on the subject are meaningless or short of the truth. Nay, worse than this, Lister does not notice the fact, specially insisted on in a postscript to my Paper, that, in the ear of the long-eared bat, which admits of being displayed for examination under the microscope, the veins are found not to be endowed with rhythmical contractility like those of the wing, and that the microscopical characters of the fibres of their muscular coat do not differ from those of the plane muscular fibres of ordinary veins.

§ 92. The microscopical characters of the rhythmically contractile muscular fibres of the walls of the veins of the bat's wing are pictorially delineated in my paper, in the 'Philosophical Transactions.' This, notwithstanding, and notwithstanding the special description I gave of them as altogether unique, the late Professor Sharpey, who, as Secretary, communicated Lister's paper, under notice, to the Royal Society, had, in an histological annotation to a Students' Manual of Anatomy (the edition which appeared several years subsequently to the publication of my Paper), alleged that the rhythmically contractile muscular fibres of the walls of the veins of the bat's wing do not differ in their microscopical characters from the ordinary plane muscular fibres of veins in other parts of the bat's body—a blunder regarding which I questioned Dr. Sharpey one evening at the Royal Society. His reply was that I had told him so, which I certainly never did. I remember quite well telling him the very opposite fact which I had specially stated in the P.S. to my Paper in the 'Philosophical Transactions,' some years previously.

§ 93. Though the muscular walls of the veins of the bat's wing are rhythmically contractile, the vessels themselves do not "pulsate" like arteries. Arteries pulsate in consequence of the rhythmical distensions of their calibre by the stream of blood rhythmically propelled with acceleration at each stroke of the heart, but their walls are not rhythmically contractile. They are tonically contractile and elastic only. We shall return to this below.

§ 94. The expression "rhythmic variations in calibre" (physiologically illiterate as it is), without any reference to the effect on the flow of blood in the vessels, to designate the rhythmical heart-like action of the walls of the veins of the bat's wing with corresponding constriction, of their calibre has been adopted by Professor Michael Foster of Cambridge (an old pupil of Dr. Sharpey, like Sir Joseph Lister), and persisted in. This blundering, both by commission and omission, on the part of Foster, is very little less excusable than the unfounded utterance of Professor Burdon Sanderson, the Oxford Professor of Biology, that "rhythmical contractions of veins occur in certain animals," or that

meaningless assertion of Professor McKendrick, the Glasgow Professor, viz. that rhythmical contractions of veins "sometimes" take place. (See my Article on the subject in the 'Lancet,' February, 1885.) I do not know whether Professor Burdon Sanderson, instead of demonstrating to his pupils, as it is his duty to do, the real fact in the bat's wing, continues to teach, in the Biological Institute of Oxford,* the meaningless figment that "rhythmical contractions of veins occur in certain animals;" but Professor McKendrick has improved on his previous misrepresentation, when in the new edition of his Physiology, recently published (volume ii., p. 269), he gives utterance to the following elaborate excogitation: "In some rare instances, the blood pressure still acting through the capillaries, the pressure of the muscles and the aspirations of the chest are unable, apparently, to carry on the circulation, and then we (*i.e.* Professor McKendrick himself) find portions of the veins 'pulsating' (?), constituting accessory hearts, as in the 'caudal vein of the eel' (?) and in the veins of the wing of the bat." On this it is to be observed that, as repeatedly said, the caudal vein of the eel does not pulsate, nor is it endowed with rhythmical contractility, nor do the veins of the bat's wing pulsate, though they contract rhythmically. Moreover, it is to be remarked, that the distance of the veins of the bat's wing from the influence of the systemic heart of the animal seems to "account" for the superaddition of the force exerted by the rhythmical contractions of the veins supported by valves. In his meaningless excogitation, merging into fiction, Professor McKendrick adopts the common mistake of confounding rhythmical contraction of the muscular walls of the veins of the bat's wing with pulsation, such as is exemplified in the rhythmical distensions of an artery (not contractions) at each stroke of the heart; thus betraying gross ignorance of

* Harvey would have been delighted to know the real facts in Nature which Burdon Sanderson here so ignorantly glosses over. When Warden of Merton College, Oxford, Harvey, could he have foreseen that a Fellow of the College and Professor of Biology in the University cared so little for crucial facts, would have been mortified.

the facts and phenomena he is pretending to describe to his *student-readers.* The walls of the caudal vein of the eel are not endowed with rhythmical contractility, nor does the vessel pulsate. Though lymph is rhythmically propelled into it by the caudal lymph heart, the caudal vein is not distended to pulsation thereby, because the channel of the vein, like that of other veins, progressively increases in width in its course.* Besides this, the stream of lymph propelled into it by the caudal heart through its short narrow duct, is so small and so little forcible that even an equally sized artery could scarcely be distended to pulsation by it. It is something deplorable that a student should be taught in his text-book, which he is expected to study and believe, under the terror of examination, that the vein in the tail of the eel which receives the lymph from the caudal heart serves the purpose of an accessory blood heart, whilst the caudal lymph heart itself is actually ignored. As to the veins in the wing of the bat, which are furnished with valves, though they are endowed with rhythmical contractility, and thereby serve as accessory blood hearts, they do not pulsate in the sense that an artery pulsates. In short, let it be repeated: the action of the veins of the bat's wing is a heart-like action by which the flow of the blood is rhythmically accelerated in aid of the force of the heart of the general system from behind. The vein could not act like a heart and pulsate like an artery at the same moment. The pulse of an artery is synchronous with the contraction of the ventricle of the heart. No other example is as yet known, in any vertebrate animal, of *veins endowed with rhythmical contractility of their walls, and serving as accessory blood hearts.*† There being valves in the veins in the bat's wing preventing regurgitation, the

* See below, the section on lymph hearts.

† I have always considered it probable that in the very long tails of some animals, and even in our toes, the extreme veins might be endowed with rhythmical contractility of their wall, but in the few microscopical examinations I have been able to make, on the point, I have not discovered in the muscular walls characters similar to those presented by the muscular coat of the veins of the bat's wing (§ 92).

blood necessarily continues in its course, which is accelerated at each of the rhythmically recurring contractions. The contractions, it may be mentioned, take place eleven or twelve times in a minute.

§ 95. McKendrick's blunder about the caudal vein of the eel, which he has evidently borrowed from Foster, would be a manifestation of ignorance and incapacity, something astounding, if we could allow ourselves to suppose that he had ever seen the caudal lymph heart of the eel in action, and the propulsion of lymph from it into the caudal vein. It is evident, however, as just remarked, that what the Glasgow Professor says is merely borrowed from the Cambridge Professor, who doggedly repeats his blundering as it appeared in a previous edition of his book, and which was commented on in my Article in the 'Lancet' five years ago. Nay, regardless of the injury which must result to the minds of students of his text-book by telling them what is not the fact disclosed by observation of phenomena, Professor Michael Foster says that "rhythmic variations" of calibre, due to contractions, may be seen elsewhere than in the veins of the bat's wing. The "elsewhere," which is here referred to, seems to be the caudal vein of the eel, as if its walls were endowed with rhythmical contractility (with which they are not), and as if the vessel were the seat of pulsations like an artery (of which it is not); at the same time, the Cambridge Professor makes no mention of the state of the blood in the vein, nor the propulsion of lymph from the caudal lymph heart into the vessel through a small duct, nor the remarkable phenomenon attending this propulsion, viz. the cutting across of the blood stream in the vein by the small lymph streams which are propelled in rhythmical succession from the lymph heart into the vein.

§ 96. *Contraction* of the walls of arteries with *constriction* of their calibre is in no case rhythmical, nor propulsive of the blood from trunk to branches;* on the contrary, the contrac-

* When a small artery of the web of a frog's foot, displayed under a microscope, is cut across, we have seen that while the upper segment becomes constricted trunkwards, the lower segment becomes constricted in

tion is propagated in a continuous retrograde direction from branches to trunk, causing a reflux of blood. In the rabbit's ear (as will be stated in detail below), the main artery when it is constricted may be seen not only no longer transmitting blood to the capillaries, but itself completely emptied, so that the ear is bloodless and cold. In the course of our observations of the phenomena of the circulation in the web of the frog's foot or bat's wing displayed under the microscope, we sometimes see a small artery or two become constricted so that the flow of blood in them is arrested—not arrested merely, but actually regurgitated. It is worthy of remark that in such cases, when an artery was seen thus beginning to close in, the animal struggled, so that further observation was for the time interrupted. When the animal became quiet, and its web could be again displayed under the microscope, the calibre of the artery was, perhaps, found still constricted, but its walls soon relaxing, the vessel became dilated by distension with the direct stream of blood which began again to flow. It is, further, to be particularly noted that there is nothing rhythmical in these constrictions and dilatations of the arteries, though it has been alleged that there is; thus, the late Professor Rolleston, of Oxford, attributed such an allegation to Lister. On this, I remarked, at p. 88 of my volume on 'Injuries of the Spine and Head' (1869), that in my Essay, "On the State of the Blood and the Blood-Vessels in Inflammation" ('Guy's Hospital Reports' for 1850), there is an account at p. 7, of tonic contraction of walls with constriction of calibre, which arteries of the frog's web are sometimes seen to undergo. Of this Professor Lister was well aware when he wrote eight years subsequently. I am quite sure, therefore, that in his Paper in the 'Philosophical Transactions' for 1858, there is no expression calculated to convey the idea that Rolleston attributed to him; and,

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a direction branchwards, squeezing the blood onwards, but this is merely for a few seconds, and the artery remains constricted only at the place of section. Subsequently when the vessel contracts below this, it does so trunkwards as usual.

certainly, that Lister does not designate the contractions of the walls of the arteries causing the constrictions of their calibre as rhythmical. In my Paper in the 'Philosophical Transactions' for 1852, "On the discovery of the Rhythmical Contractility of the veins of the Bat's Wing," I refer at p. 133 to the non-rhythmical contractions of the walls with constriction of calibre which the small arteries of the bat's wing may be seen to present, as similar to those of the arteries of the frog's web.

Tonic Contractions of Wall with Constrictions of Calibre of the Main Artery in the Rabbit's Ear.

§ 97. In my Paper, "On the Rhythmical Contractility of the veins of the Bat's Wing," in the 'Philosophical Transactions' for 1852, I refer in a note to the tonic constrictions of the main artery in the ear of a rabbit which I observed to take place occasionally in a manner similar to that in which the phenomenon presents itself in an artery of the web of a frog's foot or bat's wing. These constrictions of the artery of the rabbit's ear which take place, at short but irregular intervals, have nothing rhythmical in them, any more than the constrictions of the arterioles from tonic contraction of their walls above mentioned, as seen to occur now and then in the frog's web or bat's wing.

§ 98. Dr. Schiff, of Frankfort, published a Paper, entitled "Ein accessorisches Arterienherz bei Kaninchen," in Vierordt's "Archiv der physiologischen Heilkunde," Band XIII., 1854, pp. 523–7 (that is two years subsequently to the appearance of my Paper in the 'Philosophical Transactions,' "On the Rhythmical Contractility of the veins of the Bat's Wing"). Herein, Dr. Schiff strangely misinterpreted the phenomenon of the tonic constrictions of the main artery of the rabbit's ear, whereby the blood, so far from being accelerated in its onward course, is positively made to regurgitate from branches to trunk, so that the artery becomes empty and the ear bloodless and cold. Notwithstanding that the simply tonic character of the contractions of the artery of the rabbit's ear is so obvious, Dr. Schiff's misconception that they are rhythmical has actually been taken up by distinguished Physiologists, such, for example, as Professor Rudolph Virchow, of Berlin. No doubt, the main artery running up the middle of the rabbit's ear pulsates under ordinary circumstances, like other arteries, in consequence of the increased distension with blood at each stroke of the systemic heart, but such pulsations, of course, can no longer take place when the vessel is tonically constricted to closure, and the blood is regurgitated from branches to trunk, in opposition to *vis a tergo* from the cardiac impulse.

§ 99. Notwithstanding its incredibly stupid character, the blunder under notice is still repeated. Of all men, the Professor of Biology in the University of Cambridge, who is also Physiological Secretary of the Royal Society, though he appears to have examined the rabbit's ear and noted its bloodless and cold condition during the time the artery is in the state of tonic constriction to closure, has shown himself incapable of interpreting the phenomena. There being no valves in the artery of the rabbit's ear, any more than in other arteries, the effect of constriction of its calibre by the tonic contraction of its wall, propagated as it is from branches trunkward, on the flow of blood is necessarily *regurgitation* as indicated by the attendant phenomena. This, however, has been entirely overlooked; as has also the fact that when relaxation of the muscular wall of the vessel supervenes and the flow of blood permitted again to take place freely, the ear becomes red and warm as in blushing. Thus, though both Harvey and Bacon were originally Cambridge men, their scientific caution against admitting any phenomena in Nature without observation, has not been imitated by Michael Foster. Improving on the blunder, Sir William Savory, a late President of the Royal College of Surgeons and Hunterian Orator, in his edition of Kirke's 'Manual of Physiology,' tells his student-readers that the *veins* of the rabbit's ear had been discovered by Dr. Schiff to possess rhythmical contractility, whereby

the flow of blood in them is expedited, as in the case of the rhythmically contractile veins of the bat's wing!

§ 100. In a different form of blundering, Schiff's "discovery" is represented in the treatise on Physiology by Professor Landois, of Greifswald, to be that the veins of the bat's wing pulsate. Such a manifestation of illiteracy in his own subject, and culpable neglect of the most ordinary painstaking on the part of a German author, I never expected to see. The book has been translated into English by Professor Stirling, of Manchester, who makes the utterances of the German Professor to stand out in such a way as to be still more formally meaningless and contrary to truth.

Of the Systemic Arterioles and their Transition into the Corresponding Capillary Network.

§ 101. In my Essay, "On the State of the Blood and the Blood-Vessels, &c.," in 'Guy's Hospital Reports' for 1850, I describe and delineate (Plate IV.) the systemic arterioles, as observed in the frog's web. The arterioles into which the arteries gradually branch, terminate in the capillary network —one extreme arteriole in a corresponding capillary—the capillary being, perhaps at the moment, of wider calibre even than the arteriole, if the latter be constricted by contraction of its wall. The thickness of the wall of the arteriole depends on its muscular coat, and when this is in a state of contraction, the thickness is increased, while the calibre of the vessel is correspondingly constricted. In 'Guy's Hospital Reports,' for October, 1850, and the 'Philosophical Transactions' for 1852, I have described small arteries in the frog's web and bat's wing as becoming constricted to such a degree, owing to contraction of their muscular coat, that their calibre is for the time closed, so that the stream of blood is wholly interrupted. In this case we can see the thickening of the muscular coat take place by the contraction which it undergoes. This is obviously not an example of muscular hypertrophy any more than the increase in thickness and hardness of the biceps muscle when we bend our arm. If a minute piece of an artery, with its muscular coat thus contracted and its calibre correspondingly constricted, be cut out from a frog's web or bat's wing, the muscular coat will be seen under microscopical examination still in a thickened state—not hypertrophic—the contraction in this case merging into the contraction of *rigor mortis*.

Of the Pulmonary Arterioles and their Entrance into the Corresponding Capillary Network.

§ 102. The systemic arterioles, it has been just stated, have strong muscular walls, by the contraction of which their calibre undergoes constriction, sometimes even to closure-resisting *vis a tergo*, with the result of causing not only interruption of the direct flow of blood to a part or arrestment altogether, but even reflux, though, as above pointed out, the capillaries and venous radicles beyond may be seen to become filled by regurgitation from neighbouring anastomosing arteries, not so constricted. In fainting, there is more or less general constriction of arterioles, so that the surface of the body is pale and cold, the blood being regurgitated in the arteries from branches to trunk; the retrograde arterial contraction overcoming weakened cardiac action. Though the cerebral arterioles may have a less strongly muscular coat, swooning appears to be owing to a similar constriction of their calibre and regurgitation of blood trunkwards. On one occasion, lying in bed weak and ill, I made an effort to rise, whereupon a swooning sensation began to come over me. I, however, contrived to lay myself back, so that the faintness passed off. At the commencement of this fit, I was sufficiently conscious to be able to compare the faintness with what would be the effect of reflux of blood from the arterioles trunkwards. Herein, I am sure, there was no incongruous *ægri somnium* on my part.

§ 103. To return: The extreme ramifications of the pulmonary artery have much less strong muscular walls than those of the systemic arteries, and are not observed in the lung of a frog or salamander, viewed under the microscope, to undergo much, if any, constriction of calibre, so that the flow of blood in the capillary network of the lungs is not found liable to any such interruption as that just mentioned in the capillaries of the general system. Obstruction of the circulation in the capillaries of a frog's lung, however, is seen to occur from stagnation of aggregated red corpuscles when the due aëration of the blood is prevented. Thus, as I long ago showed (in the 'British and Foreign Medical Review,' 1842), when a slight stream of carbonic acid gas was directed on the lung of a frog, displayed under a microscope, the flow of blood was arrested in the vessels of the part acted on in consequence of the aggregation and stagnation of the red corpuscles, which became darker in tint and more flattened in form.

§ 104. At a meeting of the Royal Medical and Chirurgical Society a few years ago, it was contended by Dr. George Johnson, the President, that in cholera collapse the arrestment of the flow of blood in the capillaries of the lungs is owing to constriction of the pulmonary arterioles to closure of their calibre by contraction of their muscular walls. In opposition to this excogitation, I observed, in a postscript to my Paper in the 'Lancet' for July 18th, 1885, entitled: "Remarks on the Circulation of the Blood," that the extreme ramifications of the pulmonary artery have much less strong muscular walls than the extreme ramifications of the aortic system, and are not observed in the lung of a frog or salamander under the microscope to undergo much, if any, constriction of calibre. Against this objection to his excogitation, Dr. George Johnson protested in the 'Lancet' for August 1st, 1885, but as he had evidently not studied by direct observation the sequence and correlations of the phenomena in Nature, I suggested to him in reply to devote some prolonged attention to the microscopical examination of the state of the blood and the blood-vessels in the lung of a frog or water-newt before discussing the question further.

As Dr. Johnson appeared not to have repeated the experiment of directing a slight draught of carbonic acid gas on a part of the frog's lung, displayed under a microscope, so as to observe the effect of deoxygenising the blood in the capillaries, I also suggested to him a study of this most important point. I might further have instanced, which I now do, the enormous engorgement of the gills with impure blood which takes place in a small eel, kept out of the water, during the time the caudal heart is under microscopical examination.

§ 105. In conclusion of my reply to Dr. Johnson's protest in the 'Lancet,' I drew attention to the peculiar abrupt manner in which the pulmonary arterioles open into the capillary network, so that the flow of blood therein is like the spreading rush of streamlets from the nozzle of a watering-can with a plain or flat rose. This peculiar abrupt termination of the pulmonary arterioles in the capillary network, and equally abrupt commencement of pulmonary venules by the abrupt inosculation of capillaries, as seen in the frog's lung, are represented with wonderful accuracy by Marcello Malpighi in the engraving illustrating his work 'De Pulmonibus.' This figure, indeed, is decisive of Malpighi's being the discoverer of the capillary system, whereby he filled up the blank in Harvey's demonstration of the circulation. Malpighi's figure, it may be stated, is even more to be relied on than his verbal description.

§ 106. Without being aware, apparently, of Malpighi's discovery, Dr. Küttner, of Heidelberg, gave a very full account of the mechanism of the extreme circulation in the frog's lung (Virchow's 'Archiv,' vol. lxi., p. 21, 1874). "The origin of very narrow tubes from relatively wide arteries; the extent of the capillary network; also, the relatively wide veins into which the capillaries open"—being all distinctly pointed out. At the same time, Dr. Küttner showed how the great rapidity of the flow of blood in the frog's lung is owing to this arrangement. Again, in vol. lxxiii., p. 476, of Virchow's 'Archiv' for 1878, Dr. Küttner enlarges on the mechanism of the pulmonary circulation in a mammiferous animal. In

Malpighi's work, 'De Pulmonibus,' there is an account, with a figure of a microscopical examination, of the vessels of the mesentery of the frog, but no small vessels intermediate between arteries and veins are represented similar to what he delineated in the lung; though it is generally supposed that capillaries were there described. Malpighi's delineation of the vessels of the frog's mesentery is as true to nature in showing *no* capillaries, as his delineation of the vessels of the frog's lung is in *showing capillaries.* I long ago insisted on the fact that there are no capillary vessels in the mesentery of the frog, the only vessels being arteries going to and veins returning from the *capillary system of the intestine*, with here and there arterioles opening directly into venous trunks. These arterioles were seen, but mistaken by the late Professor Theodore Schwann for capillaries with muscular walls. Capillaries, he forgot, do not open into venous trunks, but only into venous radicles.

Mechanism of the Propulsion of Lymph from Lymphatic Hearts into Veins.

§ 107. The efferent vessel of a lymphatic heart is a short duct, through which the lymph is propelled into a venous trunk. Nothing like a vein arises from a lymphatic heart as has been commonly supposed. The *receptaculum chyli* may be compared to a lymph heart; the thoracic duct, though so long, to the efferent vessel or duct of a lymph heart; and the entrance of the thoracic duct into the subclavian vein to the entrance of the duct of a lymph heart into its corresponding venous trunk. It would, therefore, be not more absurd to say that the subclavian vein arises from the *receptaculum chyli*, than to say that the venous trunk, situated on the pelvic side of the large transverse process of the third vertebra in the frog, and into which lymph is propelled from the corresponding anterior lymph heart of that animal, actually arises from the said anterior lymph heart.*

* See the diagram *infra.*

§ 108. In the tail of a small eel displayed under a microscope, we see that the efferent vessel of the lymph heart, which is there situated, is a short duct opening into one of the two trunks which, by their junction, form the great caudal vein.* The lymph propelled by each stroke of the lymph heart through this duct into the venous trunk mentioned, cuts across the stream of red blood therein, so that an appearance is occasioned as if separate drops of red blood were actually propelled from the heart. Mislead by this deceptive appearance, Dr. Marshall Hall, who discovered the organ, took the lymphatic heart of the eel's tail for an auxiliary blood heart, not having recognised the colourless lymph as the exclusive issue of its contractions and the simple cutting across thereby of the red blood stream in the vein at each stroke.

§ 109. The caudal heart of the eel, then, is a lymphatic heart and propels lymph by a short valvular duct into one of the two large veins which unite to form the great caudal vein; but no vein arises from the heart, and as little does a vein arise from either of the anterior lymphatic hearts of the frog, as the late Professor Müller, of Berlin, and Panizza, of Pavia, supposed. The jugular vein of the frog, which is very black from the quantity of pigment deposit in its walls, was originally observed by Dr. Marshall Hall, but he took it for an artery on account of the movements which it exhibits, which, however, are not pulsations, but are backward and forward movements of the vessel as a whole in the direction of its length. Noting that these movements are synchronous with the contractions of the anterior lymphatic heart of the corresponding side, and recognising the vessel to be a vein, Müller thought that the movements are pulsations caused by the propulsion of lymph into the vein by the heart. A little reflection, however, might have suggested to that distinguished discoverer of the lymph heart, that as veins go on to increase in width, the vein under notice could not be distended by the sudden propulsion of lymph into it, even if

* See my Paper in the 'Philosophical Transactions' for 1868, p. 675, entitled: 'The Caudal Heart of the Eel, a Lymphatic Heart.'

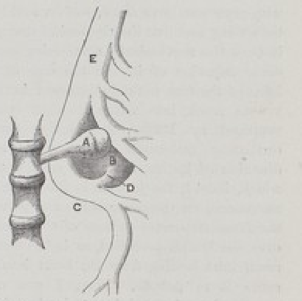
the vein had had its origin from the heart, and consequently that it could not be made to pulsate in the manner an artery is made to pulsate. Moreover, had Professor Müller known that it is a small duct only through which a lymphatic heart propels lymph into a vein, he would still less have supposed that pulsation of the vein could be caused by the propulsion of lymph into it through such a narrow channel.

§ 110. It is thus seen, that in the tail of a small eel displayed under a microscope, the caudal vein is *not* endowed with rhythmical contractility of its wall like the veins of the bat's wing, and that the rhythmical propulsion of lymph into it from the rhythmically contracting caudal heart does not cause pulsation of it. In the case of an anterior lymph heart of the frog, not only does no vein arise from it, but the venous trunk into which its duct opens is not, as was supposed by Müller, the jugular trunk which is seen oscillating backwards and forwards as a whole in the direction of its length; it is, on the contrary, a vein (of which, indeed, the jugular is the trunk) situated, as above mentioned, on the other side—the pelvic side—namely, of the large transverse process of the third vertebra.* Moreover, the lymph propelled, as before mentioned, through the small duct leading from the heart into this vein, does not cause it to pulsate. Thus, I saw under microscopical examination of the left anterior lymphatic heart, that the lymph, on entering the vein from the duct at each systole, caused no pulsatory distension of the vessel, but merely pressed the stream of red blood gently aside, at the same time sweeping it onward in front, though arresting its flow, for the moment, behind. In this case the stream of lymph from the lymphatic heart did not cut the stream of red blood in the vein right across, in the manner the stream of blood in the vein of the eel is cut across by the stream of lymph propelled into it by the caudal heart, a difference of no fundamental significance, but owing merely to the less degree of force with which the lymph is propelled in the former case, and to the difference in the mode of ramification

* See the diagram *infra*.

of the vein in the latter. The vein into which the lymph is propelled from an anterior lymphatic heart of the frog, it is to be further stated, is *not* endowed with rhythmical contractility of its wall, calculated to act as a propelling force, any more than it is, itself, made to pulsate by the propulsion of lymph into it.

The Paper entitled, "On the Phenomena observed to attend the Propulsion of Lymph from an anterior lymphatic



Description of the diagram (magnified three or four diameters).

A. The large transverse process of the third vertebra. B. The lymphatic heart. C. The vein into which the heart propels the lymph. D. The duct by which the heart opens into the vein. E. The large venous trunk (the pigmentation not represented), a continuation of C, which runs up as if from the lymphatic heart.

heart into a vein in the Frog," just analysed, was communicated to the Royal Society in 1868. On account of its fundamental importance as the first record of a crucial fact, whereby a glaring but current mistake is corrected, I here add extracts from the Paper explaining the mode of procedure in the research.

I. *Description of the phenomena.*

§ 111. It was shown by the late Dr. Marshall Hall that by plunging a frog into water of a temperature from 110° to

120° Fahrenheit, the animal is killed as regards sensation and voluntary motion, without stoppage of the circulation. A frog, having been thus treated and rendered so far dead, I laid the thoraco-abdominal cavity completely open and pushed the viscera to one side. On looking into the other side—the left, for example—thus emptied of its contents, and directing attention to the niche behind and below the extremity of the large transverse process of the third vertebra, the pulsations of the anterior lymphatic heart of the said side were seen with the naked eye. By now removing the skin of the back from over the scapular region, the posterior part of the heart admitted of being examined under the microscope by transmitted light, and the phenomena attending the propulsion of lymph from it into a vein at its posterior border, observed.

§ 112. Here I would remark, in passing, that in laying open the thoraco-abdominal cavity of the animal, care is to taken not to wound the blood heart and great vessels; for though the lymphatic hearts pulsate independently of the presence of the blood heart, it is a necessary condition for the continuance of the whole phenomena that the circulation of the blood should be going on. In making my observations, I found it more convenient to use a simple than a compound microscope. Viewing then the parts from the inside of the thorax with a lens of half-an-inch focus, I observed that when the lymphatic heart contracted, the lymph stream propelled through its duct into the vein swept before it the blood-column in this vessel. The lymph, thus propelled, occupied the whole of that part of the vein into which the heart opens, so that the vessel appeared for the moment quite colourless at the place. As soon, however, as diastole of the lymphatic heart supervened, the flow of blood from behind became re-established, and the lymph, filling the vein at the place, was, in its turn, driven onwards, and mingled with the general stream. The vein, thus becoming refilled with blood, now appeared red. Systole of the heart, however, again ensuing, the lymph stream propelled into the vein swept onwards the blood in that vessel as before, whilst the flow of blood from behind was arrested; and so the same series of phenomena was repeated.

§ 113. It is thus seen that the phenomena attending the propulsion of lymph from an anterior lymphatic heart of the frog into the vein with which it communicates by a small duct, are essentially similar to those attending the propulsion of the lymph from the caudal heart of the eel into its corresponding vein. In the frog, the lymphatic heart contracts about sixty times in the minute according to Müller, while the caudal heart of the eel contracts about 160 times according to Hall. This great difference in the number of pulsations a minute I have noted, though I did not take the pains to count.

II. *Of the vein into which the anterior lymphatic heart propels the lymph, as just described.*

§ 114. The branches of the vein at the posterior border of the heart which receives the lymph therefrom, as above described, come from the lateral part of the thoraco-abdominal wall. After receiving the short duct from the heart, it turns behind the large transverse process of the third vertebra, and passes forward along the inner to the anterior border of the lymphatic heart to unite with veins on the outer border of the said heart. The large venous trunk thus resulting (blackish-looking from the quantity of pigment deposit on its outer coat), runs up as if from the heart, and is described by Müller as the jugular. The veins joining it from below are bound in a manner to the outer border of the lymphatic heart by the surrounding tissues.

§ 115. At each systole of the lymphatic heart, I observed that the blackish vein was drawn as a whole backwards in the direction of its length, and that at each diastole, the vessel moved forwards by recoil into its previous position. This rhythmical backward and forward movement of the vein, longways, appeared to be owing to this: that the heart, bound as just explained, to the blackish vein, through the medium of the surrounding venous roots, in contracting, drags the vein towards it, and that when relaxation of the heart succeeds the contraction, elasticity of the surrounding structures occasions the recoil.

§ 116. According to Professor Johannes Müller,* the large blackish venous trunk in the neck issues from the lymphatic heart anteriorly. That this is not the case, dissection and examination of the parts from the dorsal aspect† under the simple microscope have satisfied me. I would, however, remark that it is not by dissection, but only by observation, under the microscope, of the direction of the streams in them, that the anatomical relations of such vessels can be correctly determined.

§ 117. Professor Müller says that the vein in question becomes turgid each time that the lymphatic heart contracts ('Physiology,' vol. i., p. 293). This could only be by injection of lymph into the vessel from the heart. But there is no such turgidity produced by the injection of lymph through the small duct of the heart into the vein as I have above shown, and I cannot help thinking that Professor Müller mistook the dragging of the vein towards the heart for turgidity of it. The late Dr. Marshall Hall mistook the vein for an artery, and considered the movements of the vessel as pulsations of it in that character.

* 'On the existence of four distinct hearts having regular pulsations, connected with the lymphatic system in certain amphibious animals, 'Philosophical Transactions' for 1833, p. 92.

† After such dissections, I have found the lymphatic heart contain a globule of air; which, no doubt, had been drawn in through an opening made by cutting into the lymph spaces.

APPENDIX.

LIST OF ARTICLES ON THE CIRCULATION, WHICH HAVE APPEARED IN THE 'LANCET' IN THE COURSE OF THE DECADE FROM 1880–1890; WITH EXTRACTS, COMPRISING INCIDENTAL STRICTURES ON THE PREVAILING MISINSTRUCTION OF STUDENTS OF MEDICINE ON THE SUBJECT.

I.—'Alleged Emigration of White Blood-corpuscles from the Interior of small Vessels by boring through their Walls.' A Remonstrance, addressed to Professors of Physiology and Pathology against teaching that the White Corpuscles of the Blood escape from the interior of small Vessels, until they have verified it scientifically by actual Observations of their own as a fact in Nature.

Ia.—'Supplement to this Remonstrance, pointing out Professor Cohnheim's change of opinion regarding the mechanism, while Dr. Binz, of Bonn, upholds the old opinion.'

An additional remonstrance recommends students not to believe what their text-books and Professors tell them, but to require the actual demonstration of facts in Nature.

II.—'Dilatation of the Calibre of small Arteries. Is it a fact in Nature, disclosed by "experimental research," that dilatation of the calibre of small arteries is primary, and owing to an active expansion of their walls under the influence of special vaso-dilator nerves?' An Inquiry addressed to Physiological Authors, Professors, and occasional Orators.

III.—'Remarks on the Circulation of the Blood. Historical Notice of the discovery that the veins of the bat's wing, which are furnished with valves, are endowed with rhythmical contractility, whereby the blood is assisted onward on its course to the heart.' A Protest against efforts made to ignore a crucial fact in Nature.

IV.—'Remarks on the Circulation of the Blood. Mechanism of the establishment of vascular Congestion: an Experimental Research.' Dedicated to Students of Medicine.

V.—'Mechanism of the Action of the Heart, &c. A Discourse on Harvey's exposition of the mechanism of the heart and great arteries, Malpighi's discovery of the capillary system, subsequent supplementary

elucidation of the "artificium admirabile" of the circulation in the extreme vessels, and the mechanism of the propulsion of lymph from lymphatic hearts into veins.' Dedicated to the President and Members of the General Medical Council.

It has lately been ordained by the General Council of Medical Education that Logic be an optional subject for students about to commence the study of Medicine. This is a wise decision; but it is to be observed, that without a knowledge of well-defined facts in Nature to serve as *data*, logic would be worse than useless. The more exact logical reasoning is, indeed, the more false is the conclusion if the premisses are not sound. The General Council should, therefore, begin with the Professors, and exhort them to teach their students facts, and the correlations thereof, in language logically correct. Students would thus acquire a knowledge of logic practically at the same time they were being instructed in the special subject engaging their attention; and their minds, instead of being unduly taxed and strained, would thereby be positively strengthened, while their labours would be rendered more easy and agreeable. The desirability of improvement on the part of Professors in a scientific knowledge of well-made-out facts in Nature, and in a logical method of communicating them to students, either in books or in demonstrations and lectures, is very evident from the blundering exposed in this and my previous articles. If the General Council of Medical Education will sift the so-called "advancing mass of biological knowledge" with which the rising generation of teachers in our medical institutions is said to be grappling, they will probably find that it comprises much chaff and little grain, and that the too often meaningless, when not false, teachings obtruded by the said biologists on their pupils must, indeed, prove an actual source of distraction to the young men under any and all circumstances.

The study of the mechanism and action of the vessels in the extreme circulation of the blood, as observable in Nature, is so inaccurately prosecuted, that the science of physiology in its applications to Medicine, as taught to students, is by no means in such a state of advancement in the curriculum of the schools as it ought to be.

VI.—'Peroration to my Reminiscences of Fifty Years' Struggle, in the footsteps of William Harvey, to search out crucial facts in promoting physiological knowledge in its relation to Medical Science.'

Herein I protest against the incongruous teachings by which the minds of students of Medicine are distracted, and to urge a plea for their better instruction in a knowledge of fundamental facts. Such, for example, as the observable mechanism and action of the vessels in the extreme circulation of the blood, regarding which their Professors seem to be ignorant, either from incapacity or wilfulness.

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The Library of the
Army Medical Department
R.V. Hospital Netley

"IN MEMORIAM:"

from the Author

AN ADDRESS

ON

OPENING THE THIRTY-SIXTH SESSION OF THE
ARMY MEDICAL SCHOOL,

AT THE ROYAL VICTORIA HOSPITAL, NETLEY,
APRIL 3, 1876.

BY

WILLIAM AITKEN, M.D., F.R.S.,
PROFESSOR OF PATHOLOGY IN THE ARMY MEDICAL SCHOOL;
CORRESPONDING MEMBER OF THE ROYAL IMPERIAL SOCIETY OF PHYSICIANS OF VIENNA, AND OF
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PATHOLOGIST ATTACHED TO THE MILITARY HOSPITALS OF THE BRITISH TROOPS AT
SCUTARI IN TURKEY DURING THE CRIMEAN WAR.

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1876.

MEMORANDUM.

"THE Summer Session of the Army Medical School (the thirty-second since its inauguration) was opened on Monday, the 3rd instant, at the Royal Victoria Hospital, Netley, with an introductory address delivered by Professor Aitken, F.R.S. The recent decease of Dr. Parkes, the distinguished Professor of Military Hygiene at the School, gave a special and melancholy interest to the occasion; and this was increased by prevailing rumours that the Government had come to a conclusion (among other changes in the Army Medical Department) to abolish the School altogether. There was a large assembly in the Lecture Room, including the military and medical staff of the Hospital, the Professors of the School, and several gentlemen who appeared to be present as visitors. The printed list shewed that thirteen candidates for the Royal Navy, and twenty-three candidates for H.M. Indian Service, together with two senior surgeons of the Indian Army, and one staff-surgeon of the Royal Navy, had arrived to go through the course of instruction. Two Bavarian Staff-Surgeons, Dr. Wille and Dr. Renk, for whose attendance during the Session permission had been given to the Bavarian Government, were also present; as was also Staff-Surgeon Dr. Sellerbeck of the Prussian Army. There were no candidates for Her Majesty's Army Medical Service."—Extract from *British Medical Journal*, April 8th, 1876.

The following Address was delivered, which is now printed, as desired, for private circulation only.

NETLEY, *April* 16, 1876.

"*IN MEMORIAM:*"

AN ADDRESS INTRODUCTORY TO THE THIRTY-SIXTH SESSION OF THE ARMY MEDICAL SCHOOL.

COLONEL GORDON AND GENTLEMEN:—

I address myself, in the first instance, to those candidates of the Indian and Naval Medical Services of the Queen, who are here for the first time.

I presume you have each made acquaintance with the Departmental Order Book, and have observed the daily routine of duty to be done throughout the Session. In this order book you would notice that each subject of the curriculum of instruction is arranged for a lecture here at this hour on a particular day, and that the subject of Pathology is fixed for Mondays. As this Session happens to begin on a Monday (and for no other reason), it devolves upon me, in the ordinary course of events, to bid you welcome to this place, and I heartily do so on my own behalf and on that of my colleagues.

You might also have observed in the order book that no formal lecture introductory to this, the thirty-sixth Session of the School, would be given; which means, that it had been arranged, for various reasons, that each Professor should at once commence the usual work of his course.

But with our grief yet green from the loss by death of a dearly loved colleague, feelings of a painful nature necessarily mingle with the pleasure of our meeting on this occasion, and which also recall the memory of those whom we have lost.

It is nearly sixteen years since the first lecture of this School was delivered at Fort Pitt, Chatham, by my colleague, Professor Longmore; and many are the changes connected with it which have taken place since that time. The School had not been long in operation when death removed its distinguished founder, the eminent statesman, Sydney (Lord) Herbert. A few more years and Sir James Gibson, the Director-General of the Army Medical Department, and President of our Senate, was no longer amongst us. He and

Lord Herbert were both present at the opening lecture sixteen years ago. Sir James Gibson died, as his predecessor Dr Alexander died, and as Lord Herbert died—at the post of honour and of duty in the public service—overborne by the great and continuous strain of official work. It killed them all; and truly has it been written, "Uneasy lies the head that wears the crown." The post of Director-General to a great public department, like that of the Army Medical Service, is by no means an easy one. Although chief of a department, he is not his own master. He is only one of many chiefs who ought to work together for the public good; for the army consists of many departments, all of which are subordinate to the Secretary of State for War—at whose bidding the Medical Director-General may have to act even against his own better judgment in matters which concern his administration. But whatever he does, it is our duty to believe that it is done for the public good, and for the benefit of the army; and that, therefore, he ought to have the sympathy of the officers of his department in the administration of it, and the moral support of all right thinking men in the very responsible and often harassing duties of his office. This crown of office has too often been "but a wreath of thorns," bringing dangers, troubles, cares, and sleepless nights to him who has worn it; for upon his shoulders each man's burden in the department is placed; while he has but the inward satisfaction of knowing that his honour, virtue, merit, and chief praise lie in the fact, that for the public good all this weight he bears.

A third great loss we sustained at the close of 1874, by the death of Sir Ranald Martin, Physician to the Council of India, and its representative on our Senate. He was a distinguished physician and medical officer of the Indian service. A veteran prince of sanitary reformers, he was one of those men who took an active part in the organisation of this School, all of whom, with one exception—another distinguished pioneer in sanitary science, Dr. John Sutherland—are now no more. Sir Ranald Martin was a member of the Senate of this School from the commencement up to the time of his death, a year and a half ago. He was a man of noble presence, possessed of a kind and genial disposition, who by his writings and by his indomitable energy and perseverance, contributed greatly to the formation and establishment of this School, having been a member of the several sanitary commissions which eventually led to its organisation.

Now we have just sustained the last, and to us the greatest loss of all, by the death of Dr. Parkes, which took place nineteen days ago, after a lengthened illness, borne with his own characteristic patience

and resignation; and I feel it is incumbent upon me, on this our first official meeting since his death, to bring to your notice and to acknowledge to ourselves the very great loss which the Army Medical School has sustained, and which Sanitary Science has sustained by his untimely end. Not only is he a loss to this School, but in him the medical profession has lost one of its brightest gems, and the country has lost one of the most useful, intelligent, zealous, disinterested, self-denying and trusted of public servants.

Greatly beloved in his life-time, he is now lamented in his death by all who had the good fortune to know him as we did. We all feel as if we had lost a brother—as if part of our very selves had been torn from us, and which we very sorely miss. Indeed we have not yet come to realise the loss we have sustained by his death, more especially when such radical changes are being made in the medical service of the army, and when the very existence of the School itself is threatened, the prosperity of which was one of the most cherished objects of his life. With the single exception of the last opening day of Session, when he was too ill to come, this is the first time for nearly sixteen years that we have met without him. Many are the interests (both private and public, besides those of this School) which will miss his wise counsels, his fostering care, his gentle tact, and that special charm of disposition and influence which was always ready to pour the oil on the troubled waters. Thus it is that as "Night brings out stars, so sorrow shews us truths."

But those who are here to-day for the first time cannot be expected to enter into the feelings of grief and sorrow which weigh upon us in the loss of a much loved colleague, with whom we have lived in friendship unalloyed for nearly sixteen years; and whose life shews that on a much shorter acquaintance he endeared himself to every one who had the good fortune to be associated with him in any kind of work. Sorrow for the loss of such a man is a natural human tribute paid to his memory, and is called forth by the irrepressible feelings of the heart. In all respects, I think Dr. Parkes was one of the most lovable of men—from some indescribable charm of manner and sweetness of disposition; and his life amongst us, beautiful in its simplicity and self-denial, has always suggested him to my mind as the "ideal" of a "perfect man."

You cannot have passed through the curriculum of your professional education at the schools of medicine without having often heard the name of Parkes; for it has been a household word in our profession for nearly thirty years, and now death hath opened still more widely for him the gateway of Fame. Under the circumstances, therefore, in which we are met together to-day for the first time, perhaps the most fitting tribute I can here pay to the memory of Parkes, will be to endeavour to help you to realise the nature of the man you and we have lost—the lessons taught to you and to us by his life and works—whose personal teaching you have the misfortune to forego, and whose loss is a loss to the profession and the world.

Parkes' character may well afford to us all many a useful theme of contemplation; and although it was most alien to the nature of the man, that his name and his virtues should be blazoned to the world (for he was a man who would never court applause); and although we know he deprecated anything like a memoir or biography of himself being written, we owe it to ourselves not to forget those who deserve to be remembered; and I hope, in the fulness of time, that some one who may have known him well will give to the world as full a biography of Parkes as it is possible to obtain. It cannot fail to be of great interest and of great usefulness to many. But so little did he "let his left hand know what his right hand did," that it is a question whether he would not have preferred entire oblivion (if that were possible) to anything like a public eulogy.

Happily it is not possible that the name of Parkes can remain in the oblivion of the past; and as it is not now possible to flatter any vanity he may have possessed, nor yet to insult the inborn modesty of his nature—if, therefore, a biography can furnish us, as we are sure it can, examples to be followed by those he leaves behind, who are trying with all their might to tread in his footsteps, and to follow out his aims, surely there is all the more reason that we should have the means of knowing and studying the characteristics of what we know to have been a noble and beautiful life.

I well remember a most eloquent lecture delivered by him on an occasion such as this is, when he personally opened the Session of this School at Fort Pitt, Chatham, on October 1, 1862. The lecture I refer to was published in the *Lancet* of October 11 of that year. I mention this that you may all read it when you can obtain it, for it concerns the main subject of your study here—that of Hygiene, and it is distinguished by the greatness in the breadth and scope of view which he himself took regarding the science he so loved to teach and to explore. His views were most eloquently expressed and spoken; and the lecture is, moreover, distinguished by the very delicate gracefulness and easy elegance of its composition. These were characteristics which distinguished all his public lectures; and in addition to the one I have just referred to, I would especially also mention, as examples for your benefit, the Gulstonian Lectures on

Fever, which he delivered to the College of Physicians in 1855, and subsequent Croonian Lectures at the same college in 1871, and notably his address to the British Medical Association when it met in London three years ago. You may well study these, not less for the information contained in them, than as models of composition on professional subjects of the deepest philosophical character, usually considered and rendered too abstruse for easy reading, but which are there made easy.

But there is another reason why I bring this lecture in the *Lancet* to your special notice *now*. It is because I think we may read and see in it an ideal of Parkes' own pure and noble life, imbued and impressed, as it ever was, by the dignity and importance of the subject of Hygiene—the subject which he taught here, and the one of all others he was most deeply interested in. You cannot fail to perceive running throughout this lecture the very high ideal he set before himself and before us all. He had, indeed, a very great and abiding sense of responsibility. "Moral responsibility" with him was no mere phrase. In his own emphatic words—"It is an actual obligation which all will have to meet;" and he himself, as we all know, from first to last, did his work with all the thoroughness of which it was capable. Whatever his hand found to do, he did it with all his might and strength of body and mind. Every duty that fell to his lot he did thoroughly and as well as it could be done, always with his whole heart devoted to his work—working "as ever in the great Taskmaster's eye."

With his finely-balanced mind he worked as if he desired to know all that he could possibly learn in the wide range of medical and sanitary science, so that he might do all that could be done for the relief of human suffering, for the sanitary benefit of the army, the country, and mankind. We know that he passed through a severe course of study as a student, and a thorough practical training for his profession at University College, London, where he afterwards became one of its most distinguished and useful practical teachers as Professor of Clinical Medicine. The subsequent details of his life and works have been more or less fully given in our weekly medical journals, therefore I will not now dwell upon them. But if you ask —as the question is often put regarding successful men—"What was the secret of his success?" I think I may answer that there was no secret with Parkes in this respect; but in accomplishing all he did, several great qualities, no doubt, contributed to it, and upon these I would like to dwell.

The first of them is *resolution*. He clearly set before himself the objects and the aim which characterised the purpose of his life, and which he resolved to achieve.

In his scheme and method of tuition here and at University College, he clearly shewed the *second* great quality he possessed—namely, "that *directness of aim*" which characterised him. He seemed to have set a great goal before himself which he aimed at reaching, so that steadfastness of purpose to reach this goal was ever before him, and sustained him to the end. With such steadfastness of purpose and directness of aim his success as a teacher and a lecturer was real and genuine, mainly by his resolution and determination to succeed, and his charming manner of tuition. He did not multiply nor change the objects of his life, although circumstances led him to give up, sixteen years ago, the arduous practice of a London physician, to become the first Professor of Hygiene in this School, and the most successful cultivator and teacher of Preventive Medicine who has yet lived. In fact, he has made the science of Hygiene what it now is; and in teaching its practical application, especially in matters pertaining to the sanitary condition of the army at home and abroad, and in making the science generally available for the public good, he reduced it to order and system from the great confusion in which it had hitherto been, and organised that course of practical tuition here which exists nowhere else, and which his able coadjutor, Dr. De Chaumont, will now carry you through. Dr. Parkes' great work on *Practical Hygiene* will be your text-book—itself a monument of industry, of exact results, and of practical usefulness.

When the history of Hygiene and of Sanitary Science comes to be written, Parkes' name will stand out as one who was born for the occasion and was equal to it. Fortunately we know not what is in the future, but it is difficult to realise that such great changes will take place in the next twenty-five years as have taken place in the past quarter of a century. Great, very great changes there no doubt will be in the course of events; and so far as sanitary progress is concerned, such changes, I dare to say, will be found to have their starting point from the writings, the teachings, and now the death of Parkes. Already the transitions in science, the great facilities of mental and personal intercommunication, the uprooting of old ideas, and the establishment of more stable principles, based on more accurate knowledge, have been unparalleled, except at the time of the Reformation. At that time principles were seen to develop themselves which began to operate at a later day; and just as the bough, when it breaks from the parent stem, bears to the earth its living blossoms, which, germinating in their turn, produce trees whose branches overshadow the land, so it is with the present reformation which has been awakened by the systematic teachings of Sanitary Science. The whole civilised world,

and this country in particular, has awakened from a sense of indifference and ignorance to the consciousness of a mighty influence for good in the practical teachings of Hygiene. It has really become a science itself, and a study worthy the efforts of the greatest intellectual exertion—efforts which are now being recognised at some of our most ancient and renowned seats of learning in this country. Such a recognition cannot but have a powerful influence for good, affording as it does a test of the progress of knowledge in Hygiene, and of the practical application of its principles to the daily wants of life. But let us not forget the brilliancy of the spark in the widespreading flame it has served to kindle; and who has been so influential as Parkes has been in extending the sanitary reformation of the day? The host of sanitary reformers he has been the means of educating here and elsewhere for the past sixteen years have carried far and wide into every region of the civilised world the practical teachings of Parkes.

We all know how he possessed in his method of teaching a most princely gift, which operated like a charm upon his pupils, who were indeed ever prepared to follow him, as soldiers follow their leader when he waves the banner of their native land before their eyes. In every climate and in many lands his pupils have enrolled his name on the banners of Sanitary Science, which they have been privileged to unfurl in the service of their Queen and country; and his teachings will doubtless go on to bear their fruits through generations yet unborn. He had very great faith in the future usefulness of what he taught. Faith walked by his side, and kept him ever cheerful in his work under all vicissitudes, and with a sweetness of temper, at once the envy and admiration of all.

With such good works as he has achieved, fresh in our memory, can we doubt, that now he is dead, he will bear through future ages

> "A lofty name,
> A light, a landmark on the cliffs of Fame."

Gentlemen,—The hope of such enduring fame (stamped as it must be by the judgment of the future) ought to be to you and to all of us a powerful incentive to follow in his footsteps; and you may well suffer the banner of Sanitary Science, with the honoured name of Parkes inscribed upon it, "to float before your eyes as a vision that will refresh you in the future battle of life—second only in power to the influence of your conscience and your God."

Thirdly. Perseverance and continuous industry were other great and very marked characteristics which Parkes possessed. No one knew better than he did, that "the work is long and that life and time are short;" but such thoughts never daunted him, and so long as his mind and body could think and work, he thought and laboured on. He was always found prepared for delays and disappointments, impediments and difficulties. But he took them all as matters of course. They impaired not his resolution, nor affected his expectation or his temper. His determination was always to finish the work he had taken up to do, and however long and patient the toil, its constancy and arduousness were to him simply the conditions under which he knew he had started in the race of life.

These characteristics were markedly brought out in the patience, perseverance, and industry with which he steadfastly worked for years and years at the trials of the Knapsack and Valise Equipment Commission; and also at those innumerable experiments and observations on which the results were founded of his papers to the Royal Society, as well as his numerous reports on different matters which were from time to time the subject of his investigation at the instance of the War Office authorities.

Fourthly. The many letters I have received since his death, from those with whom he had been associated in numerous and varied official interests, all unite in bearing testimony to the faithfulness, loyalty, and trustworthiness of his personal character, his sterling good sense and prudence, the calmness and impartiality of his judgment, and the steady, serious gravity with which he gave his mind to the consideration of all matters submitted to him. To do good in his generation was the aim of his life, and to do right at whatever cost to himself was a governing principle of his conduct.

"His loins were girt about with Truth."

Reality of character, sincere earnestness of purpose, and thoroughness of devotion to duty were the links which bound together this inestimable girdle, which adorned his walk in life.

In a military hospital and school such as this is, breaches of discipline have occasionally arisen, and in connection with the inquiries into such breaches of discipline by the Professors, these characteristics of Parkes which I have just named, always stood out most prominently. That most ancient of sentiments seemed to be ever present in his mind—"In righteousness shalt thou judge thy neighbour." He always leaned to mercy's side, a tendency which doubtless arose out of the inborn goodness of his feelings; and hearing reports of evil imputed to others, his earnest desire was that they might prove exaggerated or untrue. His mind was so disciplined, that its habitual feeling on learning of any breach

of discipline being brought home to a man, was that of unfeigned sorrow.

In all the inquiries here into breaches of discipline, and in so judging his neighbour, he was ever jealously alive to the motives which might corrupt the judgment. Keeping his passions cool and unbiased, he was ever alive to the infirmities of our mortal nature—carrying into all differences a candid, liberal, and forgiving spirit—exhibiting the purest and most impartial justice towards every opponent—fully exercising his own right of decision, and denying not that right to others; and while obeying the results of deliberation, he still always remembered how much even the truth may be mistaken, exceeded, or distorted.

Thus, in the investigations into breaches of discipline, he generally, and as it were naturally, became the defender of the accused, so far as consistent with justice and with duty, carefully considering the degree of credibility due to evil report, the temptation to misrepresentation, and the chances of mistake. He took the facts with all their most favourable colours and extenuating circumstances, and in weighing the answer and position of the accused, he insisted upon all the good that had been previously known of him being fully recognised.

These are unmistakable evidences of a naturally good, noble, and Christian disposition, ever cherishing a fixed concern for human happiness—a phase of life and character in Parkes which practically teaches us, that it is our duty to receive with reluctance the imputations of evil, to guard against every impulse of prejudice or passion which may bias the judgment, to defend where we can do so consistently with duty and justice, and never to believe in evil report, except upon the most satisfactory evidence. Thus we may hope to secure, as he did, the purest and most perfect of all pleasures—self-approbation and respect—raising the mind to such an elevation of virtue as to gain, as he did, the love and admiration of all who knew him, while every one felt his honour and good name were safe in his keeping. Here, again, he followed by his teaching and example the method and the dictates of the Great Teacher, "to judge in mercy, and to love our neighbour as ourselves."

These characteristics of Dr. Parkes, which I have thus prominently but feebly brought to your notice, are such as will always either prognosticate or explain a career of success in any man.

It is this "possibility of achieving greatness" which is open to every man, according to his ability, that constitutes one of the most glorious features in the constitution of our country.

Learn, therefore, from the life of Parkes, to believe in the sufficiency of intellectual and moral excellence for the attainment of great success.

The late distinguished statesman, Sir Robert Peel, when addressing, as Lord Rector, the students of Glasgow University, made use of these memorable words :—" There is a presumption amounting almost to a certainty, that if any one of you will determine to be eminent, in whatever profession you may choose, and will act with unvarying steadiness in pursuance of that determination, you will, if health and strength be given you, infallibly succeed."

Another not less distinguished statesman has spoken in this same strain—" That it is in man himself, and not in his circumstances, that the secret of his destiny resides." For you that destiny will henceforth take its final bent towards good or towards evil, from the habits of mind, habits of thought, and habits of life which you will form during the coming early years of your military medical service.

The life of Parkes stands out conspicuous for its great amount of labour and accomplished work, and for the exemplary way he did it. So quietly and unobtrusively did he go through the laborious details of work, that I never knew him to name any particular investigation he was specially engaged upon till it was finished. He was extremely reticent in this respect. There is also reason to believe that to get through so much work as he did he regulated his time with a severe economy—redeeming many hours at night—consuming the midnight oil into the early morning—hours which others give to sleep.*

As to his own bodily constitution and physical fitness for such constant work, I think he illustrated by his life and premature death the quotation from Roger Bacon with which he so emphatically commenced that eloquent lecture " On the Cure of Old Age," to which I have referred. The quotation is this :—" There is a *nature* assumed from the parent which has an utmost term of existence which cannot be surpassed; so there are numberless instances of age which comes before its time—of a body decayed even before its term of maturity has been reached—of strength gone—of death commencing at a term of life when, according to Nature's laws, the body should be in all its vigour and the mind in all its strength."

Parkes' death was a premature death of this kind, at the age of fifty-six, when the body should be in all its vigour and the mind in all its strength. That dread disease was upon him " which so prepares its victims, as it were, for death, which throws around familiar looks unearthly indications of the coming change—a dread disease in which the struggle between soul and body is so gradual, quiet, and

* See Appendix for epitome of work done by Dr. Parkes.

solemn, and the result so sure, that day by day, and grain by grain, the mortal part wastes and withers away, so that the spirit grows light and sanguine with its lightening load; and feeling immortality at hand, deems it but a new term of mortal life :"—And so he passed away! There is every reason to believe that he impaired by overwork that originally feeble " nature assumed from the parent," and if it did not shorten the term of his life, almost fixed the manner of his death.

That he has been taken from us so soon is, no doubt, the result of his incessant devotion to work and chivalrous devotion to duty, utterly regardless of himself, and with too much indifference in later years to the requisite nutrition and rest of body and mind.

But while his life was thus in all respects a pure and beautiful life, his death was that of a self-denying hero; calmly resigned, and at perfect peace with all, he died with expressions of kindly remembrances of every one he could think of lingering on his lips, when he could scarce do more than whisper a name.

Such a walk in life as that of Dr. Parkes could do none other than lead to perfect blessedness; and I speak not words of course when I say that those who knew him as we did here " will never look upon his like again."

Gentlemen,—I cannot more fitly bring to a close this feeble tribute to the memory of our departed colleague than by reading the closing paragraph of the lecture to which I have referred, and which I specially address to those who are here for the first time. It is in these words:—

" By attention to what is taught in this School you will be prepared to enter on your service, and to perform its multifarious duties with success; and in performing them with success, you ought to find, and will find, your chief happiness. You will be in a position of great usefulness—' a helper of man,' as the old motto has it, literally, ' throughout the world.' And in all the varied phases of that famous military life which you will accompany and witness, officers and men should alike turn to you with confidence, as able to do for them *all that can be done* in their hours of sickness and peril. You will then be recognised as worthy associates in that grand English army which is now engaged all over the world in the work of peace; which everywhere is the servant of justice and of right; which watches over the youth of infant nations; which in the East and in the West alike represses anarchy, repels aggression, and in the midst of turbulent and disorderly nations maintains the rights and advances the cause of humanity. No nation has performed such a work since the Roman legions recoiled before the barbarian hordes. To do one's part worthily in so great a labour, and to spread throughout the wide range of the British possessions those rules of health which render both mind and body better instruments in the great work of improvement, is surely a career which might satisfy the ambition of any one. Such a career is now open before you, if you have strength enough honestly and loyally to fulfil its duties; and these duties possess happily something of the divine quality of mercy, which we are told carries a twofold blessing—blessing the giver and receiver. In endeavouring to preserve the health of others you will ensure your own; and when old age comes, it will not be as an evil to be cured, but as an ending which worthily crowns a life of labour—an ending which has been anticipated without repining, and will be endured without regret."

"Remarks on Cholera, with Post Mortem Examinations of a few Cases, by Dr Parkes, Assistant Surgeon H.M. 84th Regt" in the Madras Quarterly Medical Journal, No 21. January 1844. Vol 6. p.p. 50 to 84, dated from "Moulmein, 1st August 1843"

APPENDIX.

EPITOME (NECESSARILY IMPERFECT) OF WRITINGS BY DR. PARKES.

On the Dysentery and Hepatitis of India. 8vo, 1846.

On Asiatic and Algide Cholera. 8vo, 1847.

An Inquiry into the Bearing of the Earliest Cases of Cholera which occurred in London on the strict theory of contagion. London, Churchill, 8vo, 1849.

Lectures on Clinical Medicine delivered at University College Hospital, published in *Medical Times and Gazette*, commencing vol. xx., 1849, p. 469; continued in vol. xxi. for 1850; also in 1852, April 22, and July 8, 1854, and Feb. 28, 1857. [These lectures are models of diagnostic analysis, abounding in sound and far-seeing pathological exposition, full of suggestive hints in therapeutics and in the curative and preventive management of diseases. They are well worthy of reproduction in any collected edition of Dr. Parkes' works.]

The editing and completing of a posthumous edition of Dr. A. T. Thomson's *Treatise on Skin Diseases*. 8vo, 1850. [Dr. T. had completed this work (of 440 pp.) up to p. 304, and had left in MS. the chapters on Acne and Sycosis. With the exception of these two chapters, Dr. Parkes wrote the remainder of this work of his relative, from the commencement of "The Tubercular Eruptions."]

On the Decomposition of Chloride of Sodium by Acetic Acid in the presence of Albumen. *Medical Times and Gazette*, vol. xxii., p. 84, 1850.

Lecture introductory to opening of Session of University College, London, Oct., 1851. Published in *Medical Times and Gazette* of that date.

Editing articles in *British and Foreign Medico-Chirurgical Review*, 1852, *et seq.* [For this periodical he wrote many reviews anonymously, which for obvious reasons cannot be named here.]

On the Formation of Crystals in Human Blood. *Medical Times and Gazette*, vol. xxvi., 1852.

On the Precipitation of Albumen by Acids and Neutral Salts. *Medical Times and Gazette*, 1852.

On Recurrent Watery Diarrhœa with Choleraic Attacks. *Medical Times and Gazette*, 1852.

On the Elimination of Lead by Iodide of Potassium. Article in *British and Foreign Medico-Chirurgical Review*, Ap. 1853, p. 522.

On the Action of Liquor Potassæ on the Urine in Health. Article in *British and Foreign Medico-Chirurgical Review*, Jan., 1853, p. 258; continued in same journal for Jan., 1854, p. 248; and again, in relation to its Influence in some Chronic Diseases, in same journal for Oct., 1854, p. 498.

Review of Dr. E. J. Waring's work *On Abscess of the Liver*. *British and Foreign Medico-Chirurgical Review*, July, 1855, p. 1.

Gulstonian Lectures on Pyrexia. Published in *Medical Times and Gazette*, vol. xxxi., 1855.

Critical Days in Pneumonia—Value of Bleeding. *Lancet*, 1855, vol. i., p. 36.

Treatment of Pneumonia by Wine and Ammonia. *Lancet*, 1855, p. 128.
Report on the Formation and General Management of Renkioi Hospital on the Dardanelles, Turkey, during the Russian War, 1854–56. Addressed to the Right Honourable the Secretary of State for War. Published in 1857.
On Pigment Deposit in the Skin (so-called bronzed skin), without disease of Supra-Renal Capsules. *Medical Times and Gazette*, vol. xxxviii., Dec. 11, 1858.
On the Value of Albuminaria as a Symptom of Kidney Disease. *Medical Times and Gazette*, Jan. 1, 1859.
On Acute Sthenic Pneumonia left without Treatment. *Medical Times and Gazette*, Feb. 25, 1860.
Composition of the Urine in Health and Disease, and under the Action of Remedies, 1860.
Introductory Lecture at University College, on the Influence of Self-Training by the Medical Student. Published by Walton & Maberly. Oct., 1856. [There were at least three hundred auditors assembled in the large theatre of the College, and it is written in the *Lancet* that "the lecture was elegantly composed and well delivered, and was altogether much more appropriate, as an introduction to a Session, than those which for some years past we have chanced to hear on similar occasions."—"This lecture," says the *Medical Times*, "was written with great elegance and delivered with much feeling, elicited frequent marks of approbation, and was much applauded at its conclusion." It cannot fail to be worthy of reproduction now.]
Review of the Progress of Hygiene; commenced in 1861, at the request of the then Director of the Army Medical Department (Sir James Gibson), and contributed by him annually to the Medical Reports of the Department up till 1875, the commencement of his fatal illness. [They are models of *précis* writing, and a most valuable record of the progress of Hygiene.]
Report on "*Carniset*," a concentrated food. [This report is signed by the Professors of the Army Medical School; but the work was really done by Dr. Parkes, and published in Vol. I. of Departmental Reports for 1861.]
Lecture on opening Fifth Session of the Army Medical School—"On the Cure of Old Age." Oct. 11, 1862.
Report on Liebig's "*Extractum Carnis*," in Departmental Reports, Vol. V., 1863, p. 455.
A Manual of Practical Hygiene, prepared especially for the use of the Medical Service of the Army. 1864. Four editions have been published.
The Detachment of the Epithelium in Cholera. Aug. 25, 1866, in *Medical Times*.
Report on the Power of Disinfectants in Preventing the Putrefaction of Sewage. *Loc. cit.*, vol. viii. for 1866, p. 318.
Report on Dr. Hassall's "Flour of Meat." *Loc. cit.*, vol. x. for 1866, p. 242.
Reports on Filters. 1867 and 1868.
Report on Three Samples of Water received from Pembroke Dock in March, 1870. *Loc. cit.*, vol. xi. for 1869, p. 361.
Report "On a Cape Tent;" with Report on it as tried in the Autumn Manœuvres, by Assistant-Surgeon Lane, 4th Regiment. *Loc. cit.*, vol. xii., 1870, p. 260.
Croonian Lectures on Nitrogenous Elimination. Published in *Lancet*, 1871.
Royal Society Papers (*Transactions*), "Elimination of Nitrogen during Muscular Action." 1867 to 1871.
Effects of Alcohol on the Human Body. 1870, 1872, and 1874. *Transactions of the Royal Society*.
A Scheme of Medical Tuition. Published in the *Lancet* of 1868, p. 441, *et. seq.* It was afterwards published and dedicated to Dr. Geo. Borrows, President of Council.
Address to British Medical Association at meeting in London, 1873.
On the Issue of a Spirit Ration during the Ashantee Campaign of 1874. London, Churchill, 1875.

Mr LD
Dr Keelans Compts

ONE YEAR'S STATISTICS

OF

LITHOTOMY OPERATIONS

PERFORMED IN THE

HYDERABAD CIVIL HOSPITAL, SIND, INDIA.

BY

SURGEON-MAJOR B. C. KEELAN,

INDIAN MEDICAL DEPARTMENT, CIVIL SURGEON
AND SUPERINTENDENT OF THE MEDICAL
SCHOOL, HYDERABAD, SIND.

"Non timeo, sed caveo."

Bombay:
PRINTED AT THE
EDUCATION SOCIETY'S PRESS, BYCULLA.
1887.

MAP OF INDIA

The part colored thus shows the Province of Sind and adjoining Districts where Vesical Calculus is prevalent.

LITHOTOMY OPERATIONS.

THE annexed table gives a summary which is taken from the Monthly Returns of the Civil Hospital, Hyderabad, Sind, of operations for lithotomy for one year commencing from the 1st June 1886 and ending the 31st May 1887, giving a total of 188 cases.

A Tabular Statement showing the number of Cases operated upon, with results, &c., &c.

Age in Quinquennial periods.	Number of cases operated on.	Results.		Average number of days in hospital.	Average duration of illness in months.	Weight of stones corresponding to the different ages of persons operated on, arranged quinquennially.
		Cured.	Died.			
1 to 5	45	45	...	15	10	ʒi., ʒii., ʒii., ʒi., ʒi., ʒiss. ʒi., ʒiiss., ʒii. ℈i., ʒii., ℥iss., ʒii., ʒv., ʒi., ʒii., ʒii., ʒiss., ʒii., ʒi., ℈ii., ʒiss., ʒi., ʒi., ʒii., ʒii., ʒii., ʒss., ʒi., ʒiss., ʒiss., ʒiii., ʒi., ʒss., ʒss., ℈i., ʒii., ʒss., ʒiiss., ʒii., ʒiiss., ʒss., ℈i., ʒiss., ʒii., ʒiiss., ʒiss.
6 to 10	33	33	...	17	18	ʒv., ʒiii., ʒv., ʒiii. ℈ii., ʒii., ʒii., ℈ii., ʒii. ℈ss., ʒii., ʒiss., ʒii., ʒv., ʒiii., ʒii., ℥i., ℥iss., ʒivss., ʒiii., ʒiiss., ʒii., ʒii., ʒvi., ʒiv., ʒi., ʒiii., ʒss., ʒvi., ʒii., ʒiii., ʒvi., ℥ss., ʒii., ʒiii.
11 to 15	9	9	...	17	20	ʒi. gr. x., ℥i. ʒvi., ʒiiss., ʒiv., ʒiv , ʒv., ℥ii., ʒv., ʒvi., ʒi.
16 to 20	10	10	...	20	24	℥i. ℈ii., ʒv., ʒi. ℈i., ℥ii., ℥ss., ʒii., ℈ii., ʒii. ʒiv., ʒiv.

Age in Quinquennial periods.	Number of cases operated on.	Result.		Average number of days in hospital.	Average duration of illness in months.	Weight of stones corresponding to the different ages of persons operated on, arranged quinquennially.
		Cured.	Died.			
21 to 25	8	8	...	22	24	ʒvi., ℥i. ʒi. ℈ii., ʒvi., ʒvi., ʒiii., ʒiv., ℥i., ℥iss.
26 to 30	10	9	1	26	28	ʒii. ℥v., ʒii., ℥i., ℥iiss., ℥i. ʒvi., ʒiv. ℥ivss., ℥i., ʒiv.
31 to 35	10	10	...	26	28	℥i. ℈ii., ʒv., ℥v., ʒiss., ℥i. ʒii., ʒii., ℥ii., ʒii., ʒiii., ʒii., ℥i.
36 to 40	13	13	...	28	30	℥i., ʒii., ℈ii., ʒiii., ℥i., ʒi., ʒiv., ʒiss., ℥ii., ℥i., ʒvii., ʒvi., ʒii., ʒv., ℥iss.
41 to 45	13	12	1	28	30	ʒvii., ℥iv. ʒvss., ℥ivss., ℥i., ℥i. ʒii., ℥i., ℥i., ʒvii., ℥iss., ʒii., ℥ii., ℥iii., ʒii.
46 to 50	24	22	2	30	36	℥i., ʒiii., ʒv., ℥v., ℥i., ʒii., ℥i. ʒi., ʒvii. gr. iv., ℥i., ʒiv., ℥i., ʒii., ℥i., ʒvi., ℥iv., ℥i., ℥i., ʒii., ʒvi., ℥xiv., ℥i., ℥iss., ℥ii., ℥ii., ℥iss., ℥iiss.
51 to 55	2	1	1	30	38	℥iii., ℥i.
56 to 60	9	8	1	30	38	ʒiv., ℥i., ℥ii. ʒii., ℥iv. ℈ii., ʒi. ℈ii., ℥iss., ℥ivss., ℥ii., ℥i.
61 to 65	1	...	1	30	36	℥i.
66 to 70	1	...	1	30	36	℥ii.
TOTAL......	188	180	8			

The patients operated upon were all healthy as far as I could ascertain. Old and weak men were not operated upon, nor were persons whom I had reason to suppose were suffering from any organic disease. The operations on moderately aged men were not

objected to by myself, provided always in those cases there was no constitutional affection or bodily infirmity discernible. Many old and feeble cases were, much against their will, sent to their homes without being operated upon, with instructions, however, for treating urgent symptoms both medicinally and dietetically.

It will be seen that there was no death among 105 persons operated upon under the age of 25 years; from 26 to 70 years there were 83 cases operated upon, with 8 deaths.

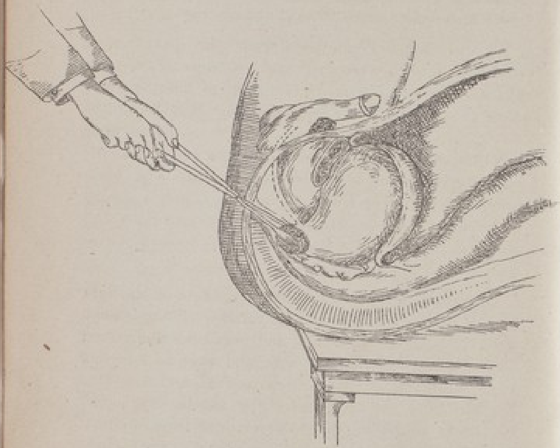
Of the 188 cases operated upon during the year under review, 163 were Mussalmans and 25 were Hindus—181 males and 7 females.

In order to avoid taking up too much room in this paper and to prevent the necessity of having too many tables, I have thought it better to arrange their ages in this table into quinquennial periods. The table will also show the average number of days spent by patients in hospital as well as the average duration of the growth of the calculi, arranged in quinquennial periods, to suit the ages of persons operated upon, which are also similarly arranged.

The weights of the stones are also shown in the same table in order to obviate the necessity of having a separate form for them.

The above statistics will show that stone is more prevalent in this Province in children of from 1 to 10 years of age and in adults from 30 to 50 years than at any other period of life. Very large calculi are only to be found late in life in persons whose ages vary from 45 to 70 years. One of the means of diagnosing whether the calculus is a very large one is by asking the patient how long he has been suffering from symptoms of stone in the bladder. If his troubles arising from this source are asserted by the patient to be of 8 or 9 years' standing, then generally a fair estimate can be made of the size of the stone; and if the symptoms are accompanied by intense pain and straining with bloody urine, the probabilities are that the stone is rough.

The admissions are from various parts of the Province of Sind, including the Thar and Parkar Districts, and also from the western parts of Gujerat and Rajputana, Kutch, Beloochistan, and the lower part of Afghanistan; and I may say that every patient suffering from stone in the bladder who comes to the Civil Hospital of Hyderabad (Sind) for treatment is generally accompanied by one or two or three of his relatives and friends, who devote their time to attending upon him in one of the stone wards until he is quite cured after operation. I have also observed that stone cases very rarely come singly, but in parties of two or three companions in affliction; so it can be easily imagined that this hospital is often crowded to excess. When a batch of stone cases come with their relations they are treated for a day or two, and all are operated upon, one after another, on the same day, as the persons who come in a party are all anxious to leave in each other's companionship. Owing to this rule in the Civil Hospital, Hyderabad, I have often to operate upon four individuals one after the other and on one and the same day. This, of course, necessitates the employment of a very large staff of attendants for



Showing the direction (viz: upwards and forwards) in which a large stone should be drawn out of the bladder.

the after treatment of the patients, and that service falls partly on the students of the Hyderabad Medical School who, I am glad to say, have always performed these arduous duties with skill and alacrity.

Of the stones removed during the year under observation, 120 were uric acid, 40 were black oxalate of lime, and 5 were white oxalate of lime; the rest were of various sorts, phosphates, &c. With regard to the uric acid calculi a great number of them were mixed with phosphatic deposit, and the nuclei examined were composed of dark coloured oxalate of lime, which goes to prove that Dr. Vandyke Carter's theory is correct, namely, that the nuclei of calculi found out here in the majority of instances are composed of oxalate of lime.

Of the oxalate of lime calculi, 40 were of the dark and 5 of the light coloured variety. Some calculi were of urate of ammonia, and were of a cinder grey colour; 2 were of xanthic oxide, and were of a cinnamon brown colour; 3 were cystic oxide, and were of a greenish hue; the latter, *viz.*, the xanthic oxide and the cystic oxide stones, were removed from children. Many of the phosphatic calculi were fetid and ammoniacal.

One of the calculi was covered with some substance which presented a considerable lustre. After some months this outer layer cracked and became very closely adherent to the stone, which was of a dark mahogany colour. This calculus appears to me to be the uro-steolith calculus described by Moore in the *Dublin Quarterly Journal* of 1854.

One of the calculi appeared to me to be similar to that which I have seen described in books as triple phosphate calculus or ammonio-magnesian phosphate.

One of the stones which were removed weighed 14 ounces; its outer covering was of uric acid and internally it was made up partly of phosphates, and consequently there was not much difficulty in breaking it up in the bladder. It was broken into 40 fragments, which were easily removed in 20 minutes. This large stone, now having been cemented together, forms the centrepiece of my collection of over 1,000 stones, which are all exposed for public view in the Hyderabad Medical School Museum, thus presenting quite an imposing spectacle and a wide field of investigation for persons skilled in the knowledge of human calculi. This collection is increasing daily, and I believe that after the lapse of five years more the number will not be less than 2,000.

These stones are all removed by means of the lateral method of lithotomy, with the exception of the very large ones, which require the bilateral operation for their removal, and the results, I may venture to state, speak well for that operation. Lithotrity in this hospital is only undertaken when the stone is small and soft, and can be crushed at one sitting. I may here mention generally that if a hard stone, weighing 2 or 3 ounces, is unfortunately crushed in the bladder of a human being and the fragments not removed in one sitting, which, to my mind, is next to impossible, the patient is not only worse off than he was before

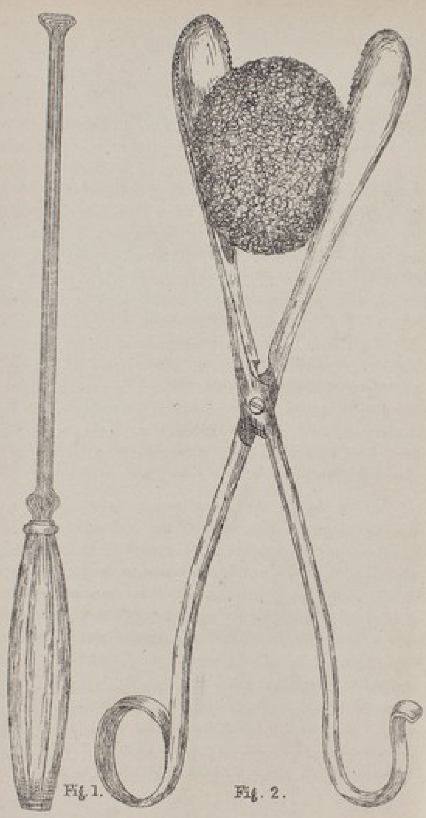


Fig. 1 Probang for pushing stone in Fig. 2 to its proper position.

the operation, but in two cases out of three the most alarming consequences may be the result.

I need not say that this state of things would be a source of great embarrassment to a Surgeon; his position would be similar to that of a General who had lost a great battle through a false manœuvre. I will now quote from that great book on Surgery, Volume II., page 656, by Agnew, of Pennsylvania. Speaking of Lithotrity, he says:—"Modern surgery is, I think, in certain directions rather too bold; there is a disposition to carry instrumentation a little beyond the solid ground of safety. I do not propose to enter a protest against all innovations on the old usages of our art, but only to utter the caution that it is wise to hasten slowly and to move circumspectly until a sufficient number of facts or observations have been accumulated to justify sound deduction on which to found a safe rule of practice."

With regard to the supra-pubic operation, I am of opinion that it should not be undertaken unless the stone be too large to be removed through the perineum, as this operation appears to me to be nearly as formidable an undertaking as the Cæsarian section. From my own experience of the very few cases which I have tried I may say that the results were far from favourable.

Were I to depart from my ordinary practice and perform lithotrity oftener than I do now, it is needless for me to say that I could hardly hope for similar results to those shown in the beginning of this paper. I have tried lithotrity with the best instruments which could be procured from London, but was obliged to abandon the operation in favour of lithotomy (except in instances when the size and structure of the stone permitted of its removal in one sitting) owing to the former operation having been attended by more fatal consequences; and it was very fortunate that I did so, for this hospital, under no other system, would, I feel convinced, have earned the confidence it now enjoys in this remote part of Her Majesty's dominions.

There is a striking contrast between the number of patients operated on for stone in the bladder in the Civil Hospital and that treated in the London hospitals.

These statistics will show that the patients admitted under this head in Hyderabad during one year were 188—a number which can hardly be exceeded by the total annual admissions of persons suffering from calculi in the bladder in twelve of the largest hospitals in the Metropolis.

The natives here affect to be so knowing that they can hardly be persuaded to undergo any operation for stone but that of lithotomy, which they are accustomed to, and which has justly won their confidence. They call for the stone after the operation, and if it is broken they consider this a bad omen, and another operation, in a year or two hence, to be a necessity—a surmise which very often proves unfortunately only too true, and they look for the same reason on lithotrity as only a half measure, which must be repeated as often as necessary, and in this I quite agree with them—not that I am against litho-

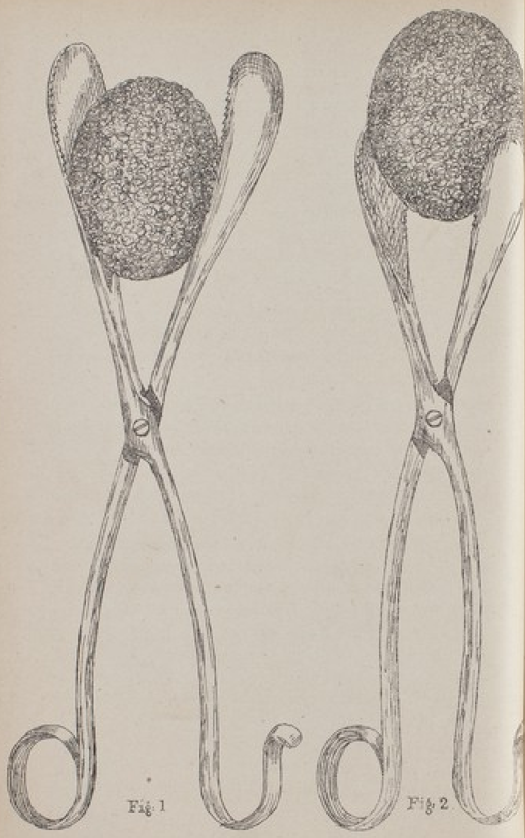


Fig. 1. How not to grasp the stone. *Fig 2. How to grasp the stone*

trity when undertaken to crush small stones or when the *débris* can be removed in one sitting.

The only means I know of ascertaining the exact size of a stone in the bladder is by introducing the lithotrite and measuring it between the blades. If it is a very large one—too large to pass through the perineum—the supra-pubic operation should then be performed after the method adopted by Sir Henry Thompson, the most eminent authority of the present generation. In the beginning of 1886, when I was enjoying my furlough in Bournemouth, I had the honour of being invited by him to London in order to witness his mode of performing this operation, and I was much impressed with the small amount of blood lost, considering the magnitude of the operation, in which he was assisted by Mr. Buxton Browne.

I have never experienced any difficulty in removing stones of under $4\frac{1}{2}$ ozs. by the lateral operations for lithotomy through the perineum. Large stones of over 6 ozs. can be felt through the abdominal walls, and the soft stone which I removed, weighing 14 ozs., formed a small tumour, somewhat resembling a small contracted uterus.

A New and Improved Mode of operating on large-sized Stones.

In removing a large-sized stone through the perineum, one of the most important points to compass is to seize it in such a manner that its long diameter may correspond with that of the wound as in nine out of ten cases the calculus has an oblong oval shape. This must be ascertained by means of the forefinger of the left hand, and if the stone is grasped crossways in the blades of the forceps, it must be dropped and seized again and the long diameter of the stone should be thoroughly ascertained and worked round with the finger until the desirable position is attained. It is sometimes exceedingly difficult to let go the stone from the blades of the forceps owing to the spasmodic contraction of the bladder; but this difficulty is easily overcome by means of a probang, as shown in the drawing, which I have invented and which has been in use in the Hyderabad Civil Hospital for the past seven years. This probang is passed through the wound by the side of the forceps until the stone is reached. The blades of the forceps having been then relaxed, the stone can be easily pushed from between them and the narrow part of the stone brought down towards the wound. The next most important matter to dwell upon is the order in which traction is to be effected, and this must be done in the direction of the lower outlet of the pelvis. Now, this direction from the position of the patient, placed as he is in the position for lithotomy on an operating table, is upwards and forwards, and in order to remove the stone in this direction (it being absolutely impossible to do so when the operator is standing in front of the perineum), the operator must stand upon a chair so as to get well above the breech. This gives him a complete command over his forceps. The stone should not be removed roughly or with any great degree of force. The parts should be cut and not torn; when the stone has been drawn into the wound, which is made to correspond with the size of the calculus, the fore-

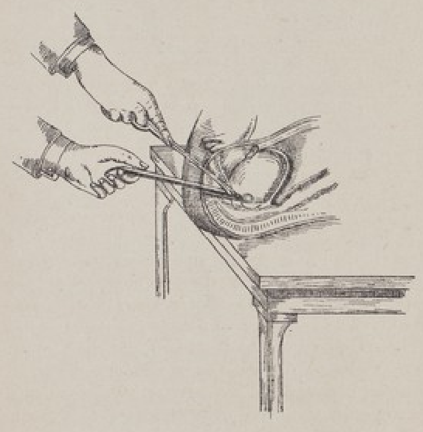


Plate to illustrate mode of using forceps and director in removing small stones in children under 5 years of age.

finger of the right hand should be passed round the stone so as to ascertain where the tension of the soft parts produced by the pressure of the stone against them is greatest. This is what has to be incised and it can be easily felt by the finger.

While exploring for this purpose, the forceps should be handed over to an assistant, who should be directed to draw upon the stone in a direction upwards and forwards, while the operator takes a scalpel in his right hand and explores with the index finger of his left hand, cutting freely and cautiously any bands of soft tissue which may be found obstructing the passage of the stone. This method of enlarging the wound should be adopted as often as any necessity is observed for so doing. The forceps having been now taken from the hands of the assistant, the stone should be pulled upwards and forwards, and at the same time rocked from right to left and *vice versâ*. This rocking should be done to the extent of one-fourth of a circle, not more, unless the stone goes round itself either to the right or left side. In this case it should be permitted to do so, as it is a sure indication of its entering the wound in a favourable diameter. Soon after the operation is begun the lower portion of the neck of the bladder will be found to give way, after which there is not much difficulty in removing the stone, provided always that the soft parts be cut when they obstruct the passage of the stone. If the calculus does not come after a moderate traction accompanied by the lateral motion above described, the forefinger of the left hand is again passed into the wound, which is searched in all directions, and those soft parts which are put upon the stretch by the pressure of the stone are incised cautiously in as many places as the circumstances will demand. It does not make much difference whether the obstructions be above, below, or to the right or left side; the tuber ischii, however, must be avoided, as the pudic artery runs under cover of it. The other arteries are so small that they hardly deserve much attention, as nearly all must be severed in removing a large stone through the perineum. Then, on again taking the forceps from the hands of the assistant, the narrow side of the stone should be seized, just sufficiently far from the edge to prevent the blades from slipping. To render this easy, the probang should be passed through the wound and the stone gently tapped or pushed with it a few times while the forceps are slightly relaxed. It is not a good practice to enclose the stone completely within the blades. The calculus is again gently pulled or rocked as before. When the stone is small, there is of course no difficulty in its removal. But when it reaches from $2\frac{1}{2}$ to 5 ozs., then I find its successful removal can only be accomplished by attending to the above remarks.

When a stone is large and round it cannot usually be removed by an ordinary stone forceps owing to its liability to slip away from the grasp of the blades. To obviate this, I use a forceps as shown in the accompanying drawing. It will be observed that the blades are bent near their extremities to meet at an acute angle.

A stone seldom slips from a forceps made in this way.

An improved and successful mode of arresting haemorrhage after the operation of lateral Lithotomy, by a pad of carbolized tow combined with palmar pressure, as practiced in the Hyderabad Hospital.

A New Operation for Children.—In performing the operation for lithotomy on children under 5 years of age, I never have occasion to introduce my finger into the bladder—a proceeding which I consider somewhat dangerous in a child so young. I perform such an operation as follows :—The usual opening having been made in the perineum with a small scalpel and carried on by a small blunt pointed bistoury in the groove of the staff, to reach the bladder I introduce through the wound in the perineum a grooved director, passing it along the groove of the staff into the bladder and then withdrawing the staff. On the groove of the director now in the bladder I then introduce through the wound a very small pointed forceps, which is much smaller than the finger and made to fit the groove in the director. The forceps cannot possibly miss the bladder, on reaching which the blades are opened to seize the stone, which can be done without any difficulty.

The advantages of this mode of operating can be easily understood, as lacerating with the finger the neck of the bladder of so young a child as this operation is intended for might be fraught with some danger or even attended with most alarming consequences. The plate will show how the pointed forceps is introduced into the bladder through the perineum in the groove of the director. In one of the children operated upon there was an obstruction in the urethra about the bulb and the sound could not be got to pass beyond it. An incision was made in the perineum down to the staff and the grooved director pushed into the bladder. This was cut open and the stone removed by the small forceps before alluded to, which I invariably use in such cases.

As regards the operation in children, which is by far the most frequently performed in this hospital, the parents have long since ceased to regard it as a formidable operation. They without the least hesitation bring their children for operation and look on the result as a certainty, namely, that the little patient will be considered convalescent and will be allowed to walk after ten or twelve days, and in the course of another few days will be completely and permanently cured of a most painful and wearing disease. The child to be operated upon is placed sitting in its mother's lap, where chloroform is administered until its little limbs have been somewhat relaxed. In this way the child is not alarmed, as it would be if put upon the operating table at once. The semi-conscious child is then placed upon the operating table and completely put under the influence of chloroform. I need not dwell upon the ordinary method of performing lithotomy in children, as this is fully described in the Text-books.

It is very common for the staff to slip out of the bladder during the time of the operation, especially in young infants, unless the operator happens to possess considerable practice in reaching the bladder. Should an accident of this description occur, I would recommend the withdrawal of the sound and the searching of the bladder by the grooved director through the wound. This manœuvre is very easily performed and the director made to strike against the stone in the bladder. A blunt pointed knife may then be passed along the groove in the director and the bladder incised and the operation gone on with.

The operation in women is a very simple proceeding,

the urethra being short and dilatable. One of the females applied for relief in the eighth month of pregnancy. She was 35 years of age, and on examination it was found that the stone was 2 inches broad and 2½ inches long. The danger of parturition under these circumstances was impressed upon her, as, of course, it was impossible for the child's head to pass down the vagina with such a formidable obstruction as this calculus presented. She was therefore operated upon, and the stone, on being removed, weighed 2½ ozs. During the operation venous hæmorrhage was enormous, but the operation was so speedily performed that the loss of blood was not very great. It was checked at once after the operation by the pressure of a pad in the ordinary way. She made an excellent recovery, and left the hospital in about three weeks from the date of the operation.

There seems to be some apprehension felt abroad in the profession generally that the operation for lithotomy is frequently attended with primary or secondary hæmorrhage; but this complication appears to me to be of rare occurrence, as out of 188 cases under review in the paper, only 4 cases gave any trouble in the after treatment from this cause and the bleeding was arrested by pressing the lips of the wound together and applying a pad, which was pressed firmly over the wound by both hands of a hospital attendant for three hours in each case. In not a single case was it necessary to tie an artery. Directly the stone is removed, a pad, consisting of very fine tow previously steeped in carbolic solution, is placed over the wound, the lips of which having been previously brought together and pressed there very tightly by a strong man. We have four such hospital attendants belonging to the stone wards who have acquired considerable experience in stopping hæmorrhage by external pressure. To this may be attributed the rare occurrence of hæmorrhage after lithotomy in the Hyderabad Civil Hospital. After the operation an opiate is given, the patient is removed from the operating table, and kept under observation of Mr. Jacob, an exceedingly able hospital assistant in the surgery, throughout the day. This is much safer than taking him to the stone ward immediately, as, if bleeding should occur, he orders external pressure to be continued as above indicated. About an hour after the operation the patient passes urine freely. This appears to give great relief from straining felt by him after the operation. This straining is a fertile cause of hæmorrhage, and generally lasts for an hour or so, when it gradually begins to decline; but it often lasts much longer than this period. When I pay my evening visit, that is about eight hours after the operation, I find generally that patients have little or no straining. They are then removed to the stone ward, where the after treatment is carried out. During this period no tube is passed into the bladder. The old system of the catheter, with the cloth tied round its middle, acts as a foreign body, and is a complete failure. Meddling with the wound during this time should be avoided, as the introduction of a catheter not only acts as a foreign body but also obstructs the free passage of urine, and therefore renders extravasation into the tissues around the neck of the bladder extremely probable. I need not dwell on the danger of this occurrence.

The urine is allowed to trickle through the wound, which is washed three times a day with water containing 2 per cent. of carbolic acid and dressed with carbolic oil, one in forty. Milk, chicken broth, and beef-tea, with rice, are given, sometimes accompanied with corn-flour, arrowroot, &c. If the wound is obstructed by a clot of blood endeavouring to escape from the bladder, a straight silver catheter is passed into the bladder and removed immediately, or the clot may be taken away by a dressing forceps. On the third day after the operation an enema is given, consisting of castor-oil, starch, and laudanum. If there is any pain over the bladder, hot fomentations are applied, accompanied by opiates. If there is fever, diaphoretics and quinine are given. These are common complications. Other complications are treated according to the circumstances of each particular case, and the patient should be watched to see that the urine is regularly voided and the nature of the fluid passed should be examined from time to time. If the urine comes freely, gradually assuming after a few days its natural colour, then it may be surmised that the patient is doing well; if, on the other hand, it is scanty and reddish, with much pain in the hypogastric region, the prognosis is not so favourable. But it must be remembered, however, that sometimes the urine becomes discoloured from clots of blood in the bladder: this must not be looked upon as an unfavourable sign. Should suppression set in, the case may be considered critical and dangerous. In eight or ten days convalescence is shown by the urine beginning to come from the urethra. Complications are so numerous that it would be too lengthy to record them in this report. Towards the end, when the patient is convalescent after the operation, tonics are given.

A few of these operations have been successfully performed by my able assistants, Drs. Aquino and Bocarro.

Cause of stone.—As regards the cause of stone I will not venture an opinion, for it does not exactly fall within my province to do so. Sufficient light has been thrown on the subject by Drs. Bernard, Pavy, Sir Henry Thompson, and others during the past 20 years or so. However, I think it would hardly be out of place to mention that the natives of this province attribute its prevalence to the use of the muddy water of the river Indus, which they invariably drink. The province of Sind is a network of canals and tanks, derived from this river and its tributaries, and their waters are laden with silt. It is a most extraordinary circumstance that the natives prefer the muddy water of the river Indus as it exists to the water when it is rendered pure and sparkling by filtration and by the addition of a little alum. I do not know why this should be the case, except that they are too lazy to filter it; but that it is so there can be no question, for, it has degenerated into a habit which seems to have been sanctioned by long custom among the inhabitants.

I will now quote from that excellent book, A Manual of Practical Hygiene, by the late Dr. Edmund Parkes, edited by Dr. F. S. B. Francois De Chaumont, of Netley, page 56 :—

"It has long been a popular opinion that drinking lime waters give rise to calculi (calcium phosphate and oxalate). Several medical writers have held the same

opinion, and have adduced individual instances of calculi (? phosphatic) being apparently caused by hard waters and cured by the use of soft or distilled water. On a large scale, statistical evidence is, as far as I know, wanting. The excess of cases of calculi in Norwich and Norfolk generally is not, in Dr. Richardson's opinion, attributable to the water. Dr. J. Murray, of Newcastle, has lately given some evidence to show a connection between the lime waters and calculi, especially phosphatics, but it does not appear to be more convincing than that previously adduced.

"At Canton stone is common, while at Amoy, Shanghai, Ningpo, and other places it is not met with. The cause of the difference is not known, but it is not chalk-water, as the Chinese always drink boiled water.

"Professor Gamgee, however, states that sheep are particularly affected by calculus in the lime-stone districts."

With reference to the foregoing remarks, I will not undertake to say positively that the prevalence of stone in Sind has any connection with the hardness of the water of the river Indus and its branches; however, I may say that I am almost convinced that the evidence is strongly in favour of Professor Gamgee's statement regarding the sheep in the lime districts of England being applicable to the people who inhabit Sind. I may assert, however, that the nucleus in at least seven out of ten cases of those stones which I opened up was found to be oxalate of lime. This is invariably rough on the outside and causes much irritation of the bladder, which is excited to throw out a mucous discharge. A layer of this glutinous material soon covers a small calculus, in which become embedded any deposits, such as uric acid, &c., which may happen to be in the urine, and which would otherwise probably pass away harmlessly: thus layer after layer surrounds the oxalate of lime nucleus until a stone is formed. Now, can this oxalate of lime nucleus be traced to the hardness of the Indus water? There can be no doubt whatever but that this water contains carbonate of lime. But how this substance becomes converted into oxalate of lime in the human body is a question which I must leave to others to decide.

It appears to me to be worth mentioning also that owing to religious customs among the natives, they are not permitted to pass their urine in any other than in the sitting position. It is very probable, therefore, that as the bladder cannot completely empty itself while a man is in this position that a few drops must remain behind owing to the pressure of the calves of both legs against the urethra. I imagine from this cause also that it is very difficult for a native to pass sediment or minute calculi when the urethra is thus constricted. Perhaps this mode of emptying the bladder might be reckoned as one of the causes of the prevalence of calculi in this country.

Sindhi Hakims.

Hippocrates, more than 400 B.C., alluded in his works to stone in the bladder and the means of its removal, which must have been exceedingly primitive in those days. It is alleged that long before this period the native hakims of India were adepts in operating for stone in the bladder by this method of "cutting on the gripe." However, whether true or not, this is purely a matter of speculation, there being no written proof as far as I could ascertain. It is a well known fact, however, that during the Kalhora and Talpur dynasties in Sind, and even after the British conquest of the province, that itinerant native doctors, called hakims, operated for lithotomy. Their mode of operating was to introduce one finger into the rectum and feel for the stone through the walls of the bladder, which was hooked down until a tumour could be felt in the perineum, in which a deep incision was made by means of a common razor and the stone removed by pincers. This mode was in olden times called in Europe "cutting on the gripe," which literally means cutting on the grip of the finger.

These hakims are said to have been much respected, and it is alleged that they demanded high fees for removing calculi in this primitive manner. They also professed to possess the power of dissolving calculi in the bladder by means of drugs. Powdered pearls was a favourite remedy with them. These and other precious stones were pounded in presence of their credulous patients, who were charged proportionately for each case, while the wily hakim demurely, but inwardly exulting, pocketed his fees. This favourable reception of the hakim's persuasive powers was rendered more easy by the fact of the natives having been taught from their infancy to look upon these impostors as endowed with profound wisdom together with a supernatural knowledge of surgery and medicine. During these last ten years I have observed that the belief of the natives has been much shaken in regard to the skill of these men to whom, I am happy to state, the natives no longer trust their lives.

Before ending this paper on lithotomy, I think I may state that what is asserted by myself suggests an allusion to a statement made by one of the foremost and famous Surgeons in London regarding this operation. I quote from page 315 of the British Medical Journal, dated August 14th, 1886, a statement made by Mr. John Eric Erichsen in an address delivered at Brighton at the meeting of the British Medical Association in August last:—

"The lithotomists of the 16th and 17th centuries cut successfully for stone until they were taught anatomy, and then a recognition of the dangers attendant on the operation shook their nerves and they lost their skill."

Now I have shown by these statistics what little danger there is attending upon this operation, and I trust that the true position which lateral lithotomy should hold in surgery may be recognised. My object in writing this paper is to show the fallacy of supposing that lithotrity or supra-pubic operation will ever supersede it. Statistics are stubborn facts, which I am sure will colour the question as to the choice of the operation for removing stone in the bladder. I would like to see other operators on stone publishing the result of their labours, being prepared to discuss the merits of their particular mode of operation, as I am anxious to advance the present knowledge of practical lithotomy, the literature of which, it is to be regretted, has had a checkered and uncertain existence in the present generation for want of reliable statistics.

It is quite true that anatomists have to some extent terrified Surgeons who have had little practical experience of this operation; but any formidable difficulties which demonstrators of anatomy can represent on the dead subject are purely theoretical, artificial, and delusive, and probably fashioned with the scalpel rather with the view to accommodate nature to descriptive prolixity than to describe the tissues of the perineum as they really exist in their entirety in the living body.

I maintain that the *transversus perineii*, long perineal and bulb arteries, are small and insignificant, and have never given me any trouble. The pudic artery is the only large artery in the perineum, and this vessel is protected by the tuber ischii. Of course, in searching out the relative merits of the different operations for removing stone from the bladder, it is necessary to work without prejudice, weighing each operation carefully, for it is only then that the interests of mankind can be fairly attended to.

My thanks are due to my assistant, Dr. Bocarro, for kindly presenting me with the map and plates which are embodied in this paper on lithotomy and which were drawn by him.

Copy of Register of Lithotomy Cases operated upon in the Civil Hospital, Hyderabad (Sind), from 1*st June* 1886 *to* 31*st May* 1887, *copied from the Hospital Register.*

No.	Names.	Caste.	Sex.	Age.	Place of residence.	Results.
1	Suchenoo	Muss ...	M.	50	Hatree	Cured.
2	Tyeb Jado...............	,, ...	M.	40	Nausharo	,,
3	Chooto Allahwarayo..	,, ...	M.	8	Sindri	,,
4	Allahrakhio	,, ...	M.	6	Moro	,,
5	Sangun	,, ...	M.	34	Khipra	,,

No.	Names.	Caste.	Sex.	Age.	Place of residence.	Results.
6	Suffar Maorid	Muss....	M.	13	Hala	Cured.
7	Babajur.....................	,, ...	M.	5	Tando Alahyar	,,
8	Gul Mahomed	,, ...	M.	28	Bula Khan's Thana.........	,,
9	Oors Chibhar	,, ...	M.	14	Tharusha	,,
10	Yaroo.....................	,, ...	M.	60	Nausharo	,,
11	Abdoola..................	,, ...	M.	25	Khairpur	,,
12	Malhoo	,, ...	M.	8	Matari	,,
13	Hajee Rahamtoola ...	,, ...	M.	50	Mooltan.........	,,
14	Lahnee	Hindoo.	F.	40	Sakrand	,,
15	Doongar	Muss....	M.	5	Tando Bago ...	,,
16	Wassayo	,, ...	M.	3	Kotri	,,
17	Yousoob	,, ...	M.	6	Jerruck.........	,,
18	Mahadoo	,, ...	M.	55	Do.	Died.
19	Sadik Joomono	,, ...	M.	24	Tando Jam. ...	Cured.
20	Bacho Auchar	,, ...	M.	60	Nausharo	Died.
21	Jeeyo Hurroo	Hindoo.	M.	6	Gidu Bunder.	Cured.
22	Kassum Rahimunoo..	Muss ...	M.	48	Matari	,,
23	Kirta	Hindoo	M.	38	Hyderabad, Sind............	,,
24	Thanwar	,, ...	M.	50	Mehar	,,
25	Mitho Salleh............	Muss....	M.	40	Hala	,,
26	Gunoo Assoo	Hindoo.	M.	50	Hyderabad, Sind............	,,
27	Oomer	Muss....	M.	8	Hyderabad, Sind............	,,
28	Manoo	Hindoo.	M.	60	Gidu Bunder...	,,
29	Mithoo Sadick	Muss....	M.	17	Kotri	,,
30	Bhejoo	Hindoo.	M.	11	Tatta	,,
31	Poonya Malleh.........	,, ...	F.	4	Talhar	,,
32	Sewoo Lakoo	,, ...	M.	4	Gidu Bunder...	,,
33	Pario Ibrahim	Muss....	M.	50	Tando Mahomed Khan ...	,,
34	Bachal	,, ...	M.	60	Nausharo	,,
35	Audul.....................	,, ...	M.	3	Moro	,,
36	Yousoof Soomar	,, ...	M.	60	Larkana	,,
37	Jeewat Laloo	Hindoo.	M.	3	Tando Bago ...	,,
38	Sadik Goolloo	Muss....	M.	40	Do. ...	,,
39	Allahwarayo	,, ...	M.	50	Do. ...	,,
40	Bacho Karim	,, ...	M.	5	Mirpur Khas. .	,,
41	Waria Sutharno	,, ...	M.	42	Shadadpur ...	,,
42	Khoodad	,, ...	M.	20	Mehara	,,
43	Hasson Ibrahim	,, ...	M.	8	Tatta	,,
44	Hasson Batcho	,, ...	M.	45	Tando Bago ...	,,
45	Chain.....................	Hindoo.	M.	55	Nausharo	,,
46	Waria Kowrho.........	Muss....	M.	40	Mirpur Butora	,,
47	Zendo.....................	,, ...	M.	35	Boodhapure ...	,,
48	Ahmed Golo............	,, ...	M.	4	Mitti	,,

No.	Names.	Caste.	Sex.	Age.	Place of residence.	Results.
49	Bachal	Muss....	M.	7	Nara	Cured.
50	Khakoo Koja	,, ...	M.	3	Jerruck	,,
51	Jooma	,, ...	M.	40	Tando Mahomed Khan ...	,,
52	Dilshahbad	,, ...	M.	60	Mehar	,,
53	Peerano Jamil	,, ...	M.	5	Badin............	,,
54	Osman Karam	,, ...	M.	4	Tando Jam ...	,,
55	Khamiso	,, ...	M.	5	Tando Bago ...	,,
56	Memghan	Hindoo.	M.	30	Do. ...	,,
57	Alli Khan Hakim ...	Muss....	M.	3	Manjhand......	,,
58	Osman Karam	,, ...	M.	4	Umerkote......	,,
59	Haroon	,, ...	M.	8	Keti Bunder...	,,
60	Sarab	,, ...	M.	7	Tando Bago ...	,,
61	Ahmed Doss............	,, ...	M.	50	Matari	,,
62	Jussoo Moorj	Hindoo.	M.	6	Do.	,,
63	Shewak Tikio	,, ...	M.	2	Bhitsha	,,
64	Sadik Gahram	Muss....	M.	2	Digree	,,
65	Duinoo Gohram	,, ...	M.	42	Tando Bago ...	Died.
66	Rozee.....................	,, ...	M.	10	Umerkote......	Cured.
67	Imam Bux	,, ...	M.	35	Do.	,,
68	Abdool Lutiff	,, ...	M.	9	Kipra............	,,
69	Hashim Joosoob	,, ...	M.	9	Khanote	,,
70	Jeewan	,, ...	M.	4	Sehwan.........	,,
71	Matharo Gulam	,, ...	M.	50	Shadadpure ...	,,
72	Sangee Bux	,, ...	M.	5	Umerkote......	,,
73	Begum	,, ...	F.	3	Do.	,,
74	Moroo Rahim	,, ...	M.	10	Khipra	,,
75	Soorio	,, ...	M.	3	TandoAllahyar	,,
76	Tahal Ayil	Hindoo.	M.	2½	Hala	,,
77	Jogee Mitho............	Muss....	M.	20	Johee............	,,
78	Ismael	,, ...	M.	3	Matari	,,
79	Gover Mitho	,, ...	M.	62	Sakrand	Died.
80	Abhayo..................	,, ...	M.	10	Do.	Cured.
81	Zangee Khan	,, ...	M.	50	Tando Jam ...	,,
82	Khoodo Salleh.........	,, ...	M.	7	Bhonote	,,
83	Sahewn Kadoo.........	,, ...	M.	4	Umerkote......	,,
84	Mookim Aliff	,, ...	M.	4	Do.	,,
85	Hajee Sayinoo.........	,, ...	M.	26	Hala	,,
86	Karimunnoo............	,, ...	M.	2	Shikarpur	,,
87	Akk. Muthoo	,, ...	M.	20	Tando Adam...	,,
88	Kambir Mohbet	,, ...	M.	30	Sakrand.........	,,
89	Moroo Saboo	,, ...	M.	10	Moro	,,
90	Mahomed Hoosain ...	,, ...	M.	70	Hyderabad, Sind............	Died.
91	Misree Isso	,, ...	M.	45	Tando Alahyar	Cured.
92	Jogo	Hindoo	M.	16	Umerkote......	,,
93	Kirta Kesree	,, ...	M.	60	Do.	,,
94	Muthoo Husson	Muss....	M.	4	Tando Alahyar	,,

No.	Names.	Caste.	Sex.	Age.	Place of residence.	Results.
95	Mullook	Muss	M.	3	Husri	Cured.
96	Hajee Soomar	,,	M.	40	Tatto	,,
97	Saheb Jadee	,,	F.	4	Mirpur Khos.	,,
98	Ahmed Khairo	,,	M.	50	Tando Mohamed Khan	,,
99	Salleh	,,	M.	8	Dowlutpoor	,,
100	Bachal	,,	M.	30	Matari	,,
101	Jooma	,,	M.	3	Bhanote	,,
102	Allahbuchayo	,,	M.	38	Mehar	,,
103	Pir Mahomed	,,	M.	6	Sakrand	,,
104	Kirpal	Hindoo.	M.	42	Umerkote	,,
105	Moorad	Muss	M.	42	Khairpoor	,,
106	Oodhow Gyan	Hindoo.	M.	25	Shadadpur	,,
107	Allahwarayo	Muss	M.	6	Hala	,,
108	Fakiro Fowzo	,,	M.	50	Sehwan	,,
109	Rijakbai	Hindoo.	F.	45	Sakrand	,,
110	Jagia	,,	M.	17	Umerkote	,,
111	Sidik Gunee	Muss	M.	3	Mirpur Butora.	,,
112	Gohram	,,	M.	34	Moro	,,
113	Pallio	,,	M.	13	Do.	,,
114	Sanyiditho	,,	M.	50	Sakrand	,,
115	Allahwarayo	,,	M.	6	Shadadpur	,,
116	Nindo Rakhio	,,	M.	25	Nasarpur	,,
117	Gool Mahomed	,,	M.	60	Matari	,,
118	Allee Bux	,,	M.	2	Kandiaro	,,
119	Sookhio	,,	M.	42	Saidabad	,,
120	Kadoo Pandhi	,,	M.	12	Tando Bago	,,
121	Hoosain	,,	M.	38	Hala	,,
122	Bahadar Habib	,,	M.	45	Kotri	,,
123	Khan Mahomed	,,	M.	13	Jesulmir	,,
124	Allee Bux Fazal	,,	M.	2	Kandiaro	,,
125	Wahsal Janee	,,	M.	26	Larkana	,,
126	Salleh Humzo	,,	M.	12	Mirpur Sacro.	,,
127	Haji Abdul	,,	M.	60	Dadu	,,
128	Bungool Jeeyand	,,	M.	48	Tando Bago	,,
129	Mahomed Khan	,,	M.	38	Shahpur	,,
130	Dhunnoo Chundun	Hindoo.	M.	30	Moro	,,
131	Joons	Muss	M.	13	Jerruk	,,
132	Mahomed Buchu	,,	M.	7	Lahore	,,
133	Khavindinoo	,,	M.	34	Kandiaro	,,
134	Hajee Doss Mahomed	,,	M.	48	Hala	,,
135	Mahomed Sadik	,,	M.	3	Hyderabad, Sind	,,
136	Allee Bux	,,	M.	34	Naushero	,,
137	Dada Choota	,,	M.	34	Do.	,,
138	Kuloo Kessoo	Hindoo.	M.	36	Dadu Taluka	,,
139	Adam Hassul	Muss	M.	34	Matari	,,
140	Joommoo Hofio	,,	M.	32	Mitti	,,

No.	Names.	Caste.	Sex.	Age.	Place of residence.	Results.
141	Oomar Abdulla	Muss	M.	7	Shadadpur	Cured.
142	Liyar	,,	M.	50	Hutree	,,
143	Pario Joommoo	,,	M.	25	Tando Kesser.	,,
144	Godoo Jessoo	Hindoo.	M.	11	Limojo Kamb.	,,
145	Bacho Bahadoor	Muss	M.	4	Shadadpur	,,
146	Sarab Soaro	,,	M.	45	TandoAlahyar.	,,
147	Oors Moorid	,,	M.	6	Tajpoor	,,
148	Yaroo	,,	M.	22	Shadadpur	,,
149	Rajoor Bhumro	,,	M	28	Hala	,,
150	Wudho Acho	,,	M.	42	Kotri	,,
151	Mutharosha	,,	M.	1½	Tando Mahomed Khan	,,
152	Meherbai	,,	F.	4	Sakrand	,,
153	Moortja Ahmedsha	,,	M.	8	Tando Mahomed Khan	,,
154	Allahrakhio	,,	M.	50	Do.	Died.
155	Badul Summo	,,	M.	8	Tando Kesser.	Cured.
156	Haroon Cassum	,,	M.	16	Gidu Bunder	,,
157	Hajee Jamal	,,	M.	16	Tando Bago	,,
158	Rumzan	,,	M.	45	Mirpur Khos	,,
159	Oorasdad	,,	M.	8	Bookera	,,
160	Gazee	,,	M.	22	Tando Mahomed Khan	,,
161	Moosa	,,	M.	42	Shadadpur	,,
162	Wassand Nebhow	,,	M.	8	Umerkote	,,
163	Mahomed Goolam	,,	M.	3	Sakrand	,,
164	Hajee Ahmed	,,	M.	50	Petaro	Died.
165	Allarakhio	,,	M.	4	Khokar	Cured.
166	Khair Mahomed	,,	M.	30	Shadadpur	Died.
167	Kadoo Abbum	,,	M.	4	Hyderabad, Sind	Cured.
168	Khamisso	,,	M.	5	Do.	,,
169	Bachal Pario	,,	M.	50	Tajpur	,,
170	Matharo Goolam	,,	M.	60	Shadadpur	,,
171	Kessur Farrid	,,	M.	4	Shahjibhit	,,
172	Khoodoo	,,	M.	4	Hyderabad, Sind	,,
173	Humzo	,,	M.	22	Sakrand	,,
174	Mahomed Dowlat	,,	M.	30	Do.	,,
175	Kandero Bulund	,,	M.	8	Tando Alahyar.	,,
176	Joomo Dinno	,,	M.	38	Matari	,,
177	Allee Bux	,,	M.	18	Mirpur Khos	,,
178	Waleno Enayet	,,	M.	50	Mehar	,,
179	Khooda Bux	,,	M.	22	Umerkote	,,
180	Hyder	,,	M.	48	Khipra	,,
181	Goolam Alee	,,	M.	17	Tando Mahomed Khan	,,
182	Pario Nebal	Hindoo.	M.	48	Sakrand	,,

No.	Names.	Caste.	Sex.	Age.	Place of residence.	Results.
183	Allahbuchayo	Muss....	M.	2	Khebar	Cured.
184	Dado Ameen	" ...	M.	50	Khipro	"
185	Sayan.....................	" ...	F.	35	Shadadpur ...	"
186	Allahwarryo..........	" ...	M.	2	Khipro	"
187	Choota	" ...	M.	9	Gidu Bunder..	"
188	Delawar	" ...	M.	6	Mehar	"

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ON VARICOCELE

IN RELATION TO

ADMISSION TO THE SERVICES

BY

HENRY RUNDLE, F.R.C.S.
SURGEON TO THE PORTSMOUTH ROYAL HOSPITAL

[*Reprinted from St. Bartholomew's Hospital Reports, Vol. XXXV.*]

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VARICOCELE IN RELATION TO ADMISSION TO THE SERVICES.

BY

HENRY RUNDLE, F.R.C.S.

The physical requirements of candidates for admission to the navy and army is a subject of interest and importance. The following notes, founded on 375 cases of varicocele treated by operation, refer to this ailment as a disqualifying cause for entering the services.

The cases were treated in the Royal Hospital, Portsmouth, in the decennium 1889 to 1898, where the surgical staff's experience of varicocele is exceptionally large. Probably there is no hospital in the kingdom in which so many cases of this kind are admitted. I find that 281 cases were operated on in St. Bartholomew's; 27 cases in the Norfolk and Norwich Hospital, representing a combined town and agricultural population; 212 cases in the General Hospital, Birmingham, a manufacturing centre, during the same ten years, whilst at the two civil hospitals at Plymouth, where the conditions are similar to those at Portsmouth, 314 cases of varicocele were operated on, and at the Royal Portsmouth Hospital there were 375, an average of 37.2 yearly.

This large number of varicoceles is out of proportion to the number of other surgical cases admitted, and is due to the close connection of Portsmouth, the chief naval arsenal of the empire, with the navy, where so many young men adopt that branch of Her Majesty's service as a career. Among the many disqualifying causes which debar candidates from admission into the public services, the existence of a varicocele is among the most frequent. Some of the patients treated were recruits for the army, but as the larger number were candidates for the navy, I have limited my figures to this service. The following table, compiled from figures kindly given me by Staff-Surgeon

J. J. Dinnis, R.N., shows the number of candidates examined for H.M.S. *St. Vincent*, the training-ship for boys at Portsmouth, for the five years 1893-1897, with the rejections for varicocele :—

Year.	Candidates Examined.	Rejected for Physical Defects.	Rate per Cent.	Rejected for Varicocele.	Rate per Cent.
1893	793	364	45.90	52	14.29
1894	861	363	42.16	55	15.15
1895	846	355	41.97	50	14.08
1896	632	314	49.68	69	21.97
1897	710	258	36.34	42	16.28

YEARLY AVERAGE ON FIVE YEARS.

Average Number Examined.	Average Number per Cent. Rejected.	Average Number per Cent. Rejected for Varicocele.
768.4	43.05	16.20

It is stated by Bennett[1] that of 100 cases of varicocele seen in hospital and private practice which sought treatment, 27 per cent. did so in order to meet the requirements of the public services. I am strongly of opinion, from practical experience, that too many men are rejected for this cause. There are probably few young men whom it would not be possible to reject on some physical ground if the examiner was so minded. Obviously it is necessary to reject cases associated with inguinal rupture, or in which the presence of a varicocele of considerable size causes a sense of aching after exercise, with inability to stand for practically any length of time. But such cases, I believe, are not common. In a large majority of instances the men were strong, well-developed young fellows from 15 to 18 years of age, in whom the enlargement of the spermatic veins was associated with robust sexual health. They were free from hæmorrhoids or other visible varices. Atrophy of the testicle—a consequence of pressure of blood in the veins—was seldom present, and the men themselves were absolutely unconscious of anything amiss, either from observation or symptoms, until they were told to be "set right" at the hospital and to come up again for examination.

Varicoceles, even when the veins are much dilated, are not due to a yielding and thinning of the walls, as takes place in

[1] On Varicocele, a Practical Treatise, 1891.

varices elsewhere (they never rupture), but, as pointed out by Pearse Gould,[1] are produced by a primary growth of venous tissue—in fact, to venous hypertrophy, consequent on the development and activity of the testicle.

In almost all these cases the left side was affected. The veins of the pampiniform plexus belong to the vascular Wolffian body in the embryo, and are more completely obliterated on the right side than on the left.

It is interesting to note the opinions of the medical officers of two of our great public schools. Dr. Clement Dukes,[2] Rugby, writes: "Boys between the ages of 13.5 and 15 have varicocele at the rate of 14 per cent.; varicocele requiring operation, 1 per cent." Dr. Clarence Haig-Brown,[2] Charterhouse, states: "Of 100 boys who enter a public school at 17 years of age, very few will be found out of 75 who do not exhibit vigour of mind and health of body. Some degree of varicocele, nearly always on the left side, will be found in from 25 to 30 per cent.; the cases in which it is sufficiently marked to require operation, about 1 per cent."

I may add the experience of two eminent living surgeons. One, held in the highest esteem by all who have been educated at St. Bartholomew's—Sir James Paget[3]—writes: "It is common enough to find varicoceles in quite healthy men, who being sufficiently careless or sensible to make light of it, suffer no harm either mental or bodily. In short, the cases in which varicocele is more than a trivial affair are very few." The other, Professor Senn,[4] of Chicago, states, "that of 9815 recruits examined, 2078 were affected with varicocele, that is, 21.17 per cent.;" and from his observation he is led to the conclusion that varicocele is very seldom a cause of disability for military service, and that operative treatment is very seldom indicated.

There is not much divergence of opinion as to the best operation when operative measures are required. I believe that two only are practised at present, viz., the "subcutaneous" and the "open." In the subcutaneous ligature you are in some degree working in the dark, and cannot be sure of including all the veins. Moreover, you are not able to shorten the cord, an important matter when the testicle hangs low. I have seen cases operated on by this method which were not cured. In the "open" procedure the veins are seen and accurately separated. I think that the "open" operation may

[1] Transactions of the Clinical Society, 1881.
[2] For these notes I am indebted to private communications.
[3] Clinical Lectures and Essays.
[4] Philadelphia Medical Journal, January 18, 1898.

be regarded as an infallible method of performing a radical cure. I have never known a failure.

In all these cases, that which I would call the "high and open" operation was adopted. The usual skin cleaning having been carried out, an incision about two inches in length is made immediately below the external abdominal ring. It is more easy to keep the wound here aseptic than lower in the scrotum. The veins are pressed forward into the wound and separated from the vas deferens. A blunt-pointed aneurysm needle armed with catgut is pushed behind the veins above and below, the intervening portion of vein removed, and the stumps, ligatured and tied together, are allowed to fall back. The wound is closed by fishing-gut sutures. It is the exception to the rule if healing by first intention does not take place, and the patient discharged within a fortnight from the day of operation. Probably there will be some orchitis, for which a suspensory bandage should be worn. I have never seen sloughing of the testicle. I have seen two cases in which slipping of the ligature occurred. This was followed by a hæmatocele, which retarded recovery.

In my recent cases local anæsthesia by a 5 per cent. solution of eucaine was employed. It produced some œdema of the part, but the result was quite satisfactory.

To sum up: the inferences which I wish to draw are:—

1st. (*a*) That varicocele exists in a large number of young men, probably 18 to 20 per cent., and does not produce any physical discomfort.

(*b*) And ought not to be considered a cause for disqualifying them, except in rare and pronounced cases, from entering the services.

(*c*) And that such ordinary cases do not demand operative interference.

2nd. In cases where an operation is required, ligature and excision of veins by an open incision is the best to adopt. It is a simple undertaking, free from danger, and the result excellent.

Received 6/5/86

from the Director General
Army Medical Dept

ADDRESS

AT

NETLEY

BY

GEORGE DAVID POLLOCK

1888

ADDRESS

DELIVERED AT THE PRESENTATION OF PRIZES

AT THE

ARMY MEDICAL SCHOOL AT NETLEY

On the 2nd of February 1888

BY

GEORGE DAVID POLLOCK

CONSULTING SURGEON TO ST. GEORGE'S HOSPITAL.

Printed by Request and for Private Use.

LONDON:
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1888.

ADDRESS.

Gentlemen,—Permit me first to express to your distinguished Director-General, Sir Thomas Crawford, and to the Senate of the Army Medical School at Netley, my high appreciation of the great honour they have conferred on me in deputing me to distribute among the successful candidates the prizes awarded them for the excellence of their work during the past session.

It is, moreover, a great pleasure to me to be here on an occasion of this kind, to participate in those feelings of satisfaction which all must experience when able to look back upon work well done, meeting with encouragement and recognition from those who have had to direct, and have watched over, your course of studies, and who can alone appreciate and estimate the comparative worth and excellence which is the outcome of those studies now terminated.

This occasion recalls to my mind the feelings with which I had to receive a prize in surgery from the hands of the late Sir Benjamin Brodie, then attached to St. George's Hospital, in the wards of which institution I endeavoured to follow, however imperfectly, the teaching and advice we received from that distinguished surgeon. I recollect with gratitude and admiration the energy and earnestness with which he strove to impress upon us the necessity of *work*, to render ourselves fitted for the important duties and responsibilities which devolved upon medical men, and that it was only by earnest, honest, and constant work in the wards, in the deadhouse, and in the lecture room, that we should obtain that solid information which would efficiently qualify us to deal with the various disorders to "which flesh is heir." Compared with what you will hereafter have to contend with your past work has been easy. You have here trusted with confidence, and properly so, to the supervision of your teachers in the practical department of your work. You have consequently been rendered independent of much personal responsibility, and of all personal anxiety when watching those patients it has been your duty to take note of. But you will now pass to another sphere of work. You will commence your official life in a country of vast and interesting features; a country of much varying soil, and in many parts still deficient in sanitary conditions; a country which offers a great field for the investigation of disease, and in the investigation of which all your energies have to be exercised to the utmost if you desire to investigate or overcome their evil influences.

This change is the commencement of much responsibility. It is only by your professional conduct, rightly directed, and by the manner of your dealing with such responsibility, that your future will be satisfactory, or that your reputation will be established as skilful, thoughtful, and trustworthy members of your profession.

What can I say to encourage you to secure that success which all should desire, but which alone must depend on the amount to which you benefit those whom you have to attend? Your success will not merely depend on the knowledge of your profession, but somewhat on the mode in which you are able to apply it,—somewhat on your general character; your conduct, on your dealings with your patients. Be kind, be attentive to the requirements of your daily duties, and to the wants of those who seek and are dependent on your help, but

> "This, above all, to thine own self be true;
> And it must follow, as the night the day;
> Thou canst not then be false to any man."

The amount of benefit to be derived by those who need your advice must in great measure depend on the amount of work you have devoted to your profession; on the accuracy of your knowledge of disease; on the care and patience with which you examine each symptom of every varying case. But if you wish to be successful practitioners you must ever read the book of nature by the bedside of the sick. You must look at each case as presenting its own peculiar features of constitutional disturbance, regardless of all theory. One patient may tell you of some idiosyncrasy, or you may detect one in the treatment of a case; a condition which may prove a most important point in your treatment. I have reason to say that we should always respect an idiosyncrasy of the most trifling character. As an instance the following well-authenticated case is a good illustration: A gentleman could not partake of rice without being attacked by such severe symptoms that it might be said that rice acted as a poison on his system. Some friends, sceptical of this peculiarity, had biscuits prepared with a grain of rice in each. The gentleman was invited to dinner, and after dinner partook of one or two. He soon complained of feeling ill and left the table, observing that were he not *morally* certain he had not partaken of rice at dinner, he should suspect he was being then poisoned by it.

It is impossible with our present knowledge to explain the conditions which give rise to idiosyncrasies, but it is highly important that we take practical cognizance of them, for we do not appear to possess any means by which to overcome or anticipate their injurious influences. These may appear trifles when compared with what may be considered more important questions in practice; but it is the attention to trifles, to these peculiarities of system, which marks the difference between the observant and the careless, the watchful and the indifferent practitioner.

Let me relate what occurred in my own experience. A lady consulted me for an acute attack of iritis. She mentioned that she was unable to take mercury without being attacked by an inflammatory eruption similar to erysipelas. I was somewhat incredulous, and considering the administration of some form of mercury desirable in her case, asked if she had ever taken "grey powder." She said she had not, and had no objection to do so if I wished it. She commenced with small doses, but two days after its trial her arms were covered with an erysipelatous blush with numerous bullæ scattered over the inflamed surface.

Has it ever occurred to you to note that just as we observe idiosyncrasies in individuals, so there occur idiosyncrasies in diseases themselves? We see under one condition of syphilis that the administration of mercury produces certain satisfactory results, but in a more advanced and different condition, in the same patient, we find sure benefit result on the internal use of iodide of potash; while in that same condition mercury would generally prove prejudicial.

Why does diabetes run a relentless course in those whom it affects in youth, while it may exist comparatively harmless in more advanced life? Then look at that cruel disease tubercle! What a variety of idiosyncrasies do we not discover in the history of this peculiar deposit and its consequences?

Have we then nothing to learn?

Are not these all questions to which your attention may be turned with profit to mankind, and consequently to yourselves? As we consider them at present, and ask for an explanation of cause and effect, it appears to me we have very little to show on the credit side in the big ledger of medical lore.

Let me now ask you how far does the use of medicine prove useful? What does it affect? Do we cure any disease by its administration?

I may say truly that we treat disorders not unfrequently with marked beneficial effects. We are useful in watching their variations and results. So far we benefit the sick man. But I think we should dismiss from our medical literature the word cure, until we can answer satisfactorily what disease is "cured" by medicine. Does it "cure" smallpox, rheumatic fever, or cancer? A case of typhoid fever will run its allotted time, and with the care bestowed and the treatment prescribed the patient may recover; and so in other disorders; but the disorder is not cut short, and the patient restored to health by the administration of the physic prescribed. Still, under your experienced management, accidents by the roadside are avoided; food, fresh air, and other matters are wisely considered, and taken advantage of, for the benefit of the invalid. He recovers, but bear in mind it is not under the sole influence of medicine he recovers; he has not been, what is too commonly but incorrectly termed "cured." If there is one thing which should humble us in our own estimation, it is this fact, that we watch the progress of diseases and, as far as our knowledge extends, help towards their removal, but we do no more, we cannot take to ourselves the credit that we have as yet discovered the secret of "curing" disease.

While on the subject of treatment excuse my drawing your attention to a point of no little importance in practice, which when neglected often leads to trouble. It is the tendency to take things for granted without sufficient evidence. Never trust too much to what may be related to you, nor attach too much importance to suppositions or suspicions without proof. Prove to yourselves the soundness of the ground on which you act, and be not deceived by a hasty or superficial examination. In no instances are these precautions of more importance than when you have to deal with disorders of the urinary organs.

I must now refer to a point regarding yourselves personally. You go forth to practise your profession with advantages that were not to be obtained when I was a student. Do not let me be supposed to exaggerate them, but it is for you to prove by your future work that they have not been thrown away upon you.

My early days of medical education commenced in the country; and it was my good fortune to be associated with a most practical and thoughtful man. He taught me to estimate the value of a clean tongue. He insisted on the important bearing of a continued quick pulse; he cautioned me ever to look to the character and colour of the discharges from the intestines, as well as to the qualities of the secretion from the kidneys; he would always draw attention to the importance of the condition of the skin and to the characteristics of aspect.

I not only learnt much of the practical importance of these considerations but I was also taught that simplicity in all treatment of disease, as far as drugs were concerned, was most favorably adapted to the larger number of cases; that careful attention to warmth, cleanliness, food, and fresh air were essential in the treatment of all disease. But my excellent teacher had not a clinical thermometer with which to estimate the fluctuations of temperature. He had no urinometer to gauge the specific gravity of urine. He had not then been taught the importance of much that is now familiar to every student as regards disease of the kidneys; anæsthetics had no place in practical surgery; lithotrity had not then been performed, or had only just been advocated in France, and yet my teacher was a most successful practitioner. I owe much to his instructions; his lessons have served me on many occasions through subsequent years.

Whatever work you may have accomplished ere you entered this great school at Netley, you must all have appreciated and benefited by the few months spent here in the acquirement of practical information by bedside work, to have been in a position to

observe closely and daily the course of disease, its intimate treatment, and its results, especially to have had the opportunity to observe the effects of disease acquired in that country which is to be the field of your active future.

What a contrast to the position of an assistant surgeon in former days, attached to a regiment as soon as he had landed in India. Without any previous knowledge of Indian climate or experience in the treatment of tropical disease, he had to contend against the most formidable and sudden epidemics which attack, and too often destroy by numbers untold, Europeans and natives alike. Was it to some of these fatal outbreaks of tropical disease that the Psalmist alludes when he wrote, "A thousand shall fall at thy side and ten thousand at thy right hand"?

The experience you have gained here and the field of inquiry now about to open out to you, should stimulate you largely to increase your knowledge and encourage a bold, inquisitive, and scientific spirit in all that relates to your profession. Recollect what has already been done by those who have preceded you in the service, who had but little to help them compared with that which you can carry to the field of investigation. Look at the works of Sir Ranald Martin, Sir Joseph Fayrer, Morehead, and others, all of whom commenced their professional lives in India with small professional advantages when weighed by the side of those you have had.

Some of you may think that where so much has already been accomplished there cannot be much left for you to investigate or improve. Turn your attention to the great field of observation which will soon lie at your feet, and you will then find that it will require all your energies, all your judgment, based on your past teaching and past experience, in any degree successfully to deal with the various diseases which occur with the varying seasons of India.

This school of Netley, rendered so perfect for clinical observation and instruction, under the supervision of Edmund Parkes, Aitken, Longmore, Maclean, and Du Chomont—and this Hospital, have been the means of sending into the sister services many men who have already done it great credit, and it is for you, gentlemen, to maintain and improve upon, by your work, the just reputation acquired by this school—I say great school and great, and deservedly great, Hospital. Both have done great good. The one has sent forth men, ready to cope with the formidable diseases of all climates, the other has been the means of affording relief, and of often restoring to health, those who have returned to their native land after having served their Queen abroad, and who, if not received here, would probably have rapidly succumbed for want of sufficient care and experienced advice.

I maintain that such an institution as Netley

Hospital and School has done and is doing an incalculable amount of good. We cannot too highly estimate its worth and work. It possesses all the means of ensuring many blessings, directly and indirectly, to an endless number of the human race, daily and yearly increasing its usefulness, not alone restricted to the European soldier in India or the Colonies, but extending those blessings to the vast native populations scattered over our great possessions in the East.

I must here give expression to the very strong opinion I entertain that this Hospital and this School have been the means of conferring great advantages on Her Majesty's Medical Services, and through them of diffusing those blessings among our fellow-creatures to which I have referred. This is the result of the able teaching carried on here. No too high an estimate can be taken of the good already effected, no too sanguine opinion can be formed of the good which may follow. This is an Institution in every true sense of the meaning, of the most truly Christian character; it ensures an education which is alone directed to the relief of the sufferings of man. It is an Institution raised on the broad foundations of Faith and Hope and Charity; Faith in its true and right principles; Hope that its results will always and ever be "Good;" and Charity, that good should be distributed to all who need it.

In any degree to diminish the utility of the

Hospital or interfere with the teaching in the School would entail a considerable and lamentable loss, a loss which would alone be appreciated by those who are familiar with the history, past and present, of Her Majesty's Medical Services.

I must remind you that you commence your professional life with some advantages which contrast favorably with those which attach to private practice. You start in the public service with an income which, though limited and not considerable, is yet a certain one, and should so far relieve you of those anxieties which many have to contend with, the "res angusta domi." But have a care that this very certainty does not spoil your future. Do not be satisfied to eat the bread of idleness by avoiding all work that is not absolutely required of you. Remember now, and always, that it is not only your duty, but that it should be your ambition and pride, to earn honestly and thoroughly the stipend you have to receive as medical officers in Her Majesty's service.

India offers a great and magnificent field for future good and useful work, and innumerable opportunities of study in a great variety of subjects, quite independent of the actual practice of your profession; and should your tastes, or your talents, incline you to direct your attention to other paths of science, you have ample choice.

You will find there is much to learn in the investigation of the causes of fever, cholera, dysentery, and

other influences of climate or soil prejudicial to health, all which point to the many sanitary improvements which much of that country still needs, ere you can effectually stay "the pestilence that walketh in darkness, and the destruction that wasteth at noonday." Again, there is a considerable field for research, and delightful occupation for all, whose tastes and inclinations lead to the study of any branch of natural history. Sir Joseph Fayrer has proved by his beautiful and valuable work on the 'Venemous snakes of the Indian Peninsula,' that one need not neglect the practical work of his profession, though he may, with advantage and interest to the scientific world, turn his attention to some of the natural products of the country. Let me also call your attention to the work done by my friend and former pupil Francis Day. He commenced his public life as an assistant surgeon in the Madras Army. Shortly after his arrival in India he devoted himself to the investigation of the fishes of the country, with the result of a most complete account of them, illustrated by his own drawings, and published at the expense of Government. The work is one of the most complete of its kind, and has acquired a just reputation, as also has his more recent work on the Salmonidæ.

There are other opportunities of work and distinction for those who care to take advantage of them. They have grown up with the increasing demands of the day and the spread of education, and offer opportunities of distinction to the enterprising and fair reward to the labourer. I allude to the more modern hospitals and schools of medicine in the various districts of India.

It is not everyone who enters the medical profession who possesses all the aptitude requisite for the successful practice of that profession, but who may excel in the work of medical teaching. To such the medical schools offer opportunities of employment congenial to their tastes, and are available to any who prefer such employment.

But I would suggest to all who are equal to it, to combine practice with teaching, especially in the earlier portion of service in India. Until you commence to teach you are not cognizant of your own deficiency, while in medicine something new is ever to be effected. A hard working, original minded, thoughtful man is delving in soil rich in materials of importance, which will generally sooner or later reward his labour by the yield of something not yet known or understood.

In surgery you have ample opportunity to exercise your skill and ingenuity, should operative surgery be congenial to your professional tastes.

I use the word "congenial" advisedly; from long personal intercourse with pupils, I have found that all that relates to surgery is enthusiastically pursued by some, while in the hands of others a scalpel would be a source of discomfort to the operator, if not of some detriment to the patient. To such the

less demonstrative field of medicine is far more congenial.

Sir Benjamin Brodie has remarked that "it cannot be predicated of any individual to what exact extent he may obtain professional success, for that must depend partly on his physical powers, partly on the situation in which he is placed, and on other contingencies;" "but," he adds, "having had no small experience in the history of those who have been medical students, I venture to assert that no one who uses the means proper for the purpose will fail to succeed sufficiently to gratify a reasonable ambition." "You have entered on pursuits of the highest interest, in which you will have the no small satisfaction of knowing that you never acquire any real advantage for yourselves which is not the consequence of your having benefited others. It is true you have years of constant exertion before you, but you will eventually learn how preferable such a situation is to that of individuals who, born to what are called the advantages of fortune, but neglecting the duties of their station, believe that they can direct their minds to no more worthy objects than the multiplication of their selfish enjoyments. It will not be your lot, as it is often theirs, to suffer the miseries of ennui, or to be satiated and disappointed with life at an early period; nor will you have to regret as you advance in age that you have lived an unprofitable or useless life."*

* Brodie's 'Lectures on Pathology and Surgery,' p. 26.

"The discoveries of great men," says another author, "never leave us; they are immortal. They contain those eternal truths which survive the shock of empires, and outlive the struggles of rival creeds. These have their different measures and their different standards. They pass away like a dream; they are the fabric of a vision which leaves not a rack behind. The discoveries of genius alone remain. It is to them we owe all that we now have. They are for all ages and all time; never young and never old; they bear the seeds of their own life; they flow on in a perennial and widening stream; they are essentially cumulative; and giving birth to the additions they subsequently receive, they thus influence the most distant posterity, and after the lapse of centuries produce more effect than they were able to do at the moment of their promulgation." *

Can I say more to induce you to work in that profession which alone seeks to mitigate or remove the evils which afflict the human race?

> "'Tis not in mortals to command success,
> But we will do more, Sempronius, we will deserve it."

Let that be your guiding principle through life.

In conclusion, gentlemen, let me urge that it be your ambition to do all the good that lies in your power; that it be your ambition by your high standard of conduct to maintain the dignity of your profession; that it be your ambition to do all in your power to advance the study and knowledge of

* Buckle's 'History of Civilization in England,' vol. i, p. 226.

disease, and so render more useful the application of practical medicine; that it be your ambition to serve yourselves alone by serving your fellow-creatures. In all rightly directed ambition there will always be found, *as sure results*, many and various prizes; in all dissipation and idleness the certain result is nothing but an utter blank!

Gentlemen, I have to thank you all for the patience with which you have listened to me, and in saying "Farewell" I wish you most sincerely a happy, prosperous, and useful future.

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Excision of the Condyle and Neck of the Inferior Maxilla for Osseous Ankylosis of the Right Temporo-Maxillary Articulation.

BY
DAVID M. GREIG, M.B., F.R.C.S.Ed.
Late Army Medical Staff.

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1892.

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By DAVID M. GREIG, M.B., F.R.C.S.Ed.

THE rarity of osseous ankylosis of the temporo-maxillary articulation makes it desirable that all cases of this condition should be placed on record, especially where operative measures have been adopted for its relief. In few text-books of surgery is the deformity even referred to, while in fewer still is any operation described.

J. C—, male, aged 12 years, came under my care in February, 1890, complaining of stiffness of the jaw and inability to open his mouth. The following history was elicited. Apart from anything bearing upon his present condition, he has always enjoyed good health. In 1885 he had scarlet fever. This was accompanied by right suppurative parotitis, which was followed by gradually increasing impairment of movement at the right temporo-maxillary articulation. In 1887 he was able to separate the teeth for a quarter of an inch, and this was increased to one inch by forcing the jaws open, under chlorofrom, by means of a wooden wedge. Although this treatment was afterwards continued, the jaws were soon approximated more firmly than formerly, until the teeth could not be separated at all.

In February, 1890, his condition was as follows:—He was well-nourished, and presented nothing noteworthy, except in connexion with the condition of the right temporo-maxillary articulation. A hard swelling, indicative of former inflammatory mischief or periostitis, extended from this articulation to the angle of the jaw, and produced undue prominence of the right cheek. The skin near the angle of the jaw was marked by cicatrices. The incisor teeth were directed forwards, leaving a space one-eighth of an inch wide between them. Through this opening the patient had to force all solid food after crushing it with his fingers, and the displacement of the incisor teeth had evidently been caused by the periodic pressure thus exercised upon them. The margin of the lower incisor teeth was posterior to that of the upper. The appearance he presented is shown in fig. 1.

FIG. 1.

Having again, under chloroform, attempted, unsuccessfully, to separate the jaws by the use of wedges, I decided to excise the condyle and neck of the jaw on the affected side. The bone was exposed by a vertical incison extending from the zygoma above to the level of the tragus below. On pushing aside the periosteum the ankylosis was found to be osseous, and the bone much thickened. The osseous mass was snipped through with bone forceps below at the level of the neck of the jaw, and above at the level of the articulation, and the piece of bone thus separated was levered out. As my bone forceps were rather large, the incison had to be prolonged slightly downwards, to gain sufficient room to work in. Though the teeth could now

be separated slightly, it was not until the coronoid process had been divided that they could be separated for a satisfactory distance. There was no hæmorrhage of importance, only the transverse facial artery requiring ligature. The wound healed by second intention in about three weeks. His appearance twenty months after the operation is shown in fig. 2. He has perfectly useful, though one-sided, masticatory movement, and is able to separate the jaws, about one inch. In extending the incision downwards some branches of the facial nerve had been divided, as the operation was followed by partial paralysis of the orbicularis palpebrarum (which has since almost entirely passed off)

FIG. 2.

and of the levator labii superioris, levator anguli oris, and zygomatici muscles. The function of the last-named muscles is taken by the facial fibres of the platysma myoides. The parotid duct may have been divided, and, if so, no inconvenience has resulted therefrom, possibly from the former parotitis having more or less disorganised the gland.

Remarks.—Osseous ankylosis of the temporo-maxillary articulation is caused by any inflammation involving the joint. Gout and rheumatism, especially chronic rheumatoid arthritis, are probably the most common causes in the adult,[1] while suppuration connected with the exanthemata is the most common cause in children. Extension of inflammation of the middle ear through the Glaserian fissure has been recorded as a cause,[2] and it also occasionally follows cancrum oris and mercurial salivation.[3] Injury is a rare cause; but Mr. Harrigan has reported[4] a noteworthy case of this in which the movements of the jaws were not permanently interfered with until twenty months after receipt of the injury. The operations devised for the relief of osseous ankylosis of the temporo-maxillary articulation are mainly three—viz., Rizzoli's, Esmarch's, and Humphry's. Rizzoli's method consists in simple division of the jaw in front of the cicatrix from within, but the great tendency to reunion of the bones renders this operation somewhat uncertain in its results. Esmarch's operation consists in removal of a wedge-shaped piece of bone at the junction of the ascending and horizontal rami, the incision being made along the lower border of the horizontal ramus. Mason[5] and others have recorded cases of this operation which have yielded very satisfactory results. Sir George Humphry[6] was the first to excise the condyle of the lower jaw for osseous ankylosis, and several successful cases of this operation have since been recorded. Mr. Page[7] has described and figured such a case in which partial facial paralysis, similar to that occurring in my case, followed the operation. Occasionally, when bilateral ankylosis exists, one of the above operations requires to be performed on both sides; and Mr. W. H. Bennett[8] has recorded a remarkable case of this kind, in which, after repeated operations, he excised the ascending rami on both sides, with a result which was wonderfully satisfactory.

Dundee.

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[1] Ashhurst: International Encyclopædia of Surgery, vol. v.
[2] C. Heath: "Injuries and Diseases of the Jaws," 2nd edition.
[3] Noble Smith: "The Surgery of Deformities."
[4] *Omaha Clinic*, September, 1889.
[5] F. Mason: "The Surgery of the Face." 1878.
[6] *Assoc. Med. Jour.*, 1856.
[7] *Brit. Med. Journ.*, March, 1889.
[8] *Clinical Society's Transactions*, vol. xxii.

not to be taken from the Library

REGULATIONS

AS TO

DEFECTS OF VISION

WHICH DISQUALIFY CANDIDATES FOR ADMISSION INTO THE

CIVIL OR MILITARY

GOVERNMENT SERVICES

BY

J. FAYRER, K.C.S.I., LL.D., M.D., F.R.S.

HONORARY PHYSICIAN TO THE QUEEN; CORRESPONDING MEMBER OF ACADEMY OF MEDICINE OF FRANCE; PHYSICIAN TO SECRETARY OF STATE FOR INDIA IN COUNCIL; PRESIDENT OF THE MEDICAL BOARD, INDIA OFFICE

SECOND EDITION

(OCTOBER 18[illegible])

LONDON
J. & A. CHURCHILL
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1887

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PREFACE TO FIRST EDITION.

(1886.)

THE want of any authorized definition of the Defects of Vision which may exist with or without prejudice to the admission of Candidates to the various departments of the Public Service, has long been felt, not only by official Medical Examiners, but by medical men generally, who, in the absence of any recognized standard, and in ignorance of the visual requirements demanded by various departments for the efficient performance of the duties of each, are unable to form or express an opinion in cases where Ametropia suggests a doubt as to the fitness of the Candidate for the Service.

In the interests of Government and of those seeking admission, it seems very desirable that rules regarding visual qualifications should be laid down: for the Government, because it should be protected, as far as possible, against the admission of persons with unsound eyesight; for the Candidate —or for those on whom he depends—because Ametropia is not always a disqualification, and because it may be necessary to determine at an early age whether the prospect of admission be such as to justify his entering on a special and costly course of education, which may have to be commenced years before he has to undergo the official medical examination on which his admission to the Service depends.

The object of this little work, therefore, is to lay down rules for the guidance of both Medical Examiners and Medical Advisers, who have, on the one hand, to determine the fitness of the Candidate for admission; on the other, to advise him at an early stage of his career.

As President of the Medical Board at the India Office, I have for many years experienced the inconvenience above referred to, and am anxious if possible, to remove it. With this view I have submitted the whole question to my friends Messrs. C. N. Macnamara and John Couper, who, having most carefully considered the subject, have drawn up the following brief but simple and complete rules in reference to Visual Defects, and the methods of ascertaining them, which I trust will be found to be of general utility.

The scientific attainments and large experience of the eminent surgeons to whom I am indebted for all that is useful in the following pages, are too well known to need any comment, whilst they are an ample assurance of the practical value of the rules laid down. It has been earnestly desired, in framing these rules, to guard equally the interests of Government and the Candidate; and with the view of making the subject as complete as possible, it has been thought well to point out not only the Defects of Vision, but the methods of ascertaining them—not with any idea of dictating to Medical Examiners how they should proceed, for of course each will adopt his own method, but for the purpose of indicating the simplest, and

at the same time an efficient, mode of testing the accuracy of vision; and as such I trust this work will be acceptable to all who are interested. The Secretary of State for India in Council has been pleased to sanction these rules for the Indian Service under the following stipulations, that—

"These rules are printed for the convenience of those who may have to conduct medical examinations, and of those who may be intending to become Candidates for any of the branches of the Indian Service to which they refer. But it must be distinctly understood that the Secretary of State in Council, while sanctioning the publication of these rules, reserves to himself an absolute right to reject at his discretion any Candidate whom he may consider to be, for any physical reason, unfitted for the service he desires to enter."*

I desire to express my cordial thanks to Messrs. Macnamara and John Couper, and also to my colleague on the Medical Board, Brigade-Surgeon H. Cayley, whose valuable counsel has been of great assistance. To these gentlemen, it is almost needless to repeat, this work owes whatever merit it may be found to possess.

J. FAYRER.

* Letter No. M. 6560, dated July 8, 1886, from Military Secretary to Government of India, to Surgeon-General Sir J. Fayrer, M.D., K.C.S.I.

In the following pages certain signs and terms are employed which medical men are familiar with, but the meaning of which may not be understood by others.

The sign — is employed to signify a concave lens.
" + " " convex lens.
" D " " dioptry—that is, a lens of one metre (40 inches) focus; a lens of two dioptries is twice the strength of the former, and has a focal length of half a metre. In the dioptric system, which is now universally employed, the lens is numbered by its refracting power, and not, as in the old system, according to its focal length.

At page 9, the meaning of the formulæ referred to in the following work is explained.

Myopia (*near sight*): parallel rays of light are brought to a focus before they reach the retina (p. 11).

Hypermetropia (*over-sight*): parallel rays of light are brought to a focus behind the retina (p. 12).

Emmetropia (*normal vision*): a well-defined image of an object, at an ordinary visible distance, is formed on the retina (p. 10).

Ametropia is any condition of the eye in which parallel rays of light are focussed behind or in front of the retina.

Astigmatism: the refractive power of the chief meridian planes of the eye differ, and so rays of light are not accurately brought to a focus on the retina (p. 14).

Diplopia (*double vision*): the person sees an object double.

Strabismus (*squint*): the optic axes of the eyes are not directed to the same object; there is a want of parallelism in the position and motion of the eyeballs.

Staphyloma: a term denoting a protrusion of the cornea or of the sclerotic.

Retinoscopy (*shadow test*): a test for errors of refraction depending on the apparent movement of the light and shadow thrown on the retina from a concave mirror held about 4 feet from the eye under observation.

Achromatopsia (*colour-blindness*): want of power to distinguish one or more of the primary colours.

Dischromatopsia: a difficulty in recognizing certain colours; one colour is frequently confounded for another; violet is taken for blue, orange for bright red, pink for blue, and so on.

MODE OF CONDUCTING THE VISUAL EXAMINATION OF CANDIDATES FOR THE GOVERNMENT SERVICE.

It is necessary to have a fixed standard by means of which to test the acuteness of vision of candidates desirous of entering the Government Service. For this purpose letters corresponding to the last edition (1885) of Snellen's test-types are to be used: these types are so constructed that the strokes comprising the letters are seen under an angle of 1′, and the whole letter under an angle of 5′ at their respective distances.

The dioptric or metric system is to be used in examining the acuteness of vision possessed by candidates for Government Service. In this system a lens of 1 metre focus is taken as the unit (for all practical purposes 1 metre is equal to 40 English inches). Snellen's types for distant vision consist of rows of letters, each row having above it the distance, in metres, at which it should be read; so that 6 should be clearly deciphered at 6 metres, or about 20 feet. The formula $\frac{6}{6}$ $\frac{\text{distance from type}}{\text{number above type}}$ is designed to represent the acuteness of vision as measured by the proportion between the actual distance at which the type can be read, and the distance at which the type subtends the standard angle of 5′; for instance, $\frac{6}{36}$ indicates that 36 is read at 6 metres; $\frac{6}{5}$, that 5 is read at 6 metres.

The person to be examined is to be placed with his back to the light, at a distance of 6 metres from the test-types, which are hung on the wall or held perfectly upright with a bright light falling on the types. Each eye is to be examined separately; the eye not under observation being covered with an opaque disc placed in spectacle frames; this is more effectual than if the candidate, or an assistant, close the eye not under examination with his hand. If glasses be employed at the examination, they must be fixed in the spectacle frame, and not held in front of the eye under examination.

It is necessary to have a series of test-types, so that they may be changed during an examination. But the existence and degree of ametropia should be carefully noted after employing not only the types above referred to, but, when necessary, the ophthalmoscope, or the shadow test (retinoscopy), otherwise hypermetropia may be overlooked, or low degrees of myopia mistaken for hypermetropia, and astigmatism for loss of sensitive power in the retina, and *vice versâ*.

If a person can with each eye read 0·5 type at 5 inches and $\frac{6}{6}$ with precision (unless specially trained to pass the examination), he is probably neither myopic, astigmatic, nor has he any serious pathological changes in his eyes—at least, not in his macula; but it is quite possible, if young, he may be hypermetropic to a considerable extent, in which case he would, however, see $\frac{6}{6}$ as clearly with a convex lens. To ascertain the existence of hypermetropia—especially among young people—it is therefore necessary to employ further tests than simply deciphering Snellen's types at their respective distances.

Emmetropia (Refraction normal).

Parallel rays of light are united on the retina. The organ being otherwise healthy, an emmetropic eye can clearly define Snellen's test-types at the indicated distances. Distant

vision is impaired either by a convex or by a concave lens if stronger than can be overcome by an effort of accommodation. By the direct method with the ophthalmoscope, the person's eye under examination being directed to a distant point, and the observer's eye being emmetropic and his accommodation relaxed, if the mirror of the ophthalmoscope be brought close to the eye under examination, a clear and enlarged image of a portion of the fundus is seen, which moves in the same direction as the observer's head. At a distance of a few inches, supposing the observer be emmetropic, he will not be able to see the details of the fundus of the eye with definition. By retinoscopy the shadow is absent or very faint, and if it move, it is in a direction opposite to that of the mirror. If in any doubt the eye should be examined when fully under the effects of atropine.

Myopia.

Parallel rays are focussed in front of the retina; divergent rays alone being focussed on the retina. The myope requires a concave glass to enable him to overcome his error of refraction; the weakest glass with which he sees best is the measure of his myopia and expresses its degree. For instance, when we speak of a person being myopic to the extent of 2 D., we mean that with a concave glass of two dioptries he can see Snellen's test-types at their correct distance. By the direct method of ophthalmoscopic examination the mirror being brought close to the myopic eye, the details of its fundus cannot be clearly defined until a concave lens be placed in front of the observer's eye: the weakest glass with which the details of the fundus can thus be distinctly defined is the measure of the myopia. In high degrees of myopia the fact must be taken into consideration, that the lens behind the ophthalmoscope does not come as close to the eye under observation as a glass in spectacle frames would do, and by that amount gives an unduly high measure of the myopia. By retinoscopy the shadow moves in the same direction as the mirror; with a correcting concave glass in front of the eye, the image no longer moves with the mirror.

As a rule, a person having 2 D. of myopia can without glasses decipher 24 of Snellen at 6 metres in a good light. Myopia depending on a posterior staphyloma, if not exceeding 2·5 D., and presenting no evidence of active changes in the choroid or retina, is unlikely to increase after the individual is about eighteen years of age. But with a low degree of myopia, if the eye be over-corrected, spasm of the ciliary muscle and temporary impairment of sight may occur, unless the error of refraction be corrected by proper glasses.

Myopia of even 4·5 or 6 D., if unaccompanied with posterior staphyloma or other morbid change, and which can be completely overcome by glasses, is not likely either to increase or to lead to pathological changes in the eyes, if proper glasses be worn.

Hypermetropia.

Parallel rays are brought to a focus behind, and convergent rays alone are focussed on the retina in a hypermetropic eye: the error of refraction may, as a rule, be entirely corrected by proper convex glasses. A young person with good accommodation may be hypermetropic to the extent of 4 D. (manifest hypermetropia), and yet able

D=60.

E

D=36.

T B

D=24.

D L N

D=18.

D=24.

D L N

D=18.

P T E R

D=12.

F Z B D E

D=8.

O E L Z T G

D=6.

L P O R F D Z

to read 0·5 Snellen at 5 inches, and also $\frac{6}{6}$; that is to say, with the types his acuteness of vision may, in a rapid examination, appear normal. In several of the Continental armies neither officers nor recruits are rejected with hypermetropia equal to 6 D., but they are allowed to wear glasses. If this were not the case, it is evident that a young man with a very much lower degree of hypermetropia than 6 D., although when healthy and strong he could perhaps see $\frac{6}{6}$, might, under the fatigues and hardships of a campaign, find his sight utterly fail him, because his muscular power—that is, his accommodation—is for the time weakened. As hypermetropes advance in life their defective sight becomes more manifest, but does not, as a rule, lead to pathological changes in the eye.

By the direct method of examination with the ophthalmoscope (the accommodation of the eye under observation being suspended), the image of the fundus is indistinct, supposing the accommodation of the observer's eye to be at rest. If the observer exert his accommodation, an erect image of the fundus of the eye is seen. The strongest convex glass with which we are able to see a clear image of the fundus by the direct method of examination, is a measure of the degree of hypermetropia. If at 9 inches or farther from the eye under examination, the observer, by aid of the ophthalmoscope, obtain a clear view of a vessel or other portion of the fundus, and if the object move in the same direction as that in which the observer moves his head, hypermetropia exists.

By retinoscopy the image moves in the opposite direction to that in which the mirror is turned. This may also be the case in emmetropia or in slight myopia, if the accommodation be not suspended; but if + 1 D. be placed in a frame in front of the eye under examination, and the shadow still move opposite to the direction of the movement of the mirror, the case is one of hypermetropia or of hypermetropic astigmatism.

If a convex glass which over-corrects the hypermetropia (say 4 D.) be placed in spectacle frames before the eye under examination, and in front of this be held the weakest concave lens which will enable the individual to read $\frac{6}{6}$, the difference between the glasses will be the measure of the hypermetropia: by this plan the accommodation is encouraged to relax, and a greater amount of manifest hypermetropia is thus got out.

Astigmatism.

In astigmatism there is a difference in the refractive power in the chief meridian planes of the eye. If slight, this error of refraction may be masked by accommodation; but if it exist beyond a limited degree, the rays of light falling on the cornea are not accurately focussed on the retina, and so the image of the object from which the rays proceed is blurred. In not a few instances of hypermetropic astigmatism, when the chief meridians are oblique in direction, the individual by tilting his head to one side can see distant objects more clearly. We not unfrequently meet with instances of both myopia and hypermetropia complicated with astigmatism.

With the ophthalmoscope we find, by the indirect as well as by the direct method, that the optic disc, instead of being circular, is elliptical; the long axis of the ellipse being in one chief meridian by direct examination, and in the opposite meridian by indirect examination. We may thus have

in the same eye the disc appearing horizontally oval when directly examined, and vertically oval when viewed indirectly.

By retinoscopy the shadows may be more or less oblique, or one shadow is clearer and moves more quickly in one meridian than in the other; or it may move with the mirror in one meridian, and against it in the opposite meridian. In the majority of cases of simple or of mixed astigmatism the error of refraction can be corrected, as in myopia and hypermetropia, by means of proper glasses.

Accommodation.

The amount of accommodation is to be tested by measuring the nearest, as also the farthest, point at which the smallest of Snellen's (·5) test-types is clearly read. If the accommodation in each eye be normal, a young person will read ·5 type at 5 inches, and as far as 20 inches from his eyes.

Diplopia.

In making an examination for the existence of diplopia (double sight), the person whose sight is to be tested should be taken into a dark room, and his head fixed in one position during the examination. A candle should then be held some 6 or 8 feet from the individual; the light being moved in different positions, a double image will be seen. If a deeply-coloured glass be held first before one eye and then before the other, the coloured flame will indicate the direction of the image in the eye which deviates from its fellow.

Defects in acuteness of vision arising from other causes than those of errors of refraction, are for the most part recognized by means of the ophthalmoscope; such as opacities of the media, or changes in the normal condition of the fundus of the eye. In such cases, however, the use of glasses will hardly bring the vision up to the normal standard. Whatever the defect in vision, the examining medical officer should clearly define its precise degree and nature. In doubtful cases, the eyes should be examined when fully under the influence of atropine or of homatropine.

Method for Testing Colour-Vision.

Holmgren's wools are the most convenient test for colour-vision, and if employed in a systematic manner are certain to detect any defect. The plan consists in making the candidate match certain test-colours from the heap of wools.

There are three tests; the first detects those who have any defect, while the other two determine its character.

The wools being placed on a table in a good light, the examiner selects for Test I. a pale but bright green skein, and asks the candidate to select other skeins which match it; if he do so correctly he has normal colour-vision, and no further steps are necessary; should he, however, select one of the confusion colours (rose, salmon, grey, straw, red, or buff) he is colour-blind; and to ascertain the nature of the defect, place in his hands Test II., which is a rose-coloured skein; if he select blue or violet he is red-blind, but should he take green or grey then he is green-blind.

To confirm the above, Test III. is applied by placing in the candidate's hand a bright red skein, when, if red-blind, he will chose green and brown of a darker shade than the test-colour, whereas, if green-blind, he will take bright greens and browns of a lighter shade.

REGULATIONS FOR CANDIDATES FOR COMMISSIONS IN THE ARMY.*

The following will be substituted for paragraph 1013*b*, added to the Regulations for the Army Medical Department by Clause 53, Army Circulars, 1887.

Letters and numbers corresponding to Snellen's Metrical Test-Types (Edition 1885) will be used for testing the standard of vision.

If a candidate's vision, measured by Snellen's test-types, be such that he can read the types numbered D. = 6 at 6 metres or 20 English feet, and the types numbered D.=0·6 at any distance selected by himself, with each eye separately and without glasses, he will be considered fit.

If a candidate cannot read with each eye separately, without glasses, Snellen's types marked D.=36 at a distance of 6 metres or 20 English feet, *i.e.*, if he do not possess one-sixth of Snellen's standard of normal acuteness of vision, although he may be able to read the types D.=0·6 at some distance with each eye, he will be considered unfit.

If a candidate can read with each eye separately Snellen's types numbered D. = 36 at a distance of 6 metres or 20 English feet, without glasses, but cannot read them beyond that distance, *i.e.*, if he just possesses one-sixth of normal acuteness of vision, and his visual deficiency is due to faulty refraction, he may be passed as fit, provided that, with the aid of correcting glasses, he can read Snellen's type D. = 6 at 6 metres or 20 English feet, with one eye, and at least Snellen's types D. = 12 at 6 metres or 20 English feet, with the other eye; and, at the same time, can read Snellen's type marked D. = 0·8 with one or both eyes,

* Army Circular, dated War Office, Sept. 1, 1887. These regulations apply to all branches of the Service, including the Medical Department.

without the aid of glasses, at any distance the candidate may select.

Squint, inability to distinguish the principal colours, or any morbid condition, subject to the risk of aggravation or recurrence in either eye, will cause the rejection of a candidate.

ROYAL NAVY.

1. A candidate is disqualified unless both eyes are emmetropic. The candidate's acuteness of vision and range of accommodation must be perfect.

2. A candidate is disqualified by any imperfection of his colour sense.

3. Strabismus, or any defective action of the exterior muscles of the eyeball, disqualifies a candidate for the Royal Navy.

THE HOME CIVIL SERVICE.

With reference to the Home Civil Service, the Commissioners refer each case to "a competent medical adviser, leaving him to apply whatever tests he may deem suitable, and whatever standard the particular situation may require."

THE INDIAN CIVIL SERVICE

(Covenanted and Uncovenanted).

1. A candidate may be admitted into the Civil Service of the Government of India, if ametropic in one or both eyes, provided that with correcting lenses the acuteness of vision be not less than $\frac{6}{9}$ in one eye, and $\frac{6}{6}$ in the other; there being no morbid changes in the fundus of either eye.

2. Cases of myopia, however, with a posterior staphyloma, may be admitted into the service, provided the ametropia in either eye do not exceed 2·5 D., and no active morbid changes of choroid or retina be present.

3. A candidate who has a defect of vision arising from nebula of the cornea is disqualified, if the sight of either eye be less than $\frac{6}{12}$; and in such a case the acuteness of vision in the better eye must equal $\frac{6}{6}$, with or without glasses.

4. Paralysis of one or more of the exterior muscles of the eyeball disqualifies a candidate for the Indian Civil Service. In the case of a candidate said to have been cured of strabismus by operation, but without restoration of binocular vision, if with correcting glasses the vision reach the above standard (1), and if the movement of each eye be good, the candidate may be passed. The same rule applies to the case of unequal ametropia without binocular vision, both eyes having full acuteness of vision with glasses and good movement.

Candidates for admission into the following Departments come under the rules laid down for the Civil Service:—Ecclesiastical, Education, Salt, and Opium.

Candidates for the Departments of Public Works, Forest, Survey, Telegraph, Railway, Factories, as well as Police, and various artificers, may be admitted into the service under the following rules:—

1. If myopia in one or both eyes exist, a candidate may be passed, provided the ametropia do not exceed 2·5 D., and if with correcting glasses, not exceeding 2·5 D., the acuteness of vision in one eye equal $\frac{6}{9}$, and the other $\frac{6}{6}$,

there being normal range of accommodation with the glasses.

2. Myopic astigmatism does not disqualify a candidate for the service, provided the combined spherical and cylindrical glasses required to correct the error of refraction do not exceed − 2·5 D.; the acuteness of vision in one eye, when corrected, being equal to $\frac{6}{6}$, and in the other eye $\frac{6}{9}$, together with normal range of accommodation with the correcting glasses, there being no evidence of progressive disease in the choroid or retina.

3. A candidate having total hypermetropia not exceeding 4 D. is not disqualified; provided, the sight in one eye (when under the influence of atropine) equal $\frac{6}{9}$, and in the other eye equal $\frac{6}{6}$, with + 4 D., or any lower power.

4. Hypermetropic astigmatism does not disqualify a candidate for the service, provided the combined lens required to cover the error of refraction do not exceed 4 D., and that the sight of one eye equal $\frac{6}{9}$, and the other $\frac{6}{6}$, with or without such a lens.

5. A candidate having a defect of vision arising from nebula of the cornea is disqualified if the sight of one eye be less than $\frac{6}{12}$. In such a case the better eye must be emmetropic and possess normal vision. Defects of vision arising from pathological or other changes in the deeper structures of either eye, which are not referred to in the above rules, may exclude a candidate from admission into the service.

6. A candidate is disqualified if he is unable to distinguish the principal colours (Achromatopsia).

7. Paralysis of one or more of the exterior muscles of the eyeball disqualifies a candidate for the service.

Candidates as guards, engine-drivers, signal- and pointsmen on the Indian railways, come under the rules prescribed for the Pilot Service.

Persons entering the Government Service on special duty must possess such an amount of acuteness of vision as will, without hindrance, enable them to perform the work of their office for the period their appointment may last.

THE INDIAN MEDICAL SERVICE

(Covenanted and Uncovenanted).

1. A candidate may be admitted into the Indian Medical Service if myopic to the extent of 5 D., provided that with correcting lenses his acuteness of vision in one eye equal $\frac{6}{12}$, and in the other $\frac{6}{6}$, there being no morbid changes in the fundus of the eyes. Cases of myopia, however, with a posterior staphyloma, may be admitted into the service, provided the ametropia in either eye do not exceed 2·5 D., the acuteness of vision with correcting glasses being equal to the above standard, no active morbid changes of choroid or retina being present.

2. Myopic astigmatism does not disqualify a candidate for the service, provided the combined spherical and cylindrical glasses required to correct the ametropia do not exceed − 5 D.; the acuteness of vision in one eye when so corrected being equal to $\frac{6}{12}$, and in the other eye $\frac{6}{6}$; the accommodation being normal with the correcting glasses, and no progressive morbid changes of the choroid or retina being present.

3. A candidate having total hypermetropia not exceeding

5 D. is not disqualified for the service, provided the sight in one eye (when under the effect of atropine) equal $\frac{6}{12}$, and in the other $\frac{6}{6}$, with + 5 D. or any lower power.

4. Hypermetropic astigmatism does not disqualify a candidate for the service, provided the combined lens required to correct the total hypermetropia do not exceed 5 D. The acuteness of vision in one eye must equal $\frac{6}{12}$, and in the other $\frac{6}{6}$, with or without the correcting glass.

5. A candidate may be accepted with a faint nebula of one cornea, reducing the vision to $\frac{6}{12}$, provided the eye in other respects be healthy. In such a case the better eye must be emmetropic and possess normal vision. Defects of vision arising from pathological or other changes in the eye, which are not referred to in the above rules, may exclude a candidate for admission into the Indian Medical Service.

6. A candidate is disqualified if he cannot distinguish the principal colours, red, green, violet or blue, yellow, and their various shades (Dischromatopsia).

7. Paralysis of one or more of the exterior muscles of the eyeball disqualifies a candidate for the Indian Medical Service.

THE INDIAN PILOT SERVICE.

1. A candidate is disqualified unless both eyes are emmetropic, his acuteness of vision and range of accommodation being perfect.

2. A candidate is disqualified by any imperfection of his colour sense.

3. Strabismus, or any defective action of the exterior muscles of the eyeball, disqualifies a candidate for the Pilot Service.

THE INDIAN MARINE SERVICE

(Including Engineers and Firemen).

1. A candidate is disqualified if he have an error of refraction in one or both eyes which is not neutralized by a concave, or by a convex 1 D. lens, or some lower power.

2. A candidate is disqualified if he cannot distinguish the primary colours and their various shades, red, green, violet or blue, and yellow.

3. Strabismus, or any defective action of the exterior muscles of the eyeball, disqualifies a candidate for the Marine Service.

BALLANTYNE PRESS, CHANDOS STREET, W.C.

$2\frac{1}{2} = \frac{5}{2} \times \frac{20}{1} = 18$

$\frac{5}{2} \times \frac{2}{8} = \frac{5}{4}$

With the Author's Kind regards

SOME REMARKS

ON

EXCISION OF THE ELBOW-JOINT;

WITH TWO CASES.

BY

SURGEON-MAJOR J. H. PORTER,

ASSISTANT PROFESSOR OF MILITARY SURGERY, ARMY MEDICAL SCHOOL, NETLEY, ETC., ETC.

Reprinted from the Dublin Journal of Medical Science—October, 1876.

DUBLIN:
PRINTED FOR THE AUTHOR
BY JOHN FALCONER, 53, UPPER SACKVILLE STREET.

1876.

Case I.

Case II.

Lithographed by John Falconer Dublin. From a Photograph.

SURGEON-MAJOR J. H. PORTER'S Cases of Excision of the Elbow.

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SOME REMARKS

ON

EXCISION OF THE ELBOW-JOINT;

WITH TWO CASES.[a]

THERE is probably no operation in surgery in which more satisfactory results may be obtained for the patient and surgeon than that of excision of the elbow-joint, provided the cases are judiciously selected, the operation properly performed, and the after-treatment carefully carried out; and yet examples are frequently met with in which, from want of due precautions, the patients are encumbered with useless limbs. I therefore feel it is unnecessary to apologise for publishing two cases, in which, I trust, some of the circumstances connected with them will be found interesting, if not instructive.

Recently two patients came under my observation in whom the elbow had been excised with most unsatisfactory results; in one he had lost all motion in the shoulder, elbow, and wrist-joints, as well as that of the hand and fingers of the affected limb, due to want of attention in the after-treatment; and in the other there was no power of extending the forearm, and the patient was unable to flex the fingers, which had become stiff and straight. In this case the want of success was attributable to the method of operation, which was by the H incision, and inattention to the after-treatment.

Such unfortunate results naturally induce the surgeon to guard against and prevent similar consequences in his own practice; and, in investigating the experience of others, I was much impressed with the importance of the observations made by Mr. R. Hodges, of America, and Mr. C. T. Maunder, of London, respecting the method of operation to secure extension of the forearm. The

[a] Being the summary of a paper read before the Southampton Medical Society, August 1st, 1876.

former remarks that, in excision of the elbow, no transverse cut across the triceps should be made, and the latter (*vide British Medical Journal* of July, 1871) that it is essential to securing extension of the forearm, which power is not unfrequently lost, and for which he says the operation is responsible to preserve those tendinous fibres of the triceps muscle which are sent from beyond the attachment to the olecranon to blend with the fascia of the forearm, and especially with that portion of the fascia overlaying the anconeus muscle. Mr. Maunder commences the operation by a longitudinal incision at the back of the limb, in length three or four fingers' breadth both above and below, and crossing the point of the olecranon. He next sinks the knife deep into the triceps muscle, and divides it also longitudinally into two portions, the inner one of which is the more firmly attached to the ulna, while the outer portion is continuous with the anconeus muscle, and sends some tendinous fibres to blend with the fascia of the forearm. It is these latter fibres that are to be scrupulously preserved.

To these suggestions of Drs. Hodges and Maunder I paid strict attention in the two cases to be hereafter detailed, and with the happy result of obtaining most perfect power of extension, as may be seen by the accompanying illustrations. It is scarcely necessary to observe that, with ankylosis in the straight position, there may also be power of extension; but as that result is not the only one desirable, it is necessary to try and induce the power of flexion so as to produce a generally useful limb, such as one possessing the natural motions of the shoulder, wrist, forearm, hand, and fingers. To obtain these results but little has been said by authorities, except as regards the movements of the elbow, and on these points opinions differ as to the period at which motion should commence. This, of course, might be influenced by the condition of the patient and the state of the wound.

In the two following cases the limbs were first simply laid in an extended position on a firm pillow, and the wound dressed with lint saturated with carbolised oil, and cold applications to the outside. In both cases slight movement of the fingers was commenced the day after operation; about the fifth day supination and pronation of the forearm, and as soon as the inflammation consequent on the operation had subsided, flexion of the elbow, with slight extension, to prevent the ends of the bones coming into contact.

When the patients were strong enough to sit up and go about,

exercises were enforced with a weight suspended to a cord passed over a pulley, which brought into action all the muscles and joints of the affected limb.

The electric induction current was also used with decided advantage.

Case I.—T. W., a delicate-looking lad, fifteen years of age, belonging to the Duke of York's school.

Family history of phthisis, his father and an uncle having died of that disease.

In March, 1875, he had a sharp attack of rheumatism, which affected the elbow and knee joints, confining him to bed for two months, at the end of which period the swelling of the joints had subsided, with the exception of the left elbow, which remained swollen and painful.

In August he was received into Netley Hospital for change of climate, his general health being impaired. The left elbow was uniformly enlarged, but there was no bulging of the synovial sac. There was slight pain in the head of the radius, increased by rotating the hand. The forearm was slightly flexed, and the elbow one inch larger in circumference than the right.

His general health improved, but in October an opening of a sinus appeared on the inner aspect of the arm, about one and a half inches above the condyle, through which a probe could detect exposed bone; there was, however, no decided evidence as to the exposed bone being connected with the joint, and he was treated with tonics and nourishing diet, the joint being kept at rest, with a hope that the diseased bone might be thrown off.

There was very little change till the beginning of December, when the elbow became much enlarged, and as compared with the sound one, was three inches larger in circumference. The skin over it had become pale and mottled, and the cutaneous veins enlarged, but there was no great amount of pain.

On the 3rd of December he accidentally struck his elbow against a table, which set up active inflammation, and early in January, 1876, when all inflammatory symptoms had subsided, it became apparent that the joint was so extensively diseased that excision would be necessary.

On the 10th of January I excised the joint by the longitudinal incision, the limb being rendered bloodless with Esmarch's bandage, and the patient being under the influence of ether.

After the operation the limb was placed in a straight position on a firm pillow, no vessels were tied, and there was very little hæmorrhage.

On the 11th the lad was directed to flex his fingers, which he did with some difficulty, but without pain. On the 15th of January, or the fifth day after the operation, he flexed his fingers with ease, which were perfect in sensibility, and slight passive exercise of the forearm was commenced, so as to secure pronation and supination, as well as flexion of the elbow-joint.

These exercises were practised daily till the 8th of February, when he commenced the use of a 1 lb. weight suspended by a cord over a pulley, which he worked by a little help from the sound arm.

His general health gradually improved, and on the 1st of March the wound of operation had quite healed, and the arm was daily becoming stronger.

On the 3rd of June he was discharged from hospital, it being a few days less than five months since the operation. He could then perform the following motions—scrub and sweep the floor, lift a considerable weight, place his hand behind his back so as to button his trousers, supinate or pronate the hand, extend the forearm, brush his hair, and feed himself with a fork. The motions of the shoulder-joint were perfect, as well as that of the wrist, hand, and fingers. The sensation in the limb was similar to that in the sound one, and he possessed in every respect a useful arm, which would enable him to earn a livelihood.

Case II.—Sapper G. S., Royal Engineers, twenty-eight years of age, of healthy appearance, with a good family history. In 1868 he struck his left elbow when mining, after which it became swollen and painful. This passed off, but in 1870, when quartered in Bermuda, it again became affected, but after suitable treatment the disease disappeared. In 1875, when quartered at Gibraltar, he again hurt it, since which time he has been unable to use it, the joint having become swollen, and painful on pressure. He was invalided to England, and arrived at Netley Hospital last December, when the joint was found much swollen and painful, but no symptoms to denote disease of the cartilages or bone.

In April, 1876, suppuration set in, and several abscesses formed, which were opened in front of the joint. His health now became much impaired, and it was found on examination that the joint was implicated.

On the 2nd of May I excised the joint by the longitudinal incision, the limb being rendered bloodless with Esmarch's bandage The operation was followed by considerable oozing, necessitating the opening of the wound. The day after the operation movement of the fingers was commenced. On the 7th of May, or fifth day after the operation, pronation and supination were commenced, and on the 12th flexion and extension of the forearm. On the 31st of May he used a 1 lb. weight suspended over a pulley, which was increased up to 4 lbs. on June 15th.

By the 14th of July the wound of operation had completely healed, and, feeling strong and well, he attempted mowing, and cut down one hundred yards of grass; which he says he performed with little inconvenience.

With the exception of the power of flexion of the forearm, all the motions of the limb are perfect, but in this he is daily improving, being able to feed himself with a fork, and brush his hair; he can also button his trousers, place his hand behind his back, and lift considerable weights.

The muscles of the arm are fairly developed, as may be seen by illustration No. 2.

In Case No. I. there was gelatinous disease of the joint with caries of all the bones.

In Case No. II. there was pulpy disease of the joint and extensive caries of the humerus and ulna.

The amount of bone removed in both cases was about two inches.

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International Medical Congress, Rome, 1894.

On the Treatment of some Forms of Stone in the Bladder by Perinæal Lithotrity

With a Description of the Instruments used

BY

REGINALD HARRISON, F.R.C.S.

Surgeon to St. Peter's Hospital, London

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1894

On the Treatment of some Forms of Stone in the Bladder by Perinæal Lithotrity, with a Description of the Instruments used.

By REGINALD HARRISON, F.R.C.S.

Surgeon to St. Peter's Hospital, London.

I HAVE recently completed a record of over 400 operations for stone in the male bladder. These figures include instances of almost every recognised method of removing a calculus from this position, and though lithotrity, as I saw practised by my late friend, Professor Bigelow, of Boston, under the name of litholapaxy, largely predominates, lateral, median, and supra-pubic lithotomy, in their various modifications, have from time to time been utilised.

The greater number of persons thus operated upon were male adults up to 82 years of age, though these figures include 56 male children, who for the most part were treated by lateral lithotomy. As showing the safety with which the lateral operation can be practised in these young subjects, I may mention that only one death, or failure to recover completely, occurred, and this was due to chronic pyelitis some weeks after the operation.

The stones, removed by me in the course of these 400 operations, include almost every variety in known chemical composition, though the hard urates and oxalates were the more frequent. One of the largest specimens of cystic calculus, weighing 1,050 grains, now in the Museum of the Royal College of Surgeons, was successfully removed by lateral lithotomy. Medium sized stones, from half an ounce to half a drachm in weight, were by far the most common, though some larger specimens, up to four ounces, occasionally presented.

These points are referred to incidentally for the purpose of showing that my practice has not been limited to one method of treatment, but has been varied to meet the different conditions under which stone in the bladder has come under my notice.

It may possibly be urged by some, considering the progress lithotrity has made during the present half century, that, save in instances where the stone is of such dimensions as to be beyond the capacity of any lithotrite, no other operation for its removal is now advisable. Such a view might be accepted if lithotrity, pure and simple, were always the entire success immediately and permanently we could desire. Mr. Cadge has pointed out in his Hunterian Lectures before the Royal College of Surgeons (1886), that the number of recurrences after the crushing operation, even in the hands of some of its warmest and most competent advocates, is such as to considerably detract from its completeness.

As in the case of other surgeons engaged in work of this kind, I may state in general terms, that my mortality has been a gradually decreasing one. Taking my last one hundred cases of stone operated upon by the various methods referred to, and excluding children and males under puberty, my number of deaths following crushing and nine cutting operations did not exceed five per cent. These cases, no doubt, at the present moment represent the best period of my work, and may be regarded as an outcome of the great advances that have been made in the operative treatment of stone in its various directions by Bigelow, Thompson, Cadge, Guyon, Keegan and Freyer, to each of whom we are indebted for something distinctive, in either the method or the application of treatment.

Fully recognising the work of these distinguished surgeons, I am at the same time disposed to give some prominence to three circumstances which have contributed in no small measure to the results I have arrived at: (1) To the earlier diagnosis of stone which now prevails, and the application of treatment before the calculus has attained any considerable dimensions; (2) To the detection of a stone in the bladder with the sound, being concurrent with its removal; and (3) To a more extended experience in selecting the most appropriate, and therefore safest operation.

The object of this paper, however, is to briefly describe a method of operating which has been found particularly applicable to some exceptional cases, and where the results obtained from it contributed materially to the small mortality of a series of operations which embraces both lithotomy as well as lithotrity.

It is not necessary for me to enter upon the history of perinæal lithotrity, and to trace the various modifications which have from time to time been described. The proceeding has been referred to by Dr. Gouley,[1] of New York, in the following words:—"The name of perinæal lithotrity was given in 1862, by Professor Dolbeau, of Paris, to an operation completed in one sitting by which the membranous portion of the urethra is opened, the prostate and neck of the bladder dilated, instead of being cut, and a large stone crushed, and the fragments immediately evacuated."

It was with this definition before me that I entered upon the study and practical application of the principles of this operation. I published my first communication[2] on perinæal lithotrity some years ago, and I have practised it in fourteen instances in male adults. In every example the operation was successful, recovery being rapid and complete, and I am not aware that recurrence of stone has in any one of these cases followed.

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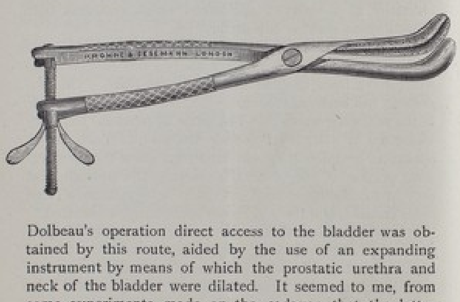
[1] "Diseases of the Urinary Organs," 1878.
[2] The *Lancet*, September 22, 1888.

The chief features in connection with the operation I am about to describe are: (1) The mode of obtaining access to the interior of the bladder from the perinæum; and (2) The mechanism connected with crushing and evacuating the stone.

From a number of experiments I made on the dead subject as well as from the performance of median cystotomy on the living for various purposes, it seemed unnecessary to do more than to make an opening from the perinæum into the membranous urethra at the apex of the prostate, on a grooved staff passed along the urethra, sufficient to admit the introduction of Wheelhouse's small tapering gorget, and subsequently the index finger into the bladder, as for digital exploration, or, as is done in the boutonnière or Cock's operation—more than this is not necessary. In



Dolbeau's operation direct access to the bladder was obtained by this route, aided by the use of an expanding instrument by means of which the prostatic urethra and neck of the bladder were dilated. It seemed to me, from some experiments made on the cadaver, that the latter means of dilatation was not only unnecessary, but was open to the objection that unless used with the greatest care, it was possible to inflict serious damage.

Further, I succeeded in demonstrating that by means of crushing forceps, shaped somewhat like the blades of a lithotrite, and not exceeding by actual measurement in

circumference that of an ordinary index finger, sufficient power might be provided to crush and assist in evacuating any stone that could be fairly seized in this way. These forceps are provided with a cutting rib within the blades, and the more powerful instruments, as you will see from the specimens I am showing you, are fitted with a movable screw on the handle. The fragments may subsequently be withdrawn by means of aspirator catheters passed through the wound, or even by the forceps. If care is taken to make the perinæal wound correspond in size with the evacuating catheters, which should be of about the size of an ordinary index finger, there is no difficulty in keeping the bladder distended during the necessary manipulations.

The chief points in favour of this operation are these: (1) It enables the operator to crush and evacuate large stones in a short space of time. (2) It is attended with a very small risk to life as compared with other operations where any cutting is done, such as lateral or supra-pubic lithotomy, and is well adapted to old and feeble subjects In his recent address, Mr. Swinford Edwards[1] shows that the latter operation for large stones has a mortality somewhere about 50 per cent. (3) It permits the operator to wash out the bladder, and any pouches connected with it, more effectually than by the urethra, as the route is shorter and the evacuating catheters employed of much larger calibre. (4) The surgeon can usually ascertain, either by exploration with the finger, or by the introduction of forceps into the bladder, that the viscus is cleared of all *débris*. (5) It enables the surgeon to deal with certain forms of prostatic outgrowth and obstruction complicated with atony of the bladder in such a way as to secure not only the removal of the stone, but the restoration of the function of micturition. (6) By the subsequent introduction and temporary retention of a soft rubber drainage-tube, states of cystitis due to the retention of urine in pouches and depressions in the bladder wall are either entirely cured, or are permanently improved. To lock up

[1] *Medical Press and Circular*, October 12, 1892.

unhealthy ammoniacal urine in a bladder that cannot properly empty itself after a lithotrity, is to court the formation or recurrence of a phosphatic stone. Hence it is well suited to some cases of recurrent calculus. I have never known the wound to remain unhealed, except in those instances where, for some reason or other, it has been desired to construct a low-level urethra, as in an instance I have recorded elsewhere.[1]

It is well adapted for some cases of stone in the bladder complicated with stricture in the deep urethra, as it enables the surgeon to deal with both at the same time. Nor does it expose the patient to the risk which may be attendant where lithotrity is performed with a weakened or permanently damaged urethra. Dr. Bazy[2] has also recently illustrated its advantage under these circumstances.

I will conclude this paper with a brief record of three illustrative cases, and show the specimens removed :—

(1) A man, 24 years of age, who was cut for stone by a perinæal method ten years previously, came under my care in 1888 suffering from a large stone in the bladder and a small perinæal fistula, the result of the preceding operation. As I thought it best to try and remove the stone and close the fistula at the same time, I adopted the method I have described, and broke up with the forceps, and extracted a large phosphatic stone weighing nearly three ounces in a few minutes. The fistulous tract was doubtless included in the line of section. A drainage tube was introduced into the bladder through the wound. On the fifth day normal urine was discharged through the tube, when the latter was withdrawn, and the wound closed soundly in forty-eight hours. The patient was known to be well two years after this operation.

(2) A man, aged 52, came into St. Peter's Hospital in 1893, suffering from calculus and some form of prostatic

[1] "Surgical Disorders of the Urinary Organs," 4th edition, 1893, by Reginald Harrison. Churchill, London.

[2] *La Semaine Médicale*, February 17, 1893.

obstruction. The latter complication requiring attention I selected the perinæal method, and in a few minutes, partly with the crushing forceps, and partly with the evacuator catheter, I removed over three ounces of very hard urate calculus in addition to a polypoid excrescence of the prostate as large as a good-sized grape. A drainage tube was passed into the bladder through the wound, and the operation was completed without delay; the tube was retained for a week, and on its withdrawal the wound healed in a few days.

(3) The third case was that of a man, aged 62, whom I operated upon in 1890. He had undergone five operations previously by other surgeons for stone, which seemed to be primarily a urate calculus, and subsequently phosphatic. When I saw him, another stone had formed within eight months, his bladder was pouched and almost completely atonic, as he was largely dependent upon his catheter. The state of his bladder, irrespective of the size of the stone, led me to select perinæal lithotrity. There was a large post-prostatic pouch containing an ounce calculus, which was readily crushed by the forceps, and removed in a few minutes. I also twisted off a piece of prostatic outgrowth, which seemed to act as a valve. A drainage tube was retained for over three weeks, when the urine being normal it was withdrawn. The wound healed soundly in the course of a few days. The power and function of the bladder has been completely restored, and there has been no recurrence of stone.

I have selected these three cases as illustrating conditions of complication which, not unfrequently, render lithotrity an imperfect success. The alternative operations of perinæal or supra-pubic lithotomy, as usually practised, would, I believe, have exposed the patients to a greater risk than I liked to incur. I therefore selected a proceeding which seems to me, whilst providing a most efficient and convenient means for rapidly removing a stone from the bladder, is, at all events, free from the risks of hæmorrhage and shock as not rarely attend the older forms of lithotomy. If a stone could be dealt with as soon as it was retained in the bladder, no other operation than lithotrity would ever be practised, except, perhaps, in some few instances where a calculus is the natural consequence of some diseased condition within the bladder which is capable of being removed.

With the author's kind regard

QUEEN VICTORIA'S JUBILEE INSTITUTE FOR NURSES 1887

A LECTURE

DELIVERED AT

St. Katharine's Royal Hospital,

TO THE

QUEEN'S JUBILEE NURSES,

At the request of the Council of the Institute,

ON

NURSING IN CHOLERA, AND HOW TO DEAL WITH IT AS FIRST AID,

BY

SIR JOSEPH FAYRER, K.C.S.I., M.D., F.R.S.,

ON

MAY 4TH, 1893.

LONDON:
PRINTED BY LOWE BROTHERS, 157, HIGH HOLBORN, W.C.

FIRST AID & NURSING IN CHOLERA.

IN an interesting lecture given recently by the Rev. the President of your Institute, I find the following appropriate words:
"I believe the influence for good of this great nursing work
"throughout the land to be incalculable. . . . A regenera-
"ting influence will follow the steps of the tender-hearted, skil-
"ful, sympathising nurse, which will tarry in the house when
"she has gone elsewhere on her mission of love and mercy. . .
"She will be the pioneer for good in more directions than one.
"The sanitary authorities will find that their hands are strength-
"ened by the practical dealing of the nurse, who will teach the
"poor how to find out what is wrong about the place, and how
"to set it right; . . . the ministers of religion will find that
"their work is often less difficult because the kindness of the
"nurse . . . has somehow or other touched a chord in the
"heart which they have long wanted to get at, but could not,
"and, if the hearts of Englishmen and Englishwomen will allow
"themselves to catch warmth from the gracious act of the So-
"vereign, and will endeavour to see how they can best help to
"give an impulse to her beneficent intentions, they will find that
"their effort is not unrequited, for . . . . there are none
"who more value the work, and are more grateful for what is
"done for them, than the sick poor themselves."

Such are some of the concluding words of the lecture referred to, and I could hardly find a better introduction to the remarks which I am about to offer you at the President's request, on the application of your knowledge of nursing to those among whom it is your mission to minister, should the emergency against which it is our duty at least to make preparation, ever arise.

Having spent many years of my life in a part of the world where cholera prevails, and having consequently had some experience of its movements, modes of action, and effects upon the human race, as also of the methods of dealing with it, I am, perhaps, in a position to offer you advice which may be of practical use should we be visited by the epidemic which, having appeared in France, Germany, Holland, and Belgium, now menaces us also, and certainly renders it expedient that preparation should be made in anticipation of its possible arrival here.

To be forewarned is to be forearmed, and there is no more effective way of ensuring peace than being prepared for war.

Whilst, however, all exaggeration or sensational statements should be avoided; whilst any action or public demonstration which may tend to excite expectancy and anxiety in respect of an impending invasion of cholera, is to be deprecated, it is expedient that whatever forethought can do, under the guidance of science and experience, should be done quietly and unostentatiously now, ere yet the enemy has assailed us, that,—should it come—it may not take us by surprise or find us unprepared.

Our mental attitude may then well be as tranquil as the confidence derived from the assurance that all possible precautions have been taken, can make it.

Now, as respects the sanitary arrangements of the country generally, of the seaports, and the influx of foreigners by sea, it is satisfactory to know that nothing is omitted by Goverment and the Sanitary Department of the Local Board, whether by action or by counsel, which can preserve the country from the evil, or mitigate it should it gain a footing in our islands.

There is good reason for believing that the precautions taken in recent years have had the salutary effect of preserving us from cholera, for whilst our neighbours on the continent have suffered grievously, we have been almost entirely exempt; and from this we may derive confidence for the future, for we know that the same vigilant observation of the progress of the epidemic in Europe is maintained, with the intent that no precaution which can guard our country from invasion or render it antagonistic to epidemic activity should be omitted.

This vigilance is by no means confined to London or the seaports. Throughout the United Kingdom there exists a well-organised sanitary service, administered by medical officers of health, all alive to the danger, and prepared with the means of dealing with it; and notwithstanding differences of opinion that may exist as to the etiology of cholera, there is much unanimity as to the measures necessary to control and mitigate it, with a full appreciation of the vital importance of pure air, pure water

and cleanliness, as well as a conviction that immunity from cholera depends on local sanitation rather than on quarantine, cordons or coercion, which are not only useless in themselves, but hurtful, by diverting attention from the only measures which *can* be relied on.

Cholera has been moving and active in our vicinity. We are alive to the danger, and are prepared to deal with it should it come among us.

But it must be remembered that notwithstanding all the efforts of Government and the health officers, there is still much to be done. The powers of these authorities are not plenary; insanitary conditions still exist in places which public authorities cannot reach, and people do not always observe all prophylatic measures. Insanitary dwellings and localities abound; imperfect drainage, impure water, unwholesome food, and insanitary habits and occupations still render people obnoxious to disease.

Now it is in the crowded resorts of the poor that your influence may be exercised for good, and that your knowledge may be brought to bear, by advice and persuasion, to effect results which sanitary coercion would hardly achieve.

It is not my intention to discuss at any length the natural history or theories of causation and diffusion of cholera. To do so would be out of place on this occasion. Nor do I intend to encroach upon that part of the subject which belongs especially to the pathologist and physician—I mean the nature and treatment of the developed disease. It is rather to the part you, as nurses, may have to play in your intimate intercourse with the people in rendering first aid—and it is impossible to overestimate the importance of the influence you may exert in controlling the earliest approaches of cholera—that I would direct my observations.

In no other circumstances—in whatever sphere of social life your work may lie—is the trained nurse likely to be of more value than in this; for as your very *raison d'être* is to minister to the poorer classes, among whom so much is wanting which is possessed by those more blessed with worldly means, it is in that sphere that your services will be most valuable and best appreciated by the sufferers and their friends, as well as by the physician to whom you will be able to render such valuable aid.

Under these circumstances it is most probable that you may be called upon to act promptly and on your own responsibility, especially should the outbreak be severe. Medical men, however active, energetic, and devoted, cannot be everywhere, and sudden emergencies are likely to occur in which your experience and action may be of the utmost importance in the inchoate stages of the disease. But let me impress on you that in all cases—however trifling they may seem—you should never depend on yourself alone if you can obtain the aid of a medical man. If this, however, be not always immediately available, it will behove you to do your best, exercising the judgment and discretion which your training in the practical work of administering first aid may have given you.

Here let me refer briefly to the subject of nursing in the present day, and I cannot do so without offering my tribute of sincere admiration and respect for a work which, though it has existed since woman first solaced and assisted those suffering from pain and disease, has of late years attained to so remarkable a pitch of perfection, and has become so essential an adjuvant to medical treatment that one marvels how disease was ever satisfactorily dealt with, or the well-being of the sick provided for without it. No social movement of recent days has been more beneficent, in nothing has your sex contributed more to the common weal.

On my return to England some years ago, after long residence in the East, nothing impressed me more favourably than the splendid system of nursing which had come into existence in my absence. I have watched with infinite pleasure and interest its steady onward progress up to the present, and I am glad of this opportunity of addressing you on a subject in which you are so well-fitted to justify the high esteem in which your vocation is held.

In laying down practical rules to be observed either in anticipation of an invasion of epidemic disease, or as touching the measures of first aid ancillary to medical treatment, I am sensible of the great advantage I have in communicating my views to those so well qualified as you are to carry them out.

The project of making preparation in anticipation of an outbreak of cholera is, under present circumstances, a most judicious one, and it is a source of extreme satisfaction to know that a large body of devoted women is ready to undertake the work of nursing.

There is scarcely any emergency in which such service could be more valuable, for in the treatment of cholera much of the prospect of success depends on early measures and on the nursing. It will not only be a boon of inconceivable value to the public, should the calamity overtake us, but it must be a source of extreme satisfaction to the gracious Lady to whom this association of nurses owes its existence, to know that among the many provisions against the possible danger to her subjects, there are so many competent persons ready, willing and able to undertake this important duty. This will also be the case as regards another great nursing association which has made similar provisions under the auspices of one of Her Majesty's royal daughters.

I must now proceed to the special subject which was represented to me in the following plain and practical words:—"The "Council of the Jubilee Institute are making arrangements to

"place the Queen's Nurses in as good a position as possible to "meet any outbreak of cholera that may occur where their work "of nursing the sick poor in their own homes lies. The Council "think that it would be a great advantage to the nurses who are "being trained in the Metropolis or are working near to it, that "they should attend a lecture given by some one who has had "experience in dealing with it, upon matters in which it is necessary that the nurse should be well instructed."

Further it is said,—"It is important that the nurses should "learn how to judge of cases in the incipient stage, and how best "to deal with them as cases requiring first aid, till the services "of the medical man can be obtained."

To this proposition I had great pleasure in acceding, for I regard it as a most judicious and reasonable one. It in no way implies encroachment on the province of the physician, whilst such services will lessen his labour and tend to save many lives.

The knowledge one would wish to impart to you is needed not only by every nurse, but would be of great advantage to each member of the community, were cholera to come among us.

I shall presently say a few words on the general characters and symptoms of cholera, sufficient to enable you, as nurses, to detect the earlier manifestations in which you can render the first aid, which may do so much good, and I shall also describe the influence exerted by hygienic measures, sufficiently to enable you not only to detect and arrest the early indications of the disease, but to point out and urge the removal of insanitary conditions which are a source of danger.

This will support you in your efforts to encourage those among whom you labour in realizing how much depends on their own exertions in repelling the assaults of the disease, and in assuring those on whom it may devolve to watch and attend on the stricken, that the danger to themselves is small, for however cholera be communicated, it is not by contagion, in the sense that that term is applied to some other diseases.

I can safely assure you that in all my experience of cholera, I have seen nothing to support the belief that the attendants on cholera patients are more liable to suffer than other members of the community.

The records kept in the military and jail hospitals throughout India show that only 1·9 per cent. of the attendants were attacked—probably a smaller per-centage than that among the community generally. Similar results, I believe, were shown by the statistics of London hospitals for 1866; whilst in the great hospitals of Calcutta, where cholera cases are admitted indiscriminately with others, the disease has never spread.

Such, indeed, has been the experience of India generally, and that too, before the antiseptic precautions and purifications now recommended were insisted on or practised.

The subject of cholera is always one of great interest, but it is especially so now that the mysterious pestilence is again casting its dark shadow over Europe, and threatening our islands.

During the recent epidemics on the continent, we have escaped, or nearly so; but who shall say that this immunity will continue? The means already adopted by the state are about as good as they can be, but it is impossible to say that the conditions which foster the diffusion of cholera are altogether extinct. It would be wrong therefore to neglect the warning by omitting to take precautions.

Cholera exhibits characteristics in common with other pestilences—for example, the plagues of the middle ages. It traverses the earth in all directions, spreading in tropical, temperate, and even northern regions; is often capricious in its incidence, and terrible from the rapidity and intensity with which it strikes, as well as from its obstinate resistance to treatment. Yet it is obedient to certain laws which regulate its origin, diffusion and decline.

Of the true nature of its cause, I fear we must still be regarded as, to a great extent, ignorant; but experience and observation have thrown so much light on its habits and modes of action, as to enable us to mitigate, if not avert, its evil effects. Nor need we be without hope that in time to come, it may have become—like the sweating sickness, black death, and other pests—a thing of the past.

That time, however, has not yet come, and we find it illustrating all the peculiarities of an epidemic, diffused far and wide over extensive countries, leaping—as it were—from one to another by bounds, or spreading rapidly among more limited communities, following a definite track, modified by climatic, meteorological, or local conditions, dying out gradually or rapidly, remaining in abeyance till revivified by new influences, or occurring sporadically or endemically in certain regions, where, as in Bengal, it is never altogether absent, and whence it may at any time appear to spread as an epidemic to countries beyond.

Parkes says—"We have no certain clue to the origin of cholera, and in some respects the propagation of the disease is "very enigmatical. The way, for example, in which the disease "has spread over vast regions, and has then entirely disappeared, and the mode in which it seems to develop and decline in a locality in a sort of regular order and at certain "seasons, are facts which we can (as yet) only imperfectly "explain."*

Among the many apparent caprices of this disease, it seems to have an affinity for certain districts—even streets and houses. The same house has been known to be twice the site of the first

* Parke's "Manual of Practical Hygiene."—De Chaumont.

outbreak of an epidemic. There were such houses in Calcutta when I was there. It is worthy of notice also that certain trades, such as the tanner's, seem to confer a prophylactic influence; but everything points to locality as the most important factor in the development of the disease, and to its being the most serious subject for consideration in dealing with an outbreak.

During epidemic prevalence cholera never attacks all the places in the area over which it is diffused, but breaks out in but few of the inhabited towns and villages, sometimes leaping over places in the direct line of its course, and returning to them later during the same epidemic. It is a remarkable fact also, that in Bengal an epidemic moves, not necessarily along the great lines of traffic or with the rivers, but rather against them. Places attacked at the same time are often widely distant, and this is constantly observed in Indian epidemics, only a comparatively small proportion of villages and towns being attacked in any large area where an epidemic, however intense, prevails.

Much of the earth's surface has felt its malign influence, but there *are* geographical regions where it has not yet appeared. It has visited our own islands on several occasions—the last severe outbreak being in 1866—when it caused great mortality. But we were not then so well prepared to contend with it as we are now, and it found a more congenial nidus in which to effect its ravages.

It is far different at present, and we may await its appearance, should it come, with much confidence that measures dictated by sanitary science and experience will render it comparatively harmless.

If we have learnt anything by experience of late years, it is that the invasion and diffusion of cholera are to be prevented or mitigated by careful application of the principles and rules of hygiene;—on the other hand, experience in Europe during the recent epidemic shows how futile coercive measures have been, while the examples of Marseilles, Toulon, Valencia, Palermo, Naples and Hamburg, whose notoriously insanitary conditions have paid their natural penalty, should be a salutary warning as to how cholera may be intensified by local causes, and give a lesson which should not be disregarded.

As I have already told you, the broader sanitary questions are carefully dealt with by Government and our officers of health, but you, who know by your experience in the houses of the lower classes how much there is still to be done towards improving the sanitary conditions of their dwellings and localities, will understand how much good you may do in your intercourse with them to amend what is defective and gradually accustom them to realize that the laws of healthy living cannot be broken or neglected with impunity, especially during the prevalence of epidemic disease.

Cholera, though happily rare in this country, is no new disease. It has been known since the days of Hippocrates: its familiar name in India up to this day is "haiza," the Arabic term by which it was known to Rhazes and Avicenna in the 10th and 11th centuries.

Were this a fitting occasion, I might tell you the story of its wanderings and its ravages in past years, but I must restrict myself to practical points in its natural history and modes of procedure which are germane to the aspects in which you are especially interested.

For similar reasons I must omit disputed questions of causation and modes of transmission and diffusion: for our action must be based on experience and not on theories. I consider it sufficient to quote a paragraph from a paper on cholera written five years ago, which seems as applicable now as it was then.

"The belief in transmission by human intercourse is still firmly
"held by the highest authorities; few consider that there is dan-
"ger from mere contact or personal communication, but that
"the danger lies in the transmission of a germ through water or
"other channel from the bowel of one person to that of another.
"Hence they insist on what all recognize—the importance of
"the purity of the drinking water, because any organic impurity
"during cholera prevalence tends to give rise to the pathological
"conditions which result in the disease.

"For my part, I am unable to accept the water theory as the
"sole and sufficient explanation of all cholera outbreaks, especi-
"ally those which occur where the water is beyond suspicion
"of cholera contamination."

It would be difficult to overestimate the importance of recent researches into micro-organisms in connection with cholera, but their true relation to the disease has not yet been fully established.

"I rather seek the solution in causes of a more general nature,
"but I would speak as one who awaits further information, and
"who, though impressed with the belief in the non-communica-
"bility of cholera by the ordinary mode of contagion, is not pre-
"pared dogmatically to assert that under certain conditions it
"may not become communicable, in localities such as quarantine
"lazarettes, or other insanitary and crowded quarters.

"I hold, moreover, that until contagion is disproved, autho-
"rities are justified in adopting measures which avoid undue
"interference with personal liberty, yet take reasonable precau-
"tions against possible sources of infection, and give effect to all
"known practical measures against the propagation and diffusion
"of disease."

Some simple and practical measures you may be called on to put in force at any time in the early stage of the disease, and whatever views on the etiology of cholera may be held by those to whom you are responsible, you will have the satisfaction of

knowing that you are doing that which experience has proved to be the best.

It is the case that British and Indian authorities, basing their measures for protection on ascertained facts, and not on theories of causation or on coercive measures, have come to rely on inspection and sanitation as the real and sufficient means of safety. It is satisfactory to know that this view is becoming more generally accepted by other nations, and that the tendency to combat the inroads and diffusion of disease by sanitary measures alone is becoming general.

The panic produced by the dread of contagion was well exemplified by the state of the South of Europe, which, during the cholera of 1887 was pitiable, and the measures of fumigation, isolation, and general interference with personal liberty which would have been ridiculous had they not been so pernicious. The same feeling still prevails in other parts of the world, and I quote an example (from the *Times* of January 22, 1886) "Two
"Japanese sailors died from cholera during the short journey
"from Kobe to Nagasaki. Their dead bodies were thrown over-
"board. The Japanese authorities immediately forbade fishing
"along the coast."—*Sanitary Review*. It would not be difficult to adduce others almost equally absurd.

Up to the present date the belief is maintained by foreign powers that epidemic diseases, and especially cholera, can be arrested in their progress and debarred from entering a country by quarantine. This, as you are probably aware, originally meant seclusion and isolation for a period of forty days, of persons either affected by a disease or coming from a locality where it prevailed. Quarantine is based on the assumption that the disease is communicable from person to person, either by means of the individual himself or of his effects. This view, however, has been modified considerably in its application of late years, and the period of isolation has been much diminished, even by those who, holding the doctrine of contagion, should therefore logically concede the theoretical efficacy of quarantine, but say with De Chaumont:—

"Whatever may be the final opinion respecting the portability
"of the disease, we are bound to act as if it was perfectly ascer-
"tained. It is usually impossible to have rigid quarantine, for
"nothing short of absolute non-communication would be useful,
"and this is impossible, except in exceptional cases. . . . .
"Then as the incubative stage can certainly last for ten or twelve
"days, and there are cases on record where it has lasted for
"more than twenty, it is clear that quarantine, unless enforced
"for at least the last period of time, may be useless. The con-
"stant evasions, also, of the most strict cordon, renders such
"plans always useless." *

* Parkes' "Manual of Practical Hygiene."—De Chaumont.

With reference to the period of incubation, it has been stated to be from a few hours up to twenty days.

The approach of an epidemic of cholera has not unfrequently been heralded by some peculiarly depressed or altered condition of the general health, or even by some other epidemic, such as the influenza, which has lately prevailed in this country.

Outbreaks of cholera, though they generally commence by dropping cases, are sometimes very sudden and violent. A province or a body of men may be struck, the whole community being affected. The outbreak starts from a definite time, and the greatest mortality is compressed into a few days, generally at the very beginning.

Let me give a few examples:—

"While proceeding up the China Sea in one of the late East "India Company's ships we were" says the writer, "suddenly "attacked by cholera, men falling on deck as if struck by "lightning. This continued for three days, when the visitation "as suddenly ceased. As we were then drinking the same water "that we had been using for three months previously, and from "the time of leaving England, there could have been no con-"tamination of the water in this instance; independently of the "fact that it was contained in tanks into which extraneous mat-"ter could not possibly have entered. A precisely similar out-"break occurred on board H.M.S. 'Undaunted,' while proceed-"ing down the China Sea. As the cases continued to increase, "the surgeon, at the end of three days, recommended the captain "to change the course of the vessel. This was no sooner done "than the attack ceased. Not a case occurred afterwards."*

"In 1854, in London, in the district of the Savoy, there were "in a few days 537 deaths from cholera; the suddenness of the "outbreak was very remarkable. The greatest local diffusion "seems to have been reached on the second day, if not on the "first. During two days it prevailed with the greatest intensity, "and in the two following days it showed a diminution of 50 "per cent."†

The suddenness of an outbreak may be followed by an equally rapid decline, and the remarkable alternations, whether for better or worse, caused by changes of weather, fall of rain, depression of temperature, thunderstorms and gales of wind, are very suggestive of the influence exerted by meteorology on its progress. Sudden outbreak followed by rapid decline was well illustrated when cholera attacked our troops and ships in the Crimea.

After its arrival in the Levant, the French army had suffered a great deal from sickness, but the British army had been comparatively free up to the 19th of July, when cholera appeared

* Parkin, "Are Epidemics contagious?"

† "Journal d'Hygiene," Nov. 3rd and 17th, 1867.

among our regiments in Bulgaria, and by August 19th had killed 532 men. Before appearing in our army it had attacked French ships of war in the Mediterranean and their army in Bulgaria, making great ravages among the three divisions marching into the Dobrudja and in the ships. In a day's march, sometimes within the space of a few hours, hundreds of men dropped down in the sudden agonies of cholera. Out of these three divisions no less than 10,000 lay dead or struck down by sickness.

The disease appeared in the British fleet, and on the 11th and 12th of August the admirals put out from their anchorage, hoping thus to arrest its progress. It nevertheless raged with a violence rare in Europe; the "Britannia" alone lost 105 men, and the number of sick was so great as to render the usual duties impracticable.

"The waywardness of the disease on board the British ships "was extraordinary; it spared the officers, who, partly by kind-"ness and sympathy, partly by remedies, seemed often able to "fight the disease, or make the men think they did so."

"Almost suddenly the cholera ceased on board ship, the sur-"vivors returned to their duties, all mention of the terrible tra-"gedy was dropped, and in a few days from the time when "cholera had been at its height, the crews were ready to embark "the troops and land them in the Crimea."*

The great epidemic which broke out among the troops of the army of Lord Hastings in India began on November the 7th, 1817, was in all parts of the camp on the 9th, and reached its height on the 17th. During the week in which it raged most violently, 764 soldiers and 8000 camp followers died; the epidemic had ceased by the 22nd or 23rd of November.†

An outbreak occurred in May, 1818, among the Nagpore subsidiary force. Between 70 and 80 cases were admitted the first day, and many were found dead and dying about the camp.†

Another instance is the great outbreak at Kurrachee in 1846. On Sunday evening, June 14th, there was a sudden change in the atmosphere, the wind veered from south-west to north-east, and a thick, lurid cloud darkened the air. Later on in the evening cholera appeared in thirteen corps of the troops stationed there; it increased in violence till the 16th, when 227 cases were admitted, of which 186 died; after that date it gradually declined, 814 cases and 442 deaths having occurred between the 15th and 18th (inclusive).†

Without any premonitary symptoms, cholera appeared at Peshawur, at five o'clock in the morning of May 17th, 1867; from that day till the 23rd, the number of cases increased daily, and after that date decreased gradually, the last case being admitted to hospital on the 31st.†

* Kinglake "Invasion of the Crimea." Vol. viii.

† Quoted from Bryden. Cholera in the Bengal Presidency from 1817 to 1872.

A remarkably sudden outbreak occurred in an orphanage at Secundra, near Agra, on May 29th, 1867. The girls were caught in a sudden shower of rain, the elder ones being the most exposed to it. One of them was found dying at four o'clock the next morning, and subsequently 40 of them and 6 of the younger girls were attacked. On May 30th, 16 cases were admitted; on the 31st, 15; between the 1st and 6th of June, 15; the disease then died out.

In an establishment for pauper children at Tooting, in 1849, there were crowded 1395 children, little more than 100 cubic feet breathing space being allowed for each child. One night cholera attacked 64 of these children; 300 were attacked in all, and within a week 180 died.*

The epidemic of 1832, in Paris, commenced on the 26th of March, and increased so rapidly, that in eighteen days it had reached its climax, and had already extended to all the quarters of the city, and had been fatal to 7000 people.†

It would be easy to adduce other examples, but these are sufficient to illustrate the point.

Let me now say a few words on the disease itself.

The premonitary symptoms of cholera are malaise and diarrhœa, generally painless and often not violent at the outset. This may continue in some cases for days before it assumes the specific character of the disease, that of profuse watery discharges from stomach and bowels.

There is good reason to believe that if diarrhœa be checked early by simple measures, cholera may often be averted. For this reason the slightest indication of it should be enquired into and at once arrested. It is at this early stage that you can render that first aid which is of such importance.

It is quite true that cases may occur in which a dose of castor oil might be more appropriate, but as you would hardly be able to discriminate between these, and bearing in mind the importance of immediately checking all diarrhœa in cholera seasons, it is better you should do so, for in the cases in which it might not have been really necessary, no harm will be done that cannot easily be remedied, whilst you *may* have averted an attack of cholera.

The medical men under whom you work will give you the formula they approve of for the purpose, probably an astringent, combined with aromatics and laudanum.

In India it used to be, perhaps still is, the custom to supply the people in cholera seasons with pills consisting of asafœtida, black pepper, and half a grain of opium in each, to be taken on the appearance of diarrhœa.

Should it progress to cholera, the diarrhœa will become frequent and like rice-water, whilst incessant vomiting of rice-watery looking fluid, cramps, great exhaustion, lividity of skin, and husky voice will soon be followed by collapse, suppression of urine, and too frequently death.

* Southwood Smith. The Common Nature of Epidemics.

† Baly and Gull. Reports on Epidemic Cholera.

There are certain erroneous notions about cholera; *e.g.*, one is to give that name to the disease only when in its fully developed condition. But the fact is that it presents many phases, varying in gravity from simple malaise to collapse. Sporadic cholera, or "cholera nostras," as it is called when it occurs in this country, is regarded by some as a different disease from Asiatic cholera, or "cholera maligna," but the cholera of our country is indistinguishable at certain stages from that of India.

I believe that the difference in intensity or epidemic prevalence depends on climate, locality, and certain conditions not yet definitely known.

Whilst the disease is in its incipient stages you may frequently have the opportunity of acting on your own responsibility, but in all cases, I repeat, obtain medical aid if possible, and remember that it is not only in the administration of simple remedies at the outset, but in the carrying out of your instructions generally that you will be able to give the most effective aid, whether in the early or later stages of the disease; in the latter especially, your action must be guided by the medical officers.

I will briefly summarise the methods of procedure before I conclude this lecture.

When the symptoms of cholera have established themselves, the patient's condition rapidly becomes one of great gravity. The vomiting and purging are frequent and profuse, the strength rapidly fails; the patient is tortured by cramps and thirst; the temperature is depressed, the voice becomes husky, the countenance and surface livid, the renal secretion is suspended, the skin of the fingers becomes shrunken and corrugated; and if reaction do not take place, death soon closes the scene.

During these stages of the disease, the services of the nurse are of the utmost importance, and her unremitting attention is required in the administration of medicine, nourishment, stimulants, and ice to relieve the intense thirst; the application of sinapisms or other counter-irritants; friction of the limbs and body, and other measures that may tend to alleviate the sufferings, moderate the symptoms, sustain the rapidly failing vital energy, and give intelligent effect to the physician's directions generally.

I cannot here pretend to indicate the remedies or nutriment that should be administered, or the local applications that should be made. In all this you must be guided by the medical officer under whose direction you work; but I can assure you that on your watchful, skilful care and intelligent interpretation and fulfilment of his behests, the life of the patient may depend.

As I have already said, the disease assumes many phases and degrees of intensity, and though very fatal in the most severe forms, happily in those of less intensity recovery often occurs; and let me repeat that in no form of disease does the issue depend on good nursing and intelligent interpretation of the physician's orders more than in cholera.

The mortality is high when cholera has reached the condition of collapse or consecutive fever. At the outset of an epidemic probably half or more than half of those affected die. The fatality decreases as time goes on, and this has sometimes led the inexperienced to think that they have found some more effective treatment than any hitherto known.

The diminution in intensity and fatality as an epidemic progresses is not confined to cholera. It was observed by Defoe in the plague of London during the 17th century. In an outbreak of cholera at Kurrachee, of the first 100 admitted, 79 died; of the second, 66; of the third, 50; of the fourth 40; at a later period the mortality diminished and the cases were less severe.

The following conclusions may be deduced from experience:—

1.—That in cholera epidemics, though the disease is generally heralded by premonitary attacks of diarrhœa, often trivial and painless, yet the cases of fully developed cholera are more frequent and more severe at the commencement than in the continuance of an outbreak.

2.—That hygienic measures afford the greatest security, but still are not an absolute safeguard against cholera. Local insanitary conditions and impure water, especially if contaminated with cholera dejecta, impure atmosphere from overcrowding and from emanations from drains and cesspools, decomposition of organic matter, imperfect ventilation, absence of cleanliness generally, favour its incidence and increase its intensity.

3.—That cordons and quarantine have utterly failed to prevent the spread of cholera, but on the contrary, have done harm.

4.—That it is important to check all diarrhœa in times of cholera prevalence.

5.—That to enter an area in which cholera is present or to travel within that area is dangerous to a new-comer, while residents whose circumstances of living are favourable have a better chance of escape.

6.—To change the locality is the best course to pursue when cholera attacks a body of men, such, for example, as a regiment.

7.—That attendants on the sick do not suffer more than others.

8.—That irritating articles of diet, unripe fruit, tainted animal food, fish, flesh or fowl, and saline aperients are liable, during cholera prevalence, to bring on diarrhœa which may rapidly pass into cholera.

9.—That fatigue, exhaustion, intemperance in alcoholic drinks, fear, anxiety begotten of dread of contagion and sensational

descriptions of the horrors of the disease, and sudden vicissitudes and alternations of temperature are powerful predisposing and exciting causes.

10.—Having suffered from cholera gives no immunity from recurrence of the disease.

The question then arises, what does it behove each individual of the community, and especially what is it incumbent on you, the Queen's Nurses, to do, as regards your household, district, village, town, or the country generally—*i.e.*, as far as your influence extends—when cholera threatens or has actually made its appearance?

In the first place, bear in mind that coercive measures are futile: they divert attention from the true and only source of safety, which lies in the removal of all insanitary conditions which may give fatal activity to the disease.

Use every effort to secure good ventilation, pure air and pure drinking water, well-trapped sinks and good drainage, with the removal of all cesspools, foul dust-bins, ash-pits, decaying vegetable or other organic matter.

Avoid as much as possible damp, ill-ventilated rooms, overcrowding, and every impediment to the free circulation of air.

Careful living—by which I mean regularity and avoidance of all errors in diet, all depressing and exhausting habits or occupations—is essential. Let the food be plain, the water and milk be boiled before drinking, and avoid all excess of alcoholic stimulants, indigestible or imperfectly cooked food, and especially animal food, whether of mammal, bird, fish, crustacean or shell-fish, unripe and partially decayed fruit or vegetables.

Professor Notter, of Netley, a high authority on hygiene, points this out in some remarks which are of great practical value.

Be most careful to avoid chills or exposure to sudden alternations of temperature, aperient medicines, especially saline aperients. Wear woollen next the skin: a flannel belt is often worn in India.

Do all you can to secure personal cleanliness of body and clothing. Avoid fatigue or exhaustion.

Be careful that all excreta are freely disinfected and removed; the drain or sink into which they are thrown should be well flushed with carbolic acid water. Use disinfectants freely for clothing, rooms, and houses.

Whenever you detect any breach of these directions, do your best by persuasion and advice, or by the intervention of sanitary executive authority, to rectify them.

Endeavour to keep a good heart and a cool head; be hopeful and cheerful yourselves, and encourage that feeling in others, for panic, fear and anxiety are very apt to favour, if not to provoke, the onset of the disease.

Do not be afraid to attend on the sick, and encourage others to the same purpose, for no danger is incurred thereby, whilst, as I have said, a mental attitude of despondency or dread of contagion is full of danger, as has been proved by frequent experience.

I would impress on you that it is on such measures only you may repose confidence, and that, if carefully carried out, experience shows that reliance may be placed on them.

Do not for a moment suppose that I regard cholera merely as a result of dirt and insanitation. It is something more than this, but so much is certain, that to prevent the onset, or control the evil effects of cholera, sanitary measures, strictly carried out, are of all things, most effective.

With reference to the part you, as Queen's Nurses, will be called on to play, I find that excellent recommendations have been already made by your Council. They are to a great extent based on those of the Royal College of Physicians and of the Government Local Board, and I can do little more than endorse and emphasize them.

In the first place I notice that the superintendents of your Nursing Homes are recommended to acquaint themselves without loss of time with whatever special arrangements may have been made by the local or other authorities for giving medical assistance within the district, and to ascertain what steps the nurses are to take with reference to cases of diarrhœa or cholera. That, having obtained this information, each Superintendent should inform the Nurses how to communicate, with the least possible delay, with the proper medical authority for notification of any such case; also the nearest centre for obtaining medical aid, medicine and disinfectants.

It is very important that centres where medicine and medical comforts and disinfectants can be got at any moment, should be well known and accessible.

I would suggest that as, in crowded neighbourhoods especially, there will probably be hospitals for the reception of cases, the Nurse should know where these are, and the best means of effecting removal to them when necessary.

I would further suggest that each Nurse be supplied with some simple remedy to be given at once to any case of diarrhœa of which she may become cognizant.

The Nurses should be made acquainted with the regulations of the Local Government Board, or district sanitary authority, with regard to the disinfection of houses, clothing, furniture, etc., so that they may at once take the requisite steps.

They should be made acquainted with any arrangements for affording relief to the very poor, so that there may be no loss of time in communicating with the relieving officer or other person appointed to dispense such relief in any case of want or destitution

since privation, as a predisposing cause, may require special aid.

If extra local centres could be established in poor, overcrowded neighbourhoods, where the Nurses could procure nourishment and comforts for the sick, it would be an excellent prophylactic measure.

It is further recommended that the Superintendents of all Nurses' Homes should enjoin the following precautions on the Nurses:—

In the first place that they should preserve an equable frame of mind, and endeavour to maintain it in others. They should avoid, as I have said before, excitement or exaggeration; they should not dwell on the dangers of exposure to contagion, and on the terrors of the disease; or, in short, do or say anything that may discourage or depress.

Let me repeat that to do so can cause nothing but harm. Panic, depression, and anxious expectancy are the worst frame of mind in which to meet cholera, whilst the converse has exactly the opposite effect.

As an illustration of this, let me tell you the following Oriental story:—

A Dervish travelling over the desert met the Genius of Cholera, to whom he said, "Where are you going?" The Genius replied, "I am going to Baghdad to kill 20,000 men." Some time afterwards the Dervish met the same Genius returning, and accused him of having killed 90,000. "No, no," said the Genius of Cholera, "I killed only 20,000, fear killed the rest."

The advice I have just given is probably unnecessary for the majority of the highly trained women I have the pleasure of addressing, but as there are timid natures to whom encouragement may be helpful, it is right that they should know that the danger exists chiefly in the imagination, as far as nursing cholera is concerned, and that, as to other sources of danger of incurring the disease, they but share alike with the rest of the community, whilst risk to all is vastly diminished by conforming to the rules of hygiene.

The Superintendents are enjoined to impress on the Nurses that they should not go on duty, if they can avoid it, when feeling fatigued or unwell, especially if affected with any relaxation of the bowels; that it is necessary for them to take a good, plain, nourishing diet—even an extra allowance—and at regular and not too long intervals. The depression caused by fatigue, hunger, and an empty stomach predisposes to the disease. Such food should be available by night as well as by day.

As to stimulants—it is not necessary that they should be taken in increased proportion, though occasions may arise when an extra allowance will be expedient.

It is only too probable that in your ministrations among the poor, especially should cholera appear in crowded neighbourhoods, it may not be possible for you to observe to the letter all these directions; but at any rate remember and observe them as nearly as you can. You must, under such circumstances, necessarily be exposed to many hardships and risks, but it is a noble work, worthy of your highest aspirations, and twice blessed, for it will, like mercy, bless those who give as well as those who receive.

The Superintendents are emphatically to caution the Nurses as to any neglect on their own part or on that of others of perfect cleanliness of person and clothing, which should be carefully disinfected. This again, under the circumstances, will often be very difficult, but do your best to ensure it, as far as possible.

You will, no doubt, see much that to your instructed eye is suggestive of danger from insanitary conditions, which, alas, you are unable to prevent. But you may do a good deal, and whatever warning, advice and remonstrance can effect, you should insist on. Do not wait for the actual advent of cholera, but try and accomplish this before it comes.

I have already referred to the need for personal cleanliness, and on this the Nurses should strenuously insist. The houses should also be kept as clean and well-ventilated as possible; dustbins emptied frequently; no decaying matter or dirt of any kind to be allowed to accumulate in or near the house or premises. No cesspools to be tolerated if it is possible to remove them. All latrines and closets should be kept in good order, and flushed frequently with disinfecting fluids. The best are solutions of corrosive sublimate $\frac{1}{4}$ oz., hydrochloric acid 1oz., dissolved in three gallons of water and coloured with five grains of aniline blue. This is a disinfectant in the truest sense; the only objection to it is its poisonous nature.

Professor Notter says that a five per cent. solution of carbolic acid is quite effective, and this would be safest for the Nurse to use for general disinfecting purposes, and a good supply of it should be available. He strongly recommends that all dejecta should be disinfected with it or by chloride of lime, whilst all linen or bedding soiled by cholera discharges should be destroyed by burning, or soaked in the corrosive sublimate solution, or heated in a disinfecting chamber.

Fumigation by burning sulphur or chlorine gas is effective in rooms, but these must be used in large quantities to be of any avail.

Much stress—and rightly so—is laid on the purity of drinking water. It should be obtained from as pure a source as possible, and should be well filtered and boiled shortly before using. All tainted wells should be closed. Milk also should be boiled shortly before it is used.

Provisions of all kinds should be as fresh as possible. As I have before said, all stale food, especially flesh or fish, should be

avoided. Notter attaches much importance to this as regards fish, which unhappily is often sold to the poor in a stale condition.

It is the conviction of most medical men who have had to deal with cholera epidemics that it is right to check diarrhœa at the outset in cholera seasons. Of this I have already spoken.

I again repeat, seek medical advice as early as possible, and it is most desirable that all persons should know where to find it; but in anticipation, the Nurse will do well to administer a dose of some astringent such as the following, whenever diarrhœa appears:

Pulv. aromat.	three drachms.
Sal volatile	three drachms.
Tr. Catechu	ten drachms.
Tr. Card. Co.	six drachms.
Tr. Opii	one drachm.
Mist. Cret.	twenty ounces.

Dose.—1oz. for an adult, $\frac{1}{2}$oz. for a child 12 years, $\frac{1}{4}$oz. for a child 7 years, less for a younger child in proportion to age, after each liquid motion.

Professor Notter says:—"For the diarrhœa which precedes "cholera, and for the early stages, to check it, I found nothing "better than:—

"Acid Sulp. dil.	fifteen minims.
"Tr. Opii	five minims.
"Aq. menth. pip.	one ounce.

"and this might be safely left with a nursing sister.

"If the comma bacillus is the cause, we know that it will not "live in acid media. So there is good reason for prescribing that "form of astringent.

"For like reason, acid drinks should be given, *ad lib.*, to make "up for the water passed off in the discharge from the bowels, "and to relieve the kidneys, which become early involved.

"I found this the best treatment in the early stages myself. "Of course, after the first two doses, I omitted the opium."

The College of Physicians has formulated some excellent rules for the early treatment of cholera. You will find them in the leaflet of recommendations issued by your Council. Those which apply to first aid I have already mentioned. The others are rather such as would appertain to the medical man, so I need not repeat them here.

I hope I have now told you enough to show you how you should act, and I can hardly sufficiently insist on the importance of the services you may render in relieving suffering, assuaging pain, and giving confidence to the healthy as well as to the sick.

You will have full opportunity of doing all this, and of justifying the encomium passed on your order by your reverend and respected President. You will establish a claim to the gratitude of your countrymen and countrywomen, but far better than this, you will have the satisfaction arising from the consciousness of duty well and thoroughly performed; the solace of knowing you have rendered valuable aid in a great emergency, relieved suffering, and, it may be, have saved life.

You will have done more too, for you will have contributed your share towards that great end to which sanitary efforts aspire, the diminution, if not the extinction of the pestilence. You will have furthered in some degree, however small it may be, the object to which we all hope to attain, as was well expressed by Dr. Southwood Smith, a sanitarian and epidemiologist, whose loss we continue to deplore, when he said:—

"Epidemics are under our own control; we may promote their "spread, we may prevent it. We may secure ourselves from "them. We have done so. We have banished the most for-"midable. Those that remain are not so difficult to be con-"quered as those that have been vanquished. . . . . We "see that epidemics are not made by a divine law the necessary "condition of a man's existence upon earth. The boon of life is "not marred with this penalty. The great laws of nature, which "are God's ordinances in their regular course and appointed "operations, do form and give off around us, products which are "injurious to us; but He has given us senses to perceive them, "and reason to devise the means of avoiding them, and epidemics "arise and spread because we will not regard the one nor use "the other."

"Let us," says Dr. Dallinger, in a recent address, "do our "duty and act up to our knowledge, and as surely as disease "comes among a people by physical laws broken, so it will de-"part from them if they see to it that physical laws are obeyed."

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LIVERPOOL SCHOOL OF TROPICAL MEDICINE

FIRST PROGRESS REPORT OF THE CAMPAIGN AGAINST MOSQUITOES IN SIERRA LEONE

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LIVERPOOL UNIVERSITY PRESS

LIVERPOOL SCHOOL OF TROPICAL MEDICINE

MEMOIR V. PART I

FIRST PROGRESS REPORT

OF THE

CAMPAIGN AGAINST MOSQUITOES IN SIERRA LEONE

BY

RONALD ROSS, F.R.C.S., D.P.H., F.R.S.
WALTER MYERS LECTURER
LIVERPOOL SCHOOL OF TROPICAL MEDICINE

Dated Liverpool, 15th October, 1901

AT THE UNIVERSITY PRESS OF LIVERPOOL 1901

REPORT

Dated Liverpool, 15th October, 1901

Preliminary

THIS enterprise was undertaken in the following circumstances:—Shortly after the development of the parasites of malaria in mosquitoes had been determined by my researches of 1895–98, I suggested that the proper way to extirpate malaria in towns and cantonments would be to drain the breeding places of the insects which carry the disease.* All efforts to induce the authorities to adopt this idea remained, however, almost entirely unavailing during two years; † and at last I resolved upon starting the work by the help of private enterprise. On the 1st May, 1901, I received from a gentleman with whom I have the honour to be acquainted the sum of one thousand pounds with which to commence the work; and this amount he has since doubled. The project was adopted with energy by the Liverpool School of Tropical

* Letter to Government of India, 16th February, 1899, partly published in *Indian Medical Gazette*, July, 1899; also *British Medical Journal*, 1st July, 1899; also *Lancet*, 1900, vol. ii, page 1400; also *Journal of the Society of Arts*, 30th November, 1900.

† The admirable measures instituted against malaria in Lagos by Sir W. MacGregor and Dr. Strachan are conducted largely on different lines; and the operations of Young and Thomson in Hong Kong, and of others elsewhere, have been very limited in area. I shall presently refer to the work in Havana.

Medicine; and supplementary gifts and assistance of all kinds were given by Alfred L. Jones, Esq., J.P., John Holt, Esq., F. Swanzy, Esq., Professor Boyce, Max Muspratt, Esq., Dr. Kohn, and other gentlemen. Mr. Logan Taylor, M.B., B.S., of the Pathological Laboratory of Glasgow University, was appointed to superintend the operations; and Freetown, Sierra Leone, was selected to be the site of the experiment, partly because its malaria had been already surveyed by the scientific expeditions of the Liverpool School of Tropical Medicine and the Royal Society, and partly because the place is so difficult to deal with on account of the heavy rainfall and the nature of the soil that it affords a fair, and, indeed, somewhat severe test, of the feasibility of the measures recommended by me. As showing the popular interest in the matter, I may mention that the expedition was entertained by Mr. Alfred L. Jones at a valedictory banquet, which was honoured by the presence of the Lord Mayor of Liverpool, the Lord Bishop of Liverpool, the Director General of the Indian Medical Service (Surgeon-General Harvey, D.S.O., C.B.), the President of the Royal Institute of Public Health (W. R. Smith, Esq., M.D., F.R.S.E.), and other distinguished guests. The Right Honourable Mr. Joseph Chamberlain, H.M. Secretary of State for the Colonies, signified his approval and support of the scheme, and the expedition left England on the 15th of June.

Commencement of Campaign

We arrived at Freetown* on the 2nd of July, and were very hospitably entertained by His Excellency the Governor, Sir Charles King Harman, K.C.M.G. At

* Freetown contains 30,000 inhabitants.

a public lecture, at which His Excellency presided, a resolution in support of our efforts was unanimously adopted.

Dr. Logan Taylor commenced work without delay. In my first suggestions for controlling malaria I had recommended measures against mosquitoes of the genus *Anopheles* only; but mosquitoes of the genus *Stegomyia* have now been conclusively proved to carry yellow fever; and mosquitoes of the genus *Culex* have long been known to carry *Filaria nocturna* (elephantiasis). Malaria and elephantiasis prevail all down the coast; and many medical men of repute consider that yellow fever also has existed there from time to time. In addition, it is beginning to be thought by some that mosquitoes may carry other diseases, especially various tropical fevers distinct from malaria and typhoid; and, altogether apart from their pathological agency, most kinds of mosquitoes undoubtedly cause an immense amount of annoyance in the tropics, and, next to the heat, constitute perhaps the principal drawback of life in warm climates. We determined, therefore, to push our campaign against all kinds of mosquitoes indiscriminately.

Dr. Taylor immediately engaged the services of over twenty men, under intelligent head men. To these His Excellency the Governor added twelve men, and gave the necessary carts and implements. This force was divided into two gangs; a small gang of six men (called the *Culex* gang), to collect from private houses all the broken bottles and buckets, empty tins, old calabashes, and similar unconsidered vessels in which mosquitoes of the genera *Stegomyia* and *Culex* breed; and a larger gang (called the *Anopheles* gang), to drain the pools and puddles in the streets and the backyards of the houses, in which *Anopheles* breed.

The *Culex* gang, under a native headman, did very rapid work. They piled the rubbish into carts, which then discharged it into an assigned rubbish shoot. At the same time they showed the larvae to occupants of houses and instructed them in the manner of destroying them by emptying the vessels which contain them, or by dropping a little oil on the surface of water in which they live. It was found that on the average this gang cleared about fifty houses, and removed about ten cart-loads of empty tins and broken bottles daily. The effect of this work on the prevalence of *Culex* and *Stegomyia* can be imagined when it is remembered that about one-third of the tins and bottles contained the larvae at this season (the rains). Every house had previously been breeding mosquitoes in its own backyard or garden. The occupants welcomed the gang wherever it went, and some stated that they had not been able to get rid of their rubbish for years.

The *Anopheles* gang had a more difficult task. The breeding-pools of these insects in Freetown, both in the rains and the dry weather, have been minutely described by two previous scientific expeditions.* At this season the water courses contained impetuous torrents too rapid for larvae to live in; but the streets, yards, and gardens possessed numerous pools of rain-water, well suited for them. These were attacked by many methods. Some were filled with earth, rubble, and turf. Others were evacuated by cutting through the rock which contained them, or by making channels in the soft earth. Owing to the large rainfall (estimated at about one hundred and sixty inches annually), to the

* Report of the Liverpool Malaria Expedition to Sierra Leone, University Press, Liverpool, 1900; and Reports of the Malaria Committee of the Royal Society, Harrison & Sons, St. Martin's Lane, London.

peculiar nature of the ground, and to the very defective surface drains, these puddles were exceptionally numerous in Freetown; and, in order to drain many of them as soon as possible, it was deemed advisable to adopt the simplest and least expensive methods at first, and to reserve more permanent works for the future. At the same time several men were specially employed in brushing out with brooms, or treating with crude petroleum or creosote, those puddles which the workmen had not yet had time to touch. Progress was fairly rapid in spite of the deluge of rain; and many of the worst streets were fairly well drained in a few weeks.*

On the 22nd of July, I left Sierra Leone in order to visit Lagos and the Gold Coast. A few days later Lieutenant McKendrick, M.B., of the Indian Medical Service arrived. The government of India, to whose well-advised action in 1898 so much is due, had determined, on the initiative of Surgeon-General Harvey, to send Lieutenant McKendrick to study our operations in Freetown. Dr. McKendrick remained there for a month.

I returned to Sierra Leone on the 16th August, and, after witnessing Dr. Taylor's excellent work, left after five days, in company with Dr. McKendrick for England, on private affairs. Shortly after my departure Dr. Daniels, Superintendent of the London School of Tropical Medicine (conveyed by the Liverpool School), arrived on the same errand as Lieutenant McKendrick. He also remained some weeks with Dr. Taylor, and studied his methods with great care. His report on the subject will be given at the end of this report.

In letters, dated the 17th and 28th September, Dr. Taylor says that progress has been satisfactory,

* The proper methods of dealing with mosquitoes are given in detail in my forthcoming work called *Mosquito Brigades, and How to Organise Them*; George Phillip & Son, 32, Fleet Street, London; price three shillings.

although impeded by heavy rain. The *Culex* gang had cleared 6,500 houses up to the former date, and, I calculate, must have removed more than a thousand cart-loads of rubbish. The total number of workmen employed, including the twelve lent by the Governor, now number fifty-three. His Excellency has also given Dr. Taylor the assistance of Dr. Berkeley, of the Colonial Medical Service, who had previously done much useful work in Freetown in this connection. Major Smith, the able head of the Royal Army Medical Corps in Sierra Leone, is taking active steps to expel mosquitoes from the various military barracks. Drs. Daniels and Taylor have been able to inspect several places at a distance from Freetown, with a view to starting work there also. Two men are specially employed in keeping the centre of the town free from mosquitoes, while the *Culex* gang is working elsewhere; but as this gang had cleared nine-tenths of the town up to the 28th September, it will now be able to commence at the centre again, and perfect its former work.

As the rains are now ceasing, the dry-weather operations will shortly begin. These will consist chiefly in attacking the drying water courses, in which *Anopheles* chiefly breed at that season. Dr. Taylor is already beginning the work from the 1st October, by filling hollows in rocks with concrete. These operations will be detailed in a future progress report. It is possible that a hundred or more men will have to be employed shortly.

Results up to the present

It is always very difficult to make an exact estimate of the number of mosquitoes anywhere, and, therefore, to gauge their increase or diminution with mathematical

certainty. For the present we must rely on a general consensus of opinion. Judging from this, the results are already most encouraging—indeed unexpectedly so. Lieut. McKendrick informs me that he was not conscious of having once been bitten by mosquitoes during his month's stay in Freetown. After the first week or so, I myself was never bitten, either at Government House* or at the house of the Expedition, in the centre of the town, though I am sure I should have been bitten several times a day in both, before the commencement of operations. Dr. Taylor writes on the 17th September, 'I think there is no doubt but that the number of mosquitoes (*Anopheles*) in the streets we have dealt with is diminishing; the people resident in the streets will tell you that at once; and the number of pots and tins that have been removed has made a considerable diminution in the *Culex*'—meaning also *Stegomyia*. On the 28th September, he writes, 'The mosquitoes are still on the decline, and in the streets we have been working in it is exceedingly difficult to find *Anopheles* now. Of course in the untouched parts they are still to be got. As for the *Culex* (or *Stegomyia*, to be correct) they have got a fright. They also are getting very scarce. The true *Culex* I seldom see; only now and again.' What this means in a tropical town only those who have resided in such can know.

The valuable testimony of Dr. Daniels to the same effect is given in his report at the end. All those who are familiar with his important work on malaria and other tropical diseases will know that he is one of the most cautious and trustworthy of observers.

Altogether I think that we have reason to be more than satisfied with the progress made.

* Capt. Hodgins, A.D.C. to the Governor, had partially cleared Government House of larvae before our arrival.

Accounts

It might be imagined that all this work has been very expensive. On the contrary the expense has been slight. The whole cost of the expedition from its beginning, including cost of fitting out, salary of Dr. Taylor, wages of from twenty to forty workmen, and of eight hammock boys, rent and fitting of the house of the expedition, and other items, had amounted, at the end of September, that is for three and a half months, to only £304. This is exclusive of passages, oil, cement, and of the services of carts, and of twelve men lent by the governor. The wages of the workmen may be put roughly at about one pound a month each. Detailed accounts have been submitted to the School Committee and to the subscribers.

Other Expeditions

On passing Bathurst, and during my visit to the Gold Coast, I was able to arrange with Sir George Denton, K.C.M.G., and Major Nathan, C.M.G., Governor of the Gambia and the Gold Coast, to start similar work in Bathurst, and in the principal towns of the latter colony. Consequently, Dr. Everett Dutton, Walter Myers Fellow, was despatched to Bathurst to make a preliminary survey of the subject there—a thing which had not yet been done; and to start some operations against mosquitoes, with the help of the governor, and of a sum of money from the Sierra Leone fund. As regards the Gold Coast, a handsome sum of money has been specially placed at my disposal by a philantrophical gentleman to pay the salary of a delegate; and I am happy to be able to state that Dr. Balfour Stewart has accepted the post. Details of these expeditions will be given in later reports.

Anti-Malaria Work Elsewhere

Some of the earliest work against malaria performed on an anti-mosquito basis was that of Young and Thomson at Hong Kong, especially at the military sanatorium, round which the bush was cleared and the breeding places drained.* Similar work has recently been done by Dr. Doty near New York, in connection with an outbreak of malaria in a collection of a hundred houses in Staten Island.† On a large scale, anti-mosquito work seems to have been first commenced a month or two before the operations in Sierra Leone by Major and Surgeon Gorgas in Havana, immediately after the demonstration there of the fact that *Stegomyia* carries yellow fever.‡ Havana contains two hundred and fifty thousand people. In April, Gorgas reports that he has transferred two-thirds of the town cleaning gangs to the mosquito brigades. In May, he says, 'most of our attention is now being paid to the destruction of mosquitoes. The suburbs, and all the small streams in the suburbs, have been pretty thoroughly cleared out; and the pools oiled and drained. The Mayor has issued an order prohibiting the keeping of standing water anywhere within the city limits, unless made mosquitoproof. This is being enforced; and all standing water found not protected as required is emptied and the owner fined. We are employing seventy-five men in this mosquito work, and have gotten over the whole city during the last month, and I expect to do this every month during the summer, at any rate as long as it seems to have the present happy result. In this way, during the past month, we have used about

* *British Medical Journal*, 1901, vol. ii, page 683.

† *Boston Medical and Surgical Journal*, 22nd August, 1901; and *British Medical Journal*, vol. ii, page 644.

‡ Monthly Reports of Vital Statistics of Havana, Office of Chief Sanitary Officer of Havana.

one thousand four hundred gallons of oil.' The Americans deserve much credit for the commonsense and energy with which they have attacked this question; so different from the hesitation and apathy generally shown by the British.

Regarding the prevention of malaria by other means, we have first the distinguished work of Koch, based on the general use of quinine,* and more recently the no less excellent work of Sir William MacGregor, K.C.M.G., C.B., and of Dr. Strachan at Lagos, based upon quinine, wire gauze to windows and doors, and drainage of marshes.† Much work is said to have been done by the use of wire gauze and quinine in Italy, but I regret that I cannot accept without reserve all the statements made on the subject in that country.

Remarks

It may be advisable to correct some popular errors regarding the operation of clearing mosquitoes. No one has ever supposed it possible to exterminate mosquitoes from whole continents, or even from large rural areas—the operation must be confined principally to towns and their suburbs. No one imagines that it will be possible to exterminate *every* mosquito even from towns—we aim only at reducing their numbers as much as possible. No one supposes that it will be invariably possible to drain or otherwise treat every breeding place of mosquitoes in a town; but even where every place cannot be dealt with, it will always be possible to deal with a very large number; and it often happens that the smallest and most easily drained or emptied puddles or pots breed the greatest number

* *Deutche Medicinische Worchenschrift*, 1899, 1900; and *Journ. of State Medicine*, October, 1901.

† *British Medical Journal*, 1901, vol. ii, pp. 644 and 680

of mosquitoes. Mosquitoes may possibly be carried into towns from a large distance by winds, though I doubt whether there is much or any reliable evidence in favour of this view; but, as a general rule, the vast majority of mosquitoes existing in a town are bred in the streets, yards, gardens, and houses of the town; and if we get rid of these breeding-places, we may calculate on at least greatly reducing the insects in the town. These are the simple principles upon which our efforts are based.

As regards the effect of such measures on mosquito-borne disease, we may expect speedy results in the case of yellow fever, which is not a lingering disease; but in the case of malaria and filariasis, which linger for years after the first infection, good results may not be so immediately manifest. But science assures us that we may continue to work in complete confidence of good results being finally obtained. We know from the experience of ages that drainage abates malaria. And, quite apart from sanitary questions, we shall all admit without argument that the extermination of mosquitoes in tropical towns will constitute one of the greatest possible reforms ever made in life in the tropics.*

(*Signed*) R. ROSS

* I estimate, for several reasons, that the amount of a mosquito-borne disease in a locality should vary roughly as the square of the number of mosquitoes capable of carrying the disease found there. Hence, if the *Anopheles* are reduced to one-half, the malaria should (finally) be reduced to a quarter; if the *Anopheles* are reduced to one-tenth, as should generally be practical, the malaria should be reduced to one-hundredth. But this is an estimate founded merely on *a priori* considerations; and it will always be a matter of great difficulty, especially in native towns, to obtain reliable statistics of the variation of the amount of malaria.

APPENDIX

Letter from C. W. Daniels, Esq., M.B. Cantab.

Note.—*In reading this letter it is necessary to remember that Dr. Daniels inspected the Sierra Leone operations little more than two months after they had been commenced. See also the remarks under the headings,* Progress of the Campaign *and* Results *above*— R. Ross.

1st October, 1901

Dear Ross,

I have carefully examined the various works which have been undertaken with a view to the serious diminution in the number of mosquitoes in Freetown, Sierra Leone. The common mosquitoes found are :—*Anopheles costalis*, the carrier of malaria, and also of *Filaria nocturna*. *Stegomyia fasciata* (*Culex taeniatus*) or brindled mosquito, Calcutta, the mosquito supposed to carry yellow fever.

Two *Culices* (I think, *fatigans*, which carries *Filaria nocturna*, and another which is known both on the East Coast and Shire and Uganda Highlands, but does not attack man) were found, but not commonly.

A. funestus was found near but not in Freetown.

In my opinion, already your efforts have been crowned with a large degree of success, as there has been a noteworthy diminution in the number of the first two genera found in the houses. The number of breeding grounds has been enormously diminished.

The operations, having been only recently begun, are, of course, as yet far from complete. A considerable part of the town, perhaps half, has not been touched. Even in the parts longest under treatment, in the yards adjoining the streets, there are still numerous breeding grounds; and in the streets themselves occasional places have either been overlooked or the works undertaken have not been effective as yet.

The breeding places dealt with could be only of importance in the peculiar circumstances of Freetown, *i.e.*, where the soil is impervious and the rainfall excessive (110 in. to 200 in.). Even in Freetown most of them would be destroyed by a week's dry weather, and some by less. As, however, the wet season in Sierra Leone is a prolonged one, for this place these breeding grounds are of great importance, and in dealing with them an excellent beginning has been made.

A great part of the work will not be permanent. The rock cuttings are too narrow, many of them being blocked after each shower. The earth cuttings are also very liable to fall in. This results in much extra work and supervision, as considerable supervision and labour is required, constantly, to keep the work already done in order.

I suggest that during the dry season the rock cuttings should be broadened, so as to be at least three inches at the bottom, the sides being inclined at about 60°. When the rush of water is greater a broader cutting will be requisite.*

The earth cuttings should in all cases have sloping sides where possible, as this minimises the liability to formation of pools, and ensures, even with a small amount of water, a persistent current. There are few things more suitable for *Anopheles* breeding grounds than a drainage system in which the water supply is insufficient to flush the drains.

* Exact uniformity is not essential, but an approximation to it will save a large amount of labour in clearing the channels; and as this requires to be done very frequently, the point is of importance.

The plan adopted of placing large stones at the edge of the channel, blocked behind by smaller ones, will, I think, suffice if the work is strengthened with cement; but brick drains would be preferable in my opinion, as they are easier to clear.

A large amount of work has been done by filling up rock pools with small broken stones, and, even where the traffic is great, this, when strengthened with cement, will prove to be permanent.

The work is so far incomplete that it is essential that at least one other complete wet season should be spent here. Constant European supervision is necessary, and one man is not sufficient for the purpose. There should be at least two Europeans engaged in supervising; and a larger staff of workmen (quite twice the present) would, I think, be required, as so much of the work will require redoing, and there are other places to deal with.

Towards the foot of Mount Aureole there are in places numerous springs from which the water is constantly running. Pits, usually shallow, have been dug in this district, and in these *Anopheles* larvae are constantly found. Some of them will be difficult to deal with by cuttings alone; and the more permanent should, I think, be converted into covered wells with an overflow underground—say two feet below the surface—leading into a drain to the nearest stream. None of these places have, as yet, been dealt with.

There is one similar place in the Grassfields District, and I feel sure that there are others both near the Wilberforce Barracks and near Kissy. The constant rains and the general waterlogged condition of the ground prevent more definite information being obtainable till there is some continued fine weather. Such places are common, and are the important ones in the hilly districts of Central Africa.

In a few of the wells, which are so numerous in many districts of Sierra Leone, *Anopheles* (*costalis*) larvae were found in numbers. Though I do not think from previous experience that these will at any season in the year be of very great importance, still they are an additional source. In none of the broad public wells which contain fish were larvae found, and on placing a few fish in one of the infested wells the larvae speedily disappeared, but many of the fish died.

Covered wells in any case are safe; but to so repair the numerous broken-down wells and provide them with covers would be costly and uncertain, as the covers would not be used in many cases.

I am informed that there would be serious difficulty in closing these private wells, and in substituting for them a smaller number of public ones, but that when a good town water supply is obtained much could be done in this direction. Such a water supply, it is expected, will be shortly sanctioned.

Equally dangerous are the numerous pits remaining from disused latrines. Those in use (in many cases overflowing) are dangerous for other reasons, but not as breeding grounds for *Anopheles*.

There are a few deep pools which probably contain water during the greater part of the dry season, and which harbour *Anopheles* larvae; these require to be filled up.

I notice that some pits are being filled with the mixed assortment of tins and bottles removed from houses. Broken bottles, or others, are well adapted for filling in pits, but the use of tins is to be avoided as the ground will certainly fall in. On these, as on other points, the practical experience of the details gained by Dr. Taylor will be invaluable in the next wet season. Opposite houses, I think, some bridging of gutters

should be done, as otherwise the edges of the gutters are bound to fall in.

As regards the proceedings that will be requisite in the dry season, I can, of course, only theorise from experience elsewhere; combined with my observation here of the character and lie of the ground.

The evidence seems to be clear that mosquitoes may be expected to be more numerous in the dry season; because, though of the present breeding grounds few will remain in dry weather, still there will be other breeding places, and these will not be so constantly disturbed or flushed by heavy rains, and, therefore, a large proportion of larvae will reach maturity.

Of the present breeding grounds, there will only remain in the dry season some of the springs, and, perhaps, some of the wells and pools; the rest of the water will then have dried up. The new places will be mainly the streams, small and large, which remain, possibly some of the other wells, and artificial collections of water in tubs, etc.

Any scheme for destroying these breeding places must take into account* (1) that abundant places must be left for the people to get drinking water; (2) that places must be left in which the people can wash clothes, etc. These two conditions will prevent any extended application of kerosine or any odorous or poisonous larvicide, and particularly their application to streams, as it is mainly in expanded pools in the course of streams, and not in isolated adjoining pools, that larvae live and proceed to maturity.

The streams are said to contain fish, but, even if they do not, much could not be hoped from stocking

* When the new water supply is obtained these points will not be essential.

them, as in such situations abundant larvae are often present in the presence of the fish.

Two possible methods which are most obvious are the formation of a central channel in the bed of the stream, with larger collections of water in sufficient numbers of places for drinking purposes, and, lower down the stream, other places for washing, etc.

The second, which might be cheaper but less certainly effective, would be to dam up the streams so as to obtain a sufficient head of water to flush out the whole channel at intervals.

Either scheme would be expensive and would have to be strong, as a rainfall of fifty inches or more in a month of the wet season will destroy any but strong works in the bed of these rocky streams.

I am inclined to think that the number of streams could be reduced, and some of the smaller diverted into the larger channels, and the number of breeding grounds thus diminished. But on these points no positive opinion can be given till the beds have been examined in the dry season.

Though I consider that you have already proved the practicability of exterminating *Anopheles* in Sierra Leone during the wet season, the work is at present incomplete, even in the streets in which most work has been done; and, I estimate, at the present rate of work, will still be incomplete at the end of the wet season, when the work will be entirely changed. During the dry season, in addition to dealing with the new conditions which will then arise, the work already done should be placed on a permanent footing.

In the next wet season double the men, say one hundred, should be employed, and two Europeans for supervision. One European, even so able and energetic a man as Dr. Logan Taylor, barely suffices for thorough supervision of the present work.

I am aware that this will cost, apart from the expense of supervision, over £100 a month instead of the £50 to £60 which, including the cost of labour provided locally, is now spent; but it will be better for one place to be done well, and that a difficult one to deal with, than that partial measures be attempted in many places.

The experiment is being so closely watched and criticized, that failure, or only doubtful success, would be a disaster.

I think, therefore, that it will be more to the true interests of West African hygiene for attention and money to be concentrated on Sierra Leone.*

In this I would make one exception, Sekondi. This new town will, as the terminus of the railway, be one of the most important places on the Coast.

The European work in connection with the railway has not only increased the actual breeding grounds, but by means of trenches *Anopheles* are being conveyed from a distance through the European settlement. No plan seems to be followed in the erection of houses, and, generally speaking, European work already done has complicated matters, and will cause much increased expense in making reasonably healthy what could easily have been from the first a model settlement.†

I think it would be advisable to attempt to obtain in Sierra Leone some numerical estimate of the present prevalence of malaria, and for this purpose suggest as the most convenient the estimation of the proportion of children with splenic enlargement at fixed ages, say between one and two years of age, as, up to two or three years, reliable statements as to the age of children

* There is no fear that our efforts will be abandoned before we have done as much as we conceive it our duty to do.—R. Ross.

† His Excellency, Major Nathan, informed me that he will deal with Sekondi very shortly.—R. Ross.

can generally be obtained. As a check on this method, Barbadians in the West India regiment who have not been previously exposed to malaria, and consequently are highly susceptible, should be examined. In them malarial infection is indicated by malarial fever. The length of residence in Sierra Leone requisite for malarial infection in the Barbadians will then give an indication of the present liability to infection.*

In conclusion, I wish to express my thanks to you personally, and to the Liverpool School of Tropical Medicine, for the opportunity afforded me of seeing the first real British practical application of the principles you have elucidated.

I am

Yours very sincerely

C. W. DANIELS, M.B.

London School of Tropical Medicine

* In order to guard against misapprehensions, it is advisable to state here that we are not now undertaking to prove over again that mosquitoes carry malaria. This fact was fully established long ago. Our present intention is simply to give an object lesson in the manner of ridding tropical towns of mosquitoes by drainage and cleaning up. We are prepared to spend a large sum of money for this purpose; but we are not prepared to continue the work for ever. The work—especially the drainage and collection of rubbish—properly belongs to the local authorities. If they choose to continue our efforts, then we can confidently promise that the mosquito-borne disease in Freetown will be, ultimately, very materially reduced. If, however, they discontinue them—if they allow the town to sink back into the condition it was in when we arrived—then I can only say that the mosquito-borne disease will remain. It is for them to choose. I may add, however, that I have no doubt that the former course will be the one adopted.

R. Ross

Publications of the Liverpool School of Tropical Medicine

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First Progress Report of the Campaign against Mosquitoes in **Sierra Leone,** by Major R. Ross, F.R.C.S., D.P.H., F.R.S., dated 15th October, 1901, giving details of the commencement of the Campaign, with a letter from Dr. Daniels regarding the results arrived at to date. 8°. Price 1s. University Press of Liverpool.

Note.—Succeeding parts of this Memoir will contain descriptions of the further progress of the campaign in Sierra Leone and elsewhere.

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All of the above, except Memoir VI, to be had from the Thompson Yates Laboratory, University College, Liverpool.

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THE CONNECTION BETWEEN MILK SUPPLY AND DISEASE.

BY

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ASSISTANT PROFESSOR OF HYGIENE, ARMY MEDICAL SCHOOL, NETLEY.

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THE CONNECTION BETWEEN MILK SUPPLY AND DISEASE.[1]

By A. M. Davies, M.R.C.S.,

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At the meeting of the International Medical Congress, held in London in the year 1881, Mr. Ernest Hart contributed a most valuable paper on "The Influence of Milk in Spreading Zymotic Disease,"[2] in which he tabulated a series of fifty epidemics of typhoid fever traceable to milk, fifteen epidemics of scarlatina, and seven of diphtheria, similarly traceable, as well as one outbreak of an anomalous character at Aberdeen, the cause and nature of which was not then fully made out, though the connection with the milk supply was evident. During the eight years that have elapsed since then, a considerable body of additional evidence has accumulated, and the scope of the enquiry has been widened, both by the inclusion of at least one other disease, in addition to the three just mentioned, and as well by the more extended views which have been recently expressed with reference to the mutual relationship existing between man and the domestic animals in regard to the communicability of disease.

The diseases, to the communicability of which through the medium of milk I wish to draw your attention, are: (1) Enteric fever, (2) scarlatina, (3) diphtheria, (4) tuberculosis. To these may be added some cases of *rare, but occasional* spread of other forms of disease, and some anomalous cases of acute poisoning.

I.—ENTERIC FEVER.

The fifty epidemics tabulated by Mr. Hart in 1881 included in round numbers 3,500 cases; of these epidemics, one occurred as far back as 1857, the others in the years 1870-1880. Though some of these are classical instances and familiar to most members of our profession, perhaps it will not be a waste of time if I refer to two or three of the most marked of them, in which the connection of the disease with the milk supply was demonstrated—almost with mathematical proof.

1. In July and August, 1870, an epidemic of typhoid broke out in Islington, which was reported on by Dr. Ballard. There were 175 cases and 30 deaths; of these 175 cases, every one occurred amongst the drinkers of the milk that was suspected; and out of 142 families that were

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[1] Read before the Southampton Medical Society.

[2] *Transactions*, International Medical Congress, 1881, iv., 491.

supplied by the one particular milkman, 70 were invaded by the disease. These are two points that it is most necessary to state clearly and numerically—(i.) the number of cases that occur amongst the drinkers of the milk, which therefore may *possibly* owe their origin to that source; and (ii.) the number of families supplied with the milk, which therefore may *possibly* get infected from that source. In the present instance, the proportion was—for the first point 100 per cent., and for the second point 49 per cent. These cases mostly occurred within a limited area; the families attacked were in well-to-do circumstances; no insanitary condition was found to be common to the houses; the fever picked out customers of the dairy in particular streets and rows of houses; and finally, in many instances it was shown that it was especially the milk drinkers who were attacked. A tank at the business premises of the dairy, the water from which was used for "washing the cans" (which is often a euphemism for diluting the milk), was found to be in communication, by means of rat-burrows, with two old drains; but no *specific* pollution of this tank water could be traced.

2. Another classical instance is that of the Marylebone outbreak in July and August, 1873, investigated by Mr. Netten Radcliffe and Mr. Power. There were 244 cases and 26 deaths; of these 244, 218 were drinkers of the suspected milk, *i.e.*, 89 per cent.; while of 760 families supplied from the dairy, 118, or 15 per cent., were invaded by the disease. All the cases occurred in the nine weeks ending 30th August, and within a circumscribed area, mostly amongst well-to-do people, in houses without any community of sewerage or water-supply. The disease picked out the streets to which the milk was distributed; and, moreover, an isolated group of twelve cases occurred in another part of London, where there was a branch of the suspected dairy, and where eleven out of the twelve cases purchased the milk. The implicated farm only supplied about one-sixth of the ordinary milk distributed by the dairy, and this will account for the partial incidence of the fever upon the customers, only 15 per cent. of the households supplied being affected. At this farm water was used for dairy purposes that was obtained from a well liable to pollution from its position. The farmer on June 8th died suddenly of ambulant typhoid. The stools had been buried in an ash heap, whence they might have gained access to the well; and there were heavy rains on June 29th, which would render this more likely. Therefore, a specific source of infection was, at the very least, possible.

3. A much greater incidence of the disease upon the customers of the suspected milk supply was found in the outbreak at Eagley and Bolton (Lancashire) in January

and February, 1876, investigated by Mr. Power and Mr. Robinson. Here there were 195 cases and 13 deaths; and of 59 families supplied with this milk, 55 were attacked, *i.e.*, 95 per cent.; while in eight families otherwise supplied that were attacked, in six out of the eight the members had been partakers of this milk at their neighbours' houses. Another series of 144 cases, with eight deaths, occurred at Bolton, two miles distant; and out of 50 families supplied from the same dairy, 47, *i.e.*, 94 per cent., were invaded. The neighbourhood had been free from fever, or other illness, for some months, and there was no community of drainage or water-supply to the district affected. The water-supply of the dairy farm-house was derived from a brook exposed to excremental pollution, and large quantities of fæcal mattter were actually found in the brook, though no specific contagion could be traced.

4. A widespread outbreak occurred in Glasgow in April, 1880, reported by Dr. J. B. Russell, in which there were 508 cases and 69 deaths—373 cases, or 73 per cent., being amongst drinkers of the suspected milk. The dairy was supplied with milk from thirty farms, all of which appeared to be in good sanitary condition, except one; here was a well exposed to possible pollution from a dung-heap, and on this dung-heap had been thrown excreta from enteric cases. A dairyman at this farm sickened with enteric fever in March, and subsequently two children of the farmer. Another girl, who passed a night in the house in nursing one of these children, partook of the milk, and sickened fourteen days after. On the day after the two children sickened, the first lot of milk was sent into Glasgow, and *exactly fourteen days afterwards*, the first case in the area of the milk supply fell ill. "The entire body of trade was tainted. It was associated with fever in the dairyman's own household, in persons served direct from his own cart; it poisoned the families of the dealers through whose shops it passed to the public; and it poisoned the customers who dealt at those shops." The milk supply was stopped, and the epidemic died out.

5. An epidemic of 44 cases, with 8 deaths, occurred at Worthing in October and November, 1880, reported by Dr. Kelly, in which every one (*i.e.*, 100 per cent.) of these 44 cases occurred amongst the customers of a particular dairy, in different parts of the town. A shallow well was used for dairy purposes, into which was traced soakage from a defective drain, leading from a house in which a fever case had occurred.

I have selected these five instances, out of the fifty collected by Mr. Ernest Hart, as being very typical, and each illustrating especially one aspect of the subject. In the Islington epidemic of 1873, out of 175 cases, every one (*i.e.*, 100 per cent.) occurred amongst the drinkers of the suspected milk; but there was no evidence of specific typhoid pollution. In the Marylebone epidemic of 1873, there was strong evidence of specific pollution; and out of 244 cases, 89 per cent. were suspected milk drinkers. In the Eagley and Bolton epidemic of 1876, though no specific infection could be traced, 95 per cent. of the families supplied from the suspected source were invaded by the disease. In the widespread outbreak at Glasgow in 1880, specific pollution seemed proved, and the incubation period of fourteen days seemed established. While, lastly, in the 1880 epidemic at Worthing, every one of the 44 cases (*i.e.*, 100 per cent.) occurred amongst the suspected milk drinkers, and specific pollution appeared most probable.

I have collected notes of nineteen epidemics subsequently to those tabulated by Mr. Hart, some details of which appear in the accompanying table. Three of these instances, however, especially present points worthy of notice.

1. An outbreak[1] occurred in 1884 in the Glasgow Hospitals, attacking successively the Western Infirmary, the Royal, and the Belvidere. This was traced conclusively by Dr. Russell to the milk supplied from one particular farm. At this farm a dairy-maid was attacked by enteric fever at the same time as the outbreak in Glasgow; but before this the cows had been suffering from a febrile disease which a local veterinary surgeon attributed to the badness of the drinking water. This water was found to be grossly contaminated with sewage products, and enteric fever was endemic in the adjacent villages. Here there is a possibility of the typhoid having occurred at the dairy farm in an ordinary way, having been conveyed there from an adjacent focus of infection; and there is also a possibility of a connection between the first case at the dairy and disease among the cows.

2. A small outbreak[2] occurred at Carlisle in 1886-7, traced unmistakably to a dairy where typhoid cases had existed. But there was nothing to show how these cases had originated, water supply and sanitation being quite good, except that the cows had suffered from a febrile disorder previously.

3. An epidemic[3] broke out at Lancing College in 1886, where the sanitary surroundings seemed perfect, and where there was a private dairy farm attached to the college, in perfect order. After very careful investigation it was found that some cream—partaken of as strawberries and cream—

[1] *British Medical Journal*, 1884, ii., 626, 724.

[2] *Practitioner* xl. (1888) 383. [3] *Practitioner* xxxvii. (1886) 223.

EPIDEMICS OF MILK-TYPHOID.

No.	Date.	Place.	Reporter and Reference	No. of Cases	No. of Deaths.	No. of cases among drinkers of suspected milk.	Per cent.	Circumstances of Outbreaks.
1	1880 Sept., Oct.	Bridlington	Dr. Parsons, *San. Rec.*, Sep., 1882	48	..	48	..	Well at dairy liable to pollution. Case of typhoid at dairy.
2	1882	Leicester Infirmary	Dr. Elgar Buck, *San. Rec.*, June, 1882	12	..	12	..	All cases drinkers of raw milk. Well at farm liable to pollution. Milk purveyor died from typhoid.
3	1882 May, June	Glasgow	Dr. Russell, *B.M.J.*, July 8, 1882	59	6	50	85	Nearly all the cases occurred in one week.
4	1882	Clapham	*B.M.J.*, Aug. 5, 1882	20	..	19	95	All cases occurred within twenty-four hours.
5	1882	Halifax—Stone Chair	Dr. Britton, *B.M.J.*, Oct. 14, 1882	11	1	11	100	Untrapped drain in room where milk was stored; polluted water. Two cases of probable typhoid at farm.
6	1883	St. Pancras	Mr. Shirley Murphy, *Prac.*, 1883, xxxi., 386	..	..	..	..	Outbreak traced to a particular milk-supply from St. Albans.
7	1883 Oct., Dec.	New York—Port Jervis	Dr. F. C. Curtis, *Lancet*, Feb. 7, 1885	148	..	128	87	Out of about 500 consumers of suspected milk, 128 cases occurred. Sudden outbreak; sudden cessation. Typhoid cases at dairy farm.
8	1883 Oct.	Dundee	*B.M.J.*, 1883, ii., 839	..	..	36	..	Typhoid at dairy.
9	1883	Stricken, near Aberdeen	*B.M.J.*, 1883, ii., 1146	..	..	..	..	Typhoid at farm.
10	1884 May, June	St. Albans	Mr. Shirley Murphy, L.G.B. Supp. for 1884, also Dr. C. E. Saunders, *B.M.J.*, 1884, i., 1262 and ii., 1086	131	23	..	..	Six different retailers, all of whom drew a portion of their supply from a particular farm where there was typhoid. Of 396 houses supplied with suspected milk, 86, or 21.7 per cent., were invaded. 2,127 houses within city boundary otherwise supplied, of which three only, or .14 per cent., were invaded. Total number of houses invaded, 90. Some of the milk was sent to London, and fever cases occurred in connection.
11	1884 Aug., Sept.	Glasgow Hospitals	Dr. J. B. Russell, *B.M.J.*, 1884, ii., 626, 724	143	32	..	..	At one of the dairy farms whence milk was supplied cattle suffered from a disease possibly due to bad drinking water. Dairy maid had typhoid.
12	1884 Oct.	Derby	*B.M.J.*, 1884, ii., 786	..	..	..	..	Well liable to pollution, and case of typhoid at dairy farm.
13	1884	Tweedmouth	*San. Rec.*, Nov., 1884	23	..	..	..	Typhoid at milkman's house.
14	1886	Lancing College	Dr. Kelly, *Prac.*, xxxvii., 223	14	2	14	100	Outbreak traced to partaking of strawberries and cream. Well at dairy whence cream was supplied liable to pollution. Many other fever cases in Shoreham connected with same dairy.
15	1886-7	Carlisle	Dr. W. Brown, *Practitioner*, xl., 383	25	..	24	96	Typhoid at dairy; also a febrile disorder among the cows previously.
16	1886	Swanage	Mr. W. Harvey, L.G.B. Supp. for 1886	..	..	..	..	
17	1888	Evesham	Mr. Fosbroke, *Pub. Hea.*, Feb., 1889	6	1	5	83	Typhoid at dairy. Polluted water. Milk adulterated.
18	1888 Aug., Nov.	Spennymoor	Dr. Spear, *Pub. Hea.*, June, 1889	..	..	..	..	Nineteen families attacked; eleven supplied from particular farm. Families supplied from this source, 144; supplied otherwise, 500. Relative incidence of fever 7.5 and 1.6 per cent. Typhoid at farm, and polluted water. Dr. Spear doubts causal connection of milk supply.
19	1889 Feb.	Stirling	Dr. McFadyen, *B.M.J.*, June 1, 1889	40	4	?40	?100	Water polluted; typhoid at farm; air of milk-house liable to pollution. All cases which occurred were supplied with milk which had been kept overnight in the milk-house; families supplied direct from the byre escaped.

was the cause of the outbreak. No specific pollution could be traced, though there was a well at the particular diary (in the neighbouring town where the cream was procured) which was exposed to fæcal contamination.

Of Mr. Hart's fifty epidemics, thirty-nine appear to be distinctly traceable to a specific pollution with typhoid contagium; in six there is no record; and in five it is stated that there is no evidence to point to this source of infection.

Of the nineteen outbreaks I have brought together, twelve appear to be traceable to specific pollution; in three there is no record; in four there is possible or probable contamination; while in two of the cases, although specific infection was possible, it appeared as if some cow disease might have been the cause of the infective property of the milk. One important fact was repeatedly noticed in investigating these epidemics—that in a very large number of cases the incidence of the disease fell mostly upon those who drank milk in large quantities, children for instance, and particularly upon those who drank it "from the cow," as it is said, or "straight from the dairy,"—*i.e.*, unboiled.

Now, assuming that enteric fever can be spread by means of milk, which I think this body of evidence justifies us in doing (although in France and Germany such is not the opinion, at any rate, universally), in what manner, or in what different kinds of manner is the infection brought about? It may occur conceivably in one or more of four different kinds of ways:—

1. As water is the most common vehicle for the spread of the typhoid contagium, this latter may gain access to milk either (*a*) through the deliberate addition of water to the milk as an adulterant; or (*b*) through the use of water for washing milk cans or dairy utensils.

2. Supposing that the specific contagium, of whatever nature it be, is floating about in the air, as in particles of dried excrement in dust, it may sink down on to exposed surfaces of milk, and impart to the milk an infective property.

3. The contagium may be communicated to the milk through anyone combining the functions of milk seller, dairyman or dairymaid, and sick nurse to a typhoid patient, by means of soiled hands or the like.

4. Lastly, it is *possible* that cows may suffer from some such disease, communicable to man through the medium of the milk.

To one of these four categories, I think, must be assigned every instance of spread of the disease through milk; probably the great majority of cases are due to the first manner, while until dairies and milkshops are effectively supervised as to their sanitary conditions, and the health of their inmates, the second and third methods of infection are sure to be found to occur. The last way, from a disease of the cow itself, is as yet without anything approaching proof, but the two outbreaks mentioned—at Glasgow and Carlisle—have served to direct attention to the matter, which is, *a priori*, not inconceivable.

II.—SCARLATINA.

Up to 1881 Mr. Hart tabulated only fifteen outbreaks of scarlatina traceable to milk infection.

1. Of these, the first, in 1867, was described by Dr. M. W. Taylor, of Penrith (who had also described the first epidemic of milk typhoid ten years earlier). In this instance there were 111 cases, and all of them were drinkers of the suspected milk, the milk retailer's child suffering from scarlet fever.

2. Another noted instance occurred in South Kensington, and was investigated by Dr. George Buchanan, in 1875. On June 9th a dinner party was given in that neighbourhood, of sixteen persons; about 150 guests assembled in the drawing room after dinner, and fourteen servants were engaged in waiting. Between June 11th and 14th, out of these 180 persons, eighteen fell ill either with scarlatina or sore throat, as well as one other case, that of a lady who lunched at the house next day. There was but little scarlatina in the locality, and except for the meeting at this particular house, no common centre of infection, or other common local circumstance, to account in any degree for the disease attacking these particular persons. The only circumstance that afforded any explanation of the attacks was the cream supply, which came exceptionally from a London dairy. All who were taken ill had partaken of cream in one form or another, and all the ladies who took cream in coffee after dinner—to the number of seven—became ill; also all the ladies—four—who partook of cream dishes at lunch the next day were attacked. It is gratifying to know that no deaths occurred.

3. In June, 1879, several remarkably sudden and rapidly fatal cases occurred in a particular district at Newcastle-on-Tyne. Out of twenty-three cases ten died. The milk supplied was derived from one particular source in every case, with one exception. But no scarlatinal infection could be traced, even after the most careful enquiry.

4. At Fallowfield near Manchester, in August, 1879, there were thirty-five cases within a month, of which twenty-four were attacked within a space of thirty-six hours. They were all drinkers of a particular milk, and one of the milkers was lodging in a house where his grandchild was desquamating after scarlet fever. From

the character of the surroundings, carriage of infection was most probable.

5. At Ilkley in Yorkshire, in November, 1880, a small outbreak of ten cases occurred, all drinking milk furnished by one purveyor. There was no disease at any of the farms or dairies, but the custom at this place was for the milkman to take his milk *into* his customers' houses in *bulk*, and this particular milkman had provided a family in which the children had been attacked with scarlet fever a month previously, and were therefore now in the desquamating stage—hence the probable absorption of infective material by the milk.

6. The most extensive epidemic reported was one that occurred at Halifax in 1881, with 510 cases and 86 deaths. Out of 135 families supplied by the dairyman, 53, or 39 per cent. were invaded. The circumstances pointed conclusively to the infection of the milk from scarlatina in the family of the farmer's man, who milked the cows and distributed the milk.

These cases are all noteworthy as showing, either (1) as in the first and sixth instances, at Penrith and Halifax, the large incidence of the disease on the suspected milk drinkers: of 111 cases of scarlatina, *all* drank the milk; of 135 families supplied, 39 per cent. were affected; or (2) the suddenness and fatality that may mark an outbreak of milk-scarlatina, 10 deaths out of 23 cases; or (3) the manner in which infection may be carried, as by the hands of the milker, or even, during the distribution of the milk, by visiting an infected house; (4) the epidemic due to use of cream is also remarkable.

I have collected notes of eighteen epidemics since those recorded by Mr. Hart, in three of which I can get no record whether or not the specific contagium of scarlatina was likely to gain access to the milk; in seven the disease existed at the dairy or farm whence the milk came; in three instances no specific connection with scarlet fever could be made out after most careful enquiry, but there seemed to be a causal connection between a disease of the teats or udders of the cow and the incidence of the scarlatina upon milk consumers; in one other instance there was a doubtful possibility of such a connection; in one instance a possibly scarlatinal sore throat at the dairy; in two instances nothing could be made out, except that in each case a cow had calved recently; and in one instance a particular brand of condensed milk was considered to be the cause of the outbreak.

This question of the possibility of the communication of the disease from cow to man—*i.e.*, of the existence of bovine scarlatina, is a most important one, and the literature of the subject has become very extensive during the

No.	Date.	Place.	Reporter and Reference	No. of Cases	No. of Deaths.	No. of cases among drinkers of suspected milk.	Per cent.	Circumstances of Outbreaks.
1	1882 Jan.	Bloomsbury	Mr. W. H. Power, L.G.B. Supp. for 1882	..	..	..	..	Outbreak apparently dependent on some condition affecting cows at dairy farm.
2	1882 Jan.	Greenock	Dr. Wallace, *B.M.J.*, Mar. 25, 1882	20	..	20	100	Scarlet fever at farm.
3	1882 Oct.	Greenock	Dr. Wallace, *B.M.J.*, Dec. 30, 1882	47	..	12	25	Scarlet fever at milk dealer's.
4	1883 April.	Wolborough	*B.M.J.*, April 21, 1883	..	..	..	..	Scarlet fever at milk dealer's. Of sixteen families attacked, nine were supplied with suspected milk.
5	1883	Dundee	*B.M.J.*, Oct. 27, 1883	17	4	17	100	Scarlet fever at dairy.
6	1884 Aug.	Dundee	*B.M.J.*, Aug. 30, 1884	..	..	..	..	Scarlet fever at dairy.
7	1884 Oct.	Greenock	*B.M.J.*, Nov. 8, 1884	..	..	..	..	
8	1885 Nov., Dec.	Marylebone and St. Pancras	Mr. W. H. Power, L.G.B. Supp. for 1885	..	..	..	..	Outbreak apparently due to a disease affecting certain cows—the "Hendon disease."
9	1886	St. George's, Hanover Sq.	Dr. Corfield, *B.M.J.*, Sep. 22, 1888	..	..	..	..	A small group of cases: the only circumstance common to all the cases was that they used condensed milk of a particular brand. In this organisms were found by Dr. Klein, supposed to be characteristic.
10	1886-7 Dec., Jan.	Wimbledon and Merton	Mr. W. H. Power, L.G.B. Supp. for 1886 also *B.M.J.*, Jan. 12, '88 and C. H. Cooper, *San. Rec.*, Mar., 1889	635	8	577	91	Sudden outbreak, reaching at its height 119 fresh cases in one day. Besides 577 cases supplied with the suspected milk No. 1, there occurred 29 cases among consumers of milk No. 2, two of the cows supplying which had formerly been with the cows supplying No. 1. ? Udder disease.
11	1887 April	Toxteth Park, Liverpool	Dr. G. W. Stevens, *B.M.J.*, Oct. 20, 1888	..	..	..	..	Outbreak supposed to be connected with milk from a particular dairy. No scarlet fever there, but a cow had recently calved. Some diphtheria also present.
12	1887	Dundee	Dr. Anderson, *B.M.J.*, Aug. 27, 1887	..	..	..	..	Scarlet fever at dairy farm.
13	1888 Jan., Feb.	Jesmond, Newcastle	Dr. H. Armstrong, *Pub. Hea.*, May, Oct., '88	19	..	17	..	Scarlet fever at dairy farm three or four months previously. One or two cows slightly denuded of hair.
14	1888 Mar.	Garnethill, Glasgow	Dr. Russell, *B.M.J.*, Oct. 27, 1888	95	..	95	100	Many other cases of scarlatina and sore throat among other families supplied by same dairy, outside this local epidemic. Three deaths in all.
15	1888 June.	Pollokshields, Glasgow	Dr. Carmichael, *B.M.J.*, July 7, 1888	70	..	..	..	Scarlet fever at dairy farm.
16	1888 Aug.	Newcastle	Dr. H. Armstrong, *Pub. Hea.*, Sept., 1888	74	..	61	67	Throat illness in family of one of the dairy helpers. Five out of 24 cases of diphtheria among drinkers of same milk.
17	1888 Oct.	Garnethill (Fk.), Glasgow	Dr. Russell, *Pub. Hea.*, Feb., 1889	56	..	..	..	Scarlet fever and sore throat at dairy. In one district, out of 600 households, of 92 supplied by this dairy, fourteen were infected. Of 502 otherwise supplied, only two were infected.
18	1888 Dec.	Govan	*San. Rec.*, Feb., 1889	37	..	35	94	Of 74 families supplied with suspected milk, 23 attacked with 35 cases. Only two cases amongst 603 families otherwise supplied. Origin unknown.

last two or three years. It is difficult to summarise the observations and conclusions of the various investigators, and especially so since so much warmth has been thrown into the discussion. I will try to indicate briefly the principal points in the controversy so far as it has proceeded at present.

1. *The Russell Square Outbreak of* 1882.[1]—In January, 1882, occurred an outbreak of scarlatina in the Russell-square district, which was found to be connected with the milk supply from a particular dairy. One of the milk carriers and his children had sore throat and scarlet fever; but it was then found that some persons were supplied with this milk from the cart *en route* between Charing-cross Railway Station and the dairy, and, therefore, before the milk came near this affected milk carrier, and that amongst these persons also scarlatina broke out. Further, thirty-nine cases of the disease occurred at Camberwell, quite removed from the dairy and its area of supply, of whom thirty-two drank the milk derived from the same farm at Farnham; also the railway officials at Charing-cross had thirteen cases of scarlet fever and sore throat, at about the same time, amongst purchasers of this milk. Mr. Power then investigated the circumstances of the dairy farm. There was no scarlet fever—no insanitary condition. A cow had calved at the beginning of January, but had not been in any way ill. On 11th February Mr. Power found she had lost portions of her coat.

2. *Marylebone Outbreak*, 1885. *The Hendon Cow Disease.*[2] In November and December, 1885, an epidemic broke out in Marylebone, also in St. Pancras and at Hampstead and Hendon, which was investigated by Mr. Power, and the conclusion was come to by him that this outbreak was due to infection from the milk from a particular dairy at Hendon. He could discover no scarlet fever either at, or in the neighbourhood of the dairy. He examined the cows at the dairy, and found some of them to be suffering from an ulcerative disease of the teats and udders. Various circumstances connected with the time of arrival at the dairy farm of certain cows, the distribution of their milk, and the outbreak and incidence of the disease, led him to the belief that these cows, through some condition or other, were the cause of the epidemic.

Dr. Klein then continued the investigation for the Local Government Board, and made bacteriological experiments, both with these cows and with blood from scarlet fever patients. He was able to isolate a streptococcus from the ulcers on the teats of the cow, and in five out of eleven human patients he found what he believed to be the same

[1] L.G.B. Report. Supp. for 1882. App. A 9.
[2] L.G.B. Report. Supp. for 1885. App. A 8.

organism in the blood. This organism was not present during the first four days, but appeared on the fourth and subsequent days. He performed experiments on animals with the organisms derived from these two sources, and obtained what he believed to be identical results and symptoms. The *post-mortem* appearances in the cow suffering from the Hendon disease, and in the animals inoculated with the streptococcus, were, he considered, similar to those found after scarlet fever. In short, the micro-organisms, the symptoms, and the *post-mortem* appearances, seemed to correspond.

Subsequently Dr. Klein found[1] that inoculation of this streptococcus produced ulcers on the teats in cows that had recently calved. He also found a similar micrococcus in a particular brand of condensed milk, which had been suspected of causing scarlet fever; also in the blood of a monkey that had died of the disease. Dr. Klein, therefore, named this organism *Micrococcus scarlatinæ*, considering that the disease was produced by its agency both in man and in cows, and that milk from cows so affected would produce the disease in man. This is the end of the first stage in the enquiry.

The Edinburgh Researches.—Dr. Jamieson and Dr. Edington made investigations[2] shortly after the publication of Dr. Klein's report. Various organisms were found in the blood of scarlet fever patients, their nature varying with the time at which they were taken. Dr. Edington considered those found during the first three days, which were bacilli, to be the cause. These disappeared from the blood after the third day, and reappeared again in the scales at the desquamating stage. When these disappeared from the blood others were found, amongst them one called by Edington *Streptococcus rubiginosus*, similar to Klein's micrococcus. Edington experimented on animals with this, and obtained appearances like scarlet fever.

The Medico-Chirurgical Society of Edinburgh made a preliminary report[3] on this research, to the effect that they consider Edington's and Klein's streptococci to be very similar, if not identical, but that there is no definite conclusion to be come to about the bacilli.

Dr. Thin's Criticism.—At the Dublin meeting of the British Medical Association in August, 1887, Dr. Thin criticised[4] what had been done so far. He found that at the same time that the Hendon cows were affected, other herds were also attacked by the same disease, the infection having originally started in a herd in Derbyshire; but no

[1] *British Medical Journal*, January 21st, 1888.
[2] *British Medical Journal*, 1887, i. 1262.
[3] *British Medical Journal*, 1887, ii. 830.
[4] *British Medical Journal*, 1887, ii. 402-473.

outbreak of scarlet fever had occurred among the consumers of the milk supplied from these other dairy farms. Further, the milkers at some of these dairy farms had no scarlatinal symptoms, *but* they had pimples and sores on their hands. Dr. Thin considered this Hendon disease to be *cow-pox*, and that the scarlet fever outbreak was possibly to be traced to a laundry in the neighbourhood, where some of the milkers resided.

Professor Crookshank.—Then the Agricultural Department of the Privy Council deputed Professor Crookshank to investigate the matter, and in December, 1887, he published his observations at a meeting of the Pathological Society.[1] After some delay and difficulty he succeeded in meeting with cases of cow disease in Wiltshire, which he believed to be identical with the Hendon disease, and he isolated a streptococcus. No scarlet fever occurred amongst the consumers of milk from this herd of cows, though it was extensively distributed. Dr. Crookshank believed the disease to be true Jennerian cow-pox. The milkers were affected with cow-pox eruption.

Dr. Klein, in his reply, denied the identity of this disease with the Hendon disease on the ground that the eruption was not the same, that the streptococcus did not grow in the same way, and that the milkers were not affected at Hendon with any eruption, as they were in Dr. Thin's and Dr. Crookshank's cases.

At the January (1888) meeting of the Pathological Society, Crookshank brought forward the results of further investigations.[2] He summarised his conclusions thus:—

1. The nature of the contagium of scarlet fever is unknown.

2. The micro-organism regarded by Dr. Klein as the contagium is the *Streptococcus pyogenes*.

3. This is found, sometimes in company with *Staphylococcus pyogenes aureus*, as a secondary result in scarlet fever, and in many other diseases.

4. Its exact relation to scarlet fever, and its identity with the streptococcus from pus and puerperal fever, was definitely established in 1885 by Fränkel and Freudenberg.

5. Both Wiltshire and Hendon cow diseases were called cow-pox by the people on the farms.

6. They correspond in clinical history.

7. The ulcers on teats correspond to the naked eye and in microscopic appearances, and the latter vividly recall the appearances of cow-pox.

8. Calves inoculated from the ulcersare similarly affected.

9. *Post-mortem* examination of such calves, and of calves

[1] *British Medical Journal*, 1887. ii. 1317-1382.

[2] *British Medical Journal*, 1888, i., 122-135.

inoculated from scarlet fever cases, show similar appearances.

10. These *post-mortem* appearances in calves are the result of septicæmia.

11. There are no specific visceral changes in cow-pox apart from complications or coincident affections.

Dr. Klein replied,[1] maintaining that the organism he had described as *M. scarlatinæ* was not the same as *S. pyogenes*, and that the Hendon cow disease was not the same as the Wilts. and the Edinburgh disease, one clinical difference being that at Hendon the ulcers only commenced on the fourth, while in Wilts. they were at their height on the fifth day. In the Edinburgh cows the ulcerations occurred still later; therefore there were probably three diseases, not one.

A discussion followed, in which it was admitted that the subject was still in great confusion.

The subject was considered at the August meeting of the British Medical Association in Glasgow, 1888, but nothing of importance was elicited.

Professor Brown's Report to the Privy Council.—Towards the end of 1888 Professor Brown, of the Royal Veterinary College, presented a report[2] embodying Crookshank's researches and other investigations by veterinary surgeons and inspectors. An important point in this report is the statement by Professor Axe that there were cases of scarlet fever existing in Hendon, and that there was thus the possibility of human infection being conveyed to the dairy at the time of the Marylebone outbreak. Mr. Axe also states that an outbreak of udder disease amongst cows at Hendon occurred in 1887, precisely similar to the former one, but not accompanied by any scarlet fever amongst the consumers of the milk. In addition, he gives the history of four other batches of cows, all derived from the original Derbyshire herd, each suffering from a disease indistinguishable from the Hendon disease, but unaccompanied by any outbreak of fever amongst milk consumers. The general tone of Professor Brown's report is very adverse to that of the Medical Officers of the Local Government Board.

It will be admitted that the nature of the "Hendon disease" is now involved in the greatest confusion; but it must also be remembered that the observations made on the spot, and at the time, were those of Mr. Power, and that the conclusions come to by him are, therefore, worthy of the highest consideration.

3. *The Outbreak at Garnet Hill, Glasgow.*[3]—Dr. J. B.

[1] *British Medical Journal*, 1888, i., 135.

[2] "Report on Eruptive Diseases of the Teats and Udders of Cows in relation to Scarlet Fever in Man." By Professor Brown. 1888.

[3] *Sanitary Record*, June, 1888.

Russell presented a report in June, 1888, on this outbreak, of a most interesting and important character. During the last week in March a house-to-house visitation of the district was made; 1473 families were visited, among whom were 96 cases of scarlet fever and sore throat. The sore throat was specific, for it dovetailed in families with scarlet fever, the elders having sore throat, and the younger ones fever. The milk supply was enquired into: 172 families were supplied by dairy X, yielding 95 cases; 1301 families were supplied from other sources, yielding only one case. Outside this local area, the customers of dairy X at West End, Hillhead, and Kelvinside furnished many more cases of scarlet fever. In all, there were 189 cases—101 of fever, 88 of sore throat. Both diseases moved together, the earliest case of each being on March 15th, and the last being on April 1st and 2nd respectively. From March 20th to 25th, 74 persons sickened with scarlatina, 62 with sore throat. The cases after March 25th were mostly by secondary infection in the ordinary way. Mortality was very low, only one death being recorded.

Thus the milk from dairy X was the medium for spreading the disease. Whence did this milk derive its infectivity?

The milk came from three sources—A, B, and C. At the farms B and C everybody was in perfect health. At A there was a case of scarlet fever on the 23rd, and of sore throat on the 24th; at the dairy in Glasgow a case of each illness on the 22nd, and another case of fever on the 23rd; also two cases of slight sore throat among the distributing boys on the 26th and 29th March.

As none of these cases could have originated the epidemic, which began on 15th March, they must be regarded, as other cases, infected from the same source. The producers and distributors, being also consumers, themselves suffered.

The milk X not being infected through a human medium, the question arises: "Was it through a cow?" The stock at B and C were perfectly healthy. At A, on March 27th, Dr. Russell found in two cows appearances resembling those in the Hendon cows. The only recent additions to this stock had been one cow purchased on February 21st, and three on March 7th. One of the latter was thin and mangy-looking, *casting hair and shedding scarf skin;* the teats had several sores covered with bloody scabs. Of the other two cows bought at the some time one was sound, the other had one small scab on one teat. The cow bought in February had scabs also. Two of these cattle were removed to the Veterinary College, and observations were made there. It was recorded that a calf fed on the infectious milk was almost at once seized with a highly febrile illness which nearly killed it; and in recovering it lost hair

and shed scarf skin copiously—*i.e.*, desquamation took place.

Now if we consider what are the various possible modes in which infection of the milk may occur, we have, I think, the same or similar four categories, as in the case of enteric fever—viz., (1) addition of water, to which the specific poison may have gained access; (2) contamination from the contagium floating about in the air, and falling into exposed surfaces of milk; (3) communication of the contagium, by personal contact with the milk, of individuals suffering from the disease, or convalescent from it, or in attendance on such cases; (4) some disease of the cow that is able to produce scarlatina in man. The second and third of these are probably the usual ways in which infection takes place, and considering the very mild character of some scarlatina cases (in which possibly a medical man is never called in), with slight fever, not much feeling of illness, and no very obvious rash, but still marked desquamation, and undoubted capability of transmitting infection, there will always be a considerable element of danger from this source. The fourth mode, from the cow herself, can hardly yet be said to be proved, although certainly Mr. Power's report on the Hendon cases does read almost as a demonstration; and Dr. Buchanan[1] says: "In the end he (Mr. Power) has demonstrated beyond reasonable doubt the dependence of the milk-scarlatina of December on a diseased condition of certain milch cows at the farm."[2]

Further investigations are required, and will no doubt be undertaken as opportunity offers. The communicability of the disease-poison from the cow is certainly possible—there is nothing impossible in it—though not proven. The question is one of the greatest interest to all practitioners, and is stated by Mr. Power in these weighty words:[3]—"Few physicians will be disposed to deny a relation between scarlatina and certain forms of febrile puerperal disease in women. The contagion of scarlatina introduced into the lying-in room has often and with reason

[1] Report for 1885, p. vi.

[2] Since the above was written a review of Professor Brown's report has appeared in the *Practitioner* for March, 1889, evidently written by "one who knows." In this it is pointed out that the scarlet fever, referred to by Professor Axe as existing at Hendon, had been noted and reported on by Dr. Cameron, in his report for 1885, as "two mild cases—both carefully isolated, and disinfectants supplied. As the district is full of laundries, it is possible that the disease was introduced from London; there was no other evident source for it. The fever did not spread beyond these houses." Mr. Axe quoted this, but omitted to say that it was a quotation, made no reference to Dr. Cameron, and left out the last sentence. Professor Brown's deduction must therefore be received with caution.

[3] Report for 1882. App. A. 9, pp. 66-67.

been held responsible for "puerperal fever." . . . . Now if it be true that there is one sort of relation between scarlatina and accidents of the puerperal state, another sort of relation becomes comparatively easy of belief; while there would be nothing improbable in the further suggestion that all such relations would be qualified by the passage of a common contagion through the system of another animal. . . . . If scarlatina in man have other animal source than human source, it may be that one such source is the cow that has recently calved, a cow either not at all ill (except for her parturition), or not so obviously ill as to prevent her milk being used for human consumption." And Mr. Power mentions three important facts:—(1) In epidemic outbreaks referred to milk as their cause, infectivity of the milk has commonly lasted a short while only—a week or ten days, according with some cow condition as well as any other suggested cause. (2) Such outbreaks have generally had relation to cow businesses that have had to do with the production of milk, and milk alone—not butter, nor cheese, nor calf-rearing—therefore the cows come into business use almost at once after calving. (3) Milk-scarlatina outbreaks have generally been characterized by mildness and small mortality. This is not inconsistent with an animal origin, not recently a human origin, of the infective poison, as in vaccinia.[1]

III.—DIPHTHERIA.

Of the seven outbreaks of diphtheria, particulars of which are related by Mr. Hart, the most extensive was one occurring in Kilburn and St. John's Wood in 1878, consisting of 264 cases in 118 households, with 38 deaths. The great majority of these households were supplied from one dairy, the incidence of the disease upon the customers of this dairy being twelve times as great as on the customers of other dairies. Most of the families were of the better class; no insanitary condition was common to the houses; no explanation could be given.

In another epidemic, at Weybridge, sixty persons were attacked during nine days, all supplied from one dairy; no insanitary condition common; no explanation. I have found other (seven) epidemics recorded since 1881, the best

[1] In the report of the Medical Officer to the Local Gov. Board for 1887, dated August, 1888, but only just published (April, 1889), Dr. Klein gives the result of further researches, and, it must be allowed, strengthens his case, of the identity of the Hendon disease and human scarlatina as shown by their both being due to the same organism, considerably. He infected cows and calves with a streptococcus from human scarlatina; ulcers on the teats and desquamation of skin resulted. In some cases the same streptococcus was recovered from the blood and organs of these animals. He states positively, after long study of streptococci, that this organism is not what is generally known as S. pyogenes.

EPIDEMICS OF MILK-DIPHTHERIA.

No.	Date.	Place.	Reporter and Reference	No. of Cases.	No. of Deaths.	No. of cases among drinkers of suspected milk.	Per cent.	Circumstances of Outbreaks.
1	1882 Dec.	Devonport	Dr. Parsons, L.G.B. Supp. for 1883	29	4	27	93	Origin unknown. Twenty out of the 29 cases were of adult age.
2	1883 Jan.	Hendon	Mr. Power, L.G.B. Supp. for 1883	62	..	34	55	Dairy utensils washed in brook contaminated by sewage. "Ropiness" of milk observed.
3	1883 April	Putney	Dr. Walker & Dr. Blaxall, *San. Rec.*, 1882-3, 515, 560 L.G.B. Supp. for 1883	17	5	17	100	Out of 400 families supplied with suspected milk, nine were attacked Diphtheria had prevailed in the district previously. Dr. Blaxa doubts whether milk was the cause.
4	1883	Cardiff	Dr. Paine, *B.M.J.*, 1883, i., 973	..	..	..	..	Polluted well at dairy.
5	1886 July	Canterbury	Dr. Wacher, *B.M.J.*, 1886, ii., 397	231	0	..	..	231 cases of local throat inflammation, with white patches on tonsils, and enlarged cervical glands, occurring within eight days. Out of 120 houses in which cases occurred, 94 were supplied with one milk.
6	1886 Oct.	Camberley and Yorktown	Mr. Power, L.G.B. Supp. for 1886	135	16	124	92	Incidence of the outbreak much more on better-class houses than on the poor, larger quantities of milk being taken, and stored before use.
7	1887 Jan.	Ealing	Mr. W. H. Power, L.G.B. Supp. for 1887, *B.M.J.*, 1887, i., 292, 342, and ii., 156	30	12	28	93	Sudden small outbreak of diphtheria during seven days, affecting solely customers of particular dairy. Before this, and subsequently, many cases of "sore throat" mainly affecting families supplied from this dairy. Connection "not proved."

known of which have been those at Devonport, Hendon, Canterbury, Camberley, and Ealing. The connection between the spread of the disease and the milk supply seems established in all but one of these outbreaks (the exception being the outbreak at Putney in 1883, in which Dr. Blaxall discredited the milk theory), but the definite manner in which the milk became infective has not been ascertained. In the Hendon instance the milk cans were washed in a brook contaminated with sewage; a similar state of things prevailed in the Cardiff instance; and in two of Mr. Hart's cases (Weybridge and Addlestone) the water supply of the dairy farm was very impure. In two instances of Mr. Harts' (Kilburn and Addlestone), the disease of the teats called "garget" was considered to be possibly connected with the epidemic. In the Canterbury case, though the cows appeared healthy, four calves had diarrhœa; at Camberley Mr. Power found that one cow had chapped teats not unlike those of the Hendon cow disease. But from a consideration of these fourteen epidemics, it is not possible at present to say what is the manner in which the milk becomes infective, though that the milk was the infective agent in these cases, is in the highest degree probable.

It is to be noted that in most instances it was found that the better class houses suffered far more than the poorer class. Mr. Power suggests[1] that this is owing to the larger quantity of milk consumed, and to the practice of taking in a larger quantity at a time and keeping it for some hours—or "setting it" for cream—while the poor only take a little, and use it at once. In the Hendon outbreak the milk was found to be ropy, and was either returned or thrown away by some of the customers in consequence.

IV.—TUBERCULOSIS.

It cannot be said that the transmission of tuberculosis from cow to man by means of milk has been actually proved, as I think can be stated with regard to the three diseases we have just been considering. But in the nature of the case there cannot be any sudden or widespread outbreak which would draw attention to the connection between this disease and the milk supply, as happens in the case of those other diseases. There is, however, a large body of evidence tending to show that this transmission is possible, and considering the enormous prevalence of tubercular disease in this country, the importance of dealing with this question can hardly be overrated.

1. It may be regarded as proven that *tuberculosis can be transmitted* from the cow to other animals *through the milk*. Dr. Francis Imlach[2] made some experiments in 1883, by

[1] L.G.B. Supp. for 1887.
[2] *British Medical Journal*, 1884, ii., 175.

feeding healthy calves, pigs, guinea pigs, monkeys, and a goat with milk from tuberculous cows, but found no signs of the transmission of the disease, except in the case of the monkeys: and this could not be considered of much importance, as they are known to be exceedingly liable to it in this country. Other observers have, however, proved the transmission beyond a doubt, especially Gerlach and Professor Bang of Copenhagen. But it appears to be the opinion generally, as far as I can gather, that it is only the milk of cows suffering from tuberculous disease of the udders that is especially likely to give infection, and that unless this local manifestation of the disease exists, tubercle bacilli are not found in the milk, and infection is not transmitted. This was the opinion stated by Principal Walley at a meeting of the Edinburgh Medico-Chirurgical Society last year,[1] and appears to have been the general opinion at the meeeting of the British Medical Association last August (1888).

2. It is now admitted that *tuberculosis is exceedingly prevalent amongst cows*. The cows that are most affected are the stall-fed dairy cows in towns. Professor Fleming states[2] that 25 per cent. of such cows are affected; some have stated even 50 per cent. At the Congress on Tuberculosis at Paris last year, it was stated that four out of every 100 cows were tuberculous.[3] Dr. Sims Woodhead[4] made a most careful inspection of over 600 cows in the Edinburgh dairies, with the veterinary Professor Macfadyean, and found thirty-seven beasts suffering from mammitis, but in only six of these could they demonstrate the presence of small numbers of tubercle bacilli in the milk, though these bacilli existed in enormous numbers in the udders. Granting that only milk from cows with tuberculous disease of the udder is infectious, 1 per cent. of dairy cows would be liable to transmit the disease. This, of course, is a very different thing from 25 or 50 per cent. It is no matter for wonder that dairy cows should be particularly susceptible to this disease, especially in town dairies. These places are often uncleanly, and nearly always ill-ventilated; the animal has no exercise, and is being drained of a large quantity of milk for a prolonged time. This prolonged lactation is known to predispose to phthisis in the human female. Even if only 1 per cent. of dairy cows are affected, as the milk of various cows is generally mixed, the tuberculous milk would be widely diffused. The presence of the disease does not lead at once to ill-health in the cow, loss of flesh, or diminution of the

[1] *British Medical Journal*, 1888, i., 419.
[2] Quoted by Dr. L. Parkes, *British Medical Journal*, 1888, i., 847.
[3] *Public Health*, September, 1888, p. 149.
[4] *Public Health*, September, 1888, p. 134.

supply of milk. On the contrary, this latter is stated to be often increased; so that the disease may have existed for some time unsuspected.

3. The question of the *identity of bovine and human tuberculosis* has been answered in the negative by Klein, and in the affirmative by Koch, Bland Sutton, Watson Cheyne, Sims Woodhead, and others. Klein considers[1] that "the tubercular virus derived from the human subject is not exactly the same as that derived from the tubercles of the cow, because (*a*) the tubercle bacilli present in the human tubercles are morphologically different from those of the cow's tubercles; and (*b*) because, although the guinea-pig is susceptible in a similar degree to both the human and bovine virus, there is nevertheless a marked contrast between the two as regards the rabbit," which is not infected by human virus, but is very susceptible to that from the cow. So Dr. Klein wrote in 1883; and further experiments in 1885, which showed that fowls were susceptible to human, but not to bovine tubercular matter (*i.e.*, the opposite of rabbits), confirmed him in this belief.[2] In 1886, however, further experiments on fowls had a different result.[3] But the numerous observers just mentioned consider the two diseases identical, and this was considered as established by M. Chauveau,[4] the president of the Congress on Tuberculosis at Paris last year, and by several speakers at the British Medical Association at Glasgow, and may be taken to be the general opinion on the subject.

4. We have, then, these three propositions: I.—Tuberculosis can be transmitted from the cow to other animals through milk. II.—Tuberculosis is very prevalent amongst cows. III.—Tuberculosis in cows is the same disease as in the human species. We then come to IV.—Tuberculosis can *probably* be transmitted from the cow to man.

Professor Walley stated[5] at Glasgow that he had himself lost a child from mesenteric tuberculosis, under such conditions as to point to milk as the source of infection; and that within the past few years one of the officials of the Veterinary Department of the Privy Council had lost a child also in a similar manner; and, doubtless, several similar instances could be related.

In a paper on this subject in the *British Medical Journal* of April 21st, 1888, Dr. L. Parkes quotes the Registrar General's statistics to show that the mortality from tubercular peritonitis and tabes mesenterica, for the ten years from 1871 to 1880, in children under five years, was on an average 2.55 per 1,000 per annum—about the same as for

[1] L.G.B. Supp. for 1883, p. 185.
[2] L.G.B. Report, Supp. for 1885. [3] L.G.B. Report, Supp. for 1886.
[4] *Public Health*, October, 1888, p. 180.
[5] *British Medical Journal*, 1888, ii., 411.

measles (2.57), and more than twelve times as great as the corresponding mortality from these diseases at any other age-period of five years, from five to 100. "The extreme incidence of primary tubercular disease of the abdominal lymphatic system on young children is at once seen from these figures. In the matter of dietary, there is one great distinguishing feature between this age-period and all others. Under five years of age, milk—usually unboiled—forms the staple food of children."

V.—OTHER DISEASES.

1. *Throat Illness* in connection with *Foot-and-Mouth Disease*.—In 1884, at Dover,[1] there suddenly broke out an epidemic of sore throat, with shivering, headache, some fever, with vesicular eruption of the throat or lips, enlarged tonsils (afterwards suppurating in some instances), and in most cases with enlargement of the glands of the neck. These symptoms resembled the aphthous fever of cattle, or foot-and-mouth disease. There were 205 cases in the week ending February 9th, all but eight above seventeen years old, all supplied with milk from one dairy, but living in different parts of the town, and with no other common condition but that of milk supply. It was ascertained that foot-and-mouth disease existed at one of the farms from which this dairy derived its milk.

In March of the same year, 1884, at East Dereham,[2] were many cases of throat illness among children, with some deaths, apparently due to milk from cows suffering from the same disease.

Mr. Hart relates[3] the case of the Aberdeen epidemic of 1881, where 300 persons were attacked with illness, the symptoms being rigors, fever, slight enlargement of tonsils, but no false membrane, and a marked feature in the illness being enlargement of the lymphatic glands of the neck, and those above the clavicle. The febrile symptoms passed off in a few days, but there were often relapses. The dairy, whence the milk supply of all the cases was derived, was attached to a Reformatory School, the boys of which got skim milk, and entirely escaped. The officials got sweet milk, but only a few were affected. With the stoppage of the milk supply, the disease ceased. The water supply of the dairy was bad. No explanation was given of the outbreak. The symptoms seem to have resembled those in the Dover outbreak, attributed to *eczema epizoötica*, or foot-and-mouth disease.

[1] *British Medical Journal*, 1884, vol. i., 627. See also a paper by Mr. Francis Vacher, in the *Sanitary Record* for September, 1881, p. 89, in which he relates three cases of this disease transmitted by milk, and refers to records in the *Veterinarian* for 1841, and the *Veterinary Review*, iv., 502, and v., 187.
[2] *British Medical Journal*, 1884, vol. i., 575. [3] *Loc. cit.*

An outbreak of sore throat occurred in an institution in Edinburgh in 1888, on which Dr. Sims Woodhead and Mr. Cotterill read a paper before the Edinburgh Medico-Chirurgical Society in June (see *British Medical Journal*, June 9th, 1888). The milk supply was suspected; it was stopped, and the epidemic ceased. The milk was again taken into use, and the epidemic re-commenced. Lastly, the milk was boiled, and no further cases occurred. Dr. Woodhead found various organisms to be present in the milk. Many of the cows showed signs of cow-pox.

2. *Gastro-enteritis.*—At the Societé de Medicine Publique in Paris, in November, 1885, M. Toussaint[1] brought forward facts from the death-register returns, showing that deaths from gastro-enteritis, and from intestinal affections, were more common among bottle-fed children in the district of Argenteuil, since a large distillery had been established there, the cows being fed on brewers' grains, and the milk being acid.

3. *Poisoning.*—Surgeon R. H. Firth relates[2] an instance of poisoning among troops at Mean Meer in August, 1886, the cause of which was traced to the drinking of some milk that had apparently been kept in a dirty pan. The symptoms were "nausea, vomiting, dryness and intense constriction of the fauces, vertigo, colic, purging, and in some a tendency to collapse: in others, numbness of the extremities, and a tendency to stupor." Under simple treatment all the cases recovered. On treating some of the milk, after coagulation, with potash and ether, and evaporating, a moist semi-crystalline residue was left, with a sickly odour, which on application to the tongue caused sharp pungent taste, nausea, dryness of the throat, and headache. Mr. Firth subsequently obtained the same, or a similar body, from good milk that had been kept for a long time. He considered it a ptomaine, and named it *lactotoxine*.

Professor Victor Vaughan, of Michigan, relates[3] some cases of poisoning from eating "sick" cheese, the symptoms being dryness of the throat, nausea, vomiting, diarrhœa, nervous prostration, headache, and sometimes double vision; the symptoms, in fact, of a gastro-intestinal irritant, with marked effects upon the nervous system. Recovery generally follows, though death has occurred in rare cases. After much trouble, he succeeded in isolating the poisonous principle by rendering the aqueous extract of the cheese alkaline with potash, and then extracting with ether. Needle-shaped crystals were formed, which, placed on the tongue, gave a burning sensation, followed

[1] *British Medical Journal*, 1885, vol. ii., 992.
[2] *Practitioner*, 1887, xxxix., 75.
[3] *Practitioner*, 1886, xxxvii., 232.

by dryness and constriction of the throat, and nausea, the taste very sickening. He named the poison tyrotoxicon, and considered that it belonged to the class of ptomaines. He found also that it developed in milk after long standing in closed vessels. He found that from cheese containing this poisonous matter, when freshly cut, there always exuded drops of a watery opalescent fluid, which reddened blue litmus paper instantly and intensely. He considers that any cheese giving this instantaneous and intense reaction is suspicious. The symptoms of poisoning, and character of the poison in these two cases, appear almost identical.

Cases of poisoning from ice cream, sold in the street, have frequently been recorded, but, as far as I know, the actual toxic agent has not been discovered. Cases of poisoning from the milk of cows afflicted with the "trembles," supposed to be produced by their feeding on *Rhus toxico-dendron*, have been recorded from the Western States of America. In this "milk-sickness" in children there is weakness, vomiting, fall in temperature, dry and swollen tongue, and constipation. Boiling removes the poisonous properties. At Malta, diarrhœa has resulted from drinking the milk of goats that have fed on Euphorbiaceous plants.

4. *Cholera.*—Dr. Simpson, Health Officer for Calcutta, in his report for the first quarter of 1887, related[1] the particulars of a slight outbreak of cholera and choleraic diarrhœa on board the ship *Ardenclutha*, lying off Calcutta, resulting in nine cases and four deaths, in which the poison seemed undoubtedly to have been conveyed through milk. Of the crew of this ship, those who drank milk brought by a particular native milkman, all (with one doubtful exception) suffered; and no one who did not drink the milk was attacked (with one doubtful exception). The milkman was traced, and was found to live near a tank into which dejecta from a cholera patient found access; and he confessed to habitually diluting his milk with one quarter water from this tank. All other likely causes were enquired into and found negative, before this apparently clear causative connection was discovered.

CONCLUSION.

The practical question that we have to answer, from a consideration of these dangers in our milk supply is, How can they best be prevented or minimised? The measures necessary or advisable may be conveniently considered under the two heads of (1) those applicable to the milk before it reaches the house of the consumer, including the inspection and management of dairies, dairy farms and

[1] *Practitioner*, xxxix. (1887) 144.

milkshops, which is a matter of Public Health; and (2) the best thing to be done by the consumer in his own home, to make sure that neither he nor his family shall run the risk of "catching" anything through the milk supply.

1. It was mentioned at the beginning of this paper, in regard to typhoid fever spread by milk, that the infection might occur conceivably in four ways:—(*a*) By addition of water to the milk containing the specific contagium; (*b*) by the specific contagium gaining access from the air to exposed surfaces of milk; (*c*) by communication to the milk of the contagium from a person engaged in the distribution of milk, either ill himself, or in attendance on someone ill with the disease; (*d*) possibly there may be disease of the cow that can be transmitted to the human subject through the milk. The spread of the other specific diseases mentioned may take place in like manner.

(*a*) By punishing adulteration with water, the first channel of infection can be in part closed to the intrusive germ; but only in part, as water used in washing cans *may* contaminate the milk. Careful inspection of the sanitary conditions of the dairy, and provision of a pure water supply are here indicated. As regards (*b*) and (*c*), we have the 9th Section of the Dairies, Milkshops, and Cowsheds Order of June 15th, 1885, which makes it an illegal act for any trader in milk, either himself or his subordinates, to have anything to do with its distribution "when suffering from a dangerous infectious disorder, or having recently been in contact with a person so suffering." The execution of this order is now vested in the sanitary authority, and when the new County Councils are fairly started, we may expect (as there is room for) a progressive improvement. But still there will always be the possibility of mild cases of scarlet fever, or diphtheria, or typhoid being unrecognised, or only recognised when the mischief has been done. (*d*) The careful inspection of dairy stock by skilled veterinarians will doubtless tend to prevent the fourth source of infection. This is especially important as regards tuberculosis, and most especially tuberculosis of the udder.

2. But even if everything is done that can be done, there will still be the possibility of infected milk reaching a household. In that case what should an ordinarily prudent man do, not one who is full of fads and crochets, and always on the look-out for fancied dangers, but the sensible man who keeps his water closets in good order, sees to the purity of his water supply, and tries to keep his house and its surroundings in a wholesome condition? Fortunately, the precaution to be taken is of the simplest possible character: it is merely to *boil all milk before use*. This does not mean placing a jug of milk in a saucepan full of

water, and just bringing the latter to the boil for a moment or two; but it means that the milk itself should be brought up to 212° F. for four or five minutes. If this be done, we have every reason to believe that no specific contagium will retain its vitality, and the milk may be drunk with safety.

It must be admitted that even now we are not armed at all points to repel every possible attack of the supposed invading germ; we can boil our milk, but we cannot boil our *butter* or our *cream*. There is nothing in the making of butter that can be considered as doing away with the possibility of the presence of the specific contagium in it, supposing any to have existed in the milk; but I am unaware of any record of disease traceable to butter, or even of any allusion to the possibility of such an occurrence, though I have searched through a considerable bulk of literature bearing on the subject. For the present, we must be content to eat our butter in fear and trembling; and with regard to cream, if we indulge in the luxury, we must be content to take it "all risks included."

With the authors kind regards

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CLINICAL REMARKS
ON
INTRAVASCULAR COAGULATION AND PULMONARY THROMBOSIS.

BY SIR JOSEPH FAYRER, K.C.S.I., M.D., F.R.S.

ABOUT thirty years ago I began to call attention in India to the formation of clots and fibrinous coagula in the heart and great vessels as a source of danger, and frequently of death, not only to persons who were suffering from various forms of disease, but also to those who had sustained injury or undergone surgical operations, in many cases where they seemed to be otherwise progressing favourably. I remarked the apparent influence of dyscrasia and cachexia depending on malarial infection and splenic disease and on conditions arising out of various other forms of toxæmia, in producing the state of blood in which this intravascular clotting is apt to occur.

I was unable then to give more than a general account of or to offer more than somewhat vague suggestions as to, the nature of the cause, but the light which has been thrown on the subject by the recent researches of pathologists in Britain and on the Continent, and which were so well expounded in the Goulstonian Lectures of 1893 by Dr. Halliburton, F.R.S.—his own contributions to the subject being of great interest and value—has now furnished a solution which goes far to explain that which has hitherto been obscure, and offers also reasonable ground for hope that a death cause often so terrible in its sudden onset and rapidly fatal termination may be in some instances mitigated, if not altogether prevented, and may prove amenable to remedies which chemico-physiological investigation has demonstrated to possess the power of controlling this abnormal tendency to intravascular coagulation.

I venture in the following communication to recur to observations made by me many years ago, and to relate briefly a few cases which illustrate the pathological conditions referred to. I would repeat my opinion that among the conditions which tend to determine this dangerous state of the blood, that which is so prevalent in tropical and malarial climates, more especially when any splenic complication exists, is a fertile cause of clotting, and that it frequently induces death by pulmonary thrombosis, not only in cholera, fever, and other diseases, but after surgical operations, not infrequently even where the progress of the sufferer appeared otherwise to be favourable.

The very lucid explanation given by Dr. Halliburton in his recent lectures and the account of his researches, as well as those of Wooldridge, Wright, W. L. Dickinson, E. H. Hankin, Green, Ringer, Sainsbury, Shore, Hardy, Schmidt, Hammarsten, Virchow, Brücke, Arthus, Pagès, Pekelharing, Grusbach, Löwit, Lilienfeld, Daremberg, into the nature and pathological causes of the processes by which it is brought about appear most conclusive, and are a striking example of the great practical value of researches conducted in the patient, persevering, and scientific spirit characteristic of those recorded and acknowledged by Dr. Halliburton in the lectures above referred to.

I am glad to find that the impression made on me by former experience of this disease, to wit, that the depraved state of the blood in malarial and splenic cachexia, in which the leucocythæmic condition is productive of danger by its tendency to cause intravascular clotting, thus receives explanation and confirmation from these pathologists, and I feel that to them are due grateful thanks for the light thrown on an important and hitherto obscure cause of suffering.

When listening with deep interest to Dr. Halliburton's lectures, I heard him refer to a particular case of pulmonary artery thrombosis which occurred in this country; my thoughts immediately reverted to many such cases which had happened in my own experience. I have therefore offered the following contributions to the subject, and I believe that Dr. Halliburton will find in them illustrations of the views which his most valuable researches have developed, and I would repeat what I have said on other occasions, that I believe intravascular coagulation with pulmonary thrombosis to be a more frequent cause of death, in this country as well as in India and the tropics, than is generally supposed. I would by no means be understood to imply that this is due only to malarial influences. I merely wish to point out that I believe that a condition of the blood which may be induced by many causes is more prone to occur in climates where such influences exist.

I have little doubt that physicians and surgeons, looking back over former experiences, will recall cases where death has occurred owing to this condition, in which necropsy has revealed the presence of a clot in the pulmonary artery as the only cause to which the fatal termination may be assigned.

The above remarks refer chiefly to clotting in the venous system, but the arterial side of the circulation is by no means exempt from it, and this I have described in the paper, "Gangrene from Arterial Embolism," p. 131 of *Clinical and Pathological Observations in India*, where I have given illustrations of it as manifested in gangrene or other lesions resulting from plugging of the main arteries of the limbs or other parts of the body.

In this paper reference is made chiefly to thrombosis of the pulmonary artery, and the following examples are given where the right ventricle, the pulmonary artery, and its extreme branches have been found, after death, to be plugged by a firm, white, fibrinous clot, which had rapidly proved fatal.

CASE I. *Ligature of the Femoral Artery for Elephantiasis of the Leg; Death from Fibrinous Coagula in the Pulmonary Artery.*—A Bengali, aged 38, was admitted on February 22nd, 1865, with elephantiasis of the right leg of seven years' duration; otherwise he was healthy looking, with no symptoms of disease elsewhere. The femoral artery was tied at 9 A.M. on the 25th, near the apex of Scarpa's triangle. He did well until March 4th,

when he had slight fever; this recurred at intervals of a day or two, without, however, affecting the foot until the 14th, when he felt a burning sensation in both legs. On the 13th pyæmic symptoms had set in, with a rapid pulse and hurried breathing. These symptoms were worse on the 14th, and he died on that day at 2 P.M. The wound had looked healthy all the way through.

Post-mortem Examination.—The liver and spleen were healthy; the kidneys were infiltrated with pus. The iliac veins appeared healthy, but the right contained a clot. The lungs contained numerous patches of dead tissue, one as large as a small orange. There was also purulent effusion into the cavities of the pleuræ. The pericardium contained a quantity of yellow serum. The right ventricle was completely filled with a firm decolorised clot, which had moulded itself in the cavity and extended far into the pulmonary arteries. There was no sign in the condition of the femoral artery of any pathological change that would have given rise to mischief. There was no phlebitis in the femoral vein.

CASE II. *Operation for Elephantiasis; Pulmonary Thrombosis; Death.*—A Mahomedan, male, aged 50, admitted January 28th, 1866, with elephantiasis of scrotum. On February 1st tumour was removed. There was much bleeding from the wounded vessels. The pulse was very weak; the wound looked healthy throughout. On the 8th he had pain in the right hypochondrium, with hurried breathing, and died on the 9th.

Post mortem, there were whitish decolorised clots in the right auricle and ventricle of the heart, extending into the pulmonary artery and all its minute ramifications in the lung. Pulmonary veins were plugged with similar clots, which extended into their branches and filled the left auricle. Other organs were healthy.

CASE III. *Operation for Elephantiasis; Pulmonary Thrombosis; Death.*—J. H., aged 45, admitted on August 24th, 1866, with scrotal tumour of two years' duration. Tumour removed on September 3rd; lost much blood; temperature rose; pulse small and weak; became delirious; breathing hurried; died on the 10th.

Post mortem, a firm, whitish clot in the upper vena cava was found extending into the right auricle, which was nearly filled by it. Clot extended into the right ventricle, through the tricuspid valve, and thence into the pulmonary artery and all its branches. Pulmonary veins filled with similar clots, which passed into their ramifications and filled up the left auricle; the left ventricle was empty. There was a clot in the aorta, which was adherent to the valves, and ended in a free extremity beyond the origin of the left subclavian artery, where it was floating loose within the calibre of the vessel. The lungs were blanched, and seemed rather shrunken; other organs healthy, except the kidneys, which were pale and flabby.

CASE IV. *Opening of a Deep Sinus; Pulmonary Thrombosis; Death.*—A Hindu, male, aged 38, was admitted on March 27th, 1867, suffering from a deep sinus running under the gluteal muscles. A counter opening was made. Had fever for the next three or four days. An incision below the great trochanter gave exit to some fœtid pus and gas. Fever ceased on 31st. Pulse weak; breathing very hurried; discharge fœtid and thin; incision enlarged; died on April 2nd.

Post-mortem Examination.—The left lung was found much congested; right lung contained a small tuberculous cavity at its apex; no pyæmic patches, no pleuritic effusion. Right auricle and ventricle of heart completely stuffed with firm fibrinous coagula, extending into the pulmonary arteries. Left lobe of liver much enlarged; its substance soft and fatty; spleen much enlarged; kidneys flabby, and their capsules easily detached. The sinus ran under the gluteus maximus, and had no communication with the bone. The tissues in the neighbourhood were in a state of decomposition.

The formation of fibrinous coagula in the cavities of the heart, or in the great vessels, is a condition which we know is liable to occur in the later stages of numerous diseases, and probably it is the actual cause of death in many, being itself due to the altered condition of the blood; perhaps to some extent to the diminished vitality of the tubes and cavities in which the blood circulates, and to altered or defective nerve force. It is not only to its occurrence under these circumstances that I now allude, but to the fact that it is a danger to be apprehended after any severe—indeed not always severe—operation or injury, and may occur independently of those signs which indicate the toxæmic state of the blood we so frequently see in hospital patients in large cities, where not only are the hygienic conditions defective, but the people themselves are anæmic and wanting in vital energy. It is right, therefore, that this source of danger should be borne in mind, and that in any case where a tendency to exhaustion or anæmia exists, particular attention should be paid to the diet, and administration of such remedies as may tend to counteract the disordered condition, which we may fairly assume to exist when these symptoms appear. In the preparation of patients for an operation, as well as in their treatment afterwards, it should be borne in mind that iron and nutrients should be freely given to improve the condition of the blood. Hyposulphites, according to Polli; alkalies, according to Richardson and others, are indicated; the former to limit the development of poison germs, the latter to obviate the tendency in the blood to clot.[1] Above all, plenty of fresh air, to oxygenate the blood and tissues. Such, no doubt, are the measures of a therapeutic and dietetic nature from which we may hope to derive benefit. In many cases, the supervention of this obstructed condition of the right side of the heart is the precursor of speedy death, but not necessarily always so; and doubtless a certain amount of clotting is frequently recovered from, or its effects are seen in a secondary form in the changes which occur in the lungs as the result of the capillary embolism to which its *débris* may give rise. In those cases wherein it proves fatal, the end is speedily brought about by the rapid and sudden withdrawal of blood from the pulmonic circulation, syncope or cardiac apnœa closing the scene.

The earliest symptoms of weakness, failing pulse, coldness of the extremities, with rapid action of the heart, pallor or lividity and hurried respiration, should receive due attention; and in some cases I believe that, provided no other changes have occurred in the viscera, as a result of septicæmia, the timely administration of remedies such as I have indicated may avert the danger and save life.

Case No. IV is an example of the conditions I have been describing. It is true there were *post-mortem* evidences of visceral changes of a chronic nature, but they were principally such as tend to induce the condition in which fibrinous clots are most likely to form, by interfering with the due elaboration and development of healthy blood; for if there be any one condition more than another unfavourable to such development, it is that disordered state of the blood-making organs so frequently found in malarious countries. It is, I believe, only right that in estimating the respective influences of the various causes by which life may be endangered or lost, after surgical operation, that we should take into consideration the malarious state of the climate, and its effects; and whilst I admit that much of the mortality may be due to intrinsic causes, I feel more strongly than ever the paramount necessity of having healthy, well-ventilated hospitals.

CASE V. *Amputation of Arm: Pulmonary Thrombosis; Death.*—A Hindu, aged 40, admitted May 6th, 1867, with lacerated wound on inner aspect of left elbow-joint, inflicted with a pickaxe. Pus formed in the wound, he did not do well, had rigors and fever, indications of pyæmia appeared, so amputation was performed through the lower third of the humerus. Fever continued; complained of pain in the left side of the chest; respiration hurried; temperature high, more rigors; died June 5th.

Post-mortem Examination.—The lungs were found to be œdematous and emphysematous, pale, but right lung congested posteriorly. Left lung had three pyæmic patches of dead lung tissue, saturated with puriform

[1] Drs. Halliburton and Wright suggest other remedies for the purpose.

sanies. Left pleural cavity contained about 5 ouces of serous fluid, with flakes of lymph. Upper lobe of left lung covered with thick layer of lymph. Firm decolorised clot in right auricle and ventricle, extending far into pulmonary artery. Liver pale and slightly enlarged; spleen considerably enlarged. Bone contained pus infiltrated throughout medullary cavity. Other organs healthy. Death occurred from pyæmia, but immediate cause was cardiac thrombosis, interrupting pulmonary circulation.

CASE VI. *Injury to the Scalp: Pulmonary Thrombosis; Death.*—A native, aged 25, admitted May 13th, 1867, for severe injury to scalp. Bone in right frontal region laid bare to extent of 4 by 2 inches. Pericranium removed, but bone itself not injured. Did well for first week. After that had much pain in head, rigors, fever, sweating, inclination to vomit, rapid pulse, and high temperature. Trephine applied over centre of denuded portion of bone, which had dull and dry appearance. On reaching the diploë, a large quantity of fœtid pus was evacuated; no pus between bone and dura mater. No improvement resulted; breathing became more hurried; became unconscious; died the same evening.

Post-mortem Examination.—The frontal bone was found in complete state of diffused osteomyelitis, diploë being infiltrated with fœtid pus. Large quantity of thin pus under dura mater, diffused over surface of that side of the brain, but none between the skull and the dura mater. There was one small pyæmic patch on the surface of the middle lobe of the right lung, and another on the left lung. The right auricle and ventricle were plugged with firm, adherent, fibrinous clots, extending into the pulmonary artery. Liver, kidneys, and spleen healthy. The cause of death in this case was undoubtedly interrupted pulmonary circulation, as proved by the clots in the heart and blanched and emphysematous condition of portions of lungs. Small pyæmic patches in lungs were quite incipient.

CASE VII. *Amputation of the Leg: Pulmonary Thrombosis; Death.*—A Hindu, aged 21, admitted June 24th, 1867; right knee injured by an agricultural instrument. Wound was found to communicate freely with the joint; sanious discharge; increased much, became puriform and fœtid. Amputation performed at the lower third of the thigh on July 2nd. Did not do well. Symptoms of toxæmia appeared and progressed rapidly, and on July 4th amputation at hip-joint was performed. Pulse and temperature high; delirium; rapid breathing; no hæmorrhage from stump. Died on July 5th, breathing having become very hurried.

Post-mortem Examination.—The right ventricle contained firm, flattened, and adherent decolorised clot, extending far into ramifications of pulmonary artery. Right auricle stuffed with firm white clot, supplemented by a more recent one. Lungs blanched, some portions being quite exsanguine, others containing a little blood; both emphysematous and œdematous. No structural change in any of the viscera. Nothing remarkable in stump; medulla infiltrated with pus. The immediate cause of death appears to have been coagula. Absence of structural change in the viscera points to the fact that recovery might have taken place had coagula not formed.

CASE VIII. *Injury to the Rectum and Bladder; Pulmonary Thrombosis; Death.*—Conductor H. was admitted on December 16th, 1868, suffering from effects of an accident which had happened eight months previously. He had slipped down a hill a few feet on to a stake, which pierced the right gluteal region and penetrated the bladder. He was in great pain for the first day or two, but after then until July 11th he did well. On that day a great deal of blood came away through the wound. The bladder and urethra became very irritable, and he suffered much from tenesmus. Under treatment the symptoms improved, and when he was admitted, on December 16th, he seemed in fair general health, but complained of an increased desire to pass water, with much pain at the neck of the bladder. Calculus was detected, and on January 7th the lateral operation was performed and a friable calculus removed. Had frequent attacks of fever and diarrhœa, and twice incisions were made in the inguinal canal and deep-seated pus evacuated. On February 9th, when apparently convalescing, he went home for change of air. He returned on February 27th much worse; had had severe rigors and fever; pulse feeble and rapid; respiration gasping and hurried. On February 28th the breathing became much more rapid and gasping, and intense cardiac apnœa preceded death.

Post-mortem Examination.—The lungs were found to be much congested posteriorly. Firm decolorised clots in the right cavities of the heart, extending far into the ramifications of the pulmonary artery. Liver enlarged; contained very numerous pyæmic patches of the size of peas. Spleen congested and softened; kidneys somewhat congested.

This was an exceedingly interesting as well as instructive case from the beginning. His recovery from so grave an accident, in the first place, was very remarkable. A stake driven through the gluteal region and rectum into the bladder might well have proved rapidly fatal, and the result wonderfully illustrates the reparative power inherent in the constitution of a man in the vigour of health. He had so far recovered in about seven months as to be able partly to resume his duty. The formation of the calculus may be accounted for, no doubt, by the condition of the bladder injured by the wound; a nucleus having formed, determined by the roughened and irregular surface of that part of the bladder where the fistula opened, and perhaps by the entry of some hard substance from the rectum, the concretion rapidly gathered round it and produced the calculus detected on his admission. No part of the stake with which he was injured could be found in the bladder, though carefully looked for. His subsequent condition was not less remarkable. There can be little doubt, I think, that the train of unfavourable events which preceded his death were mainly due to the influence of malarious poisoning. The fever that supervened after the operation was most probably of malarious origin, and the blood, already thus poisoned, was more readily affected by the toxic conditions excited by the operation. The fibrinous coagula in the heart, which were the immediate cause of death, were no doubt due to the same causes. That the absorption of septic matter in this case took place mainly through the portal circulation is indicated by the state of the liver, which was studded with local deaths of tissue; and the enlarged spleen tends to support the theory that malarious poisoning was much concerned in inducing a state of the blood generally which finally accelerated the fatal result by determining the formation of fibrinous coagula in the right cavities of the heart.

CASE IX. *Contusion of the Leg; Pulmonary Thrombosis - Death.*—A Bengali, male, aged 20, was admitted on April 15th, 1870, with contusion on the right leg. Had been suffering from malarious fever and enlarged spleen for five months previously. Leg and knee were œdematous. The bruised portion, just below the knee-joint, looked as though it were becoming gangrenous. Temperature low; pulse small and feeble. Remained in this state for two days. Respiration began to be hurried on the 18th; became more gasping and hurried; died at midnight on the 20th in a state of extreme cardiac apnœa.

Post-mortem Examination.—The spleen was found to be much enlarged. The lungs were somewhat congested hypostatically, and a portion of the lower lobe of the right lung was consolidated. In the heart a firm fibrinous coagulum was found extending from the right auricle, where it was reddish, into the ventricle, where it was straw-coloured, and thence firm and fibrinous into the pulmonary artery and its minute subdivisions. A similar one was found in the left cavities, extending into the aorta. The integument was gangrenous for several inches down the leg. The knee-joint was not compromised; and, on being laid open, its structures were found to be normal.

There was certainly not sufficient in this case, in the mere gangrene of the integument of the leg, to account for death in an ordinary individual; but in a person suffering from malarial blood poisoning and enlargement of the spleen, it was more than sufficient. Probably in no condition of the disease is the formation of fibrinous coagula more likely to occur, on the least disturbance, than in splenic or malarious cachexia. In a marked case, such as this, where the spleen was four or five times its natural size, it may be said that there is nothing remarkable in its termination; for do we not see such almost daily in the cases of cancrum oris, sloughing ulceration, and necrosis, that are unhappily so common in Bengal, and probably in other localities wherever malarial influences are rife? The imperfect condition of the blood-making organs, and the impoverished character of the blood they elaborate, are amply demonstrated in the leucocythæmia.

and in the great tendency to disintegration and death of the soft tissues and bones. The evil results of thrombosis, when it occurs in the arterial circulation, are seen in the limbs or other parts of the body, which become gangrenous, or, still worse, in the multiple deaths of portions of the viscera, which are so frequently observed in the so-called pyæmic conditions generally met with after wounds and injuries, though by no means infrequently, idiopathically.

I have repeatedly called attention to the subject as one of great importance in a surgical point of view, for it is not only in cases where an enlarged spleen renders almost any operation impossible, and causes almost any wound to prove fatal, but in many others, whether of wound or injury, where there is no obvious disease of the spleen, and where all seems to be doing well, that this may and often does supervene, and rapidly carry off the sufferer. The condition is one most common in exhaustive diseases, and it is, no doubt, often one of the latest pathological phenomena manifested by the moribund, but it is more than this, for, as I have said, it may set in where there is no appearance of exhaustion, when repair and nutrition are going on satisfactorily, and within twenty-four or forty-eight hours carry off the patient, whose body presents no solution of the cause of death beyond a firm, white, adherent clot in the right auricle or ventricle, or it may be just at the ostium of the pulmonary artery, which is indeed the janua vitæ.

This condition taking place in the right side of the heart or in the pulmonary artery is one of the dangers that the subject of a surgical operation, wound, or injury has to encounter, and not merely as the last act of a series of pathological processes, the result of exhaustive or prolonged disease, but as an original and dangerous consequence of some blood change. What the nature of this change may be I am uncertain; it may perhaps arise out of the presence of matters retained in the blood that should have ministered to the nutrition of the part removed in cases of amputation or ablation of parts of the body, a condition somewhat analogous perhaps to the retention in the body of a secretion that should have been eliminated; or, in cases where no removal of parts has occurred, it may be due to some disturbed condition in which the blood is prone to coagulation. I have a strong suspicion that climate is not without influence in originating this dangerous state. In Bengal all are more or less under the influence of malaria; it is true, happily, that in a large majority of persons its effects are not generally perceptible.

I do not regard this as altogether due to a malarious condition of the blood; I know that, although it may not have been noticed as a result of surgical operations, Dr. Richardson long ago pointed out its tendency to occur in exhaustive diseases; but I cannot help thinking that a pathological state capable of producing so many important changes as malarial infection does, may have something to do with this one also.

CASE X. *Catheterism; Urethral Fever; Pulmonary Thrombosis; Death.*—An English sailor, aged 39, applied for relief from retention of urine on June 20th, 1870. He said he had suffered from slight stricture for the last five or six years. A catheter passed and urine drawn off without difficulty. Returned in the afternoon, very ill, in great distress about the stomach; pain across abdomen or lower part of the chest. Had passed some urine tinged with blood after his return home. On May 21st the pain seemed to localise itself in the right hypochondriac region, and there was excessive tenderness on pressure over the liver. Breathing hurried. No urine had been passed since admission; dulness on percussion over the base of the right lung; breathing hurried and gasping; distress increased, and he complained that something was choking him. At about 10.30 he passed water, but no improvement resulted, and he died at midnight "in a sudden fit of gasping." Struggle for breath was most distressing to witness.

Post-mortem Examination.—The lungs were hypostatically congested, the right most so; one portion of the middle lobe was solidified; lower lobe was also hepatised. There were one or two very small patches of tuberculous deposit in the apices of the lungs; with this exception they were healthy and crepitant. Heart was normal, but its cavities contained firm, adherent, fibrinous clots; that in the left side extended from the auricle into the ventricle and into the aorta for about 3 inches; that in the right was larger, and extended from the auricle through the ventricle into the finer ramifications of the pulmonary artery; the pleuræ were normal. The kidneys were congested; the other viscera and peritoneum were healthy. The bladder was somewhat thickened, and the urethra was slightly strictured in front of the bulb; there was no wound and no false passage.

Case x is very instructive. A man in the prime of life, in good health, with the exception of a slight stricture, a steady, intelligent, and temperate person, suffers from retention of urine, due to a slight excess a day or two previously. He is relieved at once by the passage of a No. 8 catheter. He returns home, feels chilly, has rigors, rapidly followed by fever and delirium; he passes urine tinged with blood after his return home. The fever is attended with intense restlessness and distress; severe pain in the right hypochondriac region and pit of the stomach follows. Rapid, deep, and gasping breathing, with the greatest præcordial distress, increase and go on getting worse and worse, until the patient dies in great agony of breathlessness about forty hours after the catheter had been passed. His intellect was perfect to the last; urine was secreted and voided not long before death. It is clear, therefore, that the symptoms were neither due to uræmic or cholæmic poisoning, nor to any cerebral disorder. There was no exhaustive disease. Air entered the chest freely, and his voice was natural to the last. There was neither heart disease, peritonitis, nor other acute inflammation. What, then, was the cause of death?

The *post-mortem* examination revealed some congestion at the base of each lung. The pleuræ were healthy, and the pericardium contained a small quantity of fluid. None of these conditions were sufficient to cause death. The abdominal viscera were not absolutely healthy, for the liver was slightly enlarged, and the kidneys were congested. The bladder, prostate, and the tissues about its neck were generally healthy.

The bladder was somewhat thickened in consequence of a slight stricture situated just in front of the bulb of the urethra. Through this an instrument had been passed. There was nothing in the abdomen to account for death; but on opening the heart, it was evident that the formation of coagula had destroyed life. They were firm, decolorised, and adherent, and on the right side not only obstructed the auricular, ventricular, and arterial openings, but extended far into the subdivisions of the pulmonary arteries, ramifying like the branches of a tree.

I have repeatedly noticed this condition as a cause of death, but I have never seen a more striking example than this. I have before mentioned my suspicions that malaria has much to do with inducing the condition of blood in which this coagulation occurs. In this case, the simple act of passing a catheter through a slightly strictured urethra was the

exciting cause. The patient cannot be said to have been, strictly speaking, in a healthy condition, although he appeared in perfect health, and no lesion was discovered that would account for death. Sufficient, however, existed to suggest how, with the addition of the shock of the operation, and the consequent urethral fever, the blood change and consequent cardiac thrombosis were brought about.

Something was said about his having recently suffered from intermittent fever, but he had none of the appearances of malarial cachexia. But no one in Bengal can be said to be exempt, especially at that season of the year; and I am convinced that this malarious influence, which affects all more or less, is in persons of irritable constitution, and especially in those suffering from stricture, a predisposing cause of that dangerous condition—urethral fever—in which, under certain conditions, fibrinous coagulation is likely to occur.

It has long been known that death may occur rapidly from this cause in puerperal patients, and that in diphtheria, croup, cholera, and other exhaustive diseases, it is not by any means infrequent; and in such cases, where the blood must necessarily be in an altered condition, and the muscular fibre of the heart weak, although the precise nature of the change may be unknown, it is not difficult to understand why the fatal result should occur. But in cases such as the preceding, and in others where fatal cardiac thrombosis has supervened after surgical operations, when the patient appeared to be doing well, the explanation is more difficult. That it occurs in persons in whom there are no obvious indications of cardiac disease is the more reason why, in a hot and exhausting climate, it should take place in those who are the subjects of fatty degeneration, or when the heart is loaded with fat externally, or where there are either pleuritic or pericarditic effusions, or the ventricles are dilated, and the muscular fibre atrophied. In such persons, indeed, the presence of fibrinous concretion may not be needed to bring about the fatal apnœa. The temperature of a night in May or June in a tropical climate such as Calcutta, the shock or after-effects of an operation, may be sufficient; and the patient, after a short and distressing struggle of breathlessness, perishes.

CASE XI.—*Malarial Poisoning; Pulmonary Thrombosis; Death.*—On August 6th, 1871, I saw a case of supposed irreducible hernia with symptoms of strangulation. The patient was a young Englishman, aged 28, with a swelling in the left groin below Poupart's ligament, painful on pressure, with general abdominal tenderness; smaller swelling in the other groin, less painful. Was feverish, and had been so during the night, with severe pain, nausea, and vomiting. He was easier in the morning, but was sent to the hospital. At about 2 P.M. the symptoms of the night recurred, and at about 4 P.M., breathing, which had been hurried before, became more so; cold sweats covered his body, and all the indications of collapse set in; breathing was painfully gasping and hurried; face and lips dusky and livid; he was conscious to the last. Sank soon after 4 P.M.

Post-mortem Examination.—It was seen that there was no hernia; the swellings in the groins consisted of thickened areolar tissue around a cluster of indurated glands, and had been present for months if not years. The lungs were intensely congested, especially at the back, and contained numerous patches of pulmonary apoplexy throughout their structure; they were œdematous, and the bronchial mucous membrane was deeply congested and covered with frothy mucus. The heart was normal and firmly contracted; both sides contained small, firm, decolorised clots extending into the aorta and pulmonary artery; all else was normal.

This is a very interesting as well as a somewhat obscure case. It is an example of the rapidly fatal effect sometimes produced at this season of malarious poisoning, the weather at the time being hot, damp, and replete with malarious influences. The symptoms were such as not unnaturally, considering the state of the groins, suggested strangulated hernia; indeed so much so that I was tempted to cut down on the swelling to remove all doubt. But when I saw him after removal to the hopital, the collapse was so complete that I did not do so. Death was due to the pulmonary engorgement accelerated by the formation of fibrinous coagula in the right side of the heart. The overwhelming action of the malarious poison can only account for the rapidly fatal phenomena. The patient was a healthy and temperate man, his organs were sound, and he had not been ill for months before the day on which this illness commenced. A certain amount of enlargement of the scrotum, combined with hydrocele, together with swelling in the groins, suggested the existence of an elephantoid taint; although in other respects he was free from disease.

CASE XII. *Carbuncle; Pulmonary Thrombosis; Death.*—A Lascar aged 28, was admitted October 20th, 1871, with a carbuncular swelling on the right cheek, involving lips and lower eyelids. The corresponding mucous membrane lining the cheek was covered with a croupous-looking exudation. Disease attributed to slight cut whilst shaving. General health much impaired by malarious enlargement of liver and spleen. Small incisions were made in cheek and lip, from which purulent matter found exit. Patch of exudation removed from the cheek. On October 22nd, pulse feeble, no fever, respiration very hurried; delirium; more punctures made. On October 23rd he was worse; breathing excessively gasping and hurried; died at 3 P.M.

Post-mortem Examination.—The lungs were hypostatically congested. No pyæmic changes. There was found a firm fibrinous clot in right ventricle, extending from the auriculo-ventricular opening into the finer ramifications of the pulmonary arteries. Smaller clot occupied the left ventricle, extending into the aorta. Liver and spleen both enlarged; other viscera appeared normal.

CASE XIII. *Carbuncle; Pulmonary Thrombosis; Death.*—A native (male), aged 27, was admitted January 8th, 1872, with carbuncular swelling of the left cheek, the lining membrane of lip on that side being affected with a diphtheritic exudation. Commenced eight days previously with a small pimple at the entrance of the nostril. Health impaired by malarious enlargement of the spleen. Incisions made, but only thin sanious fluid evacuated. On January 9th there was slight fever. Next day he was worse, respiration being very rapid and hurried. Sank and died of apnœa.

Post-mortem Examination.—The muscular structure of the heart was pale and flabby. A large coagulum, partially decolorised, occupied the right auricle and ventricle, and extended into the pulmonary artery. Dark deposits, varying in size from a walnut to a pea, were found scattered through the substance of the lungs. Malarial enlargement of liver; spleen also somewhat enlarged.

CASE XIV. *Injury to the Head; Pulmonary Thrombosis; Death.*—An English boy, aged 4½, fell on July 15th and cut the back of his head slightly. It bled freely, and his mother applied a piece of sticking plaster. For a week after he was considered to be in his usual health and spirits. In the night, about a week afterwards, he was feverish, restless, and sick. In the morning still feverish and light headed, with a peculiar twitching of the muscles. When examined, the wound was found to be deep, the scalp round it was swollen, œdematous, boggy, but not red; there was no positive evidence of pus. He rapidly became worse; was violently convulsed; became silent; respiration became excessively hurried; was quite unconscious; pupils widely dilated; died at 4 P.M.

Post-mortem Examination.—The scalp was reflected. All round the wound it was infiltrated with a dark red serous, and probably partially purulent, fluid. This occupied an area of an inch in each direction; beyond this and down to the neck it was infiltrated with turbid serum. All this part of the scalp was œdematous. The wound itself was healthy, and reached nearly, not quite, to the pericranium, which was unwounded. The pericranium was detached from the bone for about a square inch, corresponding to the wound. The bone was bare but did not appear dead. The bones of the cranium were healthy; the section revealed no suppuration in the cancellated textures. The longitudinal and other sinuses were distended with blood, and contained coagula. The brain was much congested on the surface; the vessels between the convolutions were engorged; the surface of the base, especially over the wound, was slightly ecchymosed under the arachnoid. There was no meningitis, nothing suggestive of tuberculosis. The brain substance, the ventricles, and the membranes were healthy; lungs pallid, almost blanched; heart firmly

contracted; pericardium natural; right auricle and ventricle contained a peculiarly tough decolorised fibrinous clot, firmly wedged in the auriculo-ventricular opening; did not extend into pulmonary vessels; pleuræ were natural, viscera healthy.

CASE XV. *Splenic Cachexia; Pulmonary Thrombosis; Death.*—A young officer, about 23 or 24, returned from India after suffering severely from repeated attacks of malarial fever, complicated with excessive enlargement of the spleen, and a profound state of splenic cachexia. Under the influence of proper care and the use of quinine and sulphate of iron he was making slow, but apparently satisfactory, progress. His condition of debility had been complicated by occurrence of hurried respiration with a weak and irregular pulse. He had been enjoined to observe perfect rest and quiet, and to avoid all attempts at muscular exertion. One day, being attracted by a sudden noise in the street, he rose from his bed, hurried to the window, and made an effort either to close or open it. He was immediately attacked with hurried and gasping respiration, staggered back to his bed, on to which he fell prostate. The symptoms continued, and within a period of an hour or so he died. To a clot already existing a fresh accretion had taken place, which rapidly brought his life to a close.

CASE XVI. *Cholera; Pulmonary Thrombosis; Death.*—A civil officer of high rank, middle-aged, was attacked with cholera in Calcutta. He passed into a state of collapse, and his life was in great peril for some hours. By aid of treatment and careful nursing he was recovering. The vomiting and purging had entirely ceased; the urinary secretion, which had been entirely suspended, was restored. He was regarded as being in a favourable condition, with every prospect of recovery, when symptoms of pulmonary obstruction supervened. His respiration became gasping and hurried, and he died in a few hours. A clot had formed in his pulmonary artery, which was the cause of death. There can be little doubt that had this untoward condition not supervened, his recovery might have been complete.

The cases here recorded proved fatal, but death does not always result; many recover, some quickly, some after protracted suffering. But recently I have had the opportunity of observing in consultation with Surgeon-Lieutenant-Colonel Platt a case in which clotting had occurred in both the arterial and venous circulation. Both femoral arteries had been compromised, whilst life had been several times in extreme peril from symptoms of coagula in the right side of the heart. Recovery is now slowly, but apparently satisfactorily, progressing.

The cases noted sufficiently illustrate the dangerous and fatal effects of cardiac and pulmonary thrombosis. Others have occurred in my experience of which I have kept the notes, but it seems needless to multiply them. It is to be noted that however much or little these cases may be referable to malarial causes, septic conditions were then very rife in Indian hospitals.

OBSERVATION D'UN CAS

DE

CARCINOME ENCÉPHALOÏDE ULCÉRÉ

DU SEIN GAUCHE

opéré par la méthode du docteur JULES FÉLIX

MÉDECIN HONORAIRE DE LA MAISON DU ROI
CHIRURGIEN DE L'HOSPICE SAINTE-GERTRUDE, A BRUXELLES

Extrait du *Scalpel*, n° 38

BRUXELLES
IMPRIMERIE VEUVE MONNOM
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Mon honoré confrère, M. le docteur Clinquart, de Saint-Ghislain, près de Mons, m'adressa le 11 janvier 1888, une dame D..., âgée de 50 ans, fermière, d'un tempérament nerveux, et voici les renseignements qu'il me donna sur la malade :

M^me^ D... l'a consulté il y a environ deux mois, pour la première fois ; cette personne s'était bien aperçue que le sein gauche, depuis dix-huit mois au moins, acquérait un développement de plus en plus volumineux ; mais très occupée des travaux des champs, elle prenait pour des rhumatismes les douleurs qu'elle éprouvait, et se livrait malgré tout aux plus rudes labeurs.

Un jour, elle vit que la paroi antérieure du sein devenait bleuâtre, et qu'en appuyant le doigt, cette région semblait se ramollir (expression de la malade). En décembre 1887, M^me^ D... fut prise d'hémorrhagie, que ses *moyens thérapeutiques* ne purent arrêter ; c'est ce qui la détermina à recourir au docteur Clinquart, parce qu'elle croyait mourir, tant l'hémorrhagie était considérable et rebelle.

Le docteur Clinquart donna à la malade les soins les plus urgents, et lui fit comprendre, après avoir vaincu les accidents hémorrhagiques, toute la gravité de son mal. Comme il ne trouvait pas, dans ce cas, la possibilité d'enlever avec succès l'énorme tumeur par le bistouri, et que, du reste, il se trouvait fort découragé des récidives fréquentes, même dans les cas d'apparence favorable, il conseilla à M^{me} D... de venir me consulter.

Le 11 janvier 1888, je constatai :

Tumeur énorme du sein gauche, dure en certains endroits, molle et fluctuante dans d'autres, surtout à la partie antérieure et supérieure du sein; bosselures; la surface antérieure de la peau est cyanosée, bleuâtre et présente à la partie supérieure une ulcération d'où s'écoule de la sanie. La tumeur semble mobile. Je ne constate point de ganglions développés dans l'aisselle. Le teint de la malade est d'un jaune ictérique; elle a beaucoup maigri depuis quelque temps, et les fonctions digestives laissent à désirer.

Diagnostic : Tumeur carcinomateuse encéphaloïde du sein à la 3^{e} période, avec kystes fongueux et hématodes.

Le cas me paraissait fort peu encourageant pour une opération radicale, mais comme l'hypoazoturie n'était point constatée et que je ne voyais pas dans l'absence de ce symptôme les signes de la *cachexie*, et non pas de la *diathèse*, comme le prétend M. le docteur Rommelaere ; comme je me trouvais en présence d'accidents hémorrhagiques aussi menaçants que mortels, je me décidai à enlever par le caustique l'énorme tumeur, qui me paraissait, dans sa plus grande partie, un véritable fongus hématode (*noli me tangere*), dans le seul espoir de prolonger autant que possible, les jours précieux d'une épouse et d'une mère de famille.

M. le docteur Loin voulut bien me prêter son concours dans cette tâche difficile; et M. le docteur Dubois-Havenith suivit avec intérêt les diverses phases de l'opération.

Avant d'entrer dans les détails de l'observation, je crois utile de dire un mot de mon caustique et de ma méthode d'application. La pâte caustique dont je me sers, se compose

Farine de froment	112	grammes
Amidon	37	—
Sublimé corrosif.	[illegible]	—
Iodol pur	10	—
Croton chloral	10	—
Bromure de camphre	10	—
Acide phénique cristallisé	10	—
Chlorure de zinc *sec*	110	—

Mode de préparation. — Mêlez dans un mortier en verre ces substances, préalablement pulvérisées à part et ajoutez peu à peu la quantité d'eau distillée suffisante pour obtenir une pâte homogène de la consistance du mastic des vitriers; on rend cette pâte plus ductile en ajoutant une petite quantité de glycérine.

Cette pâte caustique est par sa composition, antiseptique; elle ne donne lieu ni à des douleurs intolérables, ni à des accidents septiques ou inflammatoires. Elle est, en outre, un excellent modificateur des ulcères atoniques, syphilitiques, tuberculeux, scrofuleux, etc., et elle a des propriétés hémostatiques remarquables.

Cette pâte n'attaque point les parties revêtues d'épiderme; le chirurgien peut donc la manier comme il veut dans la main, en ayant la précaution de se mouiller les doigts avec de l'eau, pour empêcher l'adhésion incommode.

Pour que ma pâte caustique puisse agir sur la peau, il faut avant tout provoquer la dénudation de l'épiderme. Le moyen le plus rapide et le plus simple est celui-ci :

Tremper un tampon d'ouate dans une solution sursaturée de potasse caustique et en frictionner les parties de la peau qu'on veut dénuder. Pour éviter la douleur, on peut faire préalablement sous la peau une ou plusieurs injections hypodermiques d'un gramme de cette solution calmante :

Pr. : Antipyrine	5	grammes
Chlorhydrate de cocaïne	15	centigr.
Aq. still lauro. cerosi.	15	grammes
M.		

Une simple pulvérisation d'éther sulfurique, chez les sujets nerveux et impressionnables, produit aussi le calme, et je pense que le stypage par la méthode du docteur Bailly, pourrait produire les meilleurs résultats : c'est une chose à essayer.

Après la friction à la potasse caustique pour dénuder l'épiderme, on applique immédiatement une couche de pâte caustique de l'épaisseur de 5 millimètres, sur toutes les parties qu'on veut attaquer.

On revêt le tout d'une couche d'ouate et l'on applique un bandage contentif.

Si l'on veut simplement cautériser un ulcère pour le modifier, un lupus, un nævus maternus, etc., il suffit d'une application du caustique pendant trois ou six heures. Mais si l'on a à enlever une tumeur volumineuse, il y a tout avantage à laisser le caustique pendant vingt-quatre heures; le médecin trouve alors à sa visite, une escarre épaisse, solide, qu'il enlève facilement au bistouri, par tranches assez épaisses, comme si l'on coupait dans une croûte de fromage. S'il arrive qu'en coupant l'escarre, des vaisseaux trop peu ou point cautérisés donnent, le moyen le plus facile d'arrêter l'hémorrhagie, c'est d'introduire la pointe d'un crayon de nitrate d'argent dans le foyer hémorrhagique, de l'y laisser quelques instants, puis de tamponner ce foyer par une boulette de charpie imbibée de perchlorure de fer liquide. Il se forme une réaction chimique, un chlorure d'argent, et l'hémostase est complète par ces réactions chimiques.

Lorsqu'on a atteint la limite de la tumeur, il suffit, pour favoriser la chute de l'escarre, de l'enduire tous les jours de glycérine phéniquée à deux pour cent. On peut y ajouter du chlorhydrate de cocaïne pour les sujets nerveux et impressionnables, et ordinairement du sixième au neuvième jour, l'escarre se détache et laisse une surface aussi bien disséquée que par le bistouri le plus habilement manié.

Il est à remarquer que la pâte caustique attaque différemment les parties malades et les parties saines; cette action chimique différente sur les tissus normaux et sur les tissus morbides a une grande importance, parce qu'elle permet de suivre et de poursuivre le néoplasme jusque dans ses derniers retranchements. C'est là, pour nous, la supériorité de notre procédé sur la méthode sanglante, car il nous est arrivé souvent, dans les nombreux cas de tumeurs que nous avons opérées, de croire qu'une tumeur était très bien circonscrite, parce qu'elle nous paraissait absolument mobile, et que le caustique nous démontrait que non seulement le sein était malade, mais que tout le muscle pectoral était atteint. Souvent la peau qui paraissait saine, sous l'action du caustique, nous montrait des travées de néoplasme existant où le chirurgien le plus expert n'aurait pu les supposer ni les découvrir.

Voilà pour nous une des raisons de la grande fréquence de la récidive des tumeurs malignes opérées par l'instrument tranchant. Nous ajouterons que lorsqu'on enlève par le bistouri les ganglions périphériques atteints, on n'enlève pas les vaisseaux sanguins et lymphatiques afférents et efférents, et que, par conséquent, on laisse non détruits et vivants les racines et les germes : microbes, cellules, noyaux, exsudats, etc., qui constituent les éléments des tissus embryonnaires, éphémères et caduques, et, par conséquent, morbides et néoplasiques. Les caustiques chimiques ont la propriété de détruire beaucoup mieux que le bistouri et le thermo-cautère, ces éléments morbigènes, et de fermer à l'auto-infection les vaisseaux lymphatiques et sanguins qu'ouvrent à large voie le raclage et le bistouri. Nous pourrions encore citer à l'avantage de la méthode opératoire par notre caustique :

1° Impossibilité d'hémorrhagie grave;

2° Point d'appareil chirurgical compliqué ou dispendieux;

3° Inutilité de la chloroformisation;

4° Point de fièvre ni d'accidents traumatiques : tétanos, érysipèle, pyoémie, choc, etc.;

5° Douleurs très supportables et n'altérant en rien la santé des malades.

A ce sujet, nous avons souvent vu que les malades craintifs et ennemis de la méthode sanglante, supportent très bien le caustique, et qu'assurés de l'innocuité absolue de ce procédé, ils se suggestionnent en quelque sorte que le caustique ne fait guère souffrir. Je me permettrai de citer à ce sujet une dame atteinte de cancer du sein récidivé, opéré d'abord par le bistouri et avec succès par un de nos plus habiles chirurgiens, qui, ne voulant plus se soumettre pour la récidive à une nouvelle opération sanglante, gardait le caustique toute la journée et s'en allait promener à pied ou en voiture, nous affirmant que le caustique ne la dérangeait nullement, lui faisait le plus grand bien et lui donnait du sommeil et de l'appétit. Cependant cette dame, qui avait plus de 50 ans, et qui portait une tumeur du sein énorme, subit l'application du caustique pendant trente-trois jours consécutifs, avec les apparences de la meilleure santé, et personne de ses amis et connaissances ne se doutait qu'elle subissait une grave opération.

Revenons maintenant à notre opérée :

Le 25 janvier 1888, nous procédons, M. le docteur Loin et moi, à l'opération. Après avoir enlevé l'épiderme de tout le sein, qui a atteint le volume de la tête d'un enfant, nous appliquons une couche de pâte caustique, revêtant une surface d'environ 20 centimètres de diamètre.

Le 26 janvier, à notre visite du matin, nous constatâmes que le caustique avait produit une escarre dure dans la moitié inférieure de la tumeur, mais que, dans le segment supérieur, elle n'avait point agi, à cause d'un suintement sanguinolent; la fibrine du sang s'étant coagulée à la surface, avait empêché l'action chimique du caustique, et dès que nous eûmes enlevé le caustique, une nouvelle hémorrhagie se produisit.

Nous constatons par le toucher, que la partie supérieure du sein n'est qu'un fongus hématode, que le doigt peut traverser aisément et qui n'offre qu'un amas de sanie et de détritus. Nous arrêtons l'hémorrhagie par le procédé que nous avons décrit plus haut, et nous réappliquons de la pâte caustique.

Mais en présence de ce cas désespéré et ne sachant trop comment obvier à ces hémorrhagies, qui devaient se reproduire sans cesse et empêcher l'action efficace du caustique, l'idée me vint de momifier la tumeur par des coagulants, et je songeai à l'emploi des injections ***capillaires*** d'eau de Pagliari, me réservant de les remplacer par des injections ***capillaires*** d'une solution de chlorure de zinc à 50 degrés, si l'eau de Pagliari ne me donnait point de résultat satisfaisant.

Je pratiquai donc, dans tous les points fluctuants ou ramollis de la tumeur, des injections d'eau de Pagliari avant de réappliquer la pâte caustique.

Le succès dépassa mon attente, car le lendemain, 27 janvier, le caustique avait très bien agi et nous pouvions déjà enlever une assez grande partie de l'escarre. Aucune réaction ne se produisit chez l'opérée; elle supporta très bien le caustique, son appétit et son sommeil étaient assez satisfaisants. La température ne dépassait pas 38 degrés centigrades.

Le 28 janvier, la tumeur est tout à fait momifiée et nous permet de l'attaquer carrément sans plus d'hémorrhagie.

A mesure que nous enlevions les escarres, nous pouvions nous assurer que la plus grande partie de la tumeur était réduite à un fongus hématode, une vraie bouillie sanguinolente, que le doigt pouvait traverser de part en part; que cette bouillie est enfermée dans des mailles de tissu fibreux, conjonctif hypertrophié, formant des kystes épars.

Le 29 janvier, dernières injections capillaires d'eau de Pagliari dans la tumeur et application du caustique. L'état de la malade s'améliore de jour en jour et quoiqu'elle soit d'un caractère singulier, craintif et désespéré, pour ne pas dire désespérant, elle dort bien six heures par nuit et mange de bon appétit à tous les repas. Aucun symptôme de fièvre.

Le 9 février, nous sommes arrivés au but; toute la tumeur est détruite, il ne reste qu'à laisser tomber l'escarre. Notre opérée a donc supporté, pendant quinze jours consécutifs, l'application du caustique, sans le moindre accident; se levant la plus grande partie de la journée; mangeant, digérant bien et dormant de six à huit heures chaque nuit. Le teint ictérique a disparu; ce teint particulier n'est pas le teint jaune paille qu'on observe dans la ***cachexie***, mais le teint dû, pour nous, à la résorption des éléments morbides de la tumeur, à l'empoisonnement par les ptomaïnes, comme l'ont si bien décrit l'éminent professeur de Strasbourg, M. le docteur E. Strohl, dans son remarquable mémoire ***sur les microbes en pathologie***, mémoire lu en séance publique de la Société de médecine de Strasbourg, en 1881, et le docteur Bougard dans son ouvrage : *Etude sur le cancer*, p. 185 et suivantes.

Le 15 février, l'escarre est tombée; elle laisse une magnifique plaie d'un rouge vif et sain, d'une étendue de 18 centimètres de diamètre, présentant le muscle pectoral à nu et parfaitement disséqué. Nous avons été obligé de détruire toute la peau qui recouvre la mamelle, et qui, nous paraissant saine dans le tiers inférieur, aurait pu nous donner un magnifique lambeau; mais nous avons été obligé de la sacrifier totalement, parce que le caustique nous a montré que la peau était déjà altérée et cancéreuse, ce qui nous eût préparé une récidive certaine. D'ailleurs, les plaies par le caustique, de quelque étendue qu'elles soient, ne nous inquiètent aucunement; leur cicatrisation se fait très rapidement, sans aucun soin spécial : un pansement simple, et la répression des bourgeons charnus exubérants, par le crayon au nitrate d'argent.

La cicatrisation ne se fait pas seulement aisément, mais les cicatrices sont magnifiques et souvent linéaires, aussi belles que celles produites par les procédés de réunion les plus efficaces. Il va sans dire que dans les cas où il nous est permis de conserver des lambeaux, nous les rapprochons au moyen de bandelettes au collodion, que nous resserrons chaque jour progressivement.

M^me D..., notre opérée, retourne chez elle le 3 mars dans les meilleures conditions : santé excellente, cicatrisation presque complète, et pas le moindre signe de récidive, ce que nous n'aurions pas osé espérer.

D^r JULES FÉLIX.

Bruxelles, ce 3 mars 1888.

Surgeon General Webb M.D.
Bombay Presidency

ENTERIC FEVER IN INDIA

AND THE

TRENCH SYSTEM OF CONSERVANCY.

Being a series of letters which appeared in the "PIONEER" during February and March, 1889, with an Introductory Note.

WILLIAM HILL CLIMO, *M. D.*

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ENTERIC FEVER IN INDIA

AND

THE TRENCH SYSTEM OF CONSERVANCY.

INTRODUCTORY NOTE.

THE following letters appeared in the *Pioneer* during February and March of this year. They were written with the hope that the attention of the public and of the responsible authorities would be directed to cantonment conservancy, and to the pernicious influence on the general health of the present system for the disposal of the excreta of populous districts. The prevalence of enteric fever all over India afforded the occasion to do so with advantage, as the public interest was in consequence so deeply involved. Moreover, it is an axiom of sanitary science that the best index of good or bad sanitation is given by the presence or absence of enteric fever. It is with the view of still further drawing attention to the subject that I have resolved to republish these letters in a pamphlet form with some additional remarks. I am the more desirous to do so as there are some points which can be more effectively dealt with in this fashion.

I beg first to express my obligations to the Editor of the *Pioneer* for so kindly affording me the opportunity of making public my views on the subject, and giving them that publicity which a daily paper with so large a circulation can alone confer. I take this occasion also of thanking my professional brethren and other correspondents for the kind and impartial criticisms which from time to time these letters met with.

The "trench system" has been in existence over twenty years. Let it be carefully noted what this means for a cantonment with a population, say, of 20,000 inhabitants (Civil and Military combined). The amount of excreta, solid and fluid, annually to be disposed of, is 10,000 tons, or half a ton per head, and of this over 1,600 tons is solid excreta. That is to say, during the past twenty years, within a limited area of that cantonment, there has been deposited 2,00,000 tons of excreta, of which more than 32,000 tons is solid. Is it any wonder that many stations are becoming unhealthy, which, on their first occupation, were healthy? and is not this unhealthiness due to the products of human decay being retained in our midst? Our present system of sanitation produces the very conditions of sub-soil which, in the case of European cities, have been found the most frequent cause of enteric fever, and to remedy which the best efforts of sanitary engineering have been directed.

Sanitation in India is attended with great difficulties. These difficulties are general, that is to say, common to most stations, or they are special, depending upon local circumstances. In the former are included the geological, physical, and climatic conditions of the country. In the latter are embraced the nature of the soil and drainage, the density of the population, and their economic conditions. It is necessary to discuss these points more in detail, but as briefly as possible. If we take our stand on the slopes of the Himalayas, somewhere on the line of watershed between the rivers Sutlej and Jumna, and face southwards, we find a vast alluvial plain standing in a south-easterly direction

to the Bay of Bengal and in a south-westerly to the Persian Gulf. This plain, the home of zymotic diseases in India, declines in both directions towards the sea. That to the south-west is sparsely inhabited and loses itself in the Indian desert, consequently it has but a secondary importance so far as the public health is concerned. If we look to the south-east until we reach the Bay of Bengal, we find this plain increasing in density of population as we travel southwards. In this direction, too, it is traversed by three great rivers, the *Jumna*, the Ganges, and the Brahmapootra, with their tributaries bearing their alluvial deposits to the more densely populated districts. Here, too, the water approaches the surface until, in Lower Bengal, we come to that area where cholera is endemic. It is curious to observe that when cholera becomes epidemic in India it travels in a north-westerly direction, and that when it has appeared, say at Lahore or Mian Mir, a rapid movement of the affected troops in a south-westerly direction has been attended with the best results.

The special or local difficulties of sanitation in India will of course vary with the nature of the soil and drainage of the locality, also its contiguity to lakes and rivers. As a general rule, the population is so scattered that it precludes the adoption of a sewage system on the lines adopted for that of a European city, where the proximity of the buildings and the regularity of their arrangement are so favourable. Associated with this is the general poverty of Indian communities, which is an economic factor that cannot be lost sight of. The two great systems for the disposal of sewage are the water and dry-earth. In India water is the life of the country, and it cannot be used for this purpose. My contention in the following letters is, that the modified dry-earth system at present existing in

India and technically called the "trench system" is the chief cause of that unhealthiness of Indian cantonments which finds its expression in the recent prevalence of enteric fever, by producing the very evil it was intended to guard against, namely, contamination of the water-supply with sub-soil sewage. It must be recollected that this water-supply is obtained from wells which are fed from the monsoon rainfall filtering through an alluvial soil laden with organic matter—the deposit of ages. If, then, to this soil fresh or raw sewage is added, and if sub-soil drainage is prevented by the nature of the clay or *kunkur* underneath, there is no other outlet for this sewage but to poison the springs from which these wells are supplied. My argument is that the soldier is not protected from zymotic disease, no matter how perfect are his sanitary surroundings in barracks, and even if the water-supply be absolutely pure, if at the same time other portions of the cantonment are being fouled and rendered impure, and if a casual visit to his regimental bazar exposes him to all the risks of water contamination, which, under present circumstances, it most assuredly does. I desire to give as an example of how a disease, which prevailed almost as a scourge, has now nearly disappeared with a purer water-supply. Take the "Delhi sore" as an instance. The City of Delhi has been built and destroyed several times, the whole district is a graveyard, and the soil is laden with salts and organic impurities. Through this soil the rainfall percolates to the wells. The water, as it filters through, takes up these salts and organic matter. It occurred to a civil officer that to introduce into these wells a column of comparatively pure water from the Jumna, and to drive back into the water-bearing strata the heavier and impure water a pure supply might be obtained. Such has been the result,

and as a consequence the "Delhi sore" is fast disappearing.

It is with these views, therefore, that I have recommended the abolition of the "trench system," the removal of excreta outside cantonment limits, and the establishment of sewage farms with areas proportional to the population. Bearing in mind, however, the general climatic conditions of India, and the relations that exist between men and animals as regards disease, I am of opinion to use raw sewage either on grass or other farms would be most dangerous to the public health, and therefore, I suggest, whatever plan be adopted for the removal of sewage from cantonments before being used as manure, it should be first rendered innocuous by chemical process. This is considered an absolute necessity in temperate climates, and it is infinitely more so in India.

There are two methods available for the removal of sewage in this country, and only two : one is the separation of the solid from the fluid and the collection of the former in depôts and subsequent removal by animal carriage. The other is—and this can only be done in stations with an artificial water-supply—by dilution of the excreta, both solid and fluid, with house drainage and removal in surface drains or pipes to subsiding and precipitating tanks. It must be recollected that for nine months of the year the absence of rain precludes the use of surface drainage as a cleansing and flushing agent. It is essential, whatever system be adopted, that the drains or pipes should be superficial and not underground. The conditions of heat and moisture, if a flaw took place in an underground sewer, would have a rapidly injurious influence on the general health. The decomposition of organic products in India is so rapid that no parallel can be drawn from the use of underground drains and sewers in temperate climates, where, in consequence of the more equable climatic conditions, putrefactive change is less rapid. The great scavenger of India is the sun, and consequently every effort should be made to assist, and not to baffle, this agency. Whichever of these systems be adopted the use of lime as a chemical agent to render sewage innocuous is an absolute necessity. Floating sewage is that which is the most dangerous, for in it already have begun those putrefactive changes which cause disease. I need not dwell upon the consequent risks under present conditions—they are so obvious: nor need I discuss further details how these systems should be worked. My object has been to give a general idea of the subject and to awaken public interest, hence I gradually have worked up to the conclusions that I have drawn in this note, and if I have in any way advanced the subject towards an ultimate decision, I shall have fulfilled my task. In any case my views are the outcome of my experience, and of almost a daily investigation of the question during a lengthened period of service in India.

ALLAHABAD;
March, 1889.

WILLIAM HILL CLIMO, *M.D.*

LETTER No. 1.

TO THE EDITOR.

SIR,—In your issue of the 24th ultimo you allude to the prevalence of enteric fever among the soldiery as compared with the civil population. This has been noticed by many observers, but it is also a fact that the disease in recent years has become more prevalent in cantonments and the type severer. In Europe the disease is always considered to have a specific origin. In India this opinion is largely entertained. But it is also thought that young Europeans, in whom the digestive functions are very active, may through climatic causes, such as malaria and exposure to heat, have developed in them a disease identical with enteric fever. Nebulous theories of this kind have done much damage, and until enteric fever in India is recognised to be a specific disease arising solely from bad sanitary surroundings, its ravages will remain unchecked.

There is no country in the world where sewage products have a greater chance of ingress into the economy than in India. I am free to admit the young soldier is exposed to conditions of life which render him very susceptible to the disease before joining his regiment; there is his life on boardship and his journey by daily stages from Bombay to his Indian station. But what I wish to point out is, that the present prevalence of enteric fever in military cantonments is a question of conservancy, and arises entirely from the present dry-earth system for the disposal of sewage. This system (Mosaic in origin), in a country without a continuous and copious water-supply, is doubtless the best if carried out according to its original inception; that is to say, three inches of sewage covered by nine inches of dry-earth with cultivation every six months. But what is the custom? The trenches are dug often two or three feet deep, and are more than half filled with sewage, then covered over with refuse. In the dry weather these trenches rise into mounds, and in the rains sink into quagmires of decomposing filth, becoming the very breeding grounds of enteric fever. I wager that taking any three large cantonments in Bengal just at random on inspection the above description will be found not to be overdrawn in at least two of them.

A very curious circumstance, which bears on this subject, was recently brought to light in Germany. A certain professor with his class of students was examining various soils, and on one occasion they visited a piece of open ground which consisted of made, not virgin, soil. Under the microscope in this soil were discovered the spores of glanders. A careful examination was made into the history of this ground, and it was found out that some twenty years before it had been used for the cremation of horses that had died of glanders. How necessary therefore is it that all organic *débris* should be entirely destroyed and not hidden. The laws of health cannot be tampered with, and we are now reaping what a former decade has sown.

MEDICUS.

LETTER No. 2.

TO THE EDITOR.

SIR,—In continuation of my letter on the above subject, published in your issue of the 7th instant, I am desirous of making some further observations. I assert *in limine* that enteric fever in India is an unnecessary disease arising from causes mainly preventible, and always having a specific origin, which obtains its development in fœcal matter. The bacillus of enteric fever can now be isolated and differentiated from those of other diseases of a zymotic origin, such, for instance, as glanders and contagious pneumonia. Primitive habits in which there is a complete want of sanitation beget cholera. Civilized life in which sanitation is imperfect affords enteric fever those conditions most favourable for its development. Therefore we must look to the immediate sanitary surroundings of the soldier in India for the sources of his liability to the disease. In Europe when any local outbreak of enteric fever occurs, an inquiry is made as to its origin. Such inquiry always embraces the water-supply, the food and the conditions as regards exposure to sewage of the sufferers. Let this question, as it affects the soldier in India, be dealt with on similar lines.

Reversing the order named I will take the last first. As the dry-earth system of sewage exists everywhere, there is not at first sight much danger of sewage gas, but still it is a factor; the latrines are brick-built with tiled or wooden roofs. Permanency of site for a latrine, where monsoon influence prevails, cannot be considered altogether without risk. The food of the soldier consists of his ordinary rations furnished by Government, supplemented by bazaar purchases, and in both there is always danger of the spores or microbes of enteric fever obtaining ingress to the system. As long as cattle are allowed to graze within cantonments or in the immediate vicinity of villages this danger is a reality, and it must be recollected the soldier's meat ration is grass-fed. Quite recently it has been discovered that cattle drinking water impregnated with sewage gives rise to enteric fever in the human subject, and sheep suffer from a fatal form of disease almost identical as regards pathological results. That this is not an academic but a question of practical sanitation, let me quote Mr. Fleming's "Manual of Veterinary Sanitary Science." In volume 1, page 143, he writes as follows :— "The living or germinal matter of some contagious diseases originating in the bodies of animals may grow and multiply in man, and *vice versa.*" Moreover, it is well known that cows and poultry fed on the products of human decay will respectively have their milk and eggs similarly tainted. Every practical gardener is acquainted with the fact that the stems of growing plants absorb colouring and extractive matter from the soil without chemical change. And from the existing conditions of the trench system in cantonments, as described in my former letter, how great this danger is needs no description.

The third and most important question is that of the water-supply, for it has a direct influence upon both men and animals. And how intimate is the connection between the diseases of both! I cannot better indicate the dangers arising from this source than by giving examples which have come under my personal observation. I select

two large cantonments where the Government has gone to great expense to supply the troops with pure water, but have stopped short of supplying the bazaars and native establishments. I do so because if such occurrences could take place in stations so supplied, what must be expected in cantonments, where the water-supply is solely obtained from wells exposed to surface drainage and defiled by native custom? The examples I give are three, and the first two were common to both stations. I had occasion to have the aërated waters, which were manufactured in the bazaars, analysed, and they were found to contain large quantities of chlorides and nitrates. These cheap beverages were daily consumed by the troops. At both stations the soldier's clothing was often, when freshly washed, offensive, and smelt of excreta, and it was found that pools fed by surface drainage were used by the regimental dhobies. Indeed, in one instance all the men's washing was done in a pool formed by the drainage from a burial-ground in which the native victims of an epidemic of cholera some years previous had been buried. The third instance is almost unique; it was a matter of frequent complaint that the bread was sour, mawkish, and dark coloured, and that colic and dyspepsia were frequent ailments. For years this bread difficulty had cropped up and the cause remained undetected. At last, and after careful investigation on the principle of exclusion, there remained but the water to examine. As the cantonment was supplied with pure water carefully filtered it was previously left out of consideration. It was elicited that the bakers for convenience had always used well water which, when analysed, was found to be most impure, so much so that after keeping a few hours it became decomposed, and emitted the fumes of sulphuretted hydrogen.

The above narrative of facts is sufficient to prove my contention, that it is in the sanitary surroundings of the soldier there is to be found the explanation of this increased prevalence of enteric fever. The great importance of the question must be my apology for trespassing so largely upon your valuable space and upon the indulgence of your readers. In conclusion, I beg to say that with your kind permission I will, in a third and final letter, point out how cantonment sanitatiou can be made really effective.

MEDICUS.

LETTER No. 3.

TO THE EDITOR.

SIR,—In the two previous letters that I have written on the above subject, I have described some of the evils of the sanitation of Indian cantonments which disastrously affect the public health. In my present letter I propose to suggest the means of rendering such a condition of things an impossibility in the future; but to clear the ground for the proposals I am about to make, it will be necessary briefly to consider the relationship of the State to the medical profession in this country, at the same time comparing it with that which exists in England, and to describe the chain of responsibility at present existing for cantonment sanitation. In India all medical work (with so few exceptions as not to require mentioning) is of necessity done by paid Government servants, whereas in England, excluding parochial appointments by which the poor are provided with gratuitous medical attendance, the country is put to no expense, and even the cost of this is defrayed by local rates. The medical treatment of lunatics and criminals need not be considered, because in every country the charge must fall upon the State. The consequence of this has been that questions affecting the public health have been treated at home with a free and independent hand, and the general public has been made acquainted with the necessity of conserving the public health, the result being that in England sanitation is a reality, while in India it is but a shadow.

In England the chief duty of the medical profession to the State is the prevention of disease and the preservation of the public health, while in India it is to provide actual medical attendance for the sick. This is a burden that should not be borne by the State, whether Imperial or Provincial: it is the prime duty of each community to provide medical aid for its poorer members. It will be asked how this question affects military cantonments? It does in two ways: first, so large an expenditure on medical establishments, &c., hampers the Government in dealing with the more important question of sanitation affecting the country at large; and second, as a direct consequence of the above, to protect the troops from epidemic diseases, the responsibility for the general health and the sanitary condition of the resident native population is thrown upon cantonment authorities. In discussing this question my sympathy is entirely with the Government as regards the expense, but the thought occurs how much wiser, nay, how much fairer, it would be to spend money on improving the health of the community at large, and thereby increasing its material prosperity, than lavishing it on the higher education of a few—an exotic growth of but questionable utility.

The chain of responsibility for cantonment sanitation is as follows, and for illustration I will take the head-quarters station of a district:—The General Officer has his sanitary adviser in the Deputy Surgeon-General, and to carry out the executive duties there is the Cantonment Magistrate: here is divided responsibility and multiplicity of council. Now I ask, what special knowledge, what training has a Cantonment Magistrate for this duty? To most men the task would be an irksome one: how much more so to a man unacquainted with sanitary science? Then, too, the Deputy Surgeon-General has the medical superintendence of his district to attend to: he is responsible for all its medical work, which includes inspections of hospitals,

distribution of establishments, the passing of indents for medical stores and commissariat supplies, invaliding, the submission of statistical returns, the command of the army hospital native corps, &c., &c. How can this officer add to his responsibilities that of the sanitary supervision of the head-quarters station? Why, this very duty is sufficient for another officer, and he too of special knowledge and training. The proposals therefore I have to make are that the Cantonment Magistrate ceases to have executive authority in cantonment sanitation, and that the Deputy Surgeon-General be relieved from his immediate responsibility in this duty also. Taking as an example the appointment of Health Officers under the orders of the Local Government Board in England, I recommed that the Quartermaster-General's Department, or, should it be abolished, the General Staff of the Army, be made responsible for the sanitary state of military stations, and that to each district a Health Officer, specially selected from the Medical Department, be attached. He should be an officer of proved sanitary experience, and with this view medical officers should be encouraged to add to their qualifications that of a diploma in State medicine. During war time there are special sanitary officers attached to the General Staff of the Army: how necessary, therefore, is it to render medical officers familiar in peace with what is a necessity during a campaign.

Believing as I do that enteric fever is a sewage disease, and that under no circumstances can there be enteric fever without sewage contamination (it is unnecessary to discuss the opinion whether ordinary excreta can develop under certain septic conditions the germs of typhoid or no, though much might be advanced in support of this view), I must revert to the trench system as it is employed for the disposal of sewage from barracks and bazaars. The very use of the word "trenches" shows that the dry-earth system of conservancy is misunderstood. Take the largest cantonment in India, and what are the areas devoted to this purpose? I very much question if any one of them will be found 50 acres in extent. I have inspected many, and I have never seen one of 30 acres. Consequently the whole area becomes charged with sewage, and all the insanitary conditions I have previously mentioned are produced. Let me describe a real sewage farm and compare it with our Indian type. I have selected that which utilises the sewage of the city of Birmingham, and I am indebted to a report of Mr. Charles Hancock for the following information :—

The sewage farm at Saltley is 1,227 acres in extent. The sewage is collected in three large tanks and treated with lime ; this is done in consequence of the presence of iron and other metals in the sewage ; the lime with the excreta forms a precipitate, the more fluid constituents or sludge being allowed to drain off to a portion of the farm. After fourteen days this ground is dug up and afterwards cultivated. No subsequent dressing is applied for a period of five years to the same ground. The precipitate is carried on to other parts of the farm by means of large sewers, and the ground so treated is similarly dealt with. There are 200 men employed on this farm, and the actual proceeds last year where £20,346.

Compare this to what exists in our Indian military stations. A field of a few acres is taken some distance from the barracks. A track, not a regular road, leads to it: by this the sewage, solid and fluid, is carted. Some half-a-dozen sweepers at most dig trenches about ten feet long by one foot wide and two or more in depth : into each trench one cart-load or more of filth is placed, which is then

closed with loose earth. The site is subsequently cultivated or not : in many cases it is not ; but in either case the amount of filth is so great and at such a depth that no cultivation can purify it : in fact, it is hidden and not purified. If the spores of glanders after the cremation of animals dying from that disease exist in the soil where this *débris* has been buried after a lapse of twenty years, what, under the above conditions, can we expect of those of enteric fever? They require heat and moisture for their development, and under this system of sanitation they are given the very conditions necessary to their production. In every large cantonment at least 500 acres should be devoted to a sewage farm : it should be carefully fenced in. The excreta should be treated with dry-earth, to which a small quantity of lime might be added when placed in the receptacles before being carted off. The resulting compound should be placed on the surface of the ground and dug into the soil, trenches never being used. This ground ought not to have a fresh application for five years.

I have gone into these details to show how widely different is sanitation in England and in this country. Note the scientific exactitude in the one case and I might say the reckless *ignorance* in the other. Surely here in India we ought to be doubly carefully, where climatic influences are so eminently favourable to the spread of zymotic diseases. The grave importance of the subject to the Army and to the public at large must be my excuse for trespassing so largely on your space.

MEDICUS.

P.S.—In my second letter I stated that the bacillus of enteric fever has been isolated. As its existence is still a matter of scientific controversy, I add this postscript ; but whether it exists or not in no wise interferes with the main question—the origin of enteric fever from sewage.

LETTER No. 4.

TO THE EDITOR.

SIR,—In an editoria lnote in your issue of the 25th ultimo you quote from a correspondent as follows:—"Is it not in any case an admitted fact that men are very much more liable to the disease than women, and if so, what becomes of the water and milk contamination theories?" Your correspondent has drawn a bow at a venture, and made an apparent hit, but one unfortunately that will not help much to solve this question. His whole argument raises up that bigger subject—the value of vital statistics in India. For certain big facts they are useful, but with the single exception of those for British troops they are of no scientific value. The reason is simple. The diagnosis during life is rarely, if ever, verified after death. In the instances of natives when the case is of a judicial character only is a *post mortem* made, and in that of European women and children I may say never. It is only the British soldier, whose medical history is recorded from the day he joins till he leaves the Service or dies, who affords true *data* for the pathological study of disease.

The tendency in all acute diseases is towards recovery. The habits and functions (with a single exception) of women are eminently favourable to this recuperative power, while those of the young soldier are absolutely antagonistic. Your correspondent proceeds to say that "children have comparative immunity, and cases after 35 are rare." Typhoid fever in Europe and in India is admittedly a disease of adolescence, but adolescence is not the cause of the disease. The diagnosis of enteric fever has been always attended with great difficulty in the case of young

children, so much so that at one time it was given a specific name—"infantile remittent fever." This difficulty was increased by a comparison of the pathology of the disease with that in the adult. The specific ulceration is almost always wanting, and in its place there are congestion and tumefaction of the bowel only. The consequence has been that, though enteric fever is a common disease in children, the mortality caused by it is recorded under the head of either diarrhœa, convulsions, or remittent and simple continued fevers. There is nothing very odd in this. A child suffering from enteric fever, exposed to an Indian climate, dies so rapidly that sufficient time is not given to differentiate the disease, and therefore the cause of death is ascribed to the most prominent symptom—diarrhœa, fever, or an intercurrent complication, such as convulsions. What I wish to impress upon the public is to attach no value to any deduction from the alleged comparative immunity of women and children from enteric fever. It is not so long since this disease was unknown in India, but careful clinical inquiry, aided by the registration of morning and evening temperatures, and verified in fatal cases by the pathological results, forced home this truth on a sceptical profession. When the diseases of women and children are exposed to the same crucial tests their claim to a scientific value will not be disputed. Brigade-Surgeon Hamilton has truly observed in his monograph on this disease that the lesions found in enteric fever in Europe and in India are identical. Why then not come to the logical conclusion as regards identity of origin—like causes producing like results?

In the report of the Sanitary Commissioner with the Government of India for 1886 the mortality in India of

British troops from enteric fever is given as 5·08 per 1,000 and for women 2·36, and this statement is followed by this remark:—"But it is curious to observe, in comparing 1886 with the period of 1870-79, that the ratio of deaths from remittent and continued fever sunk in the same proportion as the ratio of deaths from enteric fever has risen." Your correspondent advises a method of scientific investigation which certain French doctors adopted as regards cholera. It is a curious fact that the comparative immunity from cholera of women and children living in barracks compared with adult males would have served his purpose much better. This fact is disclosed in the official report just quoted. What is the inference? Married families live in their homes and do not constantly visit bazaars. There is also domestic prudence in the purchase of their food-supplies, for now cows and goats are milked hard by the married quarters. The young soldier's love of adventure leads him to cantonment bazaars, and there is no doubt that here the sanitary surroundings are bad. The drinking water supplied in barracks may be pure and wholesome, whereas the cheap aërated drinks sold by small native vendors are made from water from any source. And close by this bazaar may be ground occupied for years on the trench system—an ever-present source of impurity.

The object of my letters has been to prove that there is in our midst an ever-present cause of a disease which is supposed to originate in sewage, and that this cause has its origin in our present system of cantonment sanitation. By all means investigate the question: the more thorough this investigation the more clearly will it be proved that "dirt breeds disease."

MEDICUS.

LETTER No. 5.

TO THE EDITOR.

SIR,—Will you kindly permit me to reply to the letter of "CANTONMENT MAGISTRATE," published in your issue of the 28th of February. I am the more desirous to do so as his criticism of my previous letters is so eminently fair and practical, and because I believe the prevalence—the increasing prevalence—of enteric fever in Indian cantonments is chiefly caused by the present "trench system" of conservancy. This letter will be therefore entirely devoted to prove this assertion, and it is made with a full consideration of its gravity and importance. In my fourth letter I have dealt with certain medical facts which were supposed to affect the question. And it has been shown that the comparison of the ratio of sickness and mortality from enteric fever between other classes of the population and British troops affords no satisfactory *data*, nor can they until the conditions of those classes as regards clinical and pathological observations are identical with those of the British soldier. For the same reasons municipal sanitation with its relation to zymotic diseases need not be discussed. Moreover, the subject is so vast, and involves so many large interests, that I feel it would be of no public advantage to mix it up with the more limited task I have set before me. Admitting, for the purposes of argument, that "CANTONMENT MAGISTRATE" is correct, and that the "trench system" is carried out strictly according to regulation, yet my contention is that this system is a cause of sewage contamination in cantonments, and one which necessarily must increase year by year. The regulations are that each trench must be one foot deep with three inches of excreta covered in with nine inches of earth, and that after six months the ground is ploughed up and cultivated. These rules have been quoted before, but it is necessary here to re-state them. I ask anyone who has any experience of Indian farming—Will an ordinary native plough turn up more than six to eight inches of earth? If not, then the excreta remains in the soil a source of future defilement and disease. This naturally leads up to the discussion of the effect of dry-earth upon excreta as a disinfectant and purifier. Its action does not appear to be of a chemical nature, but merely absorbent and mechanical, that is to say, it absorbs the gases generated from excreta during the process of oxidation, and it mechanically divides and separates the particles of sewage by admixture. The value of dry-earth as a purifier therefore depends upon three things—dryness, fineness of division, and previous freedom from organic matter. Nearness to the surface will assist the process of oxidation. It should be recollected that some earths, such as certain tenacious clays, have but slight disinfecting qualities, and are rather preservative from rapidity of change, and thus in this way the deleterious products of sewage may be locked up for years, and (if I may coin the word) the ground may become the "zymograph" of future epidemic disease. The surface soil of most Indian stations is loaded with organic matter, below is often a tenacious yellow clay, and this is supported on a bed of kunkur which prevents all drainage. Into this soil add fresh excreta at the depth of a foot, which cannot be turned over by a native plough, and you artificially produce the very conditions of sub-soil essential to the genesis of the typhoid virus. On this point there is no better example than that of the city of Munich to which Von Pettenköfer has

recently drawn attention, contrasting as he does the fever mortality which occurred there before and after the establishment of sewage works and the thorough drainage of the sub-soil. Professor Von Ziemssen has supplemented Von Pettenköfer's statistics by comparing the admissions for typhoid fever into the Munich hospitals for the periods from 1866 to 1880 and from 1881 to 1888. The former is before, and the latter after, this system for draining the sub-soil of the city was established. The average annual admissions for enteric fever during the first period was 594, and for the second only 104. Then again during the first period the average mortality of the whole city from this disease was 208, while for the second period it was only 40.

There are many grave objections to the way the "trench system" is worked in any large cantonment. Where all arms of the Service are quartered, each corps has its own regimental bazaar, and there is probably a large sudder bazaar also. Each native regiment and each bazaar have separate pieces of ground for their trenches, and in the case of British troops, for the convenience of carriage, each corps may have a separate site also to which all refuse from their barracks are removed. Thus dotted all over the cantonment are numerous sites, a sanitary failure in any one of which may have disastrous consequences on the public health. The multiplicity of these sites enormously increases the danger of sewage contamination. This danger is intensified by their unfenced condition, and in case of native troops and bazaars by their proximity to inhabited localities. During the past twenty years I have served in many cantonments, and I have carefully watched the working of the "trench system."

In every instance there have been sanitary faults—the necessary outcome of this system—leading to the contamination of the sub-soil with sewage. It will be apparent that with responsibility so divided between the Cantonment Magistrate, the Officers commanding corps, and the local senior medical officer, how likely this is to occur. It is needless to go on with this subject. If any disease has a specific origin, it is enteric fever. It is essentially a filth disease and of fœcal origin, the germ or virus entering the system through the alimentary canal. This is the accepted view in Europe. It may be an unpleasant, but it is no less a true, one in India. I have already shown how the sanitary surroundings of the British soldier in his daily life afford the opportunity for this poison to obtain ingress to his system. It only remains for me to make a few observations on how the above conditions are to be remedied. With this view I propose to discuss a little more in detail the proposals made in my third letter. My suggestions are then to entirely abolish the "trench system" within cantonment limits, on no account to allow excreta to be deposited within this area, and to establish a sewage farm in the vicinity of each cantonment. The sewage must be deposited on the surface and dug into the ground; the ground so treated should not be used again for this purpose for a period of five years, hence the area of each farm must reach to several hundred acres. I have already alluded to the danger of permanency of site of latrines as a source of sub-soil contamination, and therefore in the case of native corps, establishments and bazaars, portable galvanized iron latrines should be used. Major Young, of the 24th P. N. I. and late of the Quartermaster-General's Department, invented a very good and cheap form of portable latrine. I cannot too strongly urge the alteration I have recommended as

regards cantonment sanitary authority. I can only re-assert that the sanitation of a cantonment should be entirely in the hands of the general staff of the Army; and as previously suggested, that a specially trained medical officer should be attached to the district staff as Health Officer. "CANTONMENT MAGISTRATE" thinks sewage farms would be expensive. This ought not to be so. Land and labour are cheap in India, and a sewage farm conducted with skill and knowledge ought to be a source of income instead of expenditure. At present cantonment conservancy is expensive because the establishment is frittered away in working at so many different places. If the labour was concentrated much more work could be done, and there would be a more sustained supervision. There are many details connected with the question of economic and sanitary interest which I should like to discuss, but this is not the proper place to do so. I will have sufficiently obtained my object if I have awakened a public interest in cantonment sanitation, and made it clear that enteric fever is a preventible disease, bred in our midst, and capable of being stamped out. What has hitherto crippled the action of the authorities and made the public apathetic has been the belief that in India some obscure climatic conditions existed developing enteric fever in young people irrespective of specific causes. It is the duty of the medical profession to brush away these figments. It is with this view that I have trespassed so much upon your kindness.

MEDICUS.

P. S.—Enteric fever has been very prevalent in many large cantonments this cold weather. I would suggest therefore as a practical test that one of them be selected, and a sewage farm established with removal of the excreta on the "Shone system."

ON THE USE

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IN THE

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AND ALL INFECTIOUS DISEASES.

BY

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Read at a Meeting of the Epidemiological Society, on March 12th, 1890, and published in the Transactions of the Society.

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By J. B. CURGENVEN, M.R.C.S.

I must apologise to the members for reading to them a disjointed paper, as it has been written at odd moments as time could be snatched from the absorbing occupation of attendance on patients suffering from the late epidemic of influenza.

Everyone must acknowledge the importance of the subject of disinfection in cases of scarlet fever and other infectious diseases, especially so, as, within the last few years, considerable sums of public money have been, and are being now, spent in erecting large fever hospitals for these cases. I hope to show that, by a method of disinfection which I have practised for nearly twelve months, this heavy burden on the ratepayers may be saved, and the cases treated in their own homes without risk to those around them.

The disinfectant that I have used is eucalyptus oil with thymol and other camphors and aromatic antiseptics in solution in definite proportions, much stronger than has been found by experiment to be sufficient, singly, to destroy anthrax spores, bacilli, and bacteriæ; and I consider that for all infectious diseases no stronger or safer disinfectant could be used. These aromatic and camphoraceous disinfectants, mixed with olive oil, fats, vaseline, or alcohol to the extent of five per cent., have no influence on bacilli or bacteriæ.

MM. Widal and Chantemesse, in a series of careful researches on the bacillus of diphtheria, have observed that the solution of Dr. Soulez, which consists of 5 grammes of carbolic acid, 20 grammes of camphor, and 30 grammes of olive oil, does not arrest the cultivation of the bacillus, but renders it slower. These investigators think that this negative result is owing to the presence of the olive oil.

Dr. Davis, in the *Medical Annual*, 1890, says: "The inertness of carbolic and thymol oils is remarkable, but does not contraindicate their use as a local application in the desquamative stages of eruptive fevers to prevent contamination of the air by infectious particles. As the action is probably mechanical, inunction with vaseline would perhaps suffice; but the addition of thymol or carbolic or camphor may possibly be more grateful to the patient." His idea in the use of these disinfectants was that they simply rendered the oil or vaseline "more grateful to the patient" in carrying out the method of inunction as proposed by the late Dr. Budd of Bristol. That method I have tried, but the oil soon became rancid from the heat of the body, and the linen had to be changed every day; while, if it prevented the cuticle from dispersion in the air, it could not prevent the infective germs from passing freely from the patient in his breath and perspiration.

Dr. Bucholtz found eucalyptus oil to be three times stronger than carbolic acid, for while the latter required a strength of 1 in 200 to prevent putrefaction, eucalyptus oil only required a strength of 1 in 666 to produce the same effect. Siegen found that blood to which one-third per cent. of the oil had been added was odourless at the end of ten days. Dr. Lascelles Scott says that it is three and a half times more powerful than carbolic acid as a bacterial antiseptic. Mr. Mayo Robson proved by experiments that the vapour of eucalyptus oil given off at the ordinary temperature of the air preserved sterilised hay-infusion from the development of bacteriæ, and he says, "it may so saturate the air as to kill all infective particles, not only bacteriæ and micrococci, but also the germs of fevers and other infectious diseases."

"The vapour of carbolic acid at ordinary temperatures", Dr. Franklin Parsons tells us, "had no destructive effect on spore-bearing bacilli, though some effect was produced at elevated temperatures." Of what use, then, is the carbolic sheet over the door, and the vapour of carbolic acid in the air of the room occupied by a scarlet-fever patient?

Professor Lister in 1881, when in the chair of the Clinical Society, said: "It had been stated that there was no antiseptic that could with safety replace carbolic acid, though several had been tried, but he was in a position to say that the oil of eucalyptus globulus, if used properly, is a powerful and perfectly reliable antiseptic, and is also quite unirritating and without toxic effects."

Dr. Lauder Brunton, in his Croonian Lectures in 1889,

said that "it is not, moreover, *à priori* impossible to imagine that antiseptics circulating in the blood-stream may be germicidal to pathogenic organisms, the results of which are seen in disease. Up to the present time, however, all trials with such an idea seem to have been without beneficial effect."

My experience proves that the vapour of eucalyptus destroys not only the spores of the pathogenic bacillus of scarlet fever, but the bacillus itself after it has set up the pathological train of symptoms constituting the fever, and is being rapidly generated in the blood and tissues of the patient.

Thymol and other disinfectants, when dissolved in an essential oil, retain their power; and a combination of these aromatic and camphoraceous disinfectants forms as powerful a solution as can be required for the destruction of any infectious poison. It was an axiom of Dr. Paris that a combination of several therapeutic agents, in smaller proportion than is required by any one singly to take effect, produces a far greater and a better effect than any one in a larger proportion. The same rule is applicable to disinfectants; a better and a stronger effect is obtained by mixing several together, for while any one singly of the strength used would have no effect, their combined action is most powerful. I only state a well-established fact, that all the essential and balsamic oils of aromatic trees and plants are excellent antiseptics, they readily volatilise, and in doing so liberate ozone, thus exercising powerful antiseptic influence. This power of liberating ozone makes eucalyptus and other aromatic oils valuable for use in sick-rooms, and in fact in all rooms that are continuously occupied. They act better if diffused through the air by means of a spray diffuser. If the bedroom and the pillows are sprayed at night the sleeper will sleep more comfortably, and awake in the morning more refreshed from sleeping in an ozonised atmosphere.

Eucalyptus is a true disinfectant, as it has the power of destroying the active matter or the infective germs generated in and discharged by a person passing through any of the eruptive or infectious fevers, and which, received by a healthy person into his system, develops the same train of symptoms, the same fever from which the former was suffering. Eucalyptus destroys the malarial poisons, which in the human system develop the various short or long malarial fevers, such as ague, jungle fever, Roman fever, rock fever, influenza, etc.; of this we may now rest assured from the experience gained in Italy, Africa, India, and America, by planting the tree extensively in malarial districts. In California thousands of acres have been planted, and the Americans are yearly extending their plantations, surrounding their houses and locations with the trees. It is easy to foresee that our chief supply of the oil of eucalyptus globulus, which is the only tree of the species they plant, will in future be derived from that country rather than from its native *habitat*, Australia. The Australians having the native forests for their supply, do not feel the stimulus to plant, and their supply will diminish.

It is more than twenty years since that Dr. Budd published a pamphlet advocating the use of olive oil for inunction in scarlet fever, not with the view of destroying the infective germs, but of saturating the cuticle and preventing it from being diffused through the air. The use of the oil was attended by great inconvenience, in that it soiled the linen and became rapidly rancid by the high temperature of the patient. Since that time I have sought some method of disinfection by inunction that would destroy all the infective germs stored in the cuticle, so as to render it when cast off perfectly innocuous. There were many disinfectants—carbolic acid, permanganate of potash, creolin (Jeyes' fluid), sanitas, etc., but none of these were suitable. Carbolic acid must be dissolved in water, oil, or fat. A watery solution of a disinfectant would not do to apply to the whole surface of the skin of a child in the first stage of scarlet fever with a temperature of 103° to 105°, and the carbolic acid could not be used strong enough to destroy the infection owing to its caustic nature. For the above reason Jeyes' fluid, sanitas, and other watery solutions were unsuitable. Antiseptics mixed with fixed oils or fat were attended by several objections. The oil or fat applied to the whole surface would interfere materially with the action of the skin, and the oil or fat would weaken their power. Spirituous solutions were also unsuitable, and the alcohol weakened their action.

Corporeal disinfection by inunction has been tried by medical men at various times. One recommended thymol mixed with vaseline, but the unctious nature of the latter was disagreeable to the patient, and if applied to large surfaces of the body interfered with transpiration. No one would be surprised that the trial was a failure.

In June last there was published, in the *Medical Record*, a method of disinfection proposed by Dr. L. Mervin Mans. He says: "Sponge the patient thoroughly, morning and evening, with a tepid solution of corrosive sublimate, 4 to 1,000, as soon as the eruption makes its appearance. The hair and the secretions are also to be disinfected with the same. As

soon as the patient is permitted to leave the bed, have the body washed with warm water and soap, then sponged with the 1 to 4,000 bichloride solution, wiped dry, and anointed with the following ointment—

Sodii biboratis, zinci oxidi āā ʒ iv.
Ol. Gaultheriæ ʒ ss., vaseline ℥ iv."

This treatment is to be continued until desquamation is complete.

We have no record of the success of this treatment, nor of the number of deaths after the use of this poisonous disinfectant. I should think that no man of ordinary intelligence would venture to use a solution of bichloride of mercury of 4 to 1,000 strength twice a day for upwards of a week, applying it over the whole surface of the body of a young child, and continuing a weaker, though still strong, solution of 1 in 4,000 for several weeks longer, anointing the body also daily with a vaseline ointment that would most seriously interfere with the proper action of the skin. One German physician applies a bichloride of mercury solution to the pustules of small-pox, and another covers them with an ointment of salicylic acid, starch, and glycerine. Another, Dr. Bianchi, recommends in small-pox, baths and washings in water containing five per cent. of boric acid, and "the whole body is to be washed, using a clean sponge, with a 1 to 1,000 solution of corrosive sublimate." . . . . . "In mild cases the whole body is to be washed once with the corrosive sublimate solution, and twice with the boric acid solution, in the twenty-four hours. In grave cases, twice with each solution daily." After washing, all the parts covered with eruption to be smeared with an iodoform ointment, 1.5 per cent. He does not say how many of the ninety-six cases so treated recovered or died. He says the treatment is rational; it diminishes the period of the eruption; practically isolates the patient; prevents suppuration; and limits contagion. What Dr. Bianchi claims for his corrosive sublimate treatment I claim for eucalyptus; and, although I have not had an opportunity of testing it, I firmly believe, from the power it possesses of killing the scarlet-fever poison, it would be equally powerful over small-pox. In the one case we are using a powerfully poisonous disinfectant, in the other one that is quite innocuous to the patient. These methods of disinfection have been made public since I commenced the treatment of scarlet fever by inunction. I had for some years given up the idea of disinfecting the skin through inability to find a suitable medium for applying the disinfectant, when, in May of last year, I was in a difficulty as to how I should isolate a child suffering from scarlet fever in a family where there were six other children. The child was a year and nine months old, the youngest of the family. The mother would not hear of its being sent to the hospital, and it was impossible to carry out any isolation in the usual way, as she had to attend to all the wants of the other children. I told her that all the children would have the disease if she kept the child in the house, but she said she would not part with her baby, and would risk the others having it. In this emergency I again thought of disinfecting the child, when I remembered having at my house a sample of Tucker's eucalyptus disinfectant, composed, as before stated, of essential oil and camphors, having no fixed oil nor alcohol in it. I determined to try it, and told the mother how I wished it used. She was to rub the child all over with it night and morning, not omitting any portion of the skin, and to sprinkle the bed and the floor of the room with it, so that the air should smell strongly of the vapour. I also gave the child eucalyptus oil in one-drop doses every four hours in an emulsion. When I first saw the child it had the scarlet-fever rash over the face, arms, and upper portion of the body. Its throat was so sore that it refused all food, and had not taken anything for two days; it had not slept during two days and nights, being fretful and crying all the time. On my second visit, the following morning, I found the child sitting up in bed eating a slice of bread and butter. The rash had all gone, and the temperature had gone down from 103° to 100.2°. The mother told me that after rubbing the child over with the fluid the previous night, it went to sleep and slept five hours, awaking apparently well, taking some milk without any difficulty in swallowing. I was quite astonished to see such a change in the child, and told the mother to go on with the disinfectant, rubbing it over night and morning for three days, then each night, after a warm bath, for four days more. The child was so saturated with the eucalyptus inunction, by inhalation of its volatile vapour, and by medication, that the disease appeared to have been stayed and every germ destroyed, as desquamation occurred only on the parts of the skin where the rash was seen. The other children had free access to the room, and none of them took the disease.

Several other cases were treated in a similar manner with like results. The fever abated after the first inunction, and the rash disappeared within twelve hours; desquamation occurring only where the rash had been seen on the

commencement of the treatment. None of the cases were isolated, other members of the family frequenting the room, and in one case a mother with a younger child living in the single room. I shall only relate other cases in detail which serve to illustrate the conclusions at which I have arrived as to the power of eucalyptus over the scarlet-fever poison, and, by analogy of action, over the pathogenic germs of all eruptive and malarial fevers.

The next case I shall relate was a boy eight years old. When first seen he had had the scarlet-fever rash out two days. A brother had been sleeping with him, and two other brothers occupied the same room; while the mother, and a sister six years old, slept in the sitting-room. The boy was anointed with the disinfectant, and sent to the hospital. The three other boys and the girl were directed to use the disinfectant for a week, rubbing it over their chests and sprinkling it on their shirt-fronts and about the room, that they might inhale the vapour continuously during the day; and sprinkling it over their pillows and sheets, that they might sleep in the midst of the vapour at night. The second day after the boy was removed the sister showed symptoms of the disease. She vomited, had a headache, a white furred tongue, and sore-throat. Her temperature was 103°, and pulse 118. My son, who saw her, told her she would have to go to the hospital unless she used plenty of the disinfectant and stopped the fever. She said she would not go to the hospital, so she took the bottle and saturated the pillow and sheets with the fluid. For the remainder of the day and the following night she breathed air saturated with the vapour, sleeping quietly. She was given two-drop doses of the oil in emulsion every four hours. When seen on the following day all symptoms of the fever had gone; no rash had appeared; her temperature was normal; she felt quite well, and had no recurrence of fever. She was given a warm bath, and the disinfectant was rubbed over the whole surface of the body as a precaution. The others all escaped the disease, and the boy sent to the hospital was kept six weeks at the public expense and died there.

The next case was a nurse in a family where there were three young children. When first seen she had the scarlet-fever rash out over her chest and arms; a sore-throat and headache having commenced about thirty-six hours previously. She was removed to the hospital, and Tucker's eucalyptus disinfectant was ordered to be freely used in the nursery. The children were kept in an atmosphere strongly impregnated with the eucalyptus vapour for three days and nights. After that they were allowed out during the day. The use of the disinfectant was continued in the nursery for four or five days longer, when the children were considered safe from the development of the fever through any infection from the nurse.

The last case I shall relate is that of a girl about eleven years of age. When first seen, on the third day of the fever, the rash was fully out; the throat was very inflamed and swollen, and the tonsils were ulcerated. The temperature was over 104°; the pulse 132. She had much difficulty in swallowing, and took very little nourishment. The eucalyptus fluid was freely sprinkled over the bed and about the room; it was rubbed over her whole body night and morning for three days, and then at night only for seven or eight days more. She took also three-drop doses of the oil every four hours. She felt relieved directly after the treatment was commenced, and the following day she could drink with less pain; but the ulcers did not heal for three days. The rash did not disappear, as in the other cases, but became very bright for two days, and then gradually faded. Desquamation commenced before the rash had disappeared, and finished on the fifteenth day. She had rheumatism in her wrists and ankles for a few days; these were rubbed with the eucalyptus. The glands on the left side of the neck swelled and were painful, the side on which the tonsil was most ulcerated. These glands were lightly rubbed every four hours with the fluid, and in a few days the swelling subsided. She had no albumen in her urine, which was examined daily from the fourteenth to the twentieth days, and on the twenty-first day she left London for Brighton. A sister of this girl slept with her until I saw her on the third day; after that she did not sleep with her, but I told the mother she had better spend much of her time in the same room, that she might inhale the vapour of the disinfectant continuously, with the view of destroying any of the fever poison she might have taken from her sister. She spent most of the first three days in the room, sitting by her sister's bed, and reading to her. On the 31st of October I felt bound to conform to the provisions of the new Act. I reported the case to the Sanitary Authority, and separated the two sisters. Two days afterwards, which was five days from the date that they ceased to sleep together, the sister showed some signs of the disease. She had headache, sickness, and a coated tongue, and felt very ill. I used the disinfectant freely about her, and at the end of the second day she was well again. There were three

other children in the house, but none of them took the infection. There was no sheet used over the door, the disinfection of the patient serving to isolate her from those close to her bedside. The vapour of the disinfectant inhaled with every breath destroyed all the infective germs proceeding from the mucous membrane of the mouth, throat, or nose. The inunction of the skin destroyed all infection proceeding from the surface of the body, and the secretions were all disinfected immediately after they were passed. With an atmosphere full of this powerful disinfectant, there is no need for the doctor or nurse to take those elaborate precautions against the risk of conveying infection to others that amateur sanitarians so strongly recommend in the daily press. The aromatic disinfectants are eliminated chiefly through the kidneys; in this way they destroy the germs stored in the epithelium of those organs, and it is hoped we shall find by further experience that it will prevent the development of desquamative nephritis, with its attendant danger to life and health. Those cases that I have treated have not had any symptoms of nephritis, nor the slightest trace of albumen in their urine. From the experience gained by the above treatment of scarlet fever during the last twelve months, I have determined the following conclusions:—

1. That no isolation of the patient in the way now practised is necessary. The skin, mucous membranes, secretions, and breath being so disinfected that he cannot communicate the disease to others, although daily in the same room.

2. In cases treated by this method of inunction during the first day of the fever the disease is arrested: no rash appears and no desquamation follows, the inhalation of the vapour being sufficient to produce this result. It is probable that in such cases so checked the patients may be protected from another attack, as by inoculation.

3. Children who have been exposed to the infection for two or three days, by inhaling the vapour diffused in the air of their rooms, are preserved from the disease.

4. The sequelæ are lightened and prevented, desquamation is hastened, the falling cuticle being incapable of conveying the disease through its complete disinfection; consequently it is not necessary to enforce six or eight weeks' isolation until its completion.

5. The specific fever and the development of the germs of the disease terminating in six or seven days, the skin and mucous membranes being kept under the influence of the disinfectant until the tenth day, the patient is then safe to mix with others.

6. The bedding requires no further disinfection, as it is thoroughly disinfected during the treatment of the patient. The volatile vapour penetrates every article, even the mattress. The room also requires no after disinfection, as every germ that escapes from the patient is killed by the vapour.

I find that to extend this paper further on the treatment of other infectious diseases by eucalyptus would take up too much of your time this evening. I will therefore merely observe that eucalyptus has been used most successfully in the treatment of diphtheria by Dr. Jules Simon and other French physicians; by Dr. Murray Gibbes in New Plymouth, who used the fresh leaves; and lately it has been successfully treated in an outbreak at Uxbridge.

It has been equally efficacious in whooping-cough when tried by Dr. William Hardewick and others.

In my own experience it prevents the spreading of the infection of measles and chicken-pox.

It protects from malarial fever and influenza those daily inhaling the vapour, and sleeping in an atmosphere of it at night; and, lastly,—I believe it would destroy the infective germs of small-pox.

NOTE

ON THE

ENDEMIC FEVER OF THE MEDITERRANEAN

BY

SURGEON-CAPTAIN MATTHEW LOUIS HUGHES
ARMY MEDICAL STAFF, MALTA

(COMMUNICATED BY DR. GEORGE THIN).

[*From Volume 79 of the 'Medico-Chirurgical Transactions'*]

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1896

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M Louis Hughes
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Received December 23rd, 1895—Read April 14th, 1896.

IN the countries bordering the Mediterranean Sea south of latitude 46° N. (isotherm 55° F.), an endemic fever prevails, to which neither satisfactory name nor a place in the official nomenclature of diseases has yet been given. In the navy this disease is returned as "remittent fever," though it has no connection with fevers of malarial origin. In the army it is returned, together with all cases of slight and indefinite pyrexia, as "simple continued fever," in spite of its many and obvious distinguishing characters. A certain slight resemblance to enteric and malarial fevers has been used as an excuse for calling it by many hybrid and unscientific names, such as pseudo-tifo, adeno-tifo, typho-malarial fever, &c. Various other names have been given to it, none of which can be said to be satisfactory, such as febris complicata, febris sudoralis, pythogenic septicæmia, and such local names as Gibraltar fever, Rock fever, Malta fever, Mediterranean fever. In this paper I follow the example of others, and call it "Mediterranean fever," with a hope that a more suitable name may be soon adopted.

The specific nature of Mediterranean fever is proved by its long and indefinite duration, irregular course, tendency to relapse, and peculiar symptoms; by the absence of intestinal ulceration, and by the constant presence in certain tissues of a definite species of micro-organism capable of producing by inoculation a similar form of pyrexia in monkeys.

The fever prevails mostly in the large seaports, but is also to be met with in inland villages, even at high altitudes. During the early part of the present century it appears to have existed both in Malta and Gibraltar, but to have been returned under such symptomatic headings as rheumatism, bronchial catarrh, lobular pneumonia, climatic cachexia, &c. The first accurate description published was that by Dr. Marston in 1861, written while serving as an army surgeon in Malta.[1] He was followed by Chartres (1865), Boileau (1866),[2] Oswald Wood, Notter,[3] and Donaldson[4] in 1876, also army surgeons serving in Malta. In 1879 Prof. Veale,[5] and in 1885 Prof. Maclean[6] published valuable reports dealing with cases invalided to Netley from the Mediterranean. In 1887 Surgeon-Major Bruce published his discovery of a causal micro-organism, and later on other papers;[7] while

[1] 'Army Medical Department: Statistical, Sanitary, and Medical Reports,' iii, 1861 (published in 1863), p. 486.

[2] Ibid., 1865 (published in 1867), p. 527; 1866 (published in 1868), p. 478.

[3] 'Edinb. Med. Journ.' xxii, 1876-7, pp. 40, 289.

[4] 'Army Medical Department: Statistical, Sanitary, and Medical Reports' for 1876 (published in 1879), p. 238.

[5] Ibid., 1879 (published in 1881), p. 260.

[6] 'Practitioner,' xxxiv, 1885, p. 78; and 'Brit. Med. Journ.,' 1875, vol. ii, p. 224.

[7] 'Practitioner,' xxxix, 1887, p. 161; and xl, 1888, p. 241; 'Annales de l'Institut Pasteur,' vii, 1893, p. 289; articles in Davidson's 'Hygiene and Diseases of Warm Climates,' p. 265, 1893, and Quain's 'Dict. of Med.,' vol. ii, p. 10, etc.

Surgeon-Captain Moffat in 1889 dealt with its occurrence in Gibraltar.[1]

Since that date I myself and others have endeavoured to carry on these investigations.[2] In Italy and Sicily, Borrelli (1872), Tomasi (1874), Cantani (1878), Rummo (1881), Galassi (1883), Capossi (1885), Federici (1885), Tomaselli (1886), Guiffre and Silva (1893), and many others have published papers;[3] as have also Carageorgiades of Cyprus (1891), and Typhaldos of Greece. These and others have met with the fever as an endemic disease in Middle and Lower Italy, Sicily, Constantinople, Crete, Greece, Smyrna, Cyprus, Malta, Gibraltar, Tunis, Algiers, &c.; while Drs. Hutchinson Miles, Pasquale, and Rho[4] would lead us to believe that the same fever exists on the borders of the Red Sea. As in India and elsewhere there still exist forms of remittent fever of long duration and irregular course, neither enteric nor malarial in nature, it would be unwise to lay down any geographical limits to its prevalence in the limited state of our present knowledge.[5]

Symptomatology.

So variable are the symptoms, and so uncertain is the duration of this fever, that it is impossible to give a description to which all cases can be referred. Putting aside those short (abortive ?) and indefinite cases of fever lasting from seven to twenty-one days, which are more severe than simple ardent fever, and unlike enteric fever,

[1] 'Army Medical Department: Statistical, Sanitary, and Medical Reports,' xxxi, 1889 (published in 1891), p. 403.

[2] 'Lancet,' ii, 1892, p. 1265; 'Annales de l'Institut Pasteur,' vii, 1893, p. 628.

[3] 'Trattato di Medicina' di Charcot, Bouchard, and Brissaud, 22a del., vol. i.

[4] 'Lancet,' i, 1892, p. 1359; 'Sperimentale,' anno xlviii, p. 545, etc.

[5] The writer hopes shortly to publish a complete bibliography of this fever.

we meet with three varieties, to which all cases of this Mediterranean fever seem to approximate clinically. The following descriptions are based on notes of over a thousand cases which I have had the opportunity of seeing in Malta during five years of constant hospital practice.

1. *Malignant or fatal type.*—(*a*) The patient, often a strong muscular man, is admitted to hospital suffering from severe pyrexia, stated to be of only one or two days' standing. He complains of severe headache, "pains all over him," distaste for food, possibly nausea, and even vomiting. His face is flushed, his tongue thickly coated with whitish-grey or yellow fur, pink at the tip and edges, moist, swollen and indented by the teeth laterally. The temperature is 104°—105° F. There is epigastric, splenic, and perhaps hepatic tenderness on pressure, while the area of splenic dulness is increased. Diarrhœa may be present, when it is usually due to involvement of the large gut. If left to take its course, after four or five days of constantly high pyrexia, signs of basal pneumonic congestion, with bronchial râles all over the chest, appear, and these may pass into lobular consolidation. The pulse remains strong and the mind clear. The urine is decreased in amount, dark in colour, and loaded with lithates; diarrhœa, if present, becomes profuse and frequent, the stools being usually brown in colour, very offensive, but variable in consistency. After a varying number of days the pulse begins to flag and become intermittent, the breathing laboured, and obstinate vomiting may be present. The tongue becomes brown, the teeth are covered with sordes, and other symptoms of the so-called "typhoid state" set in; the respirations are shallow and fast; delirium supervenes and passes into coma; the fæces are passed involuntarily; the temperature rises, the heart gives way, and the patient dies of hyperpyrexia. At death the temperature is, as a rule, about 110° F., but may continue to rise, so that a temperature of 112°—115° F. has been registered shortly after in the internal organs. Rapidly fatal cases are rare in

these days of improved treatment. In a few cases there is a temporary fall to normal with great exhaustion, for a few hours before death from hyperpyrexia; while other delicate individuals appear to die of the direct toxic effects of the virus, at a temperature well below hyperpyrexia.

(*b*) In some cases the patient passes safely through the primary attack, the pyrexia abates at the end of two or three weeks for a few days, followed by a gradual rise and relapse, in the course of which similar fatal symptoms may supervene.

(*c*) In cases which prove fatal at a later stage in the disease (70th to 150th day) death is usually due to sudden cardiac failure, to debility and exhaustion, or to the supervention of phthisis or some other intercurrent disease.

Of twenty-nine fatal cases, death occurred in 13·7 per cent. during the first week in hospital, in 18·3 per cent. during the second week, in 25 per cent. during the third week; in 57 per cent. during the first month, 22·6 per cent. during the second month, 9 per cent. during the third month, 4·5 per cent. during the fourth month, 2·2 per cent. during the sixth month.

2. *Undulatory type.*—These cases are marked by intermittent waves of remittent pyrexia of variable length, marking the pyrexial intensity, separated from one another by periods of temporary abatement or absence of symptoms. In typical uncomplicated cases, confined to bed, there is usually a premonitory stage of low spirits, sleeplessness, anorexia with dyspeptic symptoms, and each evening headache and and slight pyrexia. The temperature next rises gradually, remitting each morning about half the amount of the previous evening rise. With this are combined slight headache, pains in the back and limbs, moist, furred, swollen tongue, a bad taste in the mouth, epigastric tenderness, and constipation. Most patients, however, do not at first report themselves sick, but, imagining that they have "a bilious attack" or "liver," take aperient pills, and attempt to work the

illness off by hard exercise. The result is that all the symptoms become exaggerated, and on admission the temperature is high, and the headache severe. The temperature having reached 103°—105° F. in the evening, accompanied by some bronchial catarrh or hypostatic pneumonic congestion in proportion to the severity of the case, after a variable period gradually falls to normal or thereabouts in the morning; and though it may be slightly higher in the evening, the patient feels better and wants to get up, while the primary wave may be said to be over. After a day or two, however, the temperature again begins to rise, and a relapse ensues, similar to the primary attack, but usually less prolonged and less severe. This subsides, but is followed by other relapses forming the undulatory temperature charts so characteristic of this fever. Such pyrexia is nearly always accompanied by obstinate constipation, though diarrhœa may occur temporarily in very severe cases, more especially during the primary attack. Each daily remission of temperature is accompanied by profuse sweating. Anæmia and muscular wasting are progressive and often extreme. At any stage, but usually late in the attack or during convalescence, symptoms of localised interstitial neuritis may occur, leading to obstinate sciatica, intercostal neuralgia, &c., or to symptoms referable to irritation of the peripheral sensory nerves or of the nerves of special sense. In many cases effusion into one or more joints may suddenly occur, of a transitory and metastatic nature, but causing extreme tension and pain; or painful orchitis may appear. Finally the patient is reduced to an emaciated, anæmic, bedridden condition; subject to attacks of bronchial catarrh, lobular pneumonia, cardiac palpitation, rheumatic or neuralgic complications on the slightest exposure to chill, change in the weather, or excitement. Disappointed at each relapse, his whole expression is the picture of despondent apathy, his only wish to get away to England. His emaciated appearance, his profuse night sweats, often

intermittent pyrexia and cough, remind one forcibly of the late stages of phthisis. Gradually, however, towards the end of the second or third month, his temperature becomes normal or subnormal in the morning, and but slightly above normal in the evening; next the evening rise ceases, giving place usually to a day or two of subnormal temperature, after which convalescence is established. The strength now slowly returns, the cheeks fill out, and the patient gets up for an increasing period every day. After a few weeks, if not invalided home, he is sent to a sanitarium, or perhaps to duty, but for months after is liable to attacks of neuralgic pain, to swollen joints or testicles, combined with slight pyrexia. Final recovery cannot be said to take place for many months, and until the anæmia has disappeared and the mucous membranes have regained their complete functions; when once, however, completely free from the disease, it does not recur like paludism.

The average duration of pyrexial symptoms is sixty to seventy days, but cases have been known to last thrice as long. The average stay in hospital is over ninety days, and convalescence has been prolonged to a year or more in certain cases.

3. *Intermittent type.*—In these cases the temperature intermits daily, and being of a non-paroxysmal nature, they resemble hectic fever cases. If, however, the temperature be accurately taken, so as to register the daily maximum and minimum, these are found to form waves of pyrexial intensity similar to those previously described, the daily remittance being exaggerated into an intermittence. These cases are, as a general rule, shorter than the undulatory ones, complications being milder in character when present. Constipation, night sweats, and progressive anæmia accompany the pyrexia, while arthritic effusion may occur. The patient is usually less despondent, the absence of marked undulations does away with the disappointment felt at each relapse, the patient's daily remark being that he is "just the same." In many

cases non-paroxysmal pyrexia and profuse night sweats are the only symptoms present, and the patient, if allowed, wishes to get up and eat solid food each morning, but suffers from slight malaise in the afternoon. Such cases go on steadily in spite of all the drugs in the pharmacopœia, and though an indiscretion may bring on serious symptoms, they seem to cease spontaneously, or at the commencement of some new line of treatment which, however, fails to stop other and similar cases.

Between the undulatory and intermittent types we meet with every variety of curve that can be said to approximate to the above individual descriptions, or to a mixture of both; but there is always a tendency to the formation of waves of pyrexial intensity if the curve is accurately registered.

Special symptoms.—In severe cases the face may be cyanosed, but in long cases towards the end of an attack the face becomes of a dull clay colour, the skin tightly drawn over the skull, with an expression of listless resignation to an uncertain fate. There is no exanthem, but sudamina are not uncommon during and after the third week, especially when the skin is not properly attended to. Prickly heat (which may become pustular) is an annoying complication of hot weather, while in the spring and autumn boils may occur. Subcutaneous hæmorrhages, combined with scorbutic symptoms, are of rare occurrence. About the fourth week desquamation takes place, being most noticeable on the soles of the feet, where the skin peels off in large flakes. Towards the end of long attacks the hair falls out extensively, but is gradually replaced by new growth during convalescence. As in enteric fever, there is a certain amount of cutaneous bronzing, but nothing approaching the pigmentation of paludism. A distinctive and disagreeable odour is present in nearly all cases, being most especially marked at post-mortem examinations. The profuse diaphoresis following the fall of temperature when intermittence is present is most characteristic, and gives rise to the name "febris sudoralis." The sweat rolls off the patient's face in large drops, soaking through the pillow; while at the same time it soaks through his flannel suit, the sheets, and even the blankets, occurring usually about one or two o'clock in the morning; this lasts an hour or more, necessitating two or three changes of clothing.

Pyrexia is the chief and often sole symptom present, and although, speaking generally, there is a relationship between the temperature curve and the other symptoms present, yet the pyrexial severity is not always an indication of the urgency of the symptoms or of the prognosis in any given case. Its height in a large number of cases seems to depend upon the capacity of the individual to nervous excitability.

The chief characteristic of the pyrexia of this fever when compared with that of others, is the variability which exists in its amount and duration in different cases. The daily curve may vary between a continuously high temperature and an intermittent one. One point, however, is common to all cases, in that the daily maximum and minimum temperatures tend to form waves of intensity of varying character and duration. These waves in individual cases have a tendency to resemble their primary wave, though they usually decrease in length and severity as the cases progress.

The typical wave in uncomplicated cases confined to bed rises like the ideal curve of enteric fever, and subsides in an equally regular manner (see Charts II and VII). Generally speaking, however, all sorts of variations occur (see Charts I, IV, VII, and XII), even to a sudden fall from a continuously high temperature to normal. The latter fall is not uncommon as a temporary abatement (see Chart X), but has only occurred three times in the writer's experience as a sudden permanent recovery by crisis. Not infrequently permanent cessation of pyrexia is immediately preceded by a burst of unusual severity (see Chart V), while convalescence is almost always preceded by a period of subnormal temperature lasting from one to three or more days (see Charts I, V, and VII). The average length of 300 well-defined waves was about ten days, the primary wave being usually longer (eighteen to twenty-three days), or it may even last almost the whole pyrexial period (see Chart III, where it lasts fifty-four days). The durations of these 300 waves, occurring in ninety-five undulatory cases, were—

One week and under	70
Two weeks	97
Three „	60
Four „	23
Five „	42
Six „	3
Seven „	3
Eight „	2
	300

The average number of waves in an attack was three (one to seven). The interval between waves is marked by a period of apyrexia, without other morbid condition, lasting from one to ten or even more days (average three to four), or simply by a comparative abatement of pyrexial and other symptoms of variable duration and degree.

The daily temperature curve is usually remittent in character, the morning temperature being one or two degrees lower than in the evening, without actually touching normal except during the intervals between waves of pyrexia. It may, however, assume in different cases any type between intermittence and a continually high temperature, or pass from one type to another in the same attack (see Chart VII).

In intermittent cases (Chart VI) the temperature is usually at or near normal during the morning visit (8 a.m.), and begins to rise steadily a little before 11 a.m. to a maximum between 2 and 3 p.m. From this it gradually falls to halfway about 6 p.m., and reaches normal again about 10 or 11 p.m. or later, after which

See Explanation of Charts, page 46.

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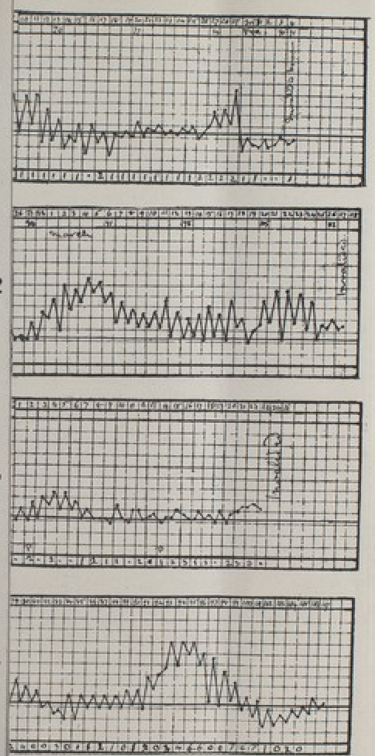

Charts illustrating Surgeon-Captain Hughes' Note on the Endemic Fever of the Mediterranean. *See Explanation of Charts, page 46.*

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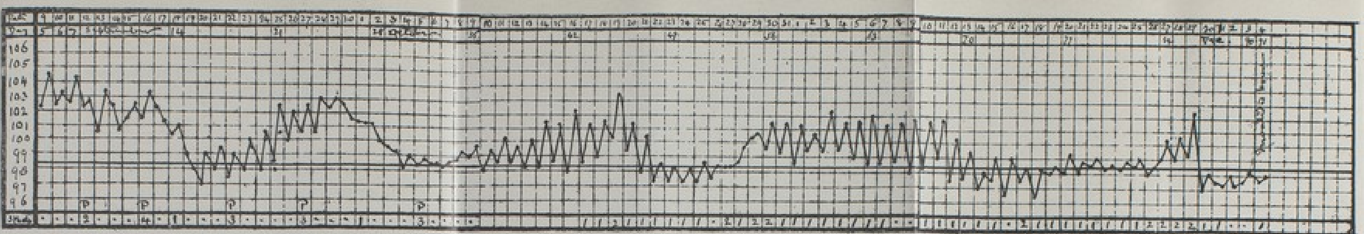

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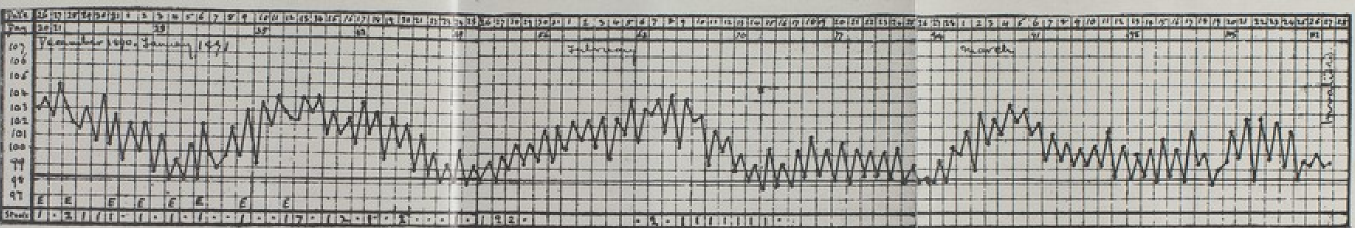

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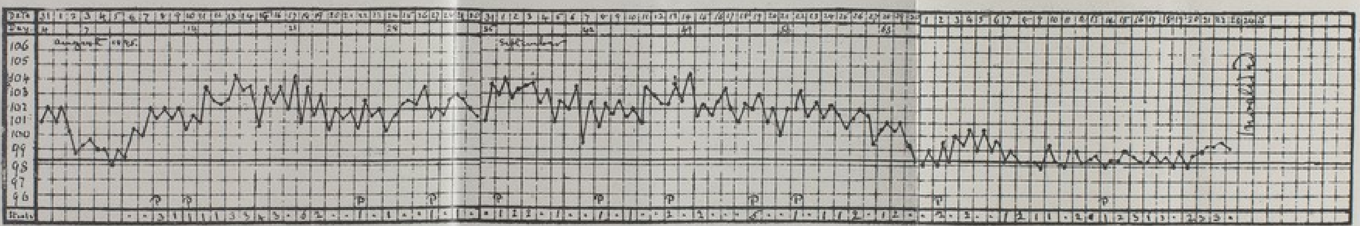

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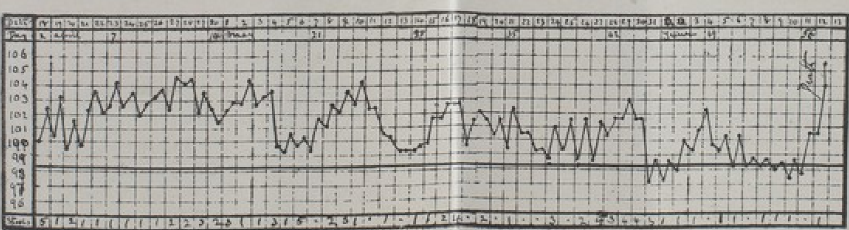

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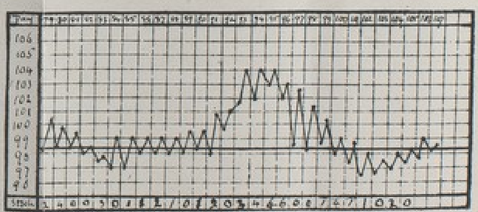

Charts illustrating Surgeon-Captain Hughes' Note on the Endemic Fever of the Mediterranean. *See Explanation of Charts, page 46.*

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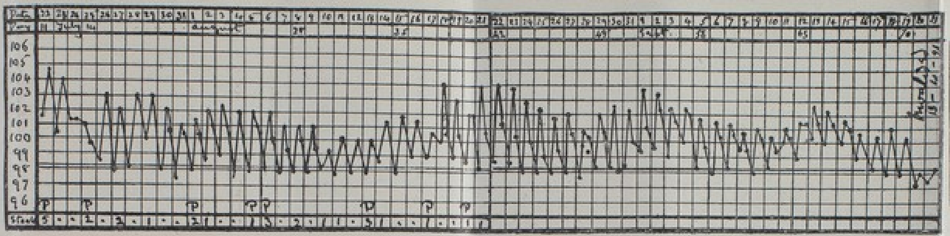

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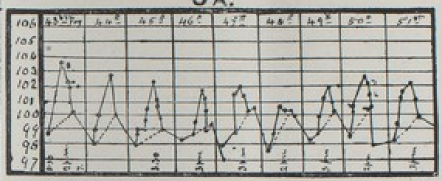

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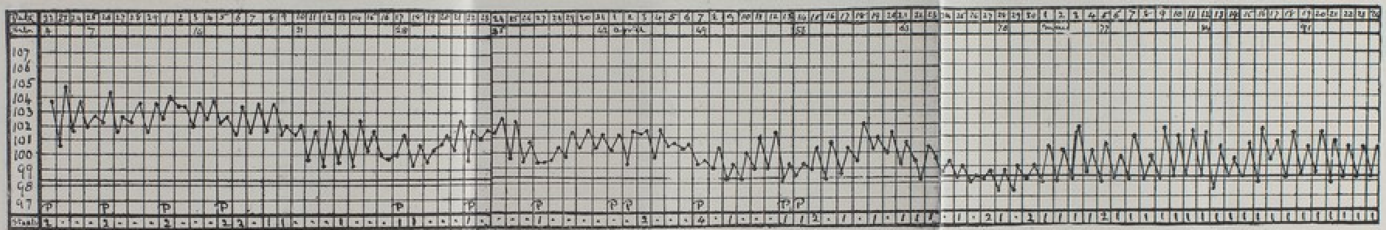

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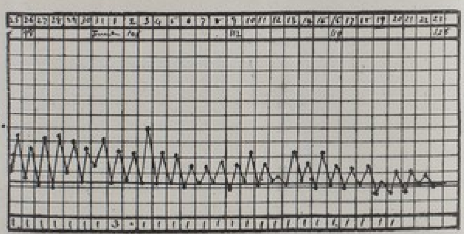

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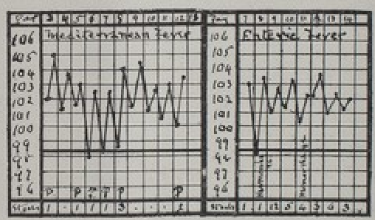

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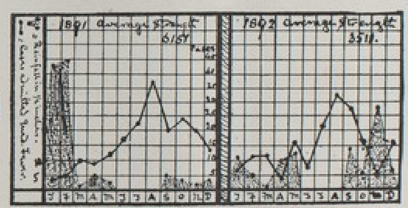

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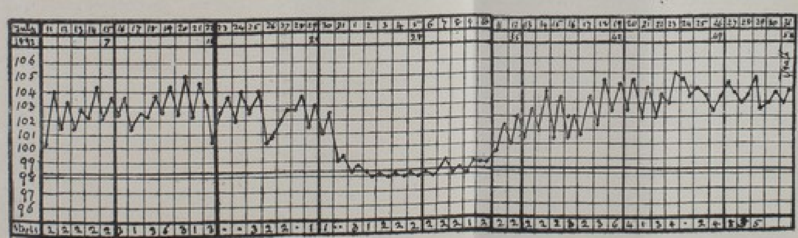

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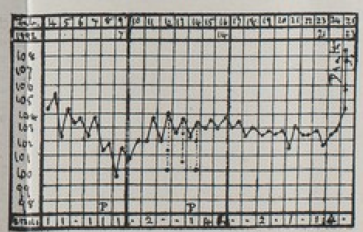
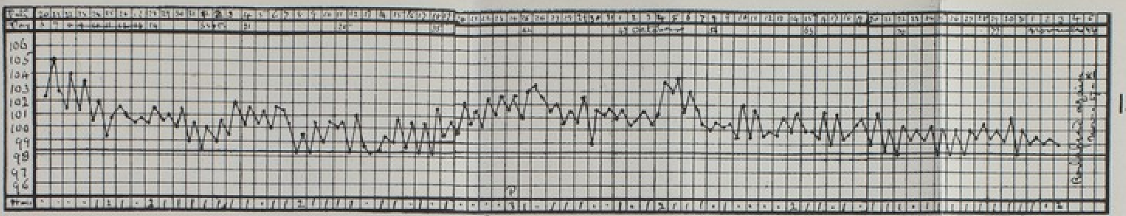


Charts illustrating Surgeon-Captain Hughes' Note on the Endemic Fever of the Mediterranean. See Explanation of Charts, page 46.

12



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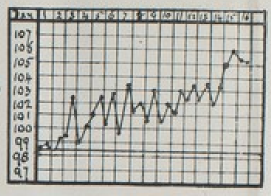

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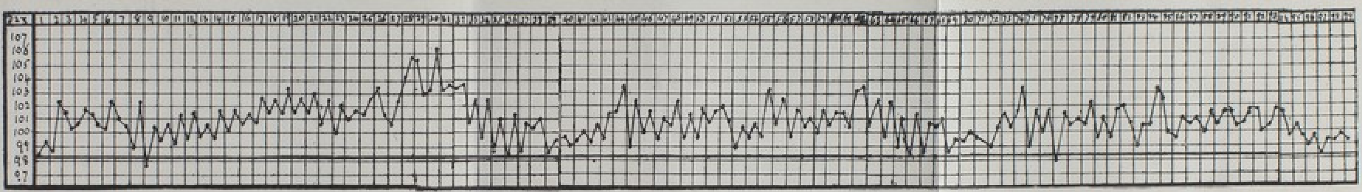

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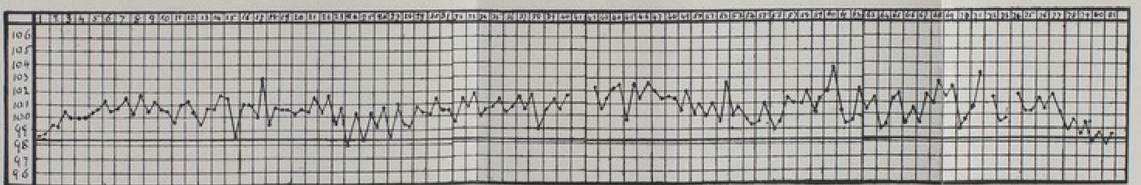


profuse diaphoresis occurs. Occasionally slight supernumerary rises of temperature are added to this curve, a common one being just after the evening visit and bed-making. This curve is accentuated by mental emotion or excitement, by exertion, injudicious dietary or medicine, excessive constipation or the reverse, by the damp enervating sirocco wind, or by the appearance of any localised special symptom. The relief of constipation or the cessation of a sirocco wind often proves an excellent antipyretic. These maximum and minimum may be postponed, so that in a few extreme cases the morning temperature becomes the high one, and the afternoon the reverse. This daily curve is non-paroxysmal, resembling more the hectic fever of phthisis than the paroxysms of ague, the daily rise being associated with a feeling of chilliness and malaise only, rigor being absent except in a few cases of specially nervous temperament.

From the above mild type, the daily temperature curve may increase in duration so as to postpone the fall well into the night, and the diaphoresis to the early morning, while at the same time the morning rise is anticipated. In more severe cases one curve appears to run into and overlap the next, until with less and less remittence the temperature comes to be continuously high, the daily variation being less than one degree, a condition leading to danger from sudden hyperpyrexia.

The pulse is usually firm and slow at first (80—90), even out of proportion to the number of the respirations, and the amount of pyrexia present. In malignant cases, where there is lung stasis, it is rapid, and becomes small, thready, and then intermittent before the overburdened heart gives out entirely. In long-continued cases it often becomes constantly increased in rate (110—120). In such cases cardiac irritability is of common occurrence, giving rise to attacks of palpitation on the slightest exertion, or even under the influence of some trifling emotion. Hæmic murmurs are met with during convalescence. Organic cardiac disease is said to arise in some cases, but I have only met with it in four instances (fatal on the 19th, 62nd, 111th, and 150th days), and in these the condition might have existed previously. In the first two cases the immediate cause of death was pericardial effusion (similar in onset to the characteristic arthritic effusions). Swelling and œdema of the ankles after standing is common during convalescence. The writer has only once met with phlegmasia dolens following an attack of this fever. The blood has been microscopically examined by Dr. Thin and numerous other observers, and culture experiments have been made, but no organisms have been found present. The spleen can nearly always be made out on percussion and palpation, and occasionally is considerably enlarged. During the first acute stage it is tender to pressure, and may be painful. The specific micro-organism has been isolated from the spleen during life. Epistaxis occasionally occurs early in an attack; intestinal hæmorrhage is limited to spots of fresh blood in the stools in cases where the lower bowel is affected.

About the beginning of the third week, or earlier in severe cases, bronchial râles may be heard on auscultation in nearly 95 per cent. of cases. In acute cases basal congestion of the lungs is a most common symptom. In severe cases, and especially in those who have previously suffered from pleurisy, pneumonia, or have organic heart lesions, this is apt to pass on to double lobular pneumonia of varying amount, most marked, as a rule, on the right side. A nervous cough unaccompanied by expectoration is occasionally present; while in mild intermittent cases emaciation and night sweats may be combined with bronchial râles and crepitations, and give rise to a wrong diagnosis of phthisis. Pleuritic effusion without suppuration is not uncommon, and often leaves permanent adhesions behind.

The tongue is usually thickly coated with whitish-yellow fur on the dorsum, pink at the tip and edges, moist, swollen, flabby, and indented laterally by the teeth. In very severe cases only does it tend to become dry and

brown. Occasionally it becomes red, glazed, raw, and with the epithelium denuded in patches. There is usually foulness of breath, tenderness on pressure in the epigastric region, nausea, and occasionally vomiting, with other signs of gastric derangement. In non-malignant cases constipation is the rule; in my experience constipation has been marked in 81 per cent., diarrhœa in 4 per cent., both conditions in 3 per cent., and a normal condition in 12 per cent. of such cases. In fatal cases, owing to the frequent involvement of the lower bowel, diarrhœa has been present in some 50 per cent. of those that were noted. The condition of the tongue is a valuable indication of the suitability of the diet given, and of the permanency of any amelioration of symptoms. A fall in the temperature rarely proves permanent if the tongue remains coated.

Albuminuria is rare even in fatal cases, though a form of large white kidney has been met with in very prolonged cases.

The action of the virus on the nervous system may be regarded as one of the special characteristics of the fever, of which indeed many of the symptoms already mentioned may be more or less the result. Severe headache with shifting pains in the back and limbs is rarely absent in the initial stages. Later on constant or repeated attacks of facial or occipital neuralgia may be present. In a large number of cases, generally late in the attack, or even during convalescence when pyrexia has ceased, other nerves may be affected, and obstinate lumbago, intercostal neuralgia, or sciatica may be set up. In rare cases the acute stage is accompanied by general cerebro-spinal irritation, characterised by mental irritability, delusions, sleeplessness, cutaneous hyperæsthesia of variable extent, girdle pains, &c. Severe pain and hyperæsthesia of the soles of the feet is a not uncommon condition. Paralysis, partial or complete, of certain muscles is a late symptom. The extensors of the foot and the deltoid are most commonly affected. The muscle slowly atrophies, and as slowly regains, first its function and then its proportions,

nervous symptoms

recovery being complete. The special senses of hearing and touch become temporarily diminished in a number of cases without the administration of quinine. Taste is usually impaired, vision to a small extent occasionally. The decubitus is lateral until the patient becomes dangerously ill. Delirium is not common except in very severe cases, when it may pass into coma before a fatal issue. The writer has not met with mania or imbecility following attacks of this fever. The mind is clearer at the beginning than in enteric fever, but during convalescence the power of concentration of thought and of remembering names or figures is often temporarily impaired. Wakefulness and sleeplessness are common at first, and the nervous prostration following an attack is most marked. Retention of urine may occur during the acute stages. The effect on the mechanisms of heat regulation have been mentioned.

joints

Effusion into one or more joints is a very common and characteristic symptom, which may occur during the acute stage, but is more common during the third week or later. In some cases this condition, combined with very slight pyrexia, may be the only symptom complained of on admission, leading to a first diagnosis of rheumatism or even synovitis. The joints are attacked in something like the following frequency:—Hip, knee, shoulder, ankle, wrist, fingers, toes, elbows, sacro-iliac synchondroses, intervertebral joints and lower jaw, &c. This may come on suddenly in the course of an hour or two, and may disappear in a few hours or days, only to be replaced by a similar affection in some other joint, and this may be repeated over and over again, usually finishing up with the fingers or toes, having no regard to symmetry. The joint rapidly fills up, with great pain and occasionally some redness. Neither suppuration nor ankylosis occurs, but if the condition persists for long some œdema may be present in the surrounding tissues, causing it to resemble a severe gonorrhœal joint. Pain and stiffness in the aponeuroses or muscle sheaths may occur.

These symptoms appear to have a special predilection for those who have previously suffered from rheumatism or rheumatic fever elsewhere.

The rheumatic and neuralgic symptoms have often a relation to chills received during an attack of the fever.

Epididymitis and orchitis (usually single) occur at a late stage in a few cases, mastitis very rarely. The testicle swells in from twenty-four to forty-eight hours to the size of an orange, is extremely painful, while there may be some redness of the skin and effusion into the tunica vaginalis. It is often long in disappearing.

Abscesses occasionally occur, but are probably unconnected with the disease in question.

Ætiology.

(*a*) *Bacteriology.*—Although the disease has existed in the Mediterranean for so many years, it was not until 1886 that a micro-organism was discovered in Malta by Surgeon-Major Bruce (recently Assistant Professor of Pathology in the Army Medical School, Netley), to the effects of which the phenomena of this fever could be attributed. Bruce's first case died on the fifteenth day of the disease, when he found nine hours after death, in splenic sections, "enormous numbers of micrococci" scattered through the tissues. In May, 1887, with Dr. Caruana Scicluna, he made between thirty and forty inoculations into sterilised agar-agar with blood aseptically taken from the fingers of ten cases of this fever without result. One of these cases, however, proving fatal, eight tubes of agar-agar were inoculated with the usual precautions at 6.30 p.m., less than one hour after death. These were kept at the temperature of the air (25° C.) until 11 a.m. the following morning, when six were placed in an incubator at 37° C., while two remained at the temperature of the air. Colonies of a micro-organism, which the writer has named the *Micrococcus miletensis*, appeared in all these tubes. In the next case Bruce was unable to make an autopsy, but seven hours after death, by means of a sterilised trocar and cannula, he obtained some splenic pulp, with which he inoculated six tubes; these being placed under similar circumstances produced similar growths. These, with six other cases in which he obtained the micro-organism from the spleen after death, and one case in which he obtained it from the spleen during life, making ten cases in all, have all been published in the 'Annales de l'Institut Pasteur' and elsewhere with full details.

Surgeon Gipps, R.N., describes two cases in the 'Transactions of the Epidemiological Society,' vol. ix, in which he isolated a micrococcus, of which he gives drawings. Though his work was done in Bruce's laboratory he does not appear to place much confidence in its causal connection with the disease.

I worked for a short time with Bruce, and have isolated from the following thirteen cases a similar micro-organism, the fullest precautions being taken to eliminate error.

Case 1.—Admitted July 27th, 1891, æt. 22. Service two years, previous health good. Admitted with the usual febrile symptoms, onset being sudden. On the tenth day the symptoms partook of a typhoid character, the tongue became dry and brown, the pulse quick and feeble, the abdomen tympanitic; there was also subsultus tendinum, and abundant crops of sudamina. This continued until the twenty-fourth day, when he began to improve, the disease being characterised by constipation and rheumatic symptoms to the end, whereas from the thirteenth to the twenty-sixth day there had been a tendency to diarrhœa. From the fortieth to the forty-fifth day there was an apyrexial period, after which there was a severe relapse. The condition gradually became worse, tympanites set in, and was a prominent symptom. There were signs of hypostatic congestion at the bases of the lungs at the back. He died much exhausted at 6.30 a.m. on the

seventy-third day of the disease. The pyrexial curve was similar to that of Case 2, except that the first or primary wave lasted thirty-nine, and the second (fatal) wave twenty-seven days.

Treatment.—No solid food, stimulants, antipyrin, salicylate of soda, diaphoretics, sponging, &c. Quinine in various doses from two to fifteen grains three times a day.

Though not in clinical charge of the case, I had constant opportunities of visiting the patient during life, and there was no doubt as to the diagnosis of Mediterranean fever. At the post-mortem examination four hours after death, six army and three civilian medical officers were present, who all confirmed the diagnosis. The body was fairly well nourished, and the heart normal. The lungs showed some hypostatic congestion of both bases, with sero-purulent exudation in the bronchioles. Liver weighed 74 ounces, was slightly fatty. Kidneys normal. Spleen 12 ounces, enlarged and dark, but firm in texture. Stomach and duodenum normal; the jejunum had a patch of congestion, four and a half inches long, a foot below the duodenum. The ileum, Peyer's patches, and the solitary glands were all normal. In the large intestine the cæcum was normal, but just below this for one foot in extent, and again for six inches at the upper part of the sigmoid flexure, were patches of congestion and exudation. There was no sign of ulceration along the whole extent of the alimentary tract.

Experiment.—The spleen was removed as aseptically as possible, and without tearing its capsule; at once wrapt in a towel soaked in a solution of perchloride of mercury, and removed to the laboratory. There three cuts were made in the spleen with three sterilised knives, each cut being through, and at right angles to the plane of the preceding one, the innermost cut being used for inoculation purposes, the cuts being allowed to fall together between each operation. Three tubes of agar-agar were inoculated by a small drop of blood removed on a sterilised platinum ooze, two tubes were at once placed in the incubator at

99° F., and one left at the temperature of the air (about 75° F.). Characteristic colonies of the *Micrococcus miletensis* appeared in both the tubes placed in the incubator after 124 hours, but the tube left at the temperature of the air remained sterile. These growths were passed through six generations of pure cultures on agar-agar, and were used for inoculation of monkeys. One primary and two secondary cultures forwarded to Bruce at Netley were identified by him as the same micro-organism that he had previously found in such cases.

CASE 2.—Similar to the last in character. Admitted July 10th, 1892. Age 20; service six years, two of which had been in Malta. This man slept in a bed from which his comrades in his room said that other cases had been admitted to hospital. The bed in question was under a roof ventilator, placed next a main drain ventilator, the smell from which was complained of in the room.

Previous history.—Had suffered from slight attacks of febricula and bronchial catarrh in Cairo in 1887; from gonorrhœa four times in Malta between October, 1891, and June, 1892. Habits latterly intemperate, physique on admittance fairly good.

Clinical history.—Onset somewhat sudden, admitted on the third day of the attack with pains in the back and limbs, epigastric tenderness, and some vomiting, the last relieved by bismuth. Primary attack lasted twenty-four days, during which time there was a tendency to diarrhœa, but no other symptom of an enteric nature. After an apyrexial period of about five days the second wave began on the twenty-fifth day of the disease, the temperature remaining high, and the patient becoming daily worse. On the forty-ninth day he suffered from subcutaneous hæmorrhages over the sacrum and buttocks, but no bedsores appeared. There was tenderness on pressure in the epigastric, splenic, and left iliac regions, a tendency to diarrhœa with loose yellow stools throughout the relapse; while during the

last four days the stools were passed involuntarily. Death occurred on the fifty-fourth day at 7.15 p.m. from heart failure and exhaustion.

Treatment.—Careful dietary, and free use of stimulants. Gastric sedatives, antipyrin, cold sponging. Lead and opium internally, and opium and starch enemata for diarrhœa.

Examination one hour after death.—Body emaciated. Heart normal. Lungs showed hypostatic congestion of both bases. Spleen weighed 14 ounces, was very dark in colour, and soft in consistency. Liver weighed 59 ounces, was slightly congested. Stomach distended with gas and fluid food, but was otherwise normal. Duodenum normal. Small intestine contracted and shrunken, and about two and a half feet from the cæcum it was hyperæmic, with arborescent congestion in the course of the vessels. Peyer's patches and the mesenteric glands were all normal. The large intestine for two feet from the ileo-cæcal valve was intensely congested and offensive, which explained the presence of diarrhœa during life.

Experiment.—Cover-glass preparations of fresh splenic substance showed micrococci here and there. Three tubes of agar-agar were inoculated in the same manner as in the last case, and placed in the incubator at 99° F. Characteristic growths appeared in every tube within 120 hours of inoculation.

CASE 3, a malignant one, proved fatal on the twenty-third day from hyperpyrexia. He was the only fatal case that occurred in the epidemic mentioned on page 239 (2). For temperature see Chart IX. At the post-mortem examination the lungs were found to be much congested at the bases; the spleen congested, friable, and weighing 15 ounces; the liver congested, but Peyer's patches and the mesenteric glands normal. Inoculations were made in broth and on agar-agar, characteristic colonies appearing on the seventh and sixth days respectively at 99° F.

Case 4, also a malignant case in a delicate subject, proved fatal from cardiac failure on the twelfth day. At the post-mortem there were mitral vegetations, with fatty degeneration and infiltration of the heart. The spleen weighed 13 ounces, and was extremely congested; liver enormously enlarged (88 ounces), but Peyer's patches and the mesenteric glands normal. The spleen was removed one hour after death, and three tubes of agar-agar inoculated, characteristic growths appearing on the fifth day at 99° F.

Case 5 died on the eighteenth day of continuously high pyrexia, in a comatose condition. At the post-mortem examination, seven hours after death, the lungs showed basal congestion; the liver (73 ounces) was congested and friable; the spleen (21 ounces) was almost in a state of liquefaction, its substance breaking up on the slightest pressure. The mesenteric glands were slightly enlarged, but Peyer's patches were normal. The great gut for eighteen inches, including the cæcum, was deeply congested, somewhat swollen and thickened, and the solitary glands were prominent. Characteristic growths were obtained from the spleen on agar-agar in five days.

Case 6 died of collapse, vomiting, and exhaustion on the thirty-fifth day of the disease, the temperature having fallen the day before death only to rise again. After death the bases of the lungs and the spleen (18 ounces) were found to be congested, the mesenteric glands slightly enlarged, but Peyer's patches and the intestines normal. Characteristic growths on agar-agar were obtained from the spleen in 130 hours at 99° F.

Case 7 died of heart failure and pericardial effusion on the nineteenth day of a very remittent case. After death the autopsy showed lobular consolidation of the lungs, the spleen (12 ounces) congested, the liver nutmeg, and the heart with mitral vegetations. Peyer's patches and the

mesenteric glands normal. The micro-organism was visible in cover-glass specimens of splenic substance, and was obtained from the spleen on agar-agar in pure growths on the sixth day.

The last two cases slept near a broken drain in a previously healthy barrack.

Case 8 died of hyperpyrexia on the twenty-fourth day of continuously high pyrexia, after admission to hospital. After death there was basal congestion of both lungs, the spleen (12 ounces) was congested, the large gut much congested, the mesenteric glands slightly enlarged, but Peyer's patches normal. One hour after death the micro-organism was visible in cover-glass preparations of fresh splenic substance, and characteristic growths were obtained on agar-agar on the fifth day.

Case 9, a long case of short undulations (see Chart IV), died of sudden hyperpyrexia on the fifty-seventh day of the disease. After death the lungs were œdematous and congested at the bases, the liver (80 ounces) intensely congested, spleen (11 ounces) congested but firm, mesenteric glands and Peyer's patches normal. Micrococci visible, and growths obtained as in the last case.

Case 10, a somewhat unique one, was admitted to hospital for three weeks' fever and then discharged, apparently cured. Four months afterwards he was again admitted with fever of a typically intermittent character, which proved fatal from cardiac failure on the 154th day of the attack. After death the heart was flabby, there was a small aneurismal dilatation above the posterior left semilunar valve, and all three of these valves had vegetations on them. There was much serous fluid in the pleural cavities, the bases of the lungs being congested and œdematous. The liver (76 ounces) was nutmegged, the spleen (14 ounces) congested; but Peyer's patches, the mesenteric glands and intestines were normal. Six tubes inoculated from the spleen all showed characteristic growths on the sixth day.

CASE 11 died of hyperpyrexia on the twenty-fourth day of acute fever. After death there was considerable congestion of the bases of both lungs; the liver was nutmeg; the spleen (14 ounces) engorged with venous blood. There were patches of congestion here and there in the intestines, most marked in the colon. Peyer's patches and the mesenteric glands were normal. Characteristic colonies were obtained from the spleen as in the other cases.

CASE 12 had served for three years in Gibraltar, and for five months in Malta. He died suddenly of cardiac failure, after a slight excitement on the 111th day of the disease. At the post-mortem examination warty vegetations were found on the mitral valve, there were recent pleuritic adhesions at the base and posterior parts of the right lung, the lower lobe of which was consolidated. The spleen (15·5 ounces) was congested, soft, and friable, the liver congested. The kidneys showed the characteristic appearances of "large white kidney." The intestinal walls were attenuated, but were otherwise healthy. The spleen was removed three hours after death, and from it characteristic growths were obtained, while sections were made of portions of the different organs.

CASE 13 died somewhat suddenly on the sixty-second day of the disease, of effusion into the pericardium, during a relapse after his temperature had been normal for seventeen days. At the post-mortem examination 17 ounces of fluid were found in the pericardium, the right pleura was obliterated by organised lymph; the right lung œdematous and congested; the liver nutmeg; the spleen (15 ounces) congested, but the intestines, Peyer's patches, and the mesenteric glands normal.

Characteristic growths were obtained from the spleen on the fifth day after inoculation.

These altogether make thirteen cases in which I have successfully isolated the micrococcus from the spleen after death. If Bruce's ten cases and Gipps's two cases be added, we have twenty-five cases,[1] which make more than a coincidence.

The only case in which the growth was not found was in one published by Bruce. The failure was due to the use of too alkaline agar, a fact proved later by control experiments with growths from my cases on the same agar.

No other micro-organism has been found present under similar circumstances, nor has the writer met with a similar organism present in many other cases in Malta which he has tested, and which died from other causes.

Description of the Micro-organism.

The *Micrococcus miletensis* grows best on nutrient material, the alkalinity of which is slightly less than that of human blood, and at a temperature of from 37° to 38° C. At temperatures between 40° and 42° C. growth is suspended; above 42° C. artificial growths die. Below 18·5° C. growth is also suspended, while if they are kept at a moist temperature of 15·5° C. for long they die. Colonies that were allowed to dry completely were found to be dead when tested three years after. On the sloping surface of 1·5 per cent. peptone agar, at a temperature of 37° C., its colonies become visible to the naked eye in from 90 to 125 hours after primary inoculation from the human spleen. They first appear as minute transparent colourless drops on the surface of the agar, appearing somewhat like the agar itself. In about thirty-six hours more they become a transparent amber colour, and increasing very slowly in size, on the fourth or fifth day of their appearance become opaque. At this stage they

[1] I have since isolated this micro-organism from a further case, fatal on the 117th day of the disease.

resemble split pearls on the agar surface. Under a low power and with transmitted light such colonies appear to be orange in colour, quite round, with a definite but granular margin. If kept on moist agar they increase slowly in size, and while retaining their circular shape individually, may gradually coalesce. In the course of three months these colonies turn to a buff or even orange colour to the naked eye, and increase in thickness by heaping up material in the centre of the colony. The individual colonies never grow to any great size when compared with other growths, ceasing to grow when a little larger than a split pea. No liquefaction takes place. Though they do not increase in size after two months' growth, the colonies retain their vitality, at a suitable temperature, for over three months. The micrococcus will not grow on agar, the alkalinity of which is in excess of that of the human blood; but if cultivated on successive media of increasing alkalinity they can be educated to grow on very alkaline media. In this case, however, they are longer in appearing and grow more slowly in a very diffuse manner on the agar surface, with only abortive attempts at the formation of definite colonies. These diffuse growths, however, when transferred to agar having a suitable alkalinity, again revert to their original characteristic mode of growth. In making primary inoculations on old agar, the blood transferred from the spleen by drying, occasionally interferes with the growth of the colonies. This never occurs when the primary inoculation is made in broth, and secondary inoculations from this to agar made a few days later.

The micrococcus grows also in bouillon and gelatine. On the latter it grows very slowly at 22° C. without liquefaction. In the latter it gives rise to a general and increasing opaqueness, commencing on the fifth or sixth day, and afterwards forms a white precipitate consisting of these cocci, but without forming a surface pellicle.

Microscopically in the hanging drop they appear as very minute cocci, ovoid in shape, and in rapid molecular

motion. Many are seen in pairs, and a few in temporary short chains of four, the latter more especially if they have been growing on alkaline agar. The chains are never seen in dried cover-glass preparations. They stain very readily with all the aniline dyes, but lose their colour very rapidly if treated with alcohol or any of the usual decolourising agents.

The slow growth, peculiar appearance on agar, the small size that the individual colonies attain, the minute coccus, and the readiness with which the micro-organism decolourises, serve to differentiate it from others.

Inoculation Experiments.

(*a*) *By Bruce.*—(1) A male Bonnet monkey was inoculated in the left forearm with growth obtained from the human spleen, by means of a perfectly clean Pravaz syringe, the growth having been growing on artificial media in a pure state for a month previously. No changes appeared at the seat of inoculation, but on the day after his temperature began to rise,[1] and reaching 106° to 107° F., he died on the twenty-second day from inoculation. On post-mortem examination the lungs showed no signs of tuberculosis; the liver and spleen were enormously enlarged, and the intestines were free from ulceration.

Six tubes of agar were inoculated from the spleen, and two from the liver with full precautions. In all those from the spleen, and in one of those from the liver, the *Micrococcus miletensis* appeared after 168 hours. In the remaining tube no growth appeared.

(2) Another male monkey (Bonnet species) was similarly inoculated. The temperature rose rapidly, and he died on the thirteenth day. Growths were obtained from the internal organs, making their appearance after four days.

Bruce further found that rabbits, guinea-pigs, and mice, gave negative results.

[1] See 'Practitioner,' xl, 1888, p. 241.

(*b*) *By me.*—(3) A small male monkey (Bonnet species) was kept under observation for two months, during which time his appetite was good and his temperature stationary (about 99° F.). He was inoculated in November, 1891, by the injection of a colony of *Micrococcus miletensis* obtained from the spleen of the the first of the writer's cases, which had been growing in a pure state in the incubator for three weeks. The site of inoculation (the muscles of the forearm) had been previously shaved, cleaned with soap and water, and washed with a solution of perchloride of mercury. The syringe and all other apparatus had been carefully sterilised; the growth being mixed with 1 c.c. of sterilised bouillon, which had been under observation for one month previously.

Forty-eight hours afterwards the temperature began to rise, and daily increasing with a remittent curve, reached 106° F. on the fifteenth day, when he was killed, 362 hours after inoculation. For the first ten days the monkey was lively and continued to eat his food, but after that he lay about and refused it. See further, Chart XIII.

Five minutes after death the lungs were found to contain sero-purulent exudation in the bronchial tubes; the liver was congested; the spleen congested and very large in proportion to its body weight; there was slight congestion near the ileo-cæcal valve, but Peyer's patches were quite normal, and no other pathological condition was present. Seven tubes of agar were inoculated from the spleen in the usual manner; two tubes were inoculated from blood collected with an aseptic syringe from the centre of the unopened heart. These were placed in the incubator at 37° C., and of the seven splenic cultures five showed colonies of the *Micrococcus miletensis* in 168 hours, two showed contamination with *Micrococcus albicans* the next day; while of the blood-cultures, one showed the tppical growth after 168 hours, the other proved sterile. These growths were identical with those obtained from human spleens, macroscopically and microscopically, were

cultivated in bouillon, were carried through six generations of pure cultures on agar without change, and were identified by Bruce at Netley.

(4) A small African monkey was inoculated in the muscles of the forearm with growth from the cardiac blood of the last monkey, the same precautions being taken. The temperature began to rise the following day, though it had remained steady for a month previous to inoculation, and for eleven weeks he suffered from remittent pyrexia (see Chart XIV). He finally made a complete recovery.

(5) A female monkey (Bonnet species), under observation and in good health for three months previously, was similarly inoculated in the muscles of the right thigh with virus obtained from the spleen of the writer's first monkey, which had also been for some time under observation in the incubator to insure its purity. This monkey developed pyrexia consisting of intermittent waves of a remittent type, lasting over ninety-four days. She ultimately made a good recovery, and lived in good health for three years until killed by a dog. During the attack she lost weight, and like the last case seemed to suffer from pain or rheumatism of the extremities at irregular intervals, with irregularity of the bowels (see Chart XV). These monkeys' temperatures were taken three times a day by the same two persons throughout, a large amount of petting, time, and thermometers being expended. In no case did any changes occur at the seat of inoculation.

(6) A very savage and impatient monkey was also inoculated with human virus, and his temperature was taken at various intervals. No changes occurred at the seat of inoculation; he suffered severely from pyrexia, and ultimately recovered, but little more can be said.

Thus it may be said that when pure growths of this micro-organism are introduced into the tissues of healthy monkeys a pyrexial condition closely analogous to the Mediterranean fever of man is set up, and that after death a similar micro-organism can be isolated from their tissues in a pure state which is capable of producing a similar disease in other healthy monkeys.

More experiments are needed, but unfortunately neither the time nor the money necessary are available. The above experiments, however, fulfil the requirements of Koch's postulates entirely.

(*b*) *Age and sex.*—All ages are liable to this fever. Among soldiers and their families the ages have usually varied between five and thirty years. Infants under two have not often suffered. In the old long-service days at least half the cases were over thirty. Among the inhabitants of Italy and Sicily Guiffré gives between fifteen and forty years as the most susceptible ages, and states that children under six and adults over fifty are relatively exempt. This would appear to agree with the cases among the native population of Malta. Though no rule is absolute the average age of enteric cases in Malta among soldiers is lower than that of Mediterranean fever.

In a given number of families the women are attacked oftener than the men, the reason appearing to depend rather on age and occupation than on sex.

(*c*) *Season and climatology.*—In Malta the admission rate is lowest during the first quarter of the year, rises rapidly in May to a maximum in July, August, and September, after which it gradually falls until November and December, which two months are somewhat higher than those of the first quarter (abstract of 1339 cases). The same is the case in Gibraltar, Rome, Palermo, and Cyprus.

In Malta and Gibraltar its prevalence has been found to be in an exact inverse ratio to the amount and continuance of the rainfall from month to month. While the surface of the ground is kept constantly wet by rainfall the admission rate keeps down, but the cessation of rain in warm weather is at once followed by an increased activity of the poison, and a sudden excess in the attack

rate. Since 1859 the greatest prevalence has been during the driest summers, while the attack rate has become of increasing importance when the average monthly temperature has exceeded 60° F., and the rainfall descended below two inches a month (see Chart XI). The attack and mortality rates have shown a tendency to form quantitative waves of about seven years' duration.

(*d*) *Length of residence.*—This does not appear to confer immunity, for while in Malta, Gibraltar, and elsewhere enteric fever specially favours new-comers, Mediterranean fever attacks those who have been in residence for even six or more years. When a regiment is placed in an unhealthy barrack, if the susceptible element is very great, it suffers accordingly, nor does previous Mediterranean service confer an immunity.

(*e*) *Mode of prevalence.*—The disease is not propagated by contagion from man to man, nor does it appear to have any causal connection with milk or food supply. The distribution of the main water supplies does not in any way account for its localised distribution, and whatever effect polluted tank water may have on the native population, many hundreds of soldiers and Maltese are attacked, who have no access to such water. The season of prevalence and the distribution of cases of water-borne enteric fever in Malta are quite different from those of Mediterranean fever, and when both fevers occur together a dual cause is found to be at work.

In the past, Marston, Boileau, Chartres, Donaldson, Oswald Wood, Notter, De Chaumont, Duncan and Moffet, have ascribed this fever to insanitation, and more particularly to defective house drainage and fæcal pollution of the soil, the latter giving an accurate illustration of an outbreak at Gibraltar from such causes. In Italy opinions are divided, but those who disbelieve in a fæcal origin give no other explanation.

In my experience nearly all cases are localised, even when in epidemic form, to certain rooms in certain buildings, which rooms yearly produce their fever cases until some insanitation is rectified; the most constant factors present being fæcal contamination of soil (and air) by persons suffering from the fever, together with warmth and moisture; the factors necessary for its diffusion being the subsequent drying of the soil, the presence of air currents, and the close proximity of the human subject (a question of from two to twenty feet perhaps). Numerous outbreaks, confined to one household, have occurred simultaneously with the flooding of the floors with sewage from a choked and burst house drain, or overflowing cesspit. Many sporadic cases can be traced to escape of sewer gas from neighbouring drain ventilators, which, though above one roof, may be on a level with, and only a few feet off the windows of neighbouring houses, or to direct communication between rooms and the main drains by means of untrapped sinks or cupboard latrines; the virus being often concentrated in such cases by insufficient room ventilation. Occupants of healthy houses are exempt, but come under its influence on moving into infective areas. It is most difficult in so short a space to deal with this important and necessarily much-debated subject; especially as the evidence is, like that of all early epidemiological investigations, of a somewhat circumstantial nature; but, as Bishop Butler has said, "probability is the very guide of life." Out of a number of instances, the following will serve to illustrate the above points.

(1) In a new and well-constructed flat in Valetta the first occupant was invalided home with this fever. The next also suffered from the same fever, together with his wife and child; the child died, and the man and woman were invalided home. The next occupant was a man with a wife and sister. The sister suffered severely and the wife slightly from this fever. An inspection of the quarter disclosed a leaking pan-latrine on the verandah off the bedroom, and a leaking drain ventilator running in a circular turret staircase communicating with the same room. The smell from both, neither of which

was ten feet distant from the bed, entered the room, and was most offensive. People of the same rank in life occupying other portions of the block were unaffected. The water-supply was excellent and common to the whole of Valetta; the milk was obtained from goats milked at the door. The latrine was rectified and the ventilator placed outside the building, with excellent results.

(2) A regiment was quartered on a small island in one of the harbours of Valetta from January 2nd, 1892, until October 10th of the same year. During this period it suffered severely from "simple continued fever," 197 cases being admitted from a total strength of 760 men. The regiment had suffered severely from this fever elsewhere during its first year of service in Malta, had been seasoned by three years' residence, and was composed of men whose ages were not below the average of the station, yet their fever rate for 1892 far exceeded that of any other regiment. Of these men 480 were quartered in wooden huts, and the remaining 280 in an old fort close by, which had been built by the Knights in 1775. A careful analysis of the fever admissions divides them into two classes:

(*a*) Cases of true Mediterranean fever.

(*b*) Relapses or slight cases of the same fever (?), cases of simple ardent fever (febricula), and other obscure but slight febrile ailments without localised symptoms. The latter class were in hospital but a short time, and there is little to note except that the numbers were greater than from any other barracks in the island, and that in proportion to strength the admissions from the fort were double those from the huts.

The admission rate per mille for true Mediterranean fever in Valetta district (strength 3511, including the island in question) in 1892 was 52·2, while those of the huts and fort in question were 46·3 and 178·6 respectively, showing that some local cause of fever must exist within the fort. The men in the fort and huts belonging to the same regiment were of the same age and class, and under identical conditions as regards food and water supplies, the latter being common to a very large area of unaffected population, civil and military. In the fort thirty-eight men, two women, and five children were affected; and of the men one died (see Chart IX, Case 3), six were invalided, of whom one was finally discharged from the service, fourteen were sent to the sanitarium, and seventeen returned to duty straight from hospital, but were in many cases readmitted with relapses after leaving Valetta in October. The average stay in hospital was 109 days each for the men. The majority of the rooms in question were dark, close, and damp, and were never intended for barrack rooms. Round the back of the rooms ran large channels cut in the extremely porous rock, and passing on each side of the fort down to the sea. From 1870 these channels were used as sewers until the substitution in 1885 of the present dry-earth system. Mediterranean fever occurred in the fort as an epidemic in 1870 and 1872, but was not excessive from 1885 to 1891. During the latter period a quantity of sewage remained boxed up, with the result that the stone became soaked with sewage, even through the walls and flooring to the adjacent rooms. Analysis of portions of the walls of the channels and rooms showed a larger percentage of chemical constituents of sewage, much organic matter, and a very large number of putrid and non-pathogenic organisms, when compared with similar but unpolluted stone. Again, though unpolluted stone was highly alkaline, the stone of these walls was neutral or faintly alkaline, forming therefore a suitable nidus theoretically for the micrococcus of this fever. Between September and December, 1891, a thorough overhauling of the drains took place, these channels being cleaned and converted into surface-water drains, gratings being placed at intervals almost on a level with, adjacent, or even opposite the windows of the barrack rooms. Owing to their situation and construction there was a varying yet constant current of air from the sea travelling up these channels, and passing out of the gratings into the fort, the porous walls at the same time being wet or dry according to the state of the atmosphere and the amount of rain. There was ample opportunity for miasmata to pass from the rock channels into the barrack rooms, and it is a significant fact that these forty-five cases slept in beds grouped in close and definite relation to the rock channels and sewage-soaked walls, and in direct proportion to the amount of varying dampness present. The first case was admitted four days after the cessation of the heavy rain. There was no other apparent cause for the outbreak, and obvious sanitary measures have resulted in a cessation of this fever prevalence.

(3) In a large modern and well-built hospital, standing on one of the best sites in Malta, a number of cases of this fever (20—40) have for many years past been treated in wards on the top floor, without the disease spreading to others in the same wards. The hospital had always been considered a very healthy one until recently, when a few cases of this fever began to occur among venereal patients on the middle floor, and the patients and sick attendants occupying the ground-floor suffered severely from this fever. In the kitchen behind the hospital two cooks died of its effects, and patients suffering from slight ailments, such as sprains, &c., and who occupied tents immediately behind the building, also developed the fever. Many of the sufferers had been in hospital over a month, while others had resided in the building for many months previously. The water-supply was good and common to a large district, the milk-supply was above suspicion. On investigation it was found that the hospital drain-pipe, which ran along the back of the hospital between the main building and the ground-floor occupied by the kitchen and tents, had been blocked for some time beyond the main building, and that the fæcal

sewage from the fever and other wards had forced the joints of the pipe and leaked in all directions under the hospital foundations, and through the ground on which the kitchen and tents were situated.

At the same time in three officers' quarters in the same grounds, but well detached and for many years considered to be among the healthiest in Malta, six cases of this fever occurred in one summer. In this case the main and house drains were found blocked, and the backflow of sewage caused offensive odours of sewer gas to enter the back rooms from adjacent drain ventilators.

Though the details are not exactly laid down in this last instance, I have preferred it to other smaller instances with exact details on account of the large number of cases occurring in an English-built hospital, which had for a number of years been healthy.

Numerous sporadic cases occur in the old barracks built by the Knights during the last century, the causes of which are not always apparent. When we remember the state of filth in which these buildings must have been in those days, the soft porous stone with which they are paved, and of which their foundations are made, and, moreover, the way in which the whole foundations of the towns have during the past been riddled with leaking sewer conduits and cesspits, with the denseness of the population in Maltese and other towns, we can only wonder that the disease is not more prevalent. As these sporadic cases occur over and over again in the same rooms, doubtless further research will extend our knowledge.

Lastly, I wish to draw attention to a theory that the soldiers and sailors catch this fever while bathing in fæcally polluted harbour water. This could only account for a portion of the cases, and is at present but a matter of opinion, unsupported by accurate data, and needing further investigation.

(*f*) *Immunity from second attack.*—Though the medical

histories of many thousands of soldiers have been examined —these histories being accurately kept official documents in the case of every enlisted soldier—no record but one has been found indicating two attacks of this fever in the same individual. Though this may be owing to the short period that men are now stationed within the infective area, yet it has not prevented men from suffering from both enteric and Mediterranean fever on separate occasions. Guiffré does not believe that it confers immunity. From its behaviour to native Maltese it is probable that a temporary but not an absolute immunity is conferred, comparable to that met with in attacks of enteric fever.

Diagnosis.

Enteric fever is the most important disease, from a diagnostic point of view, that this fever can be mistaken for. The mistake is most likely to be made in severe cases with a tendency to pass into the so-called "typhoid state." Mediterranean fever is specially marked by its uncertain duration, irregular course, and the tendency in many cases to approach or reach normal during the first week, without apparent reason such as hæmorrhage, &c. (see Chart X); by the absence of hæmorrhages, rash, and iliac tenderness; by the rarity of diarrhœa and meteorism, by the physiognomy, moist tongue, smell, and an indescribable something about the fevers felt by the experienced; and lastly by the peculiar diaphoresis, neuralgic and rheumatic symptoms, and an absence of a rose-red reaction with Ehrlich's urine test.

From *paludism* it is distinguished by its non-paroxysmal nature, its resistance to quinine, and by the entire absence of the hæmatophyllum of Laveran.

From *phthisis, liver abscess,* and other suppurating diseases it is distinguished by the want of any local lesion to account for an apparently hectic temperature.

Prognosis.

This is good as regards danger to life and ultimate recovery, the case mortality being under 2 per cent.; as regards the length of time on the sick list, however, it is very unsatisfactory, the average time spent on the sick list being about ninety days. A previous history of cardiac or pulmonary disease, the presence of organic cardiac or renal disease, of excessive pyrexia, intermittent heart's action, pericardial effusion, diarrhœa from involvement of the large gut, broncho-pneumonia, tendency to dry brown tongue, and bedsores are all grave symptoms calling for constant attention and a guarded prognosis.

Pathological anatomy.

Based on reports of sixty post-mortem examinations on soldiers (duration of disease 4 to 156 days), at thirteen of which I was present. The general congestive appearances in cases which proved fatal during the first thirty days will, when necessary, be kept distinct from the generally more localised lesions in later cases.

Brain.—In thirteen cases in which the cranium was examined, the meninges and choroid plexus were congested (most marked in early cases), and in some there was effusion into the ventricles.

Heart.—The muscular walls are described as pale and flabby. In two cases (duration seventeen and sixty-two days) there was thickening of the mitral valves with pericardial effusion, the latter being the actual cause of death. In three short and three long cases mitral vegetations were present, and in one of the latter (duration 156 days) there were also aortic vegetations, a small aneurismal dilatation at the root of the aorta, and old pericardial adhesions.

Lungs.—In 87 per cent. of all cases, basal pneumonic congestion, injection of the bronchial tubes, with serous or sero-purulent exudation, were present. In 80 per cent. of early cases this had gone on to lobular consolidation, generally more marked on the right side. In 25 per cent. of cases there were pleuritic adhesions on one or both sides, in early cases apparently of former origin, but in later cases often undergoing vascular organisation. The bronchial glands were enlarged in proportion to the lung mischief present.

The *alimentary canal* is subject to patches of congestion, which, however, are not specially characteristic of this fever. These occurred in the stomach in 18 per cent., in the duodenum in 17 per cent. of short cases; and in the small intestines in 68 per cent. of all cases; while in the colon the condition occurred in 27 per cent. of all cases, of which thirteen had that peculiar swollen, inflamed, and œdematous condition of the mucous membrane which characterises certain severe cases of this fever. The congestion occurs in patches, following the arborescent course of the vessels, is not confined to nor constant in any one situation, and has no relation to Peyer's patches, which latter are unaffected. In early cases the mucous membrane is swollen and softened, but in late cases the intestines become extremely attenuated, the muscular and mucous coats having shrunk.

The *mesenteric glands* are enlarged in proportion to the intestinal congestion, being of normal size in most of the late cases.

Liver.—In half the cases this is congested and slightly enlarged, while in very late cases it is often nutmeg.

Spleen.—The spleen is always enlarged and congested. In early cases its weight averages 18 to 19 ounces, of a dark reddish-black colour, and in some 70 per cent. of such cases it is soft and friable like blood-clot, and in about 18 per cent. it is absolutely diffluent. In late cases the average weight is about 15 ounces, and it is of firmer texture.

Kidneys.—These are congested in early cases and often slightly enlarged; while in two long cases a condition of large white kidney was present. The capsules are usually somewhat more adherent in long cases.

Microscopical appearances.—The microscopical appearances are scarcely characteristic, but are more or less common to other acute fevers. In acute cases, according to Bruce, "the Malpighian bodies of the spleen are enlarged from an apparent increase in the number of the round lymphoid cells; the endothelial cells of the marginal sinuses are proliferating and swollen; a condition of intense congestion is seen in the section, the sinuses being enormously distended with blood; there is a marked exudation of small round cells along the lines of most of the venules. The liver is congested, the cells in a condition of cloudy swelling, and there is an infiltration of small round cells in the interlobular fissures. The kidney is congested and in a state of glomerular nephritis. The mesenteric glands when enlarged show proliferation of the cellular elements of the lymphoid tissue. The only change in the Peyer's patches is a slight proliferation of the cellular elements of the mucous and submucous layers."

Dr. R. T. Hewlett, of the British Institute of Preventive Medicine, has kindly examined the tissues of Case 12, in which death occurred on the 111th day of the pyrexia. He reports as follows:

"*Heart* (mitral valve), a small vegetation is present, which has become nearly fully organised into fibrous tissue.

"*Lung*, many of the air-vesicles contain large catarrhal cells and shreds of fibrin.

"*Liver*, neither fatty nor fibroid change; some slight amount of cloudy or granular degeneration of the liver cells.

"*Spleen*, nothing abnormal detected. *Mesenteric glands*, ditto.

"*Peyer's patch*, a slight increase in the lymphoid cells, no ulceration.

"*Kidney*, some tubular nephritis, evinced by cloudy swelling of the protoplasm and loss of nuclei of the epithelial cells of the tubules. In some places there is

some infiltration of round cells into the intertubular tissue. The glomeruli are normal.

"These changes are such as would be met with in the lungs, liver, and kidneys of any case of severe and prolonged fever."

Prophylaxis.

The institution of sound water drainage for all new houses when first built, constant and efficient flushing of both main and house drains, the raising of all drain ventilators well above and away from all windows, the abolition of all leaking cesspits in porous soils in thickly populated districts, the paving of cellars, yards, and in some cases of the streets, and the proper trapping and disconnection of all sinks, &c., the avoidance of polluted ground for camping purposes, and the prevention of pollution to the ground round camps and buildings, and due attention to all latrines and urinals, proper ventilation, and avoidance of damp and overcrowding. I here assume that the virus is of an aërial and fæcal nature—a conclusion I adopt from the nature of the virus, the season of its prevalence, and the distribution of cases. Finally, avoid Mediterranean towns between the months of June and October, and send all women and children away when possible during those months, and always remember that the Mediterranean, except in the hot summer months, is subject to sudden changes of temperature and that the air is very moist, necessitating the possession of the warmest of clothes, an extra cloak at sundown, and teaching the desirability of always sleeping in flannel, and wearing it next the skin.

Treatment.—There is no specific drug at present known which will cut short an attack of this fever. The treatment consists of placing the patient under the best circumstances for Nature to effect her own cure. Although many cases do well with careful nursing and dietary alone, it is a great mistake to think that that is all that is necessary, for we each find that as our experience increases our deaths decrease, our cases become milder and shorter, and complications are less frequent.

The patient should first be removed from any insanitary surroundings; he should be confined to bed entirely, and placed on fluid diet, as would be done in the case of enteric fever, bearing in mind that beef tea is incompatible with the presence of diarrhœa. Lemonade made from fresh lemons, grapes, or lime juice should be given to prevent any tendency to scorbutic symptoms, while soda water and fluids should not be restricted. If dyspeptic symptoms, nausea, or vomiting be present lime water should be added to the milk, and bismuth given internally; while if this condition becomes serious beef-juice, peptonised food, and champagne are very useful. There is a great tendency to overfeed patients with high temperatures. Patients should have abundance of fresh air, but be screened from direct draughts, and on account of the tendency to lung symptoms care should be taken to lay the dust with tea leaves before sweeping, especially in the case of the soft stone floors of Malta. All patients should wear flannel or flannelette sleeping suits, which in the case of children should be in the form of "combinations." As these will need frequent changing during the night a good supply should be available. Sheets should be of cotton.

Should the diagnosis be sure, the bowels should at once be opened. For this nothing works better than a good dose of calomel, combined with Pulvis Jalapæ, which frequently alone is sufficient to reduce the temperature in a constipated case. The bowels must further be kept open every other day at least, with occasional doses of calomel, cascara, or Pulvis Glycerrhizæ Co., or by enemata where any doubt as to the diagnosis exists. As diarrhœa is usually due to congestion of the large (or less often of the small) bowel, such treatment tends rather to prevent than to produce diarrhœa, and further appears to prevent the necessity for their constant use at later stages when persevered with at first. If diarrhœa be present, the greatest care must be taken to prevent it becoming serious. The diet must be attended to, and in the case of the large bowel, enemata of starch and opium must be given frequently. These enemata should be made with sufficient boiled starch to produce a consistency like cream, be given warm, and retained as long as possible. Rectal irrigation with a solution of boracic acid has been advocated. Diarrhœa of the small bowel is often due to unsuitable food or medicine, when otherwise it may generally be checked by a lead and opium pill, or by a mixture of opium, aromatic chalk powder, and astringents. The teeth, gums, and tongue must be attended to, and in summer a net is useful to keep off the flies which swarm round severe cases.

The skin should be sponged daily with tepid water and acetic acid, while a warm dose of diaphoretic mixture and brandy at night is often beneficial when the skin in severe cases remains dry. Sudamina and prickly heat should be bathed (but not rubbed) three times a day with a solution of boracic acid, while the extreme irritation of the latter may often be allayed by a coating of mild soap, left to dry on the surface until the next application of the boracic solution. Precautions should be taken against bedsores, especially towards the end of an attack, and when boils are present. The pulse must be carefully watched, its condition being taken as an index of the amount of stimulants necessary. When intermittent or weak in action, small doses of strychnia and digitalis with the exhibition of good champagne have worked well. In two cases of effusion into the pericardium without other complication, aspiration was not tried, and both proved fatal. Sleeplessness and nervous irritability are best treated by a full dose of morphia with bromide of potassium at night, or by Dover's powder when diaphoresis is desired; acute affection of individual nerves by the application of heat, flannel, and cotton wool, with perhaps opium or belladonna locally. Chronic sciatica during convalescence by constant flannel next the skin, warm ironing, gentle massage and rubbing with counter-irritant liniments. Painful and acutely swollen joints are soon relieved by continuous hot fomentation, followed by wrapping in cotton wool and flannel; acute orchitis by warm hip-baths, followed by support and belladonna. The painful hyperæsthetic condition of the feet yields best when soaked in cold water or wrapped in cold water bandages, any application of heat or warmth being intolerable. Lung complications should be at once treated with sal volatile, alcohol, and other stimulating expectorants, and when severe by jacket poultices, which followed by a cotton-wool jacket are most efficacious.

The bladder must be watched in severe cases lest retention be missed, while any irritability is generally removed by the administration of acetate of potash, soda water, and saline diuretics.

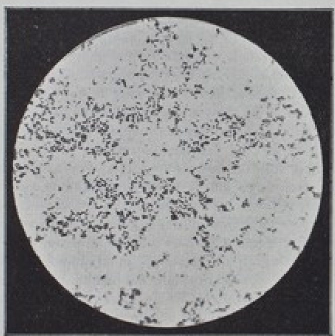
One of the greatest advances, however, in the treatment of this fever consists in the moderate regulation of the pyrexia by the application of tepid, cold, or iced water externally. By this means the commonest cause of death (hyperpyrexia) is avoided; the exhausting effect of high temperature on the heart, respiration, and higher nerve-centres abated, and death from these causes postponed or averted; chest and other complications become less common, while severe cases are converted into mild ones. We find that this form of treatment, while acting strongly on a special symptom, at the same time by stimulating the circulation and respiration, the metabolic and eliminatory processes, improves oxygenation, and aids in the elimination of toxic substances from the blood. At the same time, by giving rest to the heart, it restores equilibrium to the internal organs, increases the resistance and fighting power of the body, and so without injuring the patient has an almost specific action in this fever, beyond that met with in any other form of pyrexia.

To produce a satisfactory result, this treatment must be begun early, and before a fatal result is anticipated, or

the patient may be found to have already lost the strength necessary for successfully combating with the disease. The form of application which I have found most satisfactory has consisted of keeping the temperature systematically below 103° F. by means of cold water sponging, the application of iced water or ice packing according to circumstances. A great deal may be done in all cases by tap-water sponging, but ice packing should always be supervised by an experienced individual, the temperature being taken frequently and the pulse watched. Bad results have not followed this treatment when reasonably applied. The great secret of success lies in the avoidance of too great reductions, the temperature being reduced 2°—3° F. to a safe range, and no further. The administration of stimulants before and the avoidance of chills after treatment should be borne in mind, and also that no two patients respond with the same rapidity to this treatment. The immediate relief of headache, the refreshing sleep which follows such reduction, are marked; while the return to consciousness from hyperpyrexial coma is too well known in other diseases to need description.

The cleaning of the tongue and shortening in duration of the daily pyrexia are indications that the time is approaching for the cautious increase of diet, and that the patient may be soon allowed up for an increasing amount each day; but in most cases, and always when acute, this is better postponed until the temperature has been normal for at least ten days. The mucous membranes take a considerable time to recover their full function. During convalescence Stout, Blaud's pills, and the Citrate of iron and quinine are useful. Change to a warm, dry inland place in England is very beneficial during the enervating heat of the summer, but the trials of a sea voyage or overland journey should not be encountered until the acute stages are over, nor until an enteric diagnosis has been excluded. During the autumn and winter months patients are best away from the rigor of the English climate, and most cases recover well if kept in Malta or sent to the dry atmosphere of Cairo or to the hill towns of Italy or Sicily at that time of year. It is not justifiable to send acute cases away from the attentions and comforts of home or hospital, to the fatigues of travelling, the doubtful comforts of foreign hotels, and away from skilled and friendly advice, for the sake of an over-estimated treatment by change of air, and often to places where the same fever is known to exist. The beneficial effect of fresh air and change of environment during convalescence is, however, not to be denied.

Quinine in acute stages acts as an acute stomachic irritant and depressant, and does more harm than good. In very late stages when the appetite has returned, and the patient, though up and about, is still subject to



Photograph (1000 diam.) by Mr. Pringle.

slight nocturnal rises of temperature, small doses given three times a day often act as a tonic and assist in

steadying the temperature. Arsenic is injurious in acute stages, aconite dangerous from its effect upon the heart. Antipyrin at the beginning of an attack reduces temperature, relieves headache, and promotes perspiration, but is inferior in action to sponging, and in severe cases has a most dangerous effect upon the heart. Germicides, such as carbolic acid, boracic acid, and mercury, have been tried without proving of specific value.

In conclusion I may point out the importance to the State of the study of this fever. Its prolonged duration and high invaliding rate cause a very large amount of non-effectiveness among the 25,000 soldiers and sailors composing the Mediterranean garrison. In the Malta garrison in 1891, the loss to the State on account of this fever alone was equal to the loss of the services and cost of a whole regiment 1000 strong in hospital for twenty-five days. The first step needed is to give this fever a place in the Official Nomenclature of Diseases.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' Third Series, vol. viii, p. 176.)

EXPLANATION OF CHARTS.

CHART I.—Case of undulatory Mediterranean fever, admitted during the primary wave, with constipation (P. = aperient) and well-marked waves. Pyrexial duration, eighty-six days.

CHART II.—Similar case, with more regular waves, admitted to hospital in December, 1891, after nineteen days' treatment in quarters. Suffered from obstinate constipation (E. = enema), anorexia, anæmia, and extreme debility, but was never dangerously ill. Invalided to England on the 114th day of the pyrexia, where he suffered from occasional rises of temperature and severe rheumatic symptoms. Returned to duty in Malta in January, 1892, and has remained perfectly well since but for a slight attack of febricula in the summer of 1892, lasting three days.

CHART III.—Mediterranean fever with prolonged wave, associated with symptoms of cerebro-spinal irritation (P. = aperient).

CHART IV.—Chart of Case No. 9, "Bacteriology."

CHART V.—Illustrates a final wave of excessive symptoms at the end of a long case.

CHART VI.—Case of intermittent Mediterranean fever with constipation (P. = aperient), night sweats, malaise in the afternoon and evening, but no other complicating symptoms, ending in complete recovery. Treated on separate occasions with quinine (large doses once a day and also with small doses three times a day), arsenic, salicylates of quinine and soda, and antipyrin, without apparent effect.

CHART VI (a).—Complete diurnal curve, same case, days 43—51, with usually taken morning and evening curve in dotted lines.

CHART VII.—Mixed case commencing with the undulatory and ending with the intermittent type.

CHART VIII.—Case 2 in "Bacteriology."

CHART IX.—Case 3 in "Bacteriology."

CHART X.—Early sudden pyrexial drops in cases of Mediterranean and enteric fevers contrasted.

CHART XI.—Admission rate and rainfall contrasted.

CHART XII.—A common type of case with the waves less clearly marked.

CHART XIII.—Monkey experiment No. 3 (Hughes).

CHARTS XIV AND XV.—Pyrexial charts, monkey experiments 4 and 5 (Hughes), inoculated from last.

[Not to] be removed from the Library.

ON "WASHING" DYSENTERIC STOOLS.

By KENNETH MACLEOD, M.D., LL.D.

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ON "WASHING" DYSENTERIC STOOLS.

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By KENNETH MACLEOD, M.D., LL.D., *Professor of Military Medicine, Army Medical School, Netley.*

THE examination of the intestinal evacuation in dysentery has an importance, in relation to diagnosis and treatment, similar to the examination of the sputum in phthisis—similar, but greater; for in phthisis the results of physical examination are more clearly demonstrative of the nature and stage of the disease than inspection, palpation, and percussion of the abdomen in dysentery. These processes do, indeed, furnish useful information. The shrunken tender belly, the pain elicited by pressure along the course of the colon, the resistance, the perception of thickening of the whole or some portion of the large intestine, the detection of scybalous accumulations,—these are aids to diagnosis and localisation of lesion which cannot be neglected, and are perhaps more helpful in chronic than in acute cases.

Symptoms subjective and otherwise are also valuable; but the scrutiny by eye and microscope of the pathological products—the castings off from the diseased surface—afford more positive knowledge of the character and stage and curability of the disease than signs and symptoms. In some cases simple inspection of excreta is sufficient. The evacuations in acute cases, and in early stages of these, may consist simply of a tablespoonful or so of blood-stained mucus, with a few small clots, and rounded or oval scybalous matter surrounded by sanious fluid. The pathological product in such instances solely constitutes the stool, or lies apart from feculent matter so completely that it can be thoroughly seen and examined, or taken for microscopic or cultivation purposes without difficulty or obscuration by admixture with other intestinal contents. These cases are, however, a small minority, and are mostly those in which the disease is located not far from the anus,—rectal or low-down sigmoid. In the great

majority of cases, more particularly in those of long standing, the pathological products are mixed up with feculence in such a way as to conceal them, and render necessary some means by which they may be separated. This may happen when the stools are liquid or solid. When diarrhœa coexists with dysentery, as often happens in the catarrhal stages of acute cases, and in chronic cases where there is defective absorption of fluid, and perhaps exudation from denuded or ulcerated surfaces, the feculent mass is gruelly or pultaceous, variously coloured—ochre, brown, umber, olive, or green—and probably gummy or glistening, but the mass seems to be uniform and its constituents are concealed. When the stool is solid, it may be lumpy and scybalous, or in rounded or flattened cylinders. These may be covered with clear or cloudy mucus; but in the interior of the masses, important things, such as casts and exuviæ of sorts, may be hidden from view. It becomes necessary, therefore, to disintegrate and dilute the mass, and if possible separate the pathological products from the feculent material. This can be done by adding water in considerable volume and successive quantities to the mass, decanting and observing after each addition of fluid, and finally retaining the residue for more careful examination. This process of "washing" dysenteric stools was first introduced into practice by Dr. Edward Goodeve, Professor of Medicine, in the Calcutta Medical College. It is habitually employed in India; but recent books and papers published in this country on tropical diseases and on dysentery do not refer to the practice, and this constitutes a sufficient reason for setting forth here its method and advantages in detail.

Technique of the process.—The stool is received in or transferred to a vessel of considerable capacity—the pan of a commode, for example. This is filled with water poured from a height of a foot or so, from a jug or ewer or tap. Masses may, if necessary, be broken up by a glass rod or stick. After allowing the material to settle for a minute or so, the fluid is slowly decanted into another vessel, so as to present to view a thin layer. The feculence floats and passes over with the fluid; the pathological products and heavy particles of feculence subside. What passes out is carefully watched and noted, and what remains may be again and again washed by adding fresh volumes of water and decanting, until the material has been freed of offensive and compromising stuff, when it may be transferred into a white plate or dish for examination. The process may be employed in other intestinal diseases, sprue for example. In most cases of dysentery, accurate study of the intestinal discharges cannot be made in any other manner.

The information gained by this process of washing the stools may be summarised as follows:—

1. The colour of the fluid indicates the amount of blood con-

tained in the evacuations, according to the depth of the tint when it is sanious.

2. The size, shape, and character of feculent masses when solid may be noticed, and inferences may be drawn as to the condition, calibre, and tone or irritability of the diseased gut.

3. The nature and activity of the digestive process may be inferred from the state of the excreta. Undigested masses of meat or farina may be seen, or curdy lumps of imperfectly digested milk observed.

4. The character of the ingesta may be determined. Imperfectly masticated and undigested pieces of potato, vegetables, or fruits are easily identified, and grains of unboiled rice or sago discerned, and seeds of oranges, figs, grapes, etc., descried. Many of these things sink and are seen amongst the residuum. The dieting of the patient can thus be very effectually watched and controlled.

5. The lighter particles of mucus float in the water, and this may be flocculent or tenacious—clear, rosy, branny, or ropy. Inferences are drawn from these characters, as regards the stage and intensity of the dysenteric process and effects of treatment. Clear or rose-coloured flecks indicate an early (catarrhal) stage; branny particles, a dysentery undergoing satisfactory cure; and ropy masses, a slower process of recovery in a more protracted case.

6. The residuum may show blood clots of various kinds and sizes, masses of jelly-like mucus, lumps of more solid inspissated mucus, and casts or exuviæ of various sorts. These latter are the most important pathological products, indicating a grave malady of some standing, and destructive lesions of varying kind and degree. The nature of the destructive process may be surmised from the character of these casts or sloughs. They may be pulpy and circular, or oval, soft, and disruptible, yellowish or greenish, consisting of a pus-infiltrated mucosa, and representing castings off of an inflamed mucosa or submucosa. They may be stringy, tenacious, and angular, consisting mostly or entirely of detached submucosa. They may be greenish or drab-coloured, thick, large, or cylindrical, the result of coagulation necrosis of an extensive diphtheritic deposit on and in the walls of the intestine. They may be dark, pulpy, offensive, and soft, due to a process of gangrene. The relation of these different products to diagnosis, prognosis, and treatment is obvious and most important.

7. The products thus obtained can be subjected to further examination, for bacteria or amœbæ for example, or preserved with spirit or carbolic water for further study.

8. The results of treatment may to some extent be judged. Changes in the character of the evacuations are best appreciated when these are subjected to this system of analysis. Pills or tabloids may be seen which have passed through unaltered and

unused. Grains of ipecacuanha or other powders, or of reduced bismuth, may be observed, which perhaps increase or perpetuate the irritation.

The intelligent treatment of dysentery necessitates continuous and systematic examination of the stools, and the method which I have described largely robs this proceeding of its unpleasantness, while it contributes most materially to thoroughness and enlightenment.

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TWO CASES OF HEPATIC ABSCESS; WITH CLINICAL REMARKS.

BY

K. McLEOD, M.D., LL.D.,
COLONEL, I.M.S. (retired),
Professor of Clinical and Military Medicine, Army Medical School, Netley.

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The following cases, which recently occurred in the Royal Victoria Hospital, Netley, illustrate several important points in the natural history, diagnosis and treatment of abscess of the liver.

Case No. 1.—*Hepatic abscess evacuating through right lung; repeated explorations; signs of rupture into right pleura; drainage; secondary hæmorrhage; death.*

Sergeant-Farrier J. E. H., 11th Hussars, *æt.* twenty-seven; service—home $3\frac{8}{12}$, Indian (Punjab) $5\frac{3}{12}$, total $8\frac{11}{12}$; invalided 17th January, 1898; left India 6th March, 1898; admitted Netley, 29th March, 1898. Character, regular and exemplary.

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* Sent for publication from A. M. D. Report for 1898.

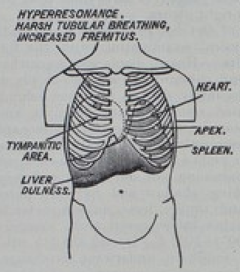
His medical history sheet does not indicate any important illness until November, 1896, when, at Sialkot, he was admitted into hospital for a smart attack of ague which detained him for seventeen days. He suffered from diarrhœa in the same station and year, but the symptoms were not so severe as to compel him to report himself sick. On the 24th of July 1897, he was admitted at Sialkot for pneumonia affecting the lower lobe of the right lung, and was discharged to duty after nineteen days' detention. His regiment being ordered to the front, he marched to Rawal Pindi, and there received orders to shoe the horses' hind feet. He received some blows on the right side while executing this duty, which were followed by pain, and a few days afterwards, whilst at work, he suddenly spat up about a quart of blood and pus. This eased his pain, and he continued to work for a week, when, the spitting persisting, he sought admission into hospital on the 4th of October 1897. His case was diagnosed to be a hepatic abscess, evacuating through the lung. He admitted at this time having been in the habit of occasionally drinking hard. The symptoms subsided and expectoration ceased, and he was discharged to duty on the 24th of October. In November he had a return of pain in the right side accompanied by fever, and on the 20th of that month profuse expectoration of purulent matter took place. This has persisted since that time.

On admission, at Netley, he was found to be very emaciated and anæmic. He spat up large quantities of fœtid chocolate-coloured material and suffered from fever of a hectic type. On seven occasions his liver was explored by means of an aspirator at different situations and levels;

but no indications of pus were discovered. The last exploration, high up, drew some clear serous fluid which was judged to have come from the cavity of the right pleura.

On the 4th of October 1898, Mr. Carmo made a careful physical examination with the following results:—Heart displaced, somewhat downwards and outwards; lower two-thirds of right lung absolutely dull in front and behind, with suppressed resonance and fremitus and respiratory sounds; left lung hyper-resonant with puerile respiration; expectorating between three and four pints a day of chocolate-coloured viscid fluid containing pus and mucus, and very fœtid; breathing shallow and hurried; pulse small, soft, and rapid; liver dulness extends about two inches below costal arch; temperature from 100° to 101° F. During the 5th, 6th, and 7th, his condition underwent no change. On the 8th there was a suppression of expectoration up to 12 noon, and free emission of the usual material afterwards. On the 9th, the expectoration was scanty, clear, and muco-purulent; temperature higher; dyspnœa; pulse smaller and more rapid.

On the 10th, expectoration still scanty and clear; dyspnœa and palpitation distressing; aching pain over right side. Heart greatly displaced to left; apex beat in 6th interspace, 3½ inches below nipple and 2 inches external to it, action tumultuous, impulse and sounds diffused, pulse 126. Liver dulness extends to near level of umbilicus; spleen enlarged. Tympanitic resonance from second to sixth rib arteriorly, extending to mid axillary line laterally; absolute dulness over rest of lung posteriorly; level of dulness altered by changing position. Resonance and vocal fremitus exaggerated superiorly, suppressed inferiorly; respiration harsh at apex, faint and distant or absent elsewhere. Left lung the same as before, respirations 88, shallow. The accompanying diagram indicates roughly the conditions observed on the 10th of October, from which, in conjunction with the general symptoms,



the inference was drawn that the abscess had broken into the right pleura, the lower two-thirds of the cavity being filled with pus and air, and the upper third shut off by adhesions. Direct drainage through the chest wall was, therefore, deemed advisable to relieve symptoms and permit of free discharge of pus and obliteration of the abscess cavity. Accordingly, the patient was transferred to the surgical division, and on the 11th, Major Dick, after the man had been anæsthetised with chloroform, introduced an aspirator needle for the purpose of exploration, through the 7th inter-space in the mid axillary line. After the instrument had entered about an inch and a half, a free discharge of grumous fœtid pus took place. A free incision was made and an inch of the seventh rib removed. Large quantities of dark

brown material flowed forth. The finger entered a spacious cavity, with smooth irregular walls; but no aperture in the diaphragm could be detected. The later discharge was thicker and more like liver pus. Two large drainage tubes were inserted, and a voluminous antiseptic dressing applied. It was observed after the operation that both heart and liver had resumed their natural positions.

The operation was followed by decided relief. The temperature fell, the breathing became easier and heart's action steadier. The patient was able to sleep, and felt altogether much more comfortable. The discharge continued for a few days to be very copious and putrid, but became on the 14th less grumous and fœtid. He had a slight attack of diarrhœa on the 17th and 18th which was checked by opium and astringents. On the 18th he had a subnormal temperature, and on the 19th there was pain in the right side, and no discharge on the dressings. The tubes were withdrawn and found to be blocked with slough. They were cleared and reintroduced without trouble. Shortly after hæmorrhage set in, which proved quickly fatal.

A *post-mortem* examination was performed on the 21st by Captain Lamb, I.M.S., who kindly supplied the following notes:—*Rigor mortis* well marked; body fairly well nourished; a wound 1½ inches long on right side of chest in mid axilliary line, corresponding to 7th inter-space. On opening the thorax, *right lung* found to be adherent to the pericardium to a slight extent, and for a considerable distance around the above-mentioned wound there are strong fibrinous adhesions; on breaking these down a large cavity is opened involving the lower lobe of the lung; this is full of blood-stained pus, with a considerable amount of clot and broken-down lung; the cavity involves the whole of the lower lobe of the lung; the upper part of the pleural cavity completely shut off by strong fibrinous adhesions.

Left lung and pleura healthy.

Pericardium contains about 2½ ozs. of clear fluid; the *heart* is somewhat flabby, but otherwise healthy. The upper surface of the right lobe of the *liver*, the diaphragm over this, and the inferior surface of the lower lobe of the right lung is firmly adherent together. On cutting into the liver towards the upper and back surface of the right lobe, an abscess cavity about the size of a tangerine orange is opened into; it is full of inspissated thick pus which is neither bile nor blood-stained; the cavity is limited all round by a very thick membrane, honeycombed on its inner surface. Between this cavity and the thickened layer which binds the lung and liver so firmly together, a thin layer of liver tissue can be dissected off, and no communication of any kind is detected between this cavity and the cavity of the lung. The lung cavity, as previously mentioned, involves the whole of the lower lobe; its walls are rugged and numerous; bronchioles open into it; no opening into any artery can be detected. Liver generally is slightly enlarged, pale and mottled.

Spleen is very dark and considerably enlarged.

Kidneys healthy.

Intestines. No ulcer or cicatrix is found in either small or large gut.

Case No. 2.—*Enteric fever; right pleuro-pneumonia; evacuation of 24 ozs of serum from right chest; rupture of hepatic abscess into right pleura; death.*

Private C. R., R. I. Fusiliers, *æt.* 22; service—home $2\frac{4}{12}$; foreign (Egypt) $\frac{7}{12}$; total, three years. Invalided from Alexandria, 1898. Admitted 20th September, into Netley Hospital 3rd October, 1898.

He was admitted into hospital from the Mustapha Barracks on the 15th of July 1898. His case was diagnosed as enteric fever, which is reported to have run a prolonged course "with the usual symptoms." He was greatly debilitated. He improved slightly on the voyage home, but complained of pain in the right side.

On admission, he suffered from cough, pain in upper part of right chest and tenderness in right groin. He was very weak and emaciated. On examination the right chest was found to be dull to percussion below the level of the nipple in front and behind. Left lung hyper-resonant. Heart displaced downwards and outwards. Liver dulness extended about two inches below costal margin. Sputum copious of a chocolate-brown colour, viscid and almost odourless. Temperature of a hectic type. Diarrhœa troublesome. On the 9th of October, the signs pointing to pleuritic effusion, the right chest was aspirated by Major Dick in consultation with Lieutenant-Colonel Webb, and 24 ozs. of clear, straw-coloured fluid were removed.

The operation was followed by considerable relief, but the tenderness of lower chest and right groin persisted. On the 13th of October, it was noticed that the cough was not so troublesome and that the character of the expectoration had altered—had become clearer and lost its brown tinge. On the 17th, pain in the hepatic region was acute, and some blood was passed with the stool, the diarrhœa continuing. On the 21st, a decided change for the worse occurred. The hepatic tenderness was more marked, and the liver dulness had descended. There was also some œdema of the hepatic area, and the sputum had resumed its previous character. Abscess of the liver was now suspected, and exploration proposed; but the patient firmly resisted any operative interference. His condition grew rapidly worse, and he sank of exhaustion on the morning of the 23rd of October.

A *post-mortem* examination was performed on the forenoon of the 26th by Captain Lamb, from whose notes the following facts are abstracted:—

External appearances.—Rigor mortis gone; body fairly well nourished; considerable bulging of right side of chest which is absolutely dull on percussion from the clavicle to below the costal margin.

Thorax.—On opening right thorax, a large quantity of dark purulent matter escapes; the right pleural cavity is distended with this material. Right lung completely collapsed and pushed to the back of the cavity which communicates by an opening in the diaphragm, about the size of a crown piece, with a large cavity in the right lobe of the liver. The wall of the pleural cavity is irregular and ragged, and is partly constituted by the middle lobe of the lung, which is deeply excavated, several bronchioles opening into the cavity; pleural membrane thickened. Upper and lower lobes collapsed and flattened and sink in water.

Left pleura free from adhesion; lung slightly œdematous. Pericardium contains fluid; heart pale and flabby, otherwise healthy.

Abdomen. — Liver considerably displaced downwards; right lobe excavated by a large abscess cavity about the size of a child's head

at birth, and full of dark grumous pus. Liver tissue fatty and congested (nutmeg liver). A small abscess in left lobe near the upper surface about the size of a pea. Spleen and kidneys normal.

A considerable number of ulcers are found in the cæcum and ascending colon; they vary in size from a pea to a florin, are raised and floored for the most part with irregular sloughs. They vary, in shape, some being circular and others oval. Some solitary glands in their neighbourhood are observed to be swollen. Peritoneal surface opposite ulcers, dull and thickened. No ulcers or cicatrices in small intestine or other portions of large intestine.

Remarks.

These two cases occurring, as often happens in hospital experience, at the same time, illustrate some interesting points and raise some useful practical questions in relation to the spontaneous evacuation of hepatic abscesses through the lung, and the proper management of such cases under various contingencies, which may be dealt with under the following heads:—

1. *The situation of the abscesses.*—In both cases the cavities occupied the upper and back part of the right lobe adjoining the fissure for the vena cava. This is the usual site in such cases, and offers less resistance upwards than in any other direction. This position also accounts for the difficulty experienced in finding the abscess with an exploring instrument, either from the front or side; also for the absence of signs, such as fulness, fluctuation, circumscribed tenderness, intercostal bulging, or œdema, which exist in liver abscesses which lie closer to the surface.

2. *The preliminary processes.*—These are phrenic and pleuritic to start with—first inflammatory and then destructive. The circumferential adhesions are the protective outer zone of a process whose centre is necrotic. During this stage, the symptoms are thoracic rather than hepatic and pleuritic rather than pulmonary. In both cases an extension of pleurisy in milder form affected that portion of the membrane which had been shut off from the abscess cavity by adhesions, resulting in serous effusion into the pleura—slight in case No. 1, and copious in case No. 2; so copious, indeed, in the latter case, as to mask the real and more important disease. This possibility of occurrence of serous effusion into the general cavity is a clinical fact of importance to be held in view. The signs and symptoms indicating the existence of these preliminary processes are pain in the region of the diaphragm, sometimes of a very acute character, extension of liver dulness upwards, painful catching on deep inspiration, dry cough, fixation of right chest and friction over the base of the right lung

3. *The Secondary Abscess.*—Whenever a liver abscess seeks a distant point of discharge, it is by means of formation of secondary abscess that the object is sought to be accomplished. Such abscesses occur in the epigastrium, hypochondrium, chest wall or loins, and they simulate parietal abscess, and are perhaps opened as such. The peculiar character of the pus reveals their true character, and on exploration with the finger, a more or less contracted aperture is found, admitting entrance into the liver cavity, unless, as may happen, this has been shut off. In evacuation into stomach, duodenum, colon, peritoneum, pleura or pericardium, such second-

ary abscesses are not formed. In cases of evacuation through the lung, cavities are excavated in that organ, either by irruption as in case No. 1, or erosion as in case No. 2. The lower lobe is the usual seat of the destructive process which opens the bronchioles and gives exit to the discharge. In case No. 2 the middle lobe was the portion implicated. The abscess had climbed up along the right side of the pericardium, and the eroded lobe formed its outer wall. Indications of gangrenous destruction of the lung substance were evident in both cases, and what remained of the lobe in both was compressed and consolidated. Why it is that in some instances complete and rapid evacuation is accomplished, and in others the process is delayed or fails to be completed until death by exhaustion occurs, it is not easy to conjecture. The first case is an illustration of apparently complete evacuation in a short time, and then, after a period of apparent convalescence, recurrence of the symptoms. This is not an uncommon history, and the period of intermission may be a prolonged one. Sometimes it looks as if a second abscess of the liver had formed, and was seeking exit by the old route; but probably in most cases the event is due to fresh accumulation in the old cavity. In either event the original symptoms of fever, pain and weight in the side, &c., are reproduced.

4. *Irruption into the pleural cavity.*—In some instances this event is primary, in others secondary. In case No. 2 it was undoubtedly the latter—must have occurred between the period of aspiration and death. Perhaps the removal of the pleuritic effusion, by altering the balance of pressure, caused or conduced to the rupture of the membrane separating the pleural

from the abscess cavity. There was no indication of the accident, and in case No. 1, there were indications which appeared to be very positive and convincing; but they were due to acute distension of the lung cavity with pus and air, owing probably to failing expulsive power. Whether the filling of the pleural cavity with the products of hepatic and pulmonary destructive suppuration be primary or secondary, there can be no hesitation regarding the immediate necessity of making a free opening in the parietes (including resection of a rib or ribs) and establishing free and direct drainage. I have seen recovery take place in very desperate cases of this nature.

5. *The reparative process in the liver.*—In case No. 1, this was advanced; the communication between lung and liver had been obliterated; the abscess cavity had been encysted; its wall thickened; its contents degenerated and converted into a fatty emulsion which would in time have become caseated and then cretified. The pathological struggle had been transferred to the chest. In case No. 2, indications of reparative change also existed; the abscess wall was thick and globular, shutting out the cavity from the liver substance, which was no longer being broken up: the walls were lined with lymph, and progressive organisation and contraction of the cicatricial material would, no doubt, had the man lived, have accomplished the shrinking, and more or less complete obliteration of the liver abscess. There also the burden of morbid activity had been translated to the cavity of the right chest.

6. *The diagnosis.*—The history in both cases was obscure. In No. 1 the abscess of the liver must have been in existence—latent or concealed

—until the events of October 1897 disclosed its existence. The diagnosis of rupture into the pleural cavity was wrong, but the physical signs and general symptoms pointed to that accident. The treatment adopted was, however, correct. In No. 2 it is more than doubtful that the man ever suffered from enteric fever. The conditions found after death must have taken a considerable time for their development, and the pyrexia, combined with the cæcal lesions, must have closely simulated enteric. The acute pleurisy further masked the abscess, until shortly before death, when the true nature of the case was recognised. An exploratory puncture through the chest wall would then, if permitted, have fully confirmed suspicions and led to the only practice which offered any hope or possibility of cure. The existence of an incipient abscess in the left lobe of the liver might, and probably would, have thwarted recovery even if removal of the morbid material had been procured by a free drainage opening.

7. *Cæcal dysentery.*—Case No. 2 was a typical example of a dysenteric process, affecting mainly the solitary glands, confined exclusively to the cæcum. In these cases, the classical symptoms of dysentery—tormina, tenesmus, colic, thickening, angina and frequent scanty discharges of blood and mucus are apt to be suppressed, and those of enteric fever simulated. The lesions in the cæcum were of long standing and may have preceded the hepatic lesion.

8. *The lesson to be learned.*—The question suggested by these cases is—whether exploration of liver abscesses seeking vent through the lunga should not be made above, rather than below, the diaphragm. I have seen so many failures to hit the liver abscess by exploration from below,

through the substance of the liver, that I am inclined to think that a cautious search along the convexity of the diaphragm would be a safer and more successful proceeding. The general cavity of the pleura is in this situation shut off by adhesions, and the route of approach indicated would also be the best route for drainage in the event of the cavity being broached. The exploration might be made by the aspirator needle introduced through the 7th interspace and pushed directly inwards, or by incision through the same interspace and subsequent use of the finger or director or a straight catheter.

With Dr. O'Connell's Comps.

AGUE
OR
INTERMITTENT FEVER.

BY

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Calcutta:
THACKER, SPINK & CO.

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I.—WHAT IS A MALARIAL CLIMATE?

——:o:——

Although, in the opinion of the majority, Laveran's discovery of the Hæmatozoon Malariæ definitely put an end to further controversy on the pathology of malarial fevers, still there are some who, remembering the ultimate fate of the Palmella of Salisbury, and the bacillus Malariæ of Klebs and Tommasi Crudeli, as well as the fact that there is even at present a rival in the form of v. Sehlen's Micrococcus, hesitate to admit that the question is yet finally answered.

Payne in discussing the pathology of Ague gives preference to the parasitic theory, and says that only two other theories are possible, *viz.* (*a*) that the disease is due to a gaseous emanation from the soil, or (*b*) that it is due to a permanent susceptibility to chill.

While not disposed to question Payne's opinion in as far as it relates to the continued, remittent, subintrant or other numerous forms of malarial fever, given by the Continental plasmodists, I venture to assert, as regards Ague, that another theory is not only possible, but fully adequate, to explain the facts of the disease and its consequences. This theory may be shortly stated in two words, meteorological environment.

The theory may be conveniently divided into two parts or questions—

1st.—What is the meteorological environment of Ague?

2nd.—Can this meteorological environment cause an intermittent fever or Ague?

With regard to the first question we know that for years Ague was believed to be caused by climate. And if asked what is malarial climate, we were told that it was characterised by a hot, moist and stagnant atmosphere.

Under such environment Ague invariably became prevalent.

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Under such environment Ague invariably became prevalent.

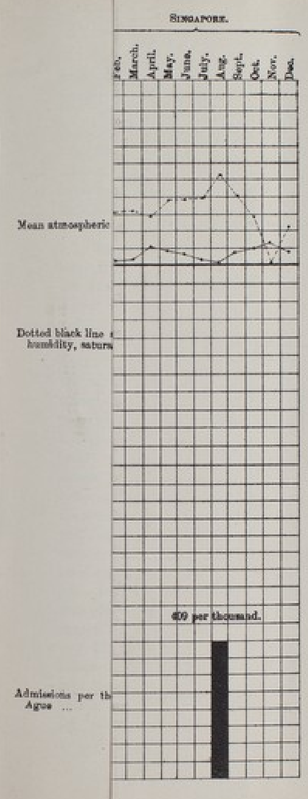
Atmospheric temperature.—The degree of atmospheric temperature under which Ague tends to become most prevalent, can be easily seen from the Reports of the Army Medical Department.

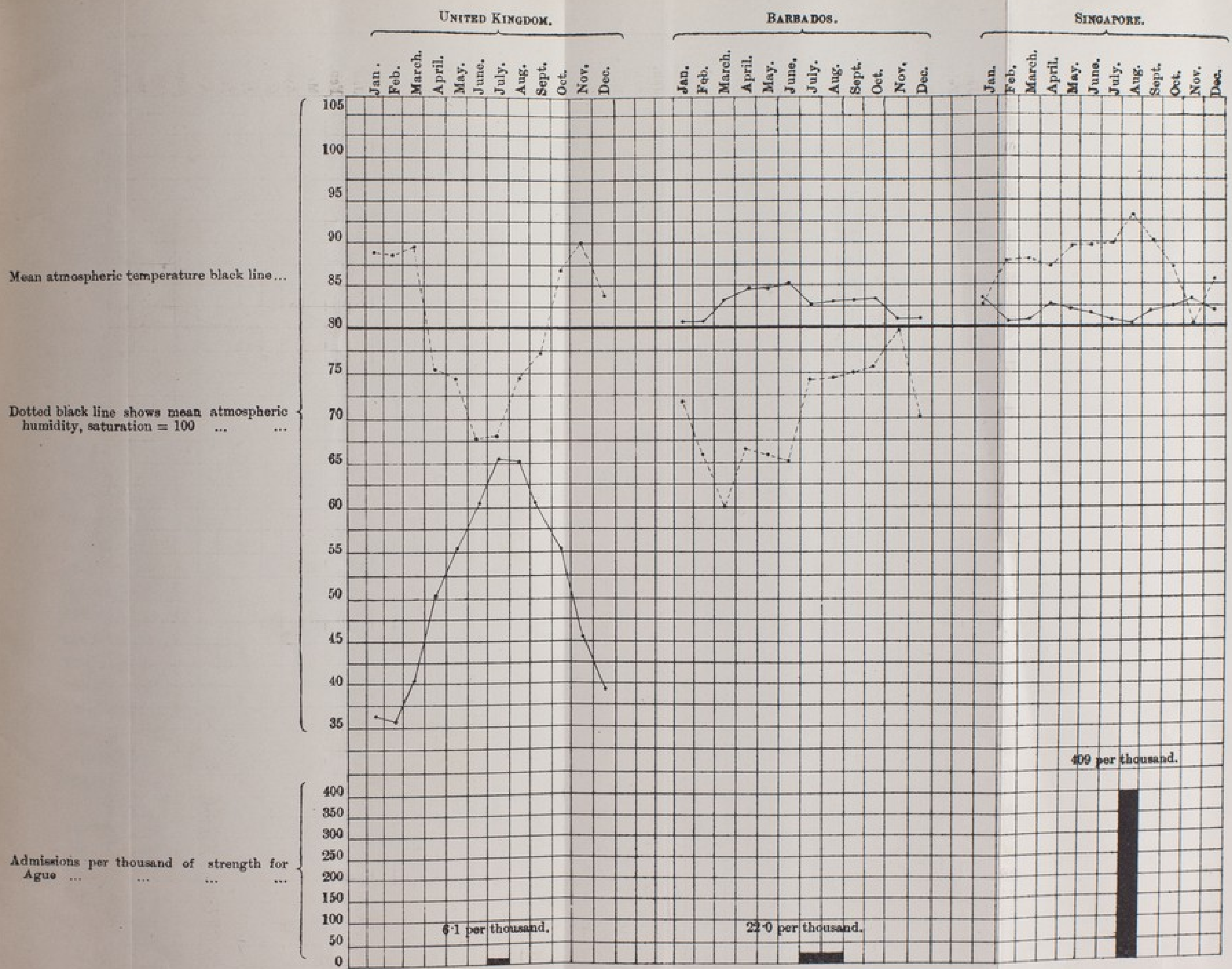
If we take for instance nine stations throughout the world, say England, Gibraltar, Malta, Bermuda, Barbados, Sierra Leone, Singapore, Hongkong and India, and examine their meteorological records and statistics of Ague, it is apparent that where Ague is prevalent the monthly mean temperature of air is F.80° or higher during those months of the year when this disease prevails. At the same time, it is seen that Ague may not be prevalent in some stations, such as Barbados, where the atmospheric temperature is over F.80° for nearly the whole year.

This, however, instead of proving to be a difficulty, will be found to be a considerable help in demonstrating the environment under which Ague prevails.

This environment evidently consists of something more than high atmospheric temperature. What is it?

Atmospheric humidity.—If the meteorological records for the same stations are examined as regards humidity, it is apparent that where Ague is prevalent the monthly mean atmospheric humidity is 80% of saturation or higher, during those months of the year when the disease prevails. At the same time it is seen that Ague is not prevalent in stations such as England where monthly mean atmospheric humidity is 80% or higher for six months of the year. From these records it is apparent that although Ague may not be prevalent where there is merely high atmospheric temperature *or* high atmospheric humidity, it is invariably prevalent where *both* temperature and humidity are high. This will perhaps be more easily seen from the accompanying chart. From it can be seen that in *England* although humidity of air is high for a considerable portion of the year Ague does not prevail. The absent factor is high atmospheric temperature.




United Kingdom.
Barbados.
Singapore.
Jan. Feb. March. April. May. June. July. Aug. Sept. Oct. Nov. Dec.
Mean atmospheric temperature black line...
Dotted black line shows mean atmospheric humidity, saturation = 100 ... ...
Admissions per thousand of strength for Ague ... ...
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
400
350
300
250
200
150
100
50
0
6·1 per thousand.
22·0 per thousand.
409 per thousand.

In *Barbados*, although temperature is high for the whole year, Ague does not prevail. The absent factor is high atmospheric humidity.

In *Singapore* both temperature and humidity are high for nearly the whole year, and Ague is very prevalent.

This only shews more clearly what has been so long known, *viz.*, that the environment under which Ague becomes most prevalent is a hot, moist, stagnant atmosphere. This indeed is not only apparent as regards *climates*, but also as regards *seasons* of the year and *localities*.

For example, as may be seen in the Reports of the Sanitary Commissioner with the Government of India, in the months, July, August, September and October, when Ague is most prevalent, the mean atmospheric temperature is F.80° or higher, and the mean atmospheric humidity is over 80% of saturation. Whereas in the months of December, January and February, when Ague is least prevalent, the mean atmospheric temperature is under F.70°, and the mean atmospheric humidity is under 70% of saturation. Here, again, we see that the environment under which Ague becomes most prevalent is the hot, moist, stagnant atmosphere. But even *within* malarial climates and season's experience teaches us that there are certain *localities* such as the low-lying swamp, dense jungle and deep ravine, where the disease is much more prevalent than on the elevated and open situations. But the low-lying swamp, deep ravine and dense jungle are obviously the localities in which the atmospheric temperature and humidity are highest. In such places the environment closely resembles the atmosphere in a Russian vapour bath, and is hot, moist and stagnant.

This, then, being the environment under which Ague becomes most prevalent, I will next endeavour to make clear how it produces an Intermittent Fever or Ague.

II.—CAN ENVIRONMENT CAUSE AGUE?

——:o:——

THE answer to the above question must, I think, be in the affirmative for the following reasons :—

1st.—The Meteorological environment under which Ague becomes most prevalent is a hot, moist, stagnant atmosphere.

2nd.—Exposure to this malarial environment produces an intermittent increase of water in the blood.

3rd.—Intermittent increase of water in the blood produces an intermittent fever.

4th.—Elimination of water from the blood, in Ague reduces temperature to normal.

5th.—Increase of water in the blood plus the increase of temperature in Ague produces (*a*) wholesale destruction of red blood corpuscles ; (*b*) increase of pigment, free or enclosed in bodies of various shapes, melanæmia ; and (*c*) enlargement of the spleen.

By *environment* in this case I mean the hot, moist, stagnant atmosphere which prevails in those climates, seasons, localities, and even periods of the day, in which Ague is known to be most certainly contracted.

Of course it will be at once objected that as Ague occurs sometimes in any and every climate, this cannot possibly be the cause of the disease. But I would point out in the first place that climates, at all events as regards their atmospheric temperature and humidity, differ only in degree ; and that a lower degree of this influence may produce the same effect on one individual as a much higher degree will produce on another. And in the next place I will point out a definite and appreciable condition of the blood which will make clear why some individuals should be more, and some less, susceptible to this influence. In other words why

some should not contract Ague in the most malarial climates, and why others do so in climates not considered malarial.

Now, that the environment of a hot, moist, stagnant atmosphere distinctly tends to increase the body-temperature, is not only generally believed but is capable of actual proof.

For example, Frey and Heiligenthal experimenting with different kinds of air-baths accurately determined the effects of exposure of the body to increased temperature and increased humidity of the atmosphere.

By exposure in a Turkish or hot *dry* air-bath to a temperature of F. 149° for fifty minutes the temperature of the body was only raised to F. 101·6°. On the other hand, exposure in a Russian or hot *vapour* bath of only F. 113° for only twenty-five minutes raised the body-temperature to F. 104·3°.

The explanation of this is obvious. In the hot *dry* atmosphere of the Turkish bath evaporation from the skin and lungs is greatly increased and this keeps the body-temperature under control. In the hot *moist* atmosphere of the Russian bath evaporation from the skin and lungs is impeded if not arrested. The natural cooling function of the skin being thus arrested, the body-temperature must of course rise as it does in the vapour bath.

But besides impeding evaporation from the skin and lungs, exposure in the hot *vapour* bath also reduces excretion of water from the kidneys. It must therefore produce *accumulation of water* in the blood. The two most obvious effects of exposure in a Russian or hot *vapour* are then—

(*1st*) increase of water in the blood ;

(*2nd*) increase of temperature of the body.

On leaving the hot vapour bath, the temperature of the body falls to normal in a few minutes.

Bearing in mind the above results of exposure in the hot, moist, stagnant atmosphere of a Russian *vapour* bath, it is evident how exposure to the hot, moist, stagnant atmosphere of malarial climates will as certainly, if not so rapidly, produce the same effects. For such environment differs only in degree from that of the Russian *vapour* bath of F.113° which raised the body-temperature to F.104·3° in twenty-five minutes.

Now, with regard to the first effect of exposure to such environment, it may be asked is there, as a matter of fact, increase of water in the blood in Ague? Liebermeister seems to have established this, for he declares that the wasting of the body in Ague is sometimes concealed by the excessive amount of *water* contained in the blood and tissues. From this cause the weight of the body may be increased as much as 10lbs., although there may be only slight œdema of the ankles to indicate an excess of water in the blood and tissues (Fagge, Vol. I, p. 48).

Now what is the effect of increase of *water* in the blood? Physiologists tell us that it increases metabolism, that is, heat production. And Payne tells us that injection of *water* into the blood causes a rise of temperature (General Pathology, p. 144).

Above I have first shewn, by example of Frey and Heiligenthal's experiments with the Russian *vapour* bath that exposure to a hot, moist, stagnant atmosphere produces an increase of water in the blood and fever. I have then pointed out that there is known to be increase of water in the blood in Ague (Liebermeister). And lastly, that increase of water in the blood produces fever (Payne).

It is now necessary to show that the increase of water in the blood, produced by exposure to the hot, moist, stagnant atmosphere of malarial climates, must be intermittent. To make this evident it only remains to point out that the environment, which causes it, is of intermittent intensity, for we know that in all climates atmospheric humidity and temperature undergo a daily variation. The highest atmospheric temperature is registered about 4 o'clock P.M. daily, and the lowest about 4 o'clock A.M. The highest atmospheric humidity is registered about 4 o'clock A.M. daily, and the lowest about 4 o'clock P.M. That is, in malarial climates the environment which produces increase of water in the blood

is of greater intensity in the early morning, and of less intensity in the afternoon. And if the cause is of intermittent intensity the result will also be intermittent in character, and the increase of water in the blood will therefore also be intermittent. As it is the increase of water in the blood that causes the rise of temperature the type of fever caused by it will of course be intermittent too, as we know it to be in Ague.

Now, in the commencement of this paper, I said that I would point out a definite and appreciable condition of blood which would explain the varying susceptibility of individuals to the disease. Moreover, it will explain why the type of fever is quotidian in some and in others tertian or quartan. It also affords an explanation why tertian and quartan types are those usually found in temperate climates, and quotidian the type usually found in tropical climates. It also affords a rational explanation why some individuals never contract the disease, or, in other words, exhibit immunity.

This definite or appreciable condition of blood is the quantity of water contained in the blood of each individual.

We know that in health the quantity of water in the blood may vary within certain limits, and that average blood contains about 790 parts in 1000 parts.

It will of course require exposure to the environment for some time more or less before the quantity of water in the blood is increased to that degree which causes fever. Let us suppose that the degree necessary to cause fever is 830 parts in 1000.

If four men whose blood contains respectively 790, 800, 810 and 820 parts of water in 1000 be exposed to the environment which produces excess of water in the blood, it is evident that the increase of water necessary to cause fever will be most rapidly produced in the man whose blood originally contained most water or was poorest. It only requires 10 parts added to it. This accords with experience which teaches that those with the poorest or most watery blood most quickly contract Ague when exposed to the environment.

It will take proportionally longer in the others to produce the 830 parts of water, the man whose blood was in the first instance normal (790 parts water) requiring the longest exposure.

Again, let us suppose that the degree of intensity of the environment to which they are exposed produces an increase of water in the blood equal to 10 parts daily. Then it is evident that the blood of the man containing originally 820 parts of water, will have its water increased to the necessary 830 parts by *one* day's exposure. And although critical elimination (sweat) reduces it to the original 820 parts, if exposure to the environment continues 10 parts will be added again next day, producing the necessary 830 parts of water increased metabolism and fever. That is the degree of hydræmia which causes the fever is reproduced daily and the type of Ague is therefore *quotidian*.

At the same rate of 10 parts daily it will require *one day longer* exposure to produce 830 parts of water in the blood of the man originally containing only 810 parts of water; and after elimination (sweat) it will take one day longer to reproduce, that is, instead of being reproduced daily, it will only be reproduced every *second* day. There will be one day of apyrexia. The type of Ague will be *tertian*.

Similarly at an increase of 10 parts daily it will require an exposure of *two days longer* to increase the amount of water in the blood of the man containing originally 800 parts of water, to the necessary 830 parts to cause fever, and after elimination (sweat) it will take *two days longer* to reproduce. That is, there will be *two days* of apyrexia and the type will be *quartan* Ague.

In the blood of the man containing originally 790 parts of water it will take still longer exposure to produce, and after elimination to reproduce, the necessary 830 parts of water. And in those with originally still less water in the

blood, and whose excretory organs are perfect it is conceivable that the necessary increase to 830 parts of water cannot be produced by any exposure, and in such cases we should expect immunity from the disease.

It can be seen then, if Ague is due to excess of water in the blood caused by environment, why the type of disease should be quotidian in some, tertian in others, and quartan in others; and also why those with the poorest or most watery condition of the blood should most certainly contract the disease, whilst those with less water in their blood should be less liable to contract it.

In addition, if Ague is due to excess of water in the blood, it is evident why quotidian is the most common form of Ague in tropical climates and tertian, or quartan forms the most common in temperate climates. For in tropical climates the environment (temperature and humidity) is of a higher degree of intensity, and in temperate climates lower. Hence in tropical climates the degree of hydræmia that causes fever will be more quickly produced and after elimination reproduced; that is, the type of Ague most commonly met with will be that with the shortest period of apyrexia, *viz.*, quotidian. In temperate climates the environment, not being so intense, will of course take longer to produce and, after elimination, to reproduce the degree of hydræmia that causes fever; that is, in temperate climates the type of Ague most commonly met with will be that with a longer period of apyrexia, *viz.*, tertian or quartan.

Moreover, as the amount of water in the blood depends to a great extent on the balance being maintained between the amount excreted and the amount taken in; and as the amount excreted depends to a great extent on the healthy performance of their functions by certain organs, skin, kidneys, &c., it can be seen how deranged or defective function of such organs might produce the increase of water in the blood that causes fever altogether independently of external environment. By such derangement I would explain those anomalous cases of Ague which occur in climates, seasons or localities where the hot, moist, stagnant atmosphere, the environment of Ague, is not found.

Again we know that free elimination of water from the blood in Ague reduces temperature to normal. Free sweating obviously does so. This fact of itself is strong presumptive evidence that the disease is due to excess of water in the blood, for there are many other fevers in which free sweating does not produce this effect. Moreover, although sweating is the natural method of termination of a paroxysm of Ague, the same result may be produced by free elimination of water through the kidneys or by purging. These two latter processes, however, only reduce the amount of water in the blood and so reduce heat production, whilst sweating besides reducing the amount of water in the blood (heat production) also increases evaporation from the skin (heat loss) and thus more quickly reduces temperature to normal.

It may be said that because free sweating induced before an expected paroxysm of Ague, does not prevent the body-temperature from rising, the disease cannot be due to excess of water in the blood. But free sweating, or what appears to be free sweating, does not prevent the body-temperature rising in the Russian vapour bath. The fact is, that although sweat appears on the skin in such cases it is not because it is excreted in larger quantity, but that, the environment being saturated with moisture, evaporation is impossible or at all events much impeded. Hence the sweat accumulates on the skin.

Now if there is increase of water in the blood in Ague, there are present during each paroxysm of the disease two influences which profoundly alter the blood corpuscles. These are *increase of water* produced by environment, and *increase of temperature*, that occurs during each paroxysm, which may amount to as much as F.110° or higher in the deep parts, such as within the portal circulation. What is the effect of such influences on the appearance of the blood corpuscles?

In answering this question I will place side by side in parallel columns a description as given by Physiologists of the changes produced in blood corpuscles by exposure to the influence of increase of water, and increase of temperature; and a description of the appearances of malarial parasites as given by plasmodists.

Physiologists tell us.	*Plasmodists tell us.*
1. If *water* be added to normal blood, the red corpuscles lose their discoid form, become spherical, swollen, and *dropsical*, the hæmoglobin is washed out of them, and ultimately they disintegrate and disappear.	1. The red corpuscles attacked by the malarial parasite are usually the larger ones. They lose their disc-like shape and become spherical, swollen and *dropsical*, they lose their colour and ultimately disappear.
2. If blood be *heated*, vacuoles are produced in the red corpuscles which appear as little clear, colourless shining spots that assume spherical, annular or other forms, they change their form, they increase in size till they occupy half, two-thirds, or the whole of a corpuscle. They exhibit amœboid movement from contractions in the surrounding hæmoglobin, and they throw out little fine headed prolongations which wave to and fro. There may be one or more vacuoles in each corpuscle.	2. Malarial parasites appear in the first instance on, or in, the red corpuscles as little clear colourless shining spots of various forms, spherical, annular or other. They change their form. They increase in size until they occupy most or the whole of the corpuscle. They exhibit amœboid movement, and throw out flagella. There may be one or more parasites in each corpuscle.
3. If water is added to normal blood *and* the specimen heated a few degrees above normal, the white blood corpuscles which may or may not contain pigment exhibit active amœboid movement, and	3. The larger spherical pigmented parasites exhibit active amœboid movement, and their contained pigment exhibits active swarming movement.

Brownian movement of the contained pigment.

4. The result of increase of water in the blood and exposure to increase of temperature is destruction of red corpuscles and production of pigment free and enclosed in spherical or various shaped bodies.	4. The result of invasion of the red corpuscles by the parasites is wholesale destruction of the corpuscles and increase of pigment in the blood free and enclosed in spheres, crescents, &c.

Mannaberg and others distinguish the small spherical parasites from the vacuoles in red corpuscles by their relative brilliancy and relative sharpness of contour before they become quiescent.

When we remember the infinitely minute size of these bodies, the difficulty of deciding on their relative brilliancy and relative sharpness of contour while in motion, is apparent. Indeed Mannaberg evidently feels that his method of distinguishing them is not very convincing, for, he adds apologetically, that the differences are difficult to describe shortly in words, but, by a little experience, it is possible in the majority of cases to decide one way or the other.

In the first place, I cannot understand why it is so difficult to describe shortly in words what experience enables him to accomplish so easily in practice, and he does not tell us how experience enables him to distinguish parasites from vacuoles except as above given.

As regards distinguishing the larger spherical pigmented parasite from a pigment bearing leucocyte, Laveran depended on the fact that the leucocyte exhibited a nucleus and the parasite did not. This was definite at all events. Mannaberg and others, however, declared that the parasites have a nucleus, thus proving them to be living organised beings, and thus destroying Laveran's distinguishing mark. Of course the leucocytes, as they present a nucleus, must also be living organised beings. Plasmodists declare, however, that they can distinguish these nuclei.

With regard to crescent-shaped parasites plasmodists seem not to be agreed as to whether their transformation into

spheres and flagellation is a developmental process providing for the continuation of the species or a sign of degeneration and death.

Ross, after many beautiful experiments, is of opinion that the transformation is developmental, and that the influence which produces the transformation or perhaps allows it, is *abstraction of water* from the serum. This he concludes is the influence to which the crescent is exposed within the stomach of the mosquitos.

But Ross had no sooner come to this conclusion than he saw that *Marshall*, also as the result of experiments, had come to a diametrically opposite conclusion, *viz.*, that the influence which causes transformation is the *addition of water*, and that this may take place within the stomach of the mosquito !

Ross tries to reconcile these very widely diverging views by saying that transformation of crescents is promoted by both increased and decreased density of the serum in which they float.

But whether it is or not I would call attention to the facts, 1*st*, that they both apparently recognise and admit the influence which *variation in the amount of water in the serum* exercises in the production of some at least (crescents, flagella and spheres) of the bodies described as parasites; and 2*nd*, that *variation in the amount of water in the serum*, produced by environment, is the pathological condition which I maintain exists in Ague.

During the paroxysm there is increase of water in the serum. Here is the condition which Marshall holds, converts crescents into spheres, &c. After the sweating there is obviously reduction of water in the serum. Here is the condition which Ross maintains, transforms crescents into spheres, &c.

How increase of water in the blood produces melanæmia or increase of pigment in the blood and tissues may be seen by reference to the lectures of Professor W. Hunter on Blood Destruction in the *Lancet* of 26th November 1892. He says the causes of hæmolysis or blood destruction are two, *viz.*, direct and indirect. The first consists of agents which injected into the blood act directly on the blood, *such as water, &c.* The second acts indirectly through the splenic cells. He then says that the hæmolysis of disease is similar to that produced by indirect hæmolytics with two exceptions, namely, hæmoglobinurea and malaria which he attributes to the direct action of parasites on the red discs. But, if there is increase of water in the blood in Ague, as I maintain in this paper, there is increase of an agent that Hunter has shewn to a most powerful direct hæmolytic.

So that whether Laveran's bodies be parasites or not, there is quite sufficient to explain the occurrence of wholesale destruction of red blood corpuscles and the presence of pigment free and enclosed in spheres, &c., in Ague. Hunter describes, during the progress of hæmolysis produced by injection of water into the blood, the appearance in the blood especially within the portal circulation of the following :—

1*st.*—*Colourless spherules*, albumenous, and highly refractile of varying size.

2*nd.*—*Coloured spherules.* A red corpuscle becomes constricted at some portion dividing into two parts connected by a colourless portion. These are best studied by warming blood to C.45° (a temperature not much above portal blood in a paroxysm of Ague) when the corpuscle breaks up into a number of highly coloured spherules. This description of the disintegration of a blood corpuscle produced by a temperature of C.45° plus addition of water, reminds one of the description of sporulation of parasites, said by plasmodists to occur during each paroxysm of Ague.

3*rd.*—Stromata decolorised red corpuscles best studied by injection into the blood of *distilled water*.

With regard to Hunter's statement that blood destruction and production of various shaped bodies and pigment takes place chiefly within the portal circulation, I would draw

attention to the fact that plasmodists say when parasites cannot be found in the general circulation they can certainly be found within the portal circulation.

From what has been written above it can be seen that if Ague is due to increase of water in the blood there must be (*a*) wholesale destruction of red blood corpuscles ; and (*b*) melanæmia. And during each paroxysm of the disease the following will be produced in the blood :—

1*st.*—Red corpuscles which have become enlarged, spherical and *dropsical*.

2*nd.*—*Vacuoles* in the red corpuscles exhibiting amœboid movement and throwing out fine headed prolongations which move to and fro.

3*rd.*—*Spherical pigmented bodies* exhibiting amœboid movement and Brownian movement of the contained pigment.

4*th.*—*Colourless Spherules*, albumenous and highly refractile.

5*th.*—*Coloured Spherules*, joined by a colourless portion, which disintegrate into a number of highly coloured spherules.

6*th.*—*Stromata.*

7*th.*—*Pigment* free and enclosed in various shaped bodies.

It is evident then if Ague is due to increase of water in the blood that many bodies will be found in the blood during each paroxysm and after, in addition to the normal unaltered corpuscles.

It next remains to be seen if intermittent increase of water in the blood will cause enlargement of the spleen. It probably must do so. For increase of water of course means increase of volume of the blood from which, the spleen, being so vascular and elastic, yields and becomes enlarged. Whether it is due to this cause or not we know as a matter of fact that the spleen does enlarge during each paroxysm, but at first returns to its normal size during the periods of apyrexia.

Thus there is intermittent enlargement of the spleen at first. This if continued must eventually produce permanent enlargement of the organ, Ague Cake. For, as Payne points out, hypertrophy of an organ is more likely to occur from transitory but repeated hyperæmia than from simple hyperæmia continued for some time.

Further argument in favour of this theory of the disease may be adduced from the fact that all effective treatment of Ague reduces the amount of water in the blood. Diaphoretics and purgatives obviously do so. So does quinine as I think any one will admit who has taken it in any quantity. And when the chronic stage is reached what is so beneficial as a course of Turkish or hot dry air-baths when available. Arsenic also reduces the amount of water in the blood, and massage also promotes its reduction. And when we treat enlargement of the spleen by counter-irritation and administration internally of quinine and iron, do we not always find it necessary to add saline purgatives.

Change of climate is indeed the best of all remedies for Ague, and what is change of climate but change of the environment that produces increase of water in the blood?

Now, as regards prevention of Ague, drainage of the soil eradicates the disease. The most obvious effect of drainage of the soil is that it dries the soil and therefore dries the superincumbent atmosphere. For humidity of the atmosphere is due chiefly to evaporation of water from the soil. Drainage of the soil therefore reduces one factor, atmospheric humidity, of the malarial environment, in the absence of which the disease never becomes prevalent. It thus obviously alters the environment which produces increase of water in the blood. And experience teaches that no measure can compare with it in value for eradication of Ague from paludal districts.

While I hold that Ague or Intermittent Fever is caused by environment, it should be understood that I do not hold that remittent, continued or other form of malarial fever is due to this cause.

To give expression to views, which in any way seem to throw doubt on the parasitic origin of malaria, requires, in these days, a certain amount of moral courage, for any one who does so is quickly denounced as unscientific and retrogressive.

Still a change in this respect seems to be foreshadowed by Mr. Malcolm Morris in his article on the progress of medicine during the Queen's reign, in the *Nineteenth Century* for May. He says: "Indeed the doctrine that every disease is a kind of fermentation caused by a micro-organism is so fascinating that it is in danger of being treated as if it were a master key which unlocks all the secret chambers of pathology; it is becoming clear however that, if microbes are necessary causes of a large number of diseases, they are sufficient causes of very few. The living body, and its environment, must be taken into account. Hence there are signs in various quarters of a reaction against the exaggerated cult of the microbe, and some of the most advanced investigators are turning once more to cellular pathology which, till quite recently, was spoken of as a creed outworn."

With Comps.ts

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C.B.

A CASE OF

UNUSUAL DEFORMITY OF THE HANDS AND FEET CAUSED BY STRUMOUS DISEASE.

By A. M. STALKER, M.D.,
Physician to the Dundee Royal Infirmary,
AND
DAVID M. GREIG, M.B., F.R.C.S. Ed.

(*Reprinted from the Edinburgh Medical Journal for April* 1892.)

George M——, æt. 43 years, mill-worker, married, no children.

Family History.—Patient's father died at the age of 48 years of a "chest complaint," and his mother, who had strumous scars on her neck, died at the age of 24 years of phthisis. She had three sisters and two brothers who reached adult life, and all presented various manifestations of scrofulous diathesis. Patient had only one brother, and his condition is specially noteworthy. He suffered from a disease of the bones of the hands and feet, which began when he was 4 years of age. The progress of the disease was slow until the right elbow became affected, and he died at the age of 14 years of exhaustion.

Personal History.—Apart from the changes relating to the patient's present condition, his previous history is unimportant. He has suffered occasionally from bronchitis, which latterly has become chronic.

History of Present Disease.—The disease of the hands and feet began at the age of 6 years, the limbs being affected consecutively, but it is impossible to ascertain in what order, though the patient maintains that only two years elapsed from the commencement until they were all affected. The affection was accompanied by considerable pain and some suppuration, and small pieces of bone escaped with the discharges from time to time. His condition, however, has remained unchanged for the past ten or fifteen years, as sketches taken by one of us in 1881 clearly show.

Present Condition.—Patient is undersized, looks younger than his years, and is of low mental development. Cicatricial remains of glandular abscesses exist below the jaw on both sides of the neck. His hands and feet present the following curious deformities:—

Left Hand (Figs. 1 and 2).—Small and narrow, the narrowing being due to displacement of the middle finger into the palm of the hand. There is a cicatrix of the size of a shilling over the lower end of the radius posteriorly, and a small puckered cicatrix over the dorsal aspect of the scaphoid bone. Neither is adherent to the bone. A lupoid affection of the skin exists on the dorsum of the hand between the second and fourth fingers. There is a small puckered cicatrix just below the pisiform bone on the palmar aspect of the hand, and another over the carpo-metacarpal joint of the thumb. The palm of the hand is convex transversely and from above downwards over the heads of the metacarpal bones, and this is caused by the proximal extremity of the first phalanx of the ring finger, which is displaced into the palm a little to the inner side of the middle line. The thumb is normal, except that flexion is imperfect in the last joint. The metacarpal bone of the index finger is normal. The axis of the index finger is directed much inwards, and movement at the metacarpo-phalangeal articulation is very slight. The middle finger is only seen on looking at the palm. Its metacarpal bone is normal. From the head of the metacarpal bone to the tip of the finger measures 5 centimetres, and the finger measures 5·7 centimetres in circumference at its thickest part. It is marked by three transverse furrows equidistant from each other, which indicate the original divisions of the finger. The finger is surmounted on its ulnar side by a small and much deformed nail, close to which is a cicatrix through which fragments of bone had been from time to time discharged. The osseous portion of this finger is represented by a single stem of bone whose distal extremity is rounded, nodular, and thickened. The finger can only be very slightly flexed on the palm. The fourth metacarpal bone is normal, but the first phalanx of the fourth finger is dislocated into the palm, and its axis crosses that of the metacarpal bone obliquely from without inwards. The finger is small and covered with smooth skin, and there is little movement at any of the joints. The fifth finger is drawn backwards, and the last joint is enlarged and fixed in a flexed position.

Right Hand (Figs. 1 and 3).—On the dorsum there is a cicatrix over the carpus and some lupoid cicatricial tissue over the bases of the fingers. The third and fifth fingers are approximated so as to hide the fourth finger which is displaced into the palm. The

Fig 1

Fig 2

Wm CATHIE, LITH

Fig 3

Fig 4

Wm CATHIE, LITH

thumb and middle finger are normal, as also are all the metacarpal bones except the fourth. The axis of the index finger is inclined inwards. There is a cicatrix over the fourth metacarpal bone, which is represented by a small osseous mass close to the carpus. There is no osseous connexion between this and the first phalanx of the fourth finger. The base of the first phalanx of the fourth finger is felt dorsally about two centimetres below the line of the other metacarpo-phalangeal articulations. The other phalanges of this finger are normal and their movement good. The base of the first phalanx of the fifth finger is displaced slightly forwards, and the finger is flexed and its first joint immovable.

Right Foot (Fig. 4).—There is a lupoid condition of the skin on the dorsum over the bases of the toes. The foot is narrow, and the toes are placed on two planes, the first, third, and fourth being below the second and fifth, which are displaced on to the dorsum of the foot. The head of the fifth metatarsal bone cannot be distinguished, and the base of the first phalanx of the fifth toe is displaced into the sole of the foot, thus throwing the whole toe on to the dorsum. The axis of the fifth toe is directed inwards, and overlaps the fourth and third toes. The second toe forms a small rounded mass between the first and fifth toes, and its anatomy cannot be made out by palpation.

Left Foot (Fig. 4).—This foot likewise presents lupoid cicatricial tissue over the bases of the toes. The first, third, and fifth toes alone are visible. The second metatarsal bone can be felt throughout its whole extent, and the second toe is represented by a fleshy nodule placed dorsally over the base of the great toe. The fourth metatarsal bone cannot be made out, but there is a tender protuberance on the plantar aspect of the foot between the third and fifth toes. This is evidently the representative of the fourth toe, and contains two small shafts of bone slightly movable on each other.

Remarks.—Apart from the very striking deformities which the patient presented when he first came under our notice, our attention was attracted by the peculiar symmetry of the lesions. The four extremities were affected—each, generally speaking, in a similar manner. In the hands, the thumbs, and in the feet, the great toes, were not affected. The index finger of each hand was slightly affected, and that only by contraction of the neighbouring parts on the ulnar side. Cario-necrosis of the bones of some of the fingers and toes, as detailed above, resulted in the disappearance of entire bones, and in the left foot, of two complete toes, and in connexion therewith the absence of cicatrices through which large pieces of bone could have passed is noticeable. The further changes consisted in both hands and feet of a lupoid affection of the skin, followed in some places by cicatrization and contraction. From this contraction of the cicatricial tissue and from the disappearance of bones resulted a marked diminution in the size of the limbs, especially from side to side. The appearance so produced was strongly suggestive of some atrophic influence, and caused us to search most carefully for a nervous lesion, which might in part account for the peculiar phenomena. This we failed to discover, and from the presence of a strong hereditary tubercular taint of the chronic strumous type, we were forced to the conclusion that strumous processes alone had sufficed to bring about these deformities.

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THE PARASITE OF MALARIA IN THE FEVERS OF SIERRA LEONE

BY

SURGEON-CAPTAIN C. W. DUGGAN, M.B.
ARMY MEDICAL STAFF

(COMMUNICATED BY DR. GEORGE THIN)

[*From Volume 80 of the 'Medico-Chirurgical Transactions'*]

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Received January 12th—Read March 23rd, 1897

THE well-known virulence of the malarial fevers which prevail on the west coast of Africa continues until the present time with unabated force. Europeans and natives are alike subject to their ravages, although they exact a higher tribute from the former. When not fatal such fevers often render life a burden for many years, whilst a few fortunate individuals seem, at least for a long time, to be proof against their attacks.

Sierra Leone (where the following observations were made) is a highly mountainous district, both its valleys and mountains being covered with a very luxuriant vegetation. The soil consists of a porous red earth, which appears to play an important part in the causation of malaria.

The river Roquelle, which has a large volume of water, opens into the sea at the native town of Freetown, half a mile inland from which are stationed the principal barracks, which are built on a hill about 600 feet high. Mangrove swamps exist near Freetown, but are covered by the tide. The average daily temperature is about 80° F., and the annual rainfall about 150 inches. The rainy season lasts from May till October. There is no cold season. The heat is trying from the large amount of moisture present in the atmosphere.

My experience in this disease was gained during a residence of two years at Sierra Leone, where I was occupied in attending the officers and men of Her Majesty's West India Regiment. The two years were not consecutive, being separated by the usual interval of one year. As I made it my practice, during both periods of residence, to examine the blood of all the fever patients with whom I came in contact, I am within the mark when I state that I must have examined the blood of at least 400 different patients suffering from fever. I have taken notes of the observations in 50 cases. The cases which I shall relate in this paper are selected from the 50, and are fair average examples of all the others. During part of the time I used a Swift's $\frac{1}{12}$ in. oil immersion, and for the rest of the time a Zeiss $\frac{1}{12}$. Both these objectives showed the parasite in the fresh blood sufficiently well. Examination of the blood was discontinued after the patients left the hospital. In many cases they had suffered from fever for some time before admission. They were detained in hospital until free from fever. The average duration of the stay in hospital of the fever cases in Sierra Leone which I observed was about a week. In most cases that short period was sufficient to cure the fever for the time being. In many instances the fever symptoms disappeared within a day, sometimes to reappear a few days afterwards; but sometimes the temperature did not again rise.

The first attack of malarial fever experienced by new-comers is usually of the quotidian remittent type. The onset is often sudden, and is frequently unattended by rigors.

The symptoms in an ordinary attack are as follows. The patient complains of headache, and pains in the trunk and limbs, and occasionally of severe giddiness. The tongue is furred, and there is frequently nausea with very distressing bilious vomiting. Constipation is common, but in some cases I have seen severe diarrhœa. Occasionally there is no disturbance of the bowels whatever. A dull aching, and sometimes an acute pain is present in the hepatic region. Jaundice is rare. The spleen is not enlarged to an appreciable extent. The temperature on the first day ranges between 103° F. and 105° F.; on the second morning there is usually a remission of two to three degrees, and towards evening a rise to 105° F.; on the third morning there is again a remission of several degrees, and in the evening another exacerbation; on the fourth morning the temperature is often normal, and in the evening there may be again a slight exacerbation—100° F. to 101° F.; on the fifth morning the temperature is normal, and as a rule remains so.

Quinine is so generally given in these cases that the above account of the course of the symptoms necessarily refers to cases that have been treated by the drug, but there is reason to believe that even without quinine the course of the fever would be somewhat similar. When I myself suffered from the fever, the quinine which I took was at once rejected by vomiting to such an extent that I do not think that any of it was retained; certainly none for the first three or four days, notwithstanding which I had a remission each morning.

The skin, which is at first hot and dry, soon becomes covered with a profuse perspiration, although for some days there is no corresponding fall of temperature.

Delirium, if present, is generally slight, but for several nights there are most distressing dreams, and a tendency to magnify the most trifling occurrences. The symptoms are, in many respects, similar to those which are characteristic of delirium tremens.

The pulse and respiration rates are directly proportional to the temperature. The urine frequently contains bile.

About the fourth day of the fever the tongue begins to clean, and there is a desire for solid food. The other evidences of fever disappear, and in a week the patient feels quite well.

Subsequent attacks occur at irregular intervals, and often last only a few hours. In many of them the three stages of an ague fit are present. In the men of the West India Regiment, recruited in the West Indies, and consisting of negroes and a large proportion of mulattos, malarial fever, except in some bad cases, does not continue for many hours, but the admissions to hospital are frequent, and there are usually several attacks during each admission.

Pyrexia, in a few cases, lasts for weeks, the temperature being about 101° F., and often remitting a degree in the morning. One such case ended fatally in the fourth week, although the patient was invalided to Grand Canary in the second week of the disease. This result was chiefly due to the debilitating effects of a long arduous expedition after two years' residence in Sierra Leone.

Dr. Prout ('Lancet,' 1891, vol. ii, p. 226) gives an account of the malarial fevers observed on the Gold Coast. The symptoms which he describes in these fevers are essentially the same as those which I have given as generally attending the fevers at Sierra Leone. It will be noticed that I have not laid the same stress on enlargement and tenderness of the spleen which Dr. Prout has done; although in chronic cases enlargement of the spleen is common, in many acute cases which I observed of a short duration I did not notice much tenderness or enlargement of that organ.

Fatal cases.—In the fatal cases I have seen, death with one exception was preceded by several hours or days of unconsciousness. In one case there were hysterical fits for five hours before death, the patient struggling violently with his attendants, whistling, singing, shouting, and

breathing about sixty per minute; these fits were preceded by two days' delirium, and at no time during this period was there any return of consciousness.

The temperature varies considerably; in some it runs up to 107° or 108° F. According to my experience this is most likely to occur in new-comers; but in those who have undergone considerable hardship in the colony, or have been resident a long time, the temperature shortly before death may be normal, or not more than two or three degrees above normal.

Death occurred in one case which I observed from hæmorrhage from the bowels. The hæmorrhage occurred suddenly, and continued till he died, about nine hours later. In several cases in which the fever was pursuing a mild course serious symptoms set in suddenly and unexpectedly, and the case terminated fatally after a shorter or longer period. During the earlier and milder stages of these attacks there was no symptom which led me to expect a fatal result.

In examining the blood, fresh and dried preparations were made in the usual way. Specimens were stained with eosin and methylene blue, or Ehrlich's hæmatoxylin, and in some cases a drop of very dilute solution of methylene blue was added to fresh blood. Parasites were always found during the whole of the attack and for several days after.

My examinations were made from 10 a.m. till 2 p.m., and again from 4.30 p.m. to 6.30 p.m. As parasites were found in every case at these times whilst the fever lasted, it is presumable that they would have been found had the examinations been made at other times of the day, and the inference may be drawn that parasites in these fevers can be found in blood taken from the finger at any time during the course of the disease.

With the exception of an account of the histology of the tissues in a fatal case of pernicious malaria at Sierra Leone by Dr. Thin, which is published in vol. lxxix of the 'Medico-Chirurgical Transactions,' nothing appears to have been published regarding the parasite of malaria which occurs in that part of the west coast.

I have only succeeded in distinguishing one kind of parasite, which was, in a proportion of cases, accompanied or followed by the so-called crescent forms. I exclude a case of tertian fever to be subsequently referred to. In the unpigmented stage this parasite appears as an extremely small bright speck on the surface of the red corpuscle, from which it cannot be detached by any ordinary pressure. At first it is constantly changing its shape, at one time spherical, and at another throwing out processes which, remaining visible for a number of seconds, are gradually withdrawn, and an irregular shape is maintained for some time. Instead of this amœboid motion the parasite every now and then suddenly contracts to half its size, and just as quickly resumes its original condition. This movement is repeated a number of times. Finally, after several hours the parasite assumes a spherical or slightly irregular form, in the centre of which what appears to be a small portion of the red cell is visible. The central portion stains with methylene blue in the youngest parasites. At a slightly more advanced stage only the periphery of the parasite takes on a blue stain, and one or two deeply stained nucleoli can be easily made out. A more advanced stage is evident in a few cases where the whole parasite containing a mass of pigment stains blue. In most cases there is only one parasite attached to a red blood-cell. The largest number I have seen occupying one red cell is five, all of which were at the same stage of development.

In some specimens stained with eosin and methylene blue I have observed two somewhat conical-shaped parasites united by their bases, each parasite having a nucleolus and with only the periphery stained blue.

I often observed the same parasites for hours continuously, and although the movements continued active the development of the parasite never progressed, as it presumably would have done if the blood had not been removed from the body.

The affected red cells did not seem to be altered as regards colour, size, and shape.

I never saw the so-called brassy-red corpuscle (the "*ottonati*" of the Italian writers), although I looked carefully for it.

In the early stage of pigmentation the parasite has enlarged slightly, and contains several minute grains of pigment. The sporulating stage was never observed by me in the peripheral blood. It is best seen, according to my observations, in the fresh blood removed from a small vessel on the surface of the brain soon after death. The effect of the parasite on the movement of the affected cells is very evident in such a case, for while the normal red cells were influenced by currents in the field of the microscope, those containing the parasite were perfectly motionless. It was then seen that sporulation occurs while the parasite does not occupy more than a third of the red cell. The spores became indistinct so soon after the death of the patient that I found it difficult to count them, but in one case in which I succeeded in doing so I saw five spores surrounding a small central block of pigment.

Crescents were found in varying numbers in most of the cases. In length they varied from about 8 to 12 mm., and in breadth from 3 to 5 mm. In most cases the pigment is massed near the centre of the crescent. In the larger crescents the pigment appears to lie in a differentiated structure in the centre, and in one crescent I saw the pigment lying beside this structure. The crescent is often seen in close relation to several blood-corpuscles, from which it can be readily detached by pressure. It does not appear to be capable of independent movement.

I have on several occasions seen an active movement in the central pigment of the crescent body, the minute spheres and rods of which it is composed moving rapidly from one clear space to another in the central portion of the parasite. This movement sometimes continued for several hours. Mannaberg states that the concentrated pigment is invariably quiescent (New Sydenham Society translation, p. 284).

I have never observed the crescent change into a spherical form with the formation of flagella. In the light of the information contained in the letter to the 'Lancet' by Dr. Marshall (October 24th, 1896) this is probably owing to the moist warm atmosphere in which the specimens were examined, which would tend to keep the blood-plasma unaltered for a considerable length of time. I never saw flagella, although the crescents were often under observation for many hours. A number of the spherical forms still retained the outline of the red cell in which they had developed, as was signified by the delicate envelope of red blood-cell substance which surrounded them. The contained pigment was sometimes in the form of comparatively large spheres, several of which became detached from the others, and moved round the interior just within the outline of the red cell.

Dr. Prout, in the paper already referred to, gives the results of microscopical observations made by him in ten cases. Examination of the blood was made in ten cases, partly European, partly native, including two cases of bilious remittent, one of hæmoglobinuria, the rest mild intermittent. Only fresh unstained specimens were examined, taken generally when the temperature was rising, and on one or two occasions at different intervals during the attack. In eight cases there were distinct changes in the red cells, divided by Dr. Prout into five kinds :—1st. Brightly refracting rod-like bodies occurred in three cases, and in one of them were very numerous. They varied in number and size, possessed a certain movement described as pulsatile, and occasionally a slight alteration of their position in the corpuscle occurred. 2nd. Brightly refracting round spots of different sizes, sometimes combined with the rod forms. 3rd. Large circular bodies like vacuoles, in the centre, or to the side of the corpuscle, sometimes with rods. 4th. Irregular bodies which may be regarded as transition stages between the above forms. 5th. In three cases

bodies like a tadpole or spermatozoon with an oval head, and tapering filament attached. Like the other bodies they were translucent and possessed limited movement. They are not so common as the others, four being the largest number in one preparation. None of these bodies contained pigment. Pigmented bodies were seen in five cases. 1st. Small corpuscles about the size of a leucocyte with dark brown pigment granules distributed evenly throughout the cell. 2nd. Bodies twice to thrice the size of a leucocyte containing similar granules of pigment, but arranged round clear spaces. 3rd. Pigmented bodies showing amœboid movement. 4th. Amœboid bodies containing large masses of pigment. These differ from the bodies described above in the character of the pigment, which is collected in large masses instead of fine rounded granules, and are probably the phagocytes on whose scavenging properties Carter lays so much stress. It is possible that all these forms are merely stages of the same body.

Dr. Prout did not detect pigmented crescents, spheres, or flagellated organisms. The intra-corpuscular forms were present before the paroxysm, and while the temperature was rising, and usually disappeared under treatment; while the pigmented forms were found at all stages, but persisted for a considerable time after the attack had ceased. In one case the whole of the bodies were found; in one there were rods, clear spots, and pigmented bodies; in one, rods, vacuoles, and pigmented bodies; in two, vacuoles and tadpole bodies; in three, vacuoles only; and in two, pigmented bodies only.

I am unable to identify most of the appearances described by Dr. Prout with the appearances which I consider to be characteristic of the parasites observed by me at Sierra Leone. I miss in his description the ring-shaped parasite which I found so universal in my cases. The larger pigmented bodies described by him, and shown in his drawings, will be generally, I believe, considered to be pigment-bearing leucocytes. As so little has yet been written on the parasite of West African fevers, I have considered it advisable to give this *résumé* of the observations recorded by Dr. Prout, so that those who are specially interested in the subject may have an opportunity of referring to his original paper.

The following eleven cases are selected so as to illustrate the usual course of the fever in its relation to the parasite. In all the observations the blood was taken from the finger. I never saw any unpigmented forms free in the blood.

Case 1.—Private B—, admitted to hospital on January 23rd, 1896, complaining of having suffered from fever since the 20th. Temperature on admission 103° F.

The blood examined at noon contained a number of free crescents. There was no movement in the crescents or their pigment. There was about a dozen in one specimen. Many of the crescents were elongated and narrow, nearly twice the size of a red cell. There were also minute unpigmented parasites in the red cells, similar to those seen in other specimens. There was a good deal of free pigment in the blood. At 5 p.m. temp. 101° F. Crescents still present in the blood. The patient received 5 grains of calomel, and later 5 grains of antifebrin, and two 15-grain doses of quinine.

January 24th.—Morning temperature normal. Patient feels better. Blood still contained crescents, but they are less numerous than on the previous day. One oval young form which was tinged externally with hæmoglobin. No evidence of spore formation. Movements of pigment visible in the crescents. Numerous pigmented leucocytes and a good deal of free pigment. Evening temp. 99° F.

25th.—Morning temperature normal. Patient feels quite well. Examined specimens of blood, one taken yesterday evening and one this morning. Crescents present in both, probably more numerous in the former. One crescent contained two separate bodies, one deeply pigmented, and the other having one or two minute dots.

At one time they appeared to unite, but in the end no special change occurred. There were a few unpigmented parasites and numerous pigmented leucocytes. Evening temperature normal.

26th.—Morning temperature normal. Crescents still present in the blood. No unpigmented parasites. Evening temperature normal.

27th.—Temperature normal. Appearances the same as yesterday.

28th.—Temperature normal. Appearances the same as yesterday.

February 1st.—Crescents still present. Patient discharged to duty.

In this case crescents were present in the blood without fever, and when fever appeared the unpigmented form was evident. While the crescents were present in this man's blood he was quite fit and well. No flagella appeared at any time.

Case 2.—Private B—, admitted to hospital on the 24th January, 1896. On the 24th his evening temperature was 102·4° F.; 25th, morning temp. 104° F., evening 100·6° F.; on morning of 26th normal, evening 104° F.; on morning of 27th 105·8° F., evening 101° F.; morning of 28th normal. The blood examined on the morning of the 27th contained numerous minute unpigmented parasites, and on the morning of the 28th the same with crescents. Evening temperature of 28th 105° F.

29th.—Morning temp. 101° F. The blood contained unpigmented parasites and crescents.

30th.—Temperature normal. Nothing abnormal noticed except pigmented leucocytes.

31st.—Temperature normal. Pigmented leucocytes.

February 1st.—Temperature and microscopical appearances of the blood normal.

Patient readmitted on the 21st. Temperature at 12 noon 101° F., and at 6 p.m. 101° F.

22nd.—Morning temperature normal. The blood contains numerous unpigmented parasites. No crescents. Some cells contained two parasites. One parasite had a dumb-bell shaped appearance. Evening temperature normal.

23rd.—Temperature at 6 a.m. 99° F., at 9 a.m. 101° F., and at 10.30 a.m. 103·4 F. The blood at 10.30 a.m. contained minute unpigmented parasites. In one cell in which I observed three parasites I saw one of them suddenly resolve itself into two separate bodies. The parasites less numerous to-day than yesterday. This patient refused to take quinine.

Case 3.—Lance-Corporal C—, has just returned to Sierra Leone from the Ashanti expedition, arriving on March 2nd, 1896. After marching to Mount Auriol, a distance of two miles from the landing stage and about 800 feet above the sea, patient states he had a slight attack of fever the same night, which passed off in a few hours. He came to hospital on March 4th, stating that at 2 a.m. on the 4th he went to the rear, and on returning felt shaky and cold, for about half an hour had headache, afterwards became hot, and then reported himself sick. He says that he never had fever before, not even on the expedition. Morning temperature when admitted to hospital on the 4th, 103·6° F. Patient could retain nothing, and was put in a wet pack for half an hour, after which his temperature fell to 99° F. The blood was examined before wet packing, and was found to contain numerous unpigmented and a few pigmented parasites, mostly oval-shaped, with a ring of hæmoglobin (part of the red cell) surrounding them—the intra-corpuscular crescent form. The pigment was confined to the centre. Evening temp. 101° F.

March 5th.—Morning temperature normal. Blood contains numerous unpigmented parasites and numerous crescents, some large and others small, with a very little pigment. A few small, rounded, unpigmented bodies were evident in some of the crescents. Pigmented leucocytes. Evening temp. 101·2° F. From this date the temperature remained normal.

8th.—Only crescents.

11th.—Blood examined before patient left hospital. Nothing abnormal, but only a cursory examination could be made.

This case is interesting from the very early appearance of crescents in the blood.

Case 4.—Corporal T—, after having been in hospital for a week, and apparently sufficiently well to leave, was seized on the night of the 11th March, 1896, with another attack of fever.

March 12th.—Morning temperature 105° F. He was put in a wet pack, and temperature fell to 102° F. The blood contained numerous unpigmented parasites. These parasites were rounded in shape, and their diameter was one sixth of that of a red corpuscle. The colourless protoplasm was peripheral, the transparent centre transmitting the ordinary colour of the red corpuscle, giving the whole parasite a rounded shape. From their periphery small protoplasmic processes were actively projected and retracted; the parasite itself contracted and dilated, during the contraction the size being only about one half that of dilation. One oval-shaped pigmented parasite was observed; a narrow ring of hæmoglobin surrounded it and retained its colour.

Evening temperature 99° F. Blood contains a number of unpigmented parasites. No crescents or other forms were observed.

13th.—Morning temperature normal. The blood contains numerous pigmented and unpigmented parasites; the former contain one or two minute grains of pigment in the periphery, which continued to move for a considerable time. These grains of pigment moved round the periphery, and would suddenly be carried towards the centre of the parasite and back again to the periphery. The parasites were contracting and dilating. The pigmented forms were about twice the size of the unpigmented. No crescents or oval forms were observed. Pigment-carrying leucocytes were seen.

A specimen was stained by allowing a small quantity of methylene blue to dry on the slide over which the drop of blood was placed. When examined, the central portion of the unpigmented parasites was stained blue, leaving the periphery quite clear. Evening temperature 99·8° F., and going up. The blood contained only a few unpigmented parasites. During the day the patient had taken 40 grains of hydrochlorate of quinine.

14th.—Temperature normal. No parasites visible in the specimens taken.

15th.—Morning temperature normal. Blood contains a few unpigmented parasites. Nothing else abnormal observed. Hydrochlorate of quinine continued in 15-grain doses twice daily.

21st.—Temperature has been normal since the 15th. To-day one parasite only observed, which was slowly throwing out its processes and having two grains of pigment. It was about twice the size of the unpigmented stage.

23rd.—Morning temperature 100° F. The blood contains a few unpigmented forms. Evening temperature 101° F. A few unpigmented forms and crescents.

24th.—Temperature normal. No parasites observed. Up to this time he continued to take 30 grains hydrochlorate of quinine daily. He left hospital on this date.

June 30th.—Returned to hospital with rigors. The blood contained numerous unpigmented forms. This patient had a great many admissions, and had a number of attacks during each admission.

Case 5.—Private F—, March 16th, 1896. After he had been in hospital for some days it is noted that his temperature on the evening of this day was 102° F. The blood contained pigmented and unpigmented parasites of the size and form described in previous cases. Both

showed the characteristic staining with methylene blue when a small quantity of the stain was added to fresh blood.

17th.—Temperature normal. The blood contains a few unpigmented parasites. A small red cell contained an oval-shaped body with pigment, and between the pigment and the periphery two small spore-like bodies moved about.

18th.—Temperature normal. In a specimen of blood, to which solution of eosin had been added, numerous parasites were observed, and one slightly crescentic body, having a somewhat granular appearance, and tinged with hæmoglobin.

19th.—Temperature normal. The blood contained a few unpigmented parasites, but a prolonged examination was not made. The parasites in this case corresponded in appearance precisely with those observed in the previous cases. The man had the routine treatment with quinine all the time he was in hospital.

Case 6.—Private E— admitted to hospital on the 27th March, 1896. Evening temp. 103·2° F., going up to 105° F. at 9 p.m. Five grains of calomel and 2 ounces of Mist. Senna Co.

March 28th.—7.30 a.m., temp. 104° F. At 10 a.m. 10 grains of antifebrin and 20 grains of quinine hydrochlorate. 10.30 a.m., examination of the blood. Unpigmented parasites and a spherical body surrounded by the remains of the red cell, with a small mass of pigment in the centre. One specimen was stained by adding methylene blue to the fresh blood, and a parasite observed which almost filled the red cell, and had taken the blue stain. There was a mass of pigment at one part of the periphery. In the unstained specimen, in addition to unpigmented forms there were red blood-cells containing small masses of pigment, the pigment masses consisting of light and dark portions. The clear part of the parasite pushed out pseudopodia-like processes. Whilst one was under observation the red cell gradually disappeared.

29th.—Temperature normal. Many red cells containing parasites spherical in form, and nearly filling the red corpuscle. In some the pigment lay towards the periphery, in others it was central. After being under observation for about an hour a spherical parasite became oval, and the central pigment grouped itself towards the centre, and could be observed moving for several hours. No free crescents were observed.

30th.—Morning temperature normal. One oval pigmented form and three unpigmented forms in one cell. No crescents.

Case 7.—Private S— admitted to hospital April 1st, 1896, at 5 p.m., comatose. Seen by Surgeon-Captain Hall, who remained with him till 7.30 p.m. I saw him about 8.30 p.m., and found him quite comatose. On touching the conjunctiva there was at first a slight contraction of the orbicularis. Pupils somewhat contracted, no reaction to light; pulse 80, resp. 20. Temperature on admission 103° F., and in the evening 100° F. Breathing not stertorous. Up to 11.30 p.m. he received 60 grains of hydrochlorate of quinine hypodermically, 1 drachm of ether, and two enemata. The patient remained comatose during the night. Morning condition was the same.

April 2nd, morning.—The blood contained numerous pigmented and unpigmented parasites. No crescents visible, but I had not time to examine the peripheral blood very long. At about 1 p.m. there was a sudden quickening of pulse and respiration to 120 and 40. At 4.30 p.m. pulse 170, resp. 60. Still comatose, coma vigil. Temperature rose to 105° F.; condition remained the same till death at 12.40 a.m. on the 3rd.

Post-mortem at 9 a.m. All the organs congested, lymph on surface of brain. Liver weighed 5 pounds. Spleen slightly enlarged, soft and friable, of a dark plum-colour. Brain capillaries contained many pigmented parasites, the pigment being in one small block near the centre of the

parasite; one sporulating form was observed. The affected red cells did not move. Blood from the liver and spleen contained much pigment. One pigmented parasite was observed in the blood from the spleen. I stained a specimen all night in hæmatoxylin, and next morning added a drop of eosin (1 in 1200). Several nuclei of the parasites took on a distinct purple stain, with one or two dark points in the clear part. In the centre of many of the parasites the eosin-stained red cell was visible, and each parasite had a ring of purple round it with one or two dark points.

This patient was in hospital a month before with an ordinary attack of malaria. He returned to duty in a few days. For two days previous to his last admission to hospital he had a slight attack of fever, but wishing to finish shooting in a rifle competition, he remained for about nine hours on each of these days at the rifle range, and very probably this prolonged exposure led to a fatal result. This case shows the necessity of absolute rest, however trivial the attack of fever may appear.

Case 8.—Corporal K— admitted to hospital on May 19th, 1896; temp. 101° F. Patient states that fever began at 4 a.m. He has had many previous attacks of fever. The blood contained a number of unpigmented parasites, and crescents with the usual appearances, pigment being always in the centre except in one in which it was scattered. In some there was only a very small quantity of dark pigment without the appearance of the central body in which I usually observed the pigment grouped. Evening temperature normal.

May 20th.—Morning temperature normal. The blood contained several small round pigmented forms, in the centre of which the red cell was visible, and they every now and then contracted and expanded. The pigment was in active movement. Numerous crescents.

21st.—Temperature normal since first day. Crescents less numerous. No other forms.

25th.—Temperature normal. Patient discharged. Crescents still present. No other forms.

CASE 9.—Private F—, admitted on the evening of June 26th, 1896. Temp. 104·6° F.

June 27th.—Morning temp. 99·2° F. Evening temperature normal.

28th.—Morning temperature normal. Evening 101° F.

29th.—Temperature normal. He had twenty grains of quinine hydrochlorate daily during this time.

Microscopical examination of the blood.—Very many red cells much enlarged, paler than normal, and containing minute numerous pigment granules. A few contained what looked like definite amœboid bodies. There was distinct movement of the pigment granules. In the unstained specimens I did not observe any of the forms seen in the cases of pernicious malaria which I have described, but in the stained specimens I saw a small parasite in the red corpuscle with one very small pigment granule. This body resembled a form described in the pernicious cases.

This is the first case of tertian fever I have seen at Sierra Leone. Patient states he had several attacks of malaria in Jamaica. He came to the coast in the beginning of 1894, and it is legitimate to infer that the attack may have been a recurrence of the malaria acquired in Jamaica. (I make this remark with all deference.)

This man's case differed from the others in the accented rigors which ushered in the attack. It will be noted that while he had fever on the 26th and 28th, on the 27th he was free from fever, and the fever yielded rapidly to 20-grain doses of quinine daily. He was kept under observation for some time, and there was no relapse. These features agree with those which are characteristic of tertian ague, and the microscopical examination of the blood showed that the case was a true tertian. The comparatively large size of the parasite, still more the very much enlarged red cells, which to a great extent had lost their colour, sharply differentiated the microscopical

appearances from those which I have described in the pernicious cases, and harmonised completely with the description of the parasite of tertian fever, as described by Golgi and others.

CASE 10.—Private H— has been in hospital several months, suffering from heart disease, and has had several attacks of fever during that time. He states that the attack usually begins with shivering, but the attack this morning commenced without rigors. Temp. 99·4° F. Vomited once.

Examination of the blood shows many unpigmented forms and many crescents. An appearance which I observed in this case, and which I had never before observed, deserves special mention. A red cell was nearly filled with a parasite, the parasite consisting of clear protoplasm on the periphery, and in the interior a number of small irregular-shaped bodies in close contact, presenting a somewhat dendriform arrangement. While under observation this body, which was crescent-shaped, first enlarged, and then the small bodies which I have described were observed to oscillate and arrange themselves in a ring form, after which a bulging took place in the side of the crescent, and these bodies appeared to endeavour to become free, but apparently the wall of the crescent would not yield. The crescent swelled to about twice its original size, and the small bodies which it contained scattered themselves irregularly in its interior, and then ceased to oscillate. I do not wish to associate this solitary observation with any general law, but in connection with Grassi and Feletti's theory of the sporulation of the crescent body I have thought it well to place it on record. It was a solitary example seen during a series of observations of the crescent form, of which I must have watched some hundreds closely. At 2 p.m. temp. 102·8° F.; 6 p.m., temp. 99·4° F.; 9 p.m., normal. A number of crescents with a nipple-shaped projection were observed in the blood.

July 9th.—Fever began shortly after 10 a.m. Temperature at 4.30 p.m. 103·6° F. I observed an oval-shaped parasite with a pigment mass similar to that seen in crescents. It filled the red cell, from which the colour had entirely disappeared. It contained three distinct spores with a distinct nucleolus in each spore. The pigment was in clumps. Close to it, but not touching this body, was a patch of pigment to which a spore was adherent. This appearance is the nearest approach to what might be a crescent in sporulation which I observed. Several pigment-containing leucocytes were observed, the pigment granules being in motion.

11th.—2 p.m., temp. 102·2° F.; 6 p.m., temp. 101·4° F.; 9 p.m., temp. 101·4° F.

12th.—Temperature normal. Patient then passed out of my observation. During the attack quinine was given in the usual doses.

Case 11.—Private M—, admitted to hospital July 10th, 1896, suffering from fever.

The blood contains pigmented and unpigmented parasites. The pigment is present in the form of one or two grains situated towards the periphery. The portion of the red cell present in the centre of the parasite sometimes consists of two parts. At 2 p.m. temperature 100·8° F.; at 6 p.m., 101·8° F.; at 9 p.m., 104° F.

11th.—Temperature at 9 a.m. 103° F. I stained a fresh specimen with Plehn's fluid, which caused the periphery of most of the parasites to become motionless, while the central mass appeared as a dark spot. The nucleolus became evident on staining some of them. In one unpigmented parasite there were two nucleoli deeply stained and moving most actively. The periphery of this parasite threw out processes, and it moved about the red cell, an appearance which I had not before observed. In the centre of many of the parasites three or four minute dark bodies moved rapidly. They were probably minute pigment granules. No crescents evident. A special appearance which was observed during this examination

should be noted. In a parasite which filled one half of the red cell, and which was oval and distinctly contoured; a block of pigment was situated at one end of the parasite, whilst a single solitary spore was observed at the other. The granules of pigment, although massed together, were in active movement. The appearance of the pigment and the shape of the parasite are very suggestive of a crescent formation (the Laverania of Grassi and Feletti). If this were the case, it would afford additional proof that the crescent form can produce a spore, but I do not insist on this interpretation. The appearance is not entirely inconsistent with the interpretation of a sporulating form of the pernicious parasite. Without insisting on any special interpretation, I simply put the fact on record. At 2 p.m. temperature 101·8° F.; at 6 p.m., 100·4° F.; at 9 p.m., 99·8° F.

12th.—Temperature at 7·45 a.m. 99·8° F.; at 10 a.m., 101·4° F.

13th.—Minute dark points no longer visible in the parasite. Few parasites visible. A parasite was seen throwing out processes on the blood-cell.

Of these 11 cases all were negroes, with the exception of Case 4, a white man.

If we exclude a case of tertian fever (the only one observed amongst about 400 cases), it will be seen that in the malarial fevers of Sierra Leone the only parasitic forms observed in the peripheral blood are a very small amœboid organism, usually ring-shaped, a slightly further advanced stage in which a little very fine pigment can be detected on the periphery, a further stage in which the pigment is massed towards the centre of the parasite, which has enlarged to about twice the original size (only observed a few times), and the crescent forms fully developed, and in the partially developed intra-corpuscular forms. In the amœboid and pigmented forms nuclear elements can be observed. Nuclear elements were not seen in the crescents, but a differentiated central portion in which the pigment accumulates could be made out. In one case appearances were observed which could be explained by assuming the accuracy of the theory of Grassi and Feletti that the crescent body may form spores, but I do not desire to lay much weight on a solitary observation. In blood taken from a vein in the brain of a fatal case I observed a sporulating form in which both the central pigment and the spores were distinct. I never saw the so-called rosette form in the peripheral blood. I never observed the quartan forms described by Golgi, and only once the characteristic appearances of the tertian parasite of that observer.

In order to compare the parasites which I saw with the quartan and tertian forms of Golgi, I was obliged to get specimens containing these forms from Europe. Dr. Thin was kind enough, at my request, to send me preparations containing the tertian and quartan parasites. These were very distinct, and I was able to satisfy myself that no such appearances (always excepting the solitary case of tertian) were present in the cases which I examined. Is there anything in my description of this parasite which can be considered evidence that the parasite of malaria in Sierra Leone is a distinct species? I find that there is not. If my description and the drawings which accompany this paper are compared with the description and the drawings which illustrate the work by Marchiafava and Bignami, it will be seen that the Sierra Leone forms correspond in every essential particular with the parasites which those authors describe as being found in the so-called summer-autumn fevers of Southern Italy. The small amœboid ring-shaped forms and the small forms with very fine pigment find their exact countertypes in the descriptions of the Italian authors. The "ottonati" or brassy forms described by them I did not observe. This is the only particular in which my description appears to differ from theirs, and in this connection it may be noted that Thayer and Hewetson in describing the summer-autumn fevers at Baltimore also find many of the so-called brassy-red corpuscles.

As regards the ætiology I can add nothing to what has already been written on this subject.

Expeditions into the interior of Sierra Leone, which are generally limited to two months on account of the difficulties of transport, are followed by a large increase in the cases of malaria. After the regiment has returned to Sierra Leone, fever very soon attacks officers and men, more especially the former, and a fatal result is by no means rare.

Among the officers of the Sierra Leone Frontier Force, who have to spend most of their fifteen months' tour in the interior, the mortality is higher than is the case with the officers of the West India Regiment who serve for a year on the coast.

Mosquitoes are present before and during the rainy season. There are so few that mosquito nets are hardly necessary. Many of the officers are bitten by these mosquitoes, some rather severely, but I do not know of a single case having been followed by fever.

It may be interesting to state that I have found examination of the blood of value diagnostically in cases brought into hospital comatose. There are cases in which it is important to eliminate other causes of coma, such as apoplexy and alcoholic poisoning. Persistent headache and cases of subacute rheumatism have been generally returned as malarial, but I have found by microscopic examination of the blood that many of these cases, particularly the latter, are frequently not caused by malaria. In all cases of malaria I found the parasite, and therefore its absence may be held as conclusive of the case being non-malarial.

For treatment I shall simply refer to the routine administration by most medical officers on the coast, of calomel, antipyretics, and quinine. Wet packing is extremely useful in cases of persistent vomiting. I obtained no benefit from boric acid in 30 grains thrice daily, or Liquor Hydrarg. Perchlor. in drachm doses thrice daily. Arsenic appeared to be of service in one case of malarial fever which lasted for several weeks. I did not employ any of these three drugs for a lengthened period.

Quinine should be given early and in large doses (15—20 grains), repeated every two to three hours until the temperature is normal.

Absolute rest is necessary in every case, however trivial the symptoms may appear.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' Third Series, vol. ix, p. 99.)

DESCRIPTION OF PLATE XXIII.

Figs. 1—22 represent the appearances observed in the fresh blood.

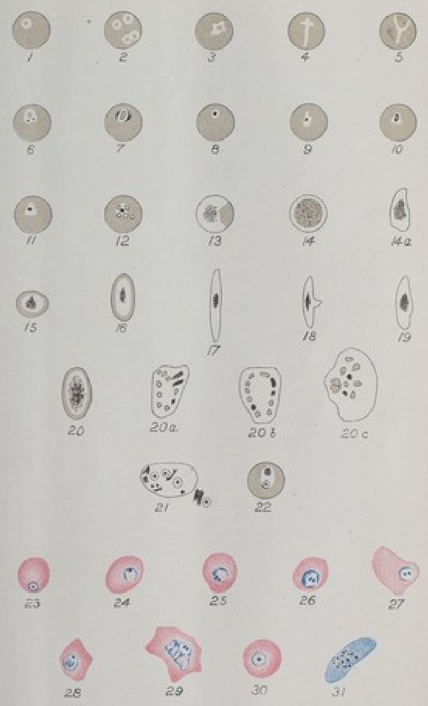
Fig. 1.—Small ring-shaped parasite. Fig. 2.—Four such parasites attacking one red corpuscle. Figs. 3, 4, and 5 show the parasite in the active motile stage. Figs. 6, 7, and 8 show the parasite in the stage in which pigment formation begins. Figs. 1—8 are blood taken from the finger.

Figs. 9—12 represent red blood-corpuscles from a drop of blood taken from the surface of the brain in a fatal case, about eight hours after death. Central pigment can be seen in all four. In Fig. 10 it appears divided into two portions. In Fig. 12 five separate spores can be counted.

Figs. 13—22 represent various appearances shown by the crescent form. In Fig. 13 the crescent nearly fills the red corpuscle. Fig. 14 shows a round crescent nearly filled with pigment, the collection of pigment being unusually large. Fig. 14*a* represents the parasite shown in 14, after it had undergone change, the pigment collecting in the centre. This change occurred whilst the parasite was under observation. Fig. 15.—A crescent with central pigment, filling about half the red corpuscle. Fig. 16.—Larger crescent than 15, almost filling the red corpuscle. Figs. 17, 18, and 19 show various types of the crescent parasite.

Figs. 20, 20*a*, 20*b*, 20*c*.—Transformations of the parasite observed under the microscope, which is described at p. 231. The first form of the parasite observed is shown in Fig. 20; the other three figures show the gradual transformation which took place. Fig. 21 represents what the author considers to be a form suggestive of spore formation in a crescent (see p. 232). There was no doubt as to the crescent nature of this body, and the pigment blocks and spore-like forms were separate and distinct in its interior. Close to the crescent, adhering to some pigment, was a free spore.

Plate XXIII. Med. Chir. Trans., Vol. LXXX.



A. Danielsson, del. *Bale, Danielsson, Ltd.*

Fig. 22 shows a small crescent body inside a red corpuscle, with a pigment block at one end, and a small circular body with a central point at the other end—suggestive of a spore. This spore-like body was identical in appearance with the three spore-like bodies shown in Fig. 21.

Figs. 23—31 represent appearances in stained preparations.

These preparations were stained at Sierra Leone, and were drawn by Mrs. Danielsson.

Fig. 23 shows the minute nucleolar body. Fig. 24 shows a similar nucleolar body on the periphery. Fig. 25.—No separate nucleolar body was observed. Fig. 26.—The deeply stained nucleolar body is surrounded by an uncoloured portion, whilst the periphery is stained blue. Figs. 27, 28, and 29 show similar phases. They were observed in one preparation in the same field of the microscope adjoining each other. In Figs. 26, 27, and 29 there were two nucleoli in each parasite. In Figs. 26, 27, and 29 the colourless space surrounding the nucleolus, which has been described by Mannaberg as the nucleus, is very distinctly observed. Fig. 30 shows the young form of the parasite in a case in which there were many crescents in the blood. Fig. 31. —Fully developed crescent form from same preparation as Fig. 30.

In none of the parasites represented from 23 to 30 had the development reached the stage of pigment formation.

Figs. 1—22 represent as near as possible the size of the elements drawn as seen by $\frac{1}{12}$ oil immersion lens and Zeiss No. 8 eye-piece. Figs. 23—29 were purposely drawn to a similar scale.

HEPATIC ABSCESS.

BY W. K. HATCH, F.R.C.S., ENG.

THE treatment of hepatic abscess by means of the aspirator is, I beleive, now almost generally superseded by the use of the knife; in fact, abscess of the liver is now treated like any other abscess. The object of my paper is to urge the desirability of early operation. It has been my experience, both in hospital and private practice, to find that the majority of these cases are left until the abscess has begun to point externally—until, in fact, a very considerable portion of the liver has been destroyed. This is in some cases due to the want of proper medical treatment, owing to poverty, prejudice against the knife, &c.; but in many instances it is owing to the medical attendant advising that the abscess should be left until it has become superficial, and can be more readily dealt with—an opinion with which in most cases the patients and friends are only too ready to agree. I believe that this is a most dangerous mode of procedure, and experience in a considerable number of cases, some of which I have tabulated, goes to convince me that the danger of hepatic abscess increases with its size, and that, when position admits of its being done, the earlier an abscess is opened the better. Consequently it will follow that in no case should delay be permitted, even with the hope of the matter bursting into the lung, which is considered a favourable termination, but one which, I venture to think, is tedious, exhausting, and dangerous. Even when this has occurred I should advise that the cavity be opened from the outside, if it can be readily found, and treated as if no such communication had taken place. The process of having to expectorate large quantities of pus day and night, almost without intermission, is so disgusting to the patient, and so liable to disturb the digestive organs (apart from the lung trouble which may be set up), that, I think, no one would prefer to undergo it who was acquainted with the mode of incision. On the one hand, incision is easily performed. There is generally immediate relief from pain and fall of temperature; the cavity at once begins to contract, the discharge to lessen, and no further damage is done to the liver; and finally, the disease is absolutely cured. On the other hand, aspiration is tedious, relieves pain for a time only, four or five days at most, the temperature falls only to rise again, the discharge goes on refilling the abscess cavity, often enlarging it and repeated operation is required. In earlier days I have aspirated again and again, seven or eight times in the same case, with but little diminution of the pus removed on each occasion, the patient gradually growing weaker and weaker. In fact, the necropsy has often shown to me the utter futility of treating large abscesses in this way. The thick contents, often like boiled down liver, cannot be satisfactorily or entirely evacuated through the largest needle; sometimes the pus will not flow through the orifice of the aspirator bottle without being forced out by blowing. Again, by aspiration a considerable bleeding into the abscess sac may be caused; and, as Dr. H. Vandyke Carter has shown in a case published in the Medical and Physical Transactions of Bombay, a vein may be opened and a fatal hæmorrhage take place.

The aspirator may be used for the following purposes:—
1. Puncture of the liver seems often in suspicious cases of hepatitis to relieve the pain to a marked extent. This may be possibily due to the evacuation of a small quantity of blood and the relief of congestion; but in other cases in which I have seen exploratory puncture have this effect, the quantity of blood has been so small that one can hardly attribute it to

this cause; nor can it be due to relief of tension by puncture of the capsule, the needle opening being a small one. Whatever the explanation, I have noticed the fact and heard it pointed out again and again by my seniors. 2. As a mode of leeching the liver, and recommended by Dr. G. Harley. This authority states that the aspirator used in this way was first advocated by him. This is, as far as I know, perfectly true; but at the same time I believe that those surgeons whom I have known advocate puncture of the liver for relief of pain have unknowingly often made use of this very mode of treatment, and I have repeatedly seen it done, and with advantage. 3. As a means of diagnosis the use of the aspirator is most common; the cavity may at the same time be evacuated entirely. 4. To set up adhesion between the parietal and visceral peritoneum, although this may be already present when the abscess is superficial; when deep it is not likely to have occurred, and this plan of treatment is probably useful. Even where no such adhesion takes place, pus seldom escapes into the abdominal cavity; in one case under my care this accident did occur, and consequently I make it a rule to aspirate before operating, as a precautionary measure.

The plan I have usually adopted is first to aspirate the abscess and remove half the contents, as near as I can judge, and in three days' time to chloroform the patient and freely open it with the knife; if desired, the aspirator needle may be used as a guide. In large abscesses, for the first two or three days the discharge is most profuse, and the dressings will require to be frequently changed; it is not usually necessary to syringe out the cavity, though this may be done if decomposition occurs; usually the pus is at first perfectly sweet, but I have known it to have a very offensive odour, probably from propinquity to the colon; gas may be present in the cavity and give a tympanitic note on percussion, as in Case 1, Table 1. When the abscess points in front, it is often advisable to open it in that position, though manifestly not favourable to drainage; the size of the cavity having been gauged with a long probe, if found to be large, I usually make a counter-opening in the axillary line and put in a tube, allowing the anterior to close, which it usually does at once. It is difficult to draw a line between small and large abscesses; by a "small" one I should understand one holding from one to ten ounces only; very large abscesses often occupy the whole of the right lobe, and may contain several pints of fluid.

The mortality of the tabulated cases is high. In the majority the patients were admitted about as bad as they well could be, with much bulging, œdema of the surface and distinct fluctuation, extreme emaciation and diarrhœa in many, and operation has been performed more to alleviate suffering than with any hope of success. In private practice the results are much more favourable; and this is due in most instances to operation being performed before the abscess has attained a very large size. The mode of death is usually by exhaustion from the profuse discharge, attended by a breaking down of the liver substance, or from diarrhœa, which is controlled with difficulty once it is set up. In the natives of this country I find that the use of stimulants not only increase but often starts the diarrhœa, and I seldom prescribe it for this reason. As a rule, the patients are not accustomed to the use of alcoholic stimulants. These patients were all natives of India and of diffierent castes. With one exception they have been under my care during the last ten months. English medical men may possibly be surprised to find that a disease which is generally attributed to abuse of alcohol and animal food should be so common amongst a class who certainly never indulged to excess in the latter, and seldom to the same extent as Europeans in the former. It is most uncommon to meet a drunken man in Bombay, and the number of men who habitually take alcohol is certainly small compared with a large European city. Chills, malaria, and chronic dysenteric, and other ulcers may account for a considerable number, but it is often difficult to ascribe the disease to any of these causes.

TABLE I.

No.	Name.	Age.	Habit.	Pus removed.		Duration of treatment.	Result.
				Asp.	Incis.		
1	L. N.	40	Intemperate	0 oz.	30 oz.	7 days	Died
2	D. C.	45	,,	7 ,,	5 ,,	6 hours	,,
3	A. D.	37	Moderate	3 ,,	28 ,,	2 days	,,
4	E. L.	49	,,	24 ,,	43 ,,	14 hours	,,
5	P. E.	40	Intemperate	2 ,,	30 ,,	26 days	,,
6	M. C.	25	Moderate	52 ,,	25 ,,	11 ,,	,,
7	F. L.	35	,,	2 ,,	19 ,,	3 ,,	,,
8	S. J.	35	,,	16 ,,	30 ,,	21 ,,	,,
9	B. B.	35	Intemperate	14 ,,	30 ,,	28 ,,	Cured
10	A. N.	40	,,	16 ,,	22 ,,	21 ,,	,,
11	B. K.	40	Moderate	0 ,,	16 ,,	15 ,,	,,
12	M. K.	40	,,	38 ,,	48 ,,	93 ,,	,,
13	F. O.	20	Intemperate	28 ,,	30 ,,	34 ,,	,,
14	M. J.	30	Abstainer	—	10 ,,	24 ,,	,,
15	B.	50	Moderate	—	8 ,,	52 ,,	,,
16	D. K.	50	Intemperate	16 ,,	25 ,,	180 ,,	,,
17	L.	22	Moderate	15 ,,	27 ,,	*	,,

* Still under treatment and doing well.

I append a *résumé* of the cases given in Table I. :—

1. A Portuguese, in good condition. Right lobe of liver much enlarged; a tympanitic area, tender on percussion in front; pus very offensive, and gas present.

2. A Parsee, who had suffered recently from diarrhœa for several weeks, had bulging of the right side. After operation he became collapsed, and there was probably an escape of pus into the peritoneum, as peritonitis followed rapidly; but no further operation was allowed.

3. A Hindu, with bulging just below the ensiform cartilage. Very much emaciated, and sinking practically at time of operation; but, as he was much distressed by the pressure of the liver, incision was performed.

4. A Hindu, suffering from dysentery. Much bulging of the whole hepatic region, with fluctuation, redness, and

œdema. The dysentery continued, and the patient died soon after incision had been performed.

5. A Parsee. Liver enlarged, chiefly in the middle line; the intercostal spaces also bulged. After operatien diarrhœa set in, which proved fatal.

6. A Hindu. Much bulging of the lower ribs on the right side, with redness, fluctuation, and œdema. He was extremely emaciated, and could not rally.

7. A Hindu. Considerable bulging in the median line; intercostal spaces not bulged, but tender. Liver very soft, and bleeding much at time of operation.

8. A Mussulman. Had bulging of right lower ribs, with much pain and tenderness. Was much relieved by operation, but was attacked by diarrhœa, which was subsquently checked.

9. A Hindu. Much emaciated. Abscess pointing externally over the ninth and tenth ribs on the right side, and fluctuation distinct.

A Hindu. Had recently suffered from diarrhœa. There was bulging on the right side, especially below the angle of the scapula, with much pain and tenderness. Constant diarrhœa was present all the time the patient was in the hospital.

11. A Hindu. He had an abscess of the right lobe, with marked bulging. Operation was followed by diarrhœa, which was subsequently checked.

12. A Hindu. Much emaciated, with a long history of diarrhœa and fever. There was considerable bulging below the ensiform cartilage. Diarrhœa, at first troublesome, was afterwards cured.

13. A Mussulman. He stated that his illness followed a chill at night. Much emaciated. No marked bulging. He made a good recovery.

14. A Mussulman. The liver was much enlarged, but marked swelling and fluctuation were present above the umbilicus. He was much relieved by operation.

15. A Parsee. The patient had a tumour about the size of a tennis-ball in the epigastrium, which was very painful, hot, and fluctuating. The abscess was found to be in the left lobe, and its walls were hard.

16. A Mussulman. He had bulging of the right lower rib, with much pain and tenderness. He was speedily relieved by operation, but was attacked by troublesome diarrhœa.

17. A Hindu. Considerably emaciated. The whole of the right hypochondrium bulged, and was tender; fluctuation felt anteriorly. He was progressing fairly.

TABLE II.

No.	Name.	Age.	Habits.	Pus removed.	Duration of treatment.	Results.
1	S. M.	40	Temperate	10 ounces	19 days	Cured
2	R. B.	18	Abstainer	*	15 ,,	Died

* Abscess burst before admission.

In Table II. are two cases :—

The first, a Mussulman interpreter, had a small swelling below and to the left of the ensiform cartilage. It was tender and hot, but not fluctuating. Aspiration was performed and ten ounces of pus removed. The liver substance was very hard. The pus did not accumulate. The pain gradually subsided, and the patient was discharged apparently cured.

The second case (of which an illustration is here given) is inserted to show the damage which may follow the expectant treatment. Large sloughs of the soft parts came away, exposing the necrosed ribs. The boy was a perfect skeleton on admission. There was a large cavity in the liver. The kidney was exposed, and an opening through the diaphragm and lung existed. The destruction was so extensive that the patient resembled a body eaten by jackals or dogs. The discharge, too, was very profuse; but notwithstanding, he lived fifteen days, taking his food well all the time, until a severe attack of diarrhœa carried him off.

Bombay.

Dr. W. K. Hatch read the following paper on Vesical Calculus:

"Cases of vesical calculus do not as a rule give much difficulty to the surgeon, once the diagnosis has been made; it is his duty to remove the stone and the disease by any of the methods most suitable to the case; from time to time we meet with a serious class of cases in which any operation is certain to be fatal. For them the questions of operation is in my opinion, better decided by the friends than by the surgeon. Once the latter has recognised the serious aspect of the case, he should explain fully both to patient and friends the *pros* and *cons* of the question, particularly laying stress on the relief to pain afforded by evacuating the bladder, which makes the sufferer during the weeks or months he lives infinitely more comfortable and easy. A division of such cases may be made into two classes, I. when there is a large stone and evidence of advanced disease in the kidney; II. when there is a large stone and much cystitis with or without kidney disease. For both these classes lithotrity from the size of the stone is out of the question, especially if there be cystitis, these patients not being able to bear the manupulation or the length of the operation, which must necessarily be considerable. It is necessary to choose between lateral lithotomy and suprapubic operation. Apart from any consideration as to deformities, like ankylosis of the hip, &c., putting lithotomy out of the question, there is one point of importance not noted in our surgical works that I know of, and that is the difference which exists in the outlet of the male pelvis; in some this is broad and roomy, in others so narrow that it is impossible for a stone

of any size to pass; here of course we should be obliged to do the suprapubic operation, whether or not cystitis was present. Even when there is no such formation, I am of opinion that for the first class of cases the suprapubic operation which is as easily performed, and not attended by anything like the hæmorrhage from the perineal wound is the most suitable, while the presence of cystitis makes the lateral operation advisable in the second class from the free drain which is at once established, enabling us to wash out and locally treat the bladder, by these means very much alleviating the condition of the patient. It is of course impossible to do this by any other operation. The following case belongs to those I have placed under the first class, the wretched state of the patient made it at once evident, that even were no complication present, an operation would probably be fatal; the size of the stone and the presence of albumen in the urine still further increased the danger. As, however, the man was suffering from severe pain, which would certainly be removed, the whole matter was put before him, and he decided to have something done. His history is as follows:—The symptoms were of 20 years duration, and some years ago there was considerable pain in the lumbar region; micturition has been difficult for years, and attended with sudden stoppages of the stream. The urine has at times contained blood, but pus was not noticed. The patient is a man of about 35 (so he says), looks nearer 40, anæmic and emaciated, with a very feeble pulse. Tongue coated and bowels constipated. Pain in glans-penis and hypogastric region with tenderness over the latter; pain and tenderness in the lumbar region; urine turbid containing pus, blood, and $\frac{1}{2}$ albumen. The slightest movement caused severe pain in abdomen; urine passed in a small stream. For the reasons before given, it was determined to extract the stone by the suprapubic operation of which I may give the following particular. Having been chloroformed, a solution of boric acid was pumped into the bladder until it was fairly distended, and the catheter left in; an assistant then introduced two fingers into the rectum and pushed the stone forwards. An incision between two and three inches long was then made into the linea alba above the pubis, and the veins superficial to the bladder pushed to one side. The front of the bladder was then made to bulge forward by pressure on the catheter, and an incision made, through which the stone was grasped and removed without difficulty. The bladder incision was then closed by five catgut sutures; the external wound was closed by nine sutures and a drainage tube put in. Dry dressings were applied over the whole, and a catheter introduced into the bladder. There were four calculi lying close against each other and their total weight—3 oz. 1 drachm 23 grains. The operation was done on the 14th. Next day he was free from pain; urine passed freely by the catheter, temp. 101°·6. On the 17th temp. normal. On the 19th it was 101°·3 and the dressings were removed for the first time. They were dry and the abdominal wound looked well; the catheter was taken out. Next morning the temp. was 97°·8 and urine was found to escape from the incision; no tenderness or abdominal distension present however. After this the patient gradually began to sink, apparently from sheer want of vitality. There were no bad symptoms, but the urine came always from the wound, and little by the urethra. On the 25th he died."

On *post-mortem* examination the 1st part of the ascending colon and the kidney were found matted together. The right ureter was somewhat dilated, and in a cul de sac at its lower end two small calculi were found. The left ureter was much diminished in calibre. The right kidney was enlarged, irregularly lobulated, and contained a coral-like calculus filling the whole of the pelvis. The calyx of the left kidney was enormously dilated and contained a small irregular calculus. One small calculus was found both on the upper and lower portion. Right auricle and ventricle of heart much dilated. Lungs emphysematous. The reason why I did not suspect more than one stone was the close apposition of the four stones, so that the sound passed over them all as one mass. With regard to the treatment of the bladder, Dr. Hatch

remarked—"evidently if the bladder incision can be securely sutured and primary union obtained, matters are much more satisfactory than when the wound is slowly filled by granulation, the process being attended by the discomfort of urine continually dribbling over the abdomen, and thus wetting the clothes, &c. For some time there seems to have been some difficulty experienced in bringing this about, but lately some successful and extremely satisfactory cases have been published in the medical papers by surgeons in England, the wound has been closed by catgut sutures placed very closely so that the subsequent movement of the bladder may not reopen it. By this method a catheter per urethram efficiently drained the bladder. At present the operation of suprapubic lithotomy is very much in fashion with some surgeons, who indeed consider it as the operation of the future. Comparing it with the lateral operation there are of course some evident advantages apart from the mortality of which at present the statistics are hardly sufficient. The chief advantage is I think the fact that urinary fistula does not follow; of this sequela I have lately seen a good many instances both perineal and rectal. The fact of sterility being caused by the lateral operation is not, I think, clearly proved. To my mind the advantages of lithotrity whenever it can be performed are pre-eminent, and there is another consideration which in this country is of some importance, it is this, that where it is understood by the masses that stones can be removed without cutting, the occupation of the village blacksmith and quacks will be gone in this particular; they will not be able to procure the necessary instruments for lithotrity, and we shall have fewer of those fistula cases, which so frequently follow the operations of these gentlemen, owing to the incision being made too far back. It is the duty of all medical men to spread as widely as possible the knowledge of this fact. As to portion of calculus being left to form the nucleus of another stone this certainly is liable to occur, but is it not better to have lithotrity twice performed than lithotomy once? For children in whom the stone is usually small, one or two turns of the instrument disposes of the case and the child is well in two or three days. The advantages of lateral lithotomy in adults are few, but in children it is so successful that I do not think we can abandon it altogether in favour of suprapubic. It is also certainly the best to perform when there is much cystitis; with this complication lithotrity may easily set up very dangerous inflammation. After this brief discussion of the operations as they now stand I may place before you the position they hold to one another in my opinion. In all cases, children or adults, I should first consider the possibility of crushing; when stricture or malformation of the part rendered this impossible, I would in children prefer lithotomy, and for the most part in adult when the stone was not too large and certainly if there be cystitis; whenever the stone is very large and when the pubic arch is a narrow one, or ankylosis of the hip be present, I should prefer the suprapubic operation, and as a relief to pain and in cases of which there is little doubt as to the prognosis being unfavourable."

Dr. Parakh remarked that he agreed with Dr. Hatch that in all cases lithotrity ought to be tried first, especially in India, where the patients dread surgical operation. He said that he tried lithotrity in four cases in children with success, though no evacuator was used, as he had none. He believed the presence of slight cystitis an indication for lithotrity than otherwise, because the symptoms subside as soon as the stone is removed. He had a case where cystitis was present and the patient got well after lithotrity, though the cystitis remained for some time; children, he said, seem to bear the operation very well. Dr. Gama was of opinion that in cystitis, removal by lithotomy was the best procedure, if the constitution at the same time had been shattered. Dr. Hatch in reply said that he meant cases of chronic cystitis and not mild attacks; lithotrity in children he said was an established operation; small stones weighing from 14 to 16 grains very often failed to be detected by the ordinary sound, but were easily detected by the evacuating catheter. Dr. Atmaram thanked Dr. Hatch for his interesting communication. Dr. P. Lisboa exhibited several

uterine and ear instruments with explanatory remarks, for which he was thanked by the Chairman.

Dr. H. P. Dimmock was then proposed a member of the Society.

Surgeon W. K. Hatch read the following notes on cases of Intestinal Obstruction and Strangulated Hernia with undescended testis:—

I have selected the following cases of Intestinal obstructions for several reasons: I. The difficulty of making an early diagnosis when the obstruction is complicated by undescended testis; II. Because I think we are in Bombay considerably behind the medical profession in Europe in the treatment of this particular class of cases; III. Because the symptoms met with, at all events in our hospital patients, are of a mild character compared with those pictured in our text-books, and consequently treatment may be delayed until too late. With regard to No. I., the fact of there being an undescended testis may not be disclosed to the medical man; either the patient is unwilling from a sense of shame, or else he is not aware that his suffering may in any way be connected with the malformation; or his history may be vague and misleading. Again the ordinary symptoms of a strangulated hernia may be accurately reproduced by an inflamed undescended testis, viz., vomiting and constipation, a painful swelling in the groin or abdomen, and much anxiety; in such a case when the absence of the testis from the scrotum has been detected, the question at once arises, Is there merely an inflamed testis or one complicated with hernia? or are the symptoms entirely due to hernia? The answer is "If in doubt cut down and see, delay is dangerous, and the operation much less so," nevertheless how often do we find such treatment postponed until too late. II. Are we behind the practice which prevails in Europe? If not, how is it that so few abdominal sections and herniotomies are performed for the relief of obstruction in Bombay; is obstruction less common? I cannot think that this is the case judging from the large number of hernias which come to the J. J. Hospital for trusses; and from the considerable percentage of patients in the hospital who suffer from this affection, the disease cannot be less common than in Europe. What becomes then of all these hernia cases? Some must become strangulated; possibly among a certain class caste reasons may stand in the way of operative procedures, but the greater number, I believe, die unrelieved, and for two reasons. Firstly, there is not a proper understanding of the relation between physician and surgeon, and the dislike to calling in another opinion from false pride. Secondly, by placing too great reliance on drugs the case is allowed to linger on until operation has become out of the question. Not only do all the surgical authorities of the present day urge early interference, but many new lines in abdominal surgery have been opened up, such as operations for the relief of perforating ulcers, particularly typhoid, for ruptured intestine from injury, from rupture of the bladder, &c. If we are not behind this practice in Europe, how is it that such cases never come to hand? Either because they do not occur, which is hardly credible, or because they are not rightly diagnosed; until this year when I operated on a case of cerebral abscess in which the abscess was successfully opened, not a single case had been brought before the profession in Bombay. Had they never existed up to this date? Hardly, for ear disease is common enough, and we must infer that some instances of cerebral abscess must have been under treatment in our hospitals and practice. It is certainly our duty to consider whether we as a profession in Bombay are on a level with the profession elsewhere and do our duty to our patients by offering them surgical assistance in such cases as those of intestinal obstruction when it is of primary importance. As to the 3rd point I am confident that the symptoms exhibited by our patients are not so acute as those noticed in Europeans. They are of a much more asthenic type, and the well known apathetic character of the lower classes here is certainly a factor; the pulse is quick but weak, the vomiting less violent, the discomfort produced by the distension of the abdomen and constipation are not so loudly

complained of, and particularly if opium has been given; there is an absence of the great suffering depicted in the general appearance and face of the European patients. The absence of such symptoms is particularly remarkable in the Hindus; the Parsees, a much more nervous race, often indeed exhibiting the symptoms in an exaggerated form. It is in the case of the former then that this difficulty of diagnosis arises; not only may the fact of their being intestinal obstruction be entirely overlooked, the patient laying stress merely on the constipation, or the patient may be actually sinking before the gravity of his condition is perceived. Lastly, we must remember that when gangrene has actually set, the condition of the patient may be apparently so much ameliorated that we may infer that there is a turn for the better. The last point is well illustrated in the last of the three cases I have to bring before you.

Case I. I was called at midnight to see a strong athletic man suffering from severe abdominal pain and inclination to vomit which had come on after exercise that afternoon.

The face was anxious, skin sweating, pulse very quick and full. Although the symptoms had commenced at 5 P. M. the patient had not mentioned his state until 10 P. M., when his friends began to think of calling in a doctor. He had suffered from a similar attack before, and recovered in two or three hours. On examination I found a hard swelling in the right iliac region, and the right testis was absent from the scrotum. On inquiry it was ascertained that the testis had never descended either into groin or scrotum. After consultation on the second day, it was decided to wait until the morning of the third and then to operate; on the third day, however, the pain appeared less, the swelling also sunken, but the vomiting and constipation continued, and the pulse was rapid. Operation having been unanimously agreed upon, I cut down on the swelling. The incision was made obliquely over the internal abdominal ring on the right side. The strangulated loop of intestine was then found tightly pushed with the right testis into the orifice of the ring. The gut was purplish, but not seriously damaged and having been freed, the testis was removed as the short cord prevented its being pulled down altogether: the organ was small and the amount of glandular substance very scanty. The different layers of the incision were carefully closed separately with cat-gut sutures and the skin by silver sutures.

The patient made a good and uninterrupted recovery, the temperature being once only above 100° and eventually went to England as he had intended prior to his illness.

"The second case" was that of an agricultural labourer, with absence of right testis. There had been absolute constipation for two or three days, vomiting at intervals, never urgent. An elastic swelling could be felt in the right iliac region, slightly tender. As there were no urgent symptoms the case was treated by a medical practitioner for some days. I operated upon him when consulted. On cutting down over the elastic swelling, it was found to be a piece of tightly constricted bowel, dark purple and much swollen just within the internal ring aperture, the testis was lying close to and above it and not at all inflamed. The constriction having been divided the bowel was returned and the testis left in the abdomen. The patient became worse and died; delay had been too great.

The third case was that of a Parsee admitted into Hospital on a Monday morning, with vomiting and swelling in the right groin. He said the bowels had been moved on Sunday night, but just before going to bed, pain and vomiting had suddenly come on, the latter being violent and continuing all night. The right testis had never since birth been seen in the scrotum, it usually remained in the groin. About a month ago he had a similar attack of pain which passed off; chloroform was at once administered and an incision made over the swelling; the right testis was found ill developed in the canal, and the bowel just above it; the ring having been enlarged, the

bowel was returned, the testis was removed as no amount of traction could bring it lower. He made a complete though slow recovery.

Case IV. Mrs. N. was brought to the J. J. Hospital by some friends on the evening of the 20th September 1888, and was then suffering from pain in the abdomen, constipation and occasional vomiting, and was evidently in great distress. She was at once treated with morphine injections, large warm enemata administered by the long tube, and a mixture of Belladonna, opium and stimulants. On the early morning of the 21st September she had rather a large amount of stercoraceous vomiting, she stated (and her statement was confirmed by her friends) that she had been suffering a good deal of anxiety for some time previous to her present illness, and that she had had occasional pains in the abdomen, but that the bowels had been fairly regular. She had neve suffered from any severe abdominal disease, nor from obstinate constipation. She had borne children, but there were never any complications during confinement, nor had she had any miscarriages. Menstruation had been always regular. On Thursday evening, the 14th September, she took a purgative on account of there being no action of the bowel since the previous day, and on the Friday morning early she was attacked with severe colic and passed 2 or 3 loose motions small in quantity. She also suffered from nausea. As she did not improve she placed herself under the care of a medical practitioner but gradually became worse, until on Tuesday, the 18th September, &c., the vomit began to smell offensively (stercoraceous?) Becoming still worse, and the bowels not having been moved, she was advised to come to hospital. She was a young woman, well nourished, but in very exhausted condition; the pulse being almost imperceptible, and the surface of the body and the extremities cold.

She complained of some amount of pain over the whole abdomen, and had occasional attacks of colic, which lasted a few minutes at a time. On the morning of September 21st a consultation was held and the following facts discovered. The abdomen was very soft and doughy and somewhat tympanitic, but no tumour or swelling could be detected, though there seemed to be a general fulness of the intestines. At this time there did not seem to be very much pain, though there was some tenderness on palpation in the left lumbar and iliac regions. The face was pinched and anxious, the cheeks sunken and marked with a circumscribed flush like that of a person suffering from hectic; the eyes were bright, wide-open, and somewhat startled and wild in expression, probably the result of the alarm the patient felt at her condition. She was menstruating. The urine was passed freely; the bowels had not been moved by the enemata, which were returned; she had vomited two or three times in the morning, the vomit being markedly stercoraceous. The liver and spleen were both within their normal limits; the vagina was irrigated and the uterus examined, and found to be retroflexed to some degree. The rectum was also examined and found to be patent and in no way interfered with by the fundus of the retroflexed uterus.

Obstruction of the small intestine was diagnosed and operation determined on immediately and proposed to and accepted by the patient.

Operation—The patient being fully under an anæshetic an incision was made in the median line below umbilicus about 3 inches long and the peritoneal cavity rapidly opened, the small intestine appeared rather redder than usual; a portion appeared to view of a bright red colour and above which the bowel was considerably though not excessively distended; here a hard plug 2 inches long and almost of stony hardness was found, it could easily be slipped up but not down the bowel, which it completely occluded, and by applying pressure over it I found myself quite unable to compress or in any way alter its shape; I made therefore a small incision ¾ in. long and introducing the end of a probe which carried a spoon on it, I gradually broke up and extracted piecemeal the whole mass, which was

chiefly of a dark green colour, lighter in places and giving an olive green stain to the fingers; the mass was evidently inspissated bile, and showed some signs of lamination in parts; the small opening having been closed and other parts of bowel inspected, the peritoneum was dried and the abdominal wound closed. The whole operation occupied a very short time, and I have no hesitation in saying no case of obstructed intestine could have been more favourable for surgical interference; the delay, however, had been too long, already in a precarious state at the time of operation she continued to sink and died the same evening.

It is an open question whether the state of mind in which the patient had been for some time had anything to do with the formation of the plug. I leave it to you, gentlemen, to consider whether it had or not.

REPORT ON THE RELATION BETWEEN MALARIAL FEVER AMONG HER MAJESTY'S WHITE TROOPS AT PORT LOUIS, MAURITIUS, AND THE METEOROLOGICAL ELEMENTS OF TEMPERATURE, RAINFALL, AND RELATIVE HUMIDITY FOR THE YEAR 1889; WITH A PRELIMINARY SKETCH OF THE MEDICAL TOPOGRAPHY OF THE ISLAND AND THE EPIDEMIC OF MALARIAL FEVER IN 1866-67.

BY

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Report on the Relation between Malarial Fever among Her Majesty's White Troops at Port Louis, Mauritius, and the Meteorological Elements of Temperature, Rainfall, and Relative Humidity for the Year 1889; with a Preliminary Sketch of the Medical Topography of the Island and the Epidemic of Malarial Fever in 1866-67.

MAURITIUS was discovered by the Portuguese in 1505. The first colony was formed on it by the Dutch in 1644, but they abandoned the island in 1712. The French took possession in 1715, and held Mauritius until 1810, when it was captured from them by the British, who have held uninterrupted possession ever since that year.

The island of Mauritius is situated in the Indian Ocean, 500 miles east of Madagascar, between lat. 19° 58′ and 20° 32′ south, and between long. 57° 17′ and 57° 46′ east of Greenwich.

It is a mountainous oceanic island, of volcanic origin, but no active volcano has been known within the memory of man. The geological formation consists of vesicular basalt, rich in olivine, which on decomposing forms a very porous ferruginous red earth, similar to that at Sierra Leone, on the west coast of Africa. The soil formed from the decomposition of this kind of rock appears to be peculiarly suitable for the development of malaria. The island has an area of 713 square miles, its greatest length from north to south being 39 miles, and its breadth from east to west 28 miles. The coast is fringed with coral reefs, and in its immediate vicinity there is a considerable number of small islets of coral and volcanic formation. The northern part of the island is a low plain, at one time covered with sugar-cane plantations, but now mostly abandoned on account of the deficient water supply, due to the learance of the virgin forests from the centre of the island.

The centre consists of an elevated cultivated plateau, 1,000 to 2,000 feet above sea level. On the outside of this central plateau, within a short distance of the sea, rise the three principal mountain ranges which the island contains. The mountains are bold and rugged, and mostly range between 2,000 and 2,711 feet above sea level.

The only two lakes of any consequence are the Grand Bassin and Mare aux Vacoas, situated at the south-west part of the central plateau. The former is a deep pool, about half-a-mile across, and it appears to occupy the crater of an extinct volcano. The latter is a shallow sheet of water, about a mile long, and surrounded by swampy margins. The water supply of the villages in the lower part of the district of Plaines Wilhems is derived from the Mare aux Vacoas, the drainage area of which is free from animal pollution, as it is devoid of human habitations, with the exception of the forest ranger's hut. There are numerous streams of water, which mostly run throughout the year. Some of these reach a length of ten or twelve miles. On the leeward side of the island many of the smaller streams become dried up in the dry season of the year. Compared with the area of the island the extent of marshy and swampy land is small, and it occurs chiefly at the estuaries of the streams and on the flatter parts of the central plateau. At the coast there are a few small mangrove swamps.

The island was originally clothed to the water's edge with dense tropical forests, in which existed a large proportion of endemic trees and shrubs, with thick dark green coriaceous leaves. On account of the terrific hurricanes which periodically visit the island the trees were nowhere high, but they formed a dense mass of nearly uniform height, and were thus better fitted to withstand the violence of the wind. Beneath this dense canopy of evergreen foliage large numbers of shade and moisture loving plants, such as orchids, ferns, club-mosses, and other cryptogams, found a genial home. These shady forests not only prevented the rapid evaporation of water from the streams and ground by the heat of a tropical sun, but they also prevented the rapid flow of water towards the sea, and thus

kept up a more uniform water supply to the lower parts of the island. During the present century almost the whole of the virgin forests have been cleared away to make room for sugar-cane plantations, with disastrous results to the health and prosperity of the colony. The water-supply in the lower parts of the island, especially on the leeward or north-west side, has fallen short of the requirements, and in consequence many of the most profitable sugar estates have been abandoned. The once fertile land is now overrun with thorny shrubs and weeds, mostly natives of Asia and America. These foreign light and drought loving plants, however, are doing a good work in the economy of nature, by protecting the humus of the soil from the scorching rays of the sun until such time as reafforestation can be carried out. The Colonial Government of Mauritius has spent large sums of money within the last ten years in reafforestation of the land round the sources of the streams and along the river banks. This work has been ably carried out by Mr John Horne, late Director of Woods and Forests; but many years must elapse before much benefit can be expected from the good work commenced by him. Much more extensive planting, with selected species of native and foreign trees, is still required to ensure permanent amelioration of the health and prosperity of the colony. The transfer of the sugar-cane plantations from the lowlands to the highlands, together with the Indian coolies and animals employed on the sugar estates, has led to the pollution of the streams from which is obtained the drinking water of Port Louis and other places in the lowlands. All the washing of clothes is done in the streams; and on one occasion, when I was analysing the drinking water at the Victoria Battery, near Port Louis, after a case of enteric fever had occurred among the soldiers stationed there, I found, besides organic impurities, a blue-dyed fibre similar to those forming the blue coloured cloth usually worn by the natives. The water supply at the Victoria Battery was derived from the Grand River North West, in which the natives wash their clothes and bathe their bodies; and among people frequently suffering from enteric fever, dysentery, and diarrhœa, it is not to be wondered at that these diseases should result from drinking the water derived from such a polluted stream as the Grand River North West.

In Baker's "Flora of Mauritius and the Seychelles," published in 1877, the number of native flowering plants and vascular cryptogams in Mauritius is given at 869 species, and the naturalised plants at 269 species. The result of my own botanical labours during the years 1887-90 has considerably extended the list of naturalised species, but I have only succeeded in adding a few new native species to the list of plants already recorded from Mauritius. Large numbers of American, Asiatic, and even European plants have become firmly established, and they are exterminating the native ones. In the neighbourhood of Port Louis, and near the coast on the north-west or leeward side of the island, where the climate is relatively much drier than on the windward side and more elevated parts, the wild plants are chiefly naturalised species of foreign introduction. Port Louis and the north-west seaboard of the island are hot-beds of malarial fever, which is very prevalent in the hot rainy season of the year. It is difficult to say whether the change of vegetation at these places has had anything or not to do with the production of malaria; but at Curepipe, Mare aux Vacoas, Grand Bassin, and other parts of the central plateau, about 2,000 feet above sea level, where the vegetation is almost entirely native, malarial fever is unknown, even where the ground is wet and marshy. The elevation of these places above sea level probably chiefly accounts for their immunity from malarial fever; but, at the same time, it must be borne in mind that the most malarial parts of Mauritius are those districts in which the climate is relatively drier, and in which the native shade and moisture loving plants have been most replaced by foreign light and drought loving ones. I think, therefore, that the reafforestation of the waste lands of Mauritius, with selected species of native trees, is likely to be followed by a distinct amelioration of the health and prosperity of the colony; and in time the timber grown in these lands would probably more than repay the original cost of planting.

Mauritius, being situated within two degrees of the Tropic of Capricorn, has a tropical climate; but owing to its isolated position in the Indian Ocean, and the cool south-east trade wind which blows during the greater part of the year, the climate is more temperate than that of other places in the same latitude. In general terms the climate may be described as hot, damp, and rainy, with a fair amount of bright sunshine, moderate winds, and occasional hurricanes of terrific violence. The higher parts of the island are much cooler, but very much damper and more rainy, than at the coast. The nature of the climate will be better understood from the following meteorological results, which have been taken from the annual reports of the Royal Alfred Observatory, under the able direction of the Honourable Charles Meldrum. The Observatory is 178.11 feet above sea level, and it is situated in the district of Pamplemousses, on the northern plain of the island, three miles from the west coast, and seven miles north-east of Port Louis. The Observatory is well equipped with modern meteorological instruments, and the annual reports contain elaborate results of all the meteorological elements forming climate.

ATMOSPHERIC PRESSURE REDUCED TO SEA LEVEL.

Mean for 1875-88	30.082 inches.
Highest in 1875-88 (20th June 1877) .	30.468 „
Lowest in 1875-88 (21st March 1879) .	29.032 „

In the great hurricane of 29th April 1892 the barometer fell to 27.95 inches.

WIND.

Mean velocity for 1876-88 . .	11.4 miles per hour.

Storms and gales very seldom occur, but the island is occasionally visited by most terrific hurricanes, which cause great loss of life and damage to crops and buildings. In the great hurricane of 29th April 1892 the wind reached a velocity of 121 miles per hour. The hurricane previous to this one occurred in 1879, between which year and 1888 the velocity of the wind exceeded 40 miles per hour on three occasions only.

TEMPERATURE OF AIR IN STEVENSON SCREEN ON LAWN.

Mean for 1885-88	74.8° Fah.
Highest in 1885-88 (11th February 1886) .	96.2° „
Lowest in 1885-88 (15th August 1887)	48.0° „

RAINFALL.

Annual mean fall for 1875-88 . .	47.02 inches.
Greatest fall in one year (1877) . .	71.86 ,,
Least fall in one year (1886) . .	29.74 ,,
Greatest fall in one day in 1875-88 (7th May 1884)	11.24 ,,
Average number of days of rainfall for 1875-88	200 days.

DEW POINT.

Mean for 1875-88	64.9° Fah.
Highest in 1875-88 (20th February 1876) .	79.9° ,,
Lowest in 1875-88 (5th September 1880) .	46.8° ,,

CLOUDS.

Upper Clouds—Mean for 1877-88 (10=overcast)	0.97
Lower Clouds—Mean for 1877-88 (10=overcast)	4.74

BRIGHT SUNSHINE.

Total duration of bright sunshine in 1888 .	2733.8 hours.
Period during which the sun was above the horizon in 1888	4410.5 ,,
Mean proportion for the year 1888 (constant sunshine=1) . . .	0.620

At the Nursery Gardens, Curepipe, 1,840 feet above sea level, within quarter of a mile of the military barracks at Curepipe Camp, in the interior of the island, the mean annual temperature in the shade for 1888 was 67.2° Fah., or 7.6° Fah. less than at the Royal Alfred Observatory, which is 178.11 feet above sea level. The rainiest station at Mauritius is at Cluny, which is 1,000 feet above sea level, on the windward side of the island, and a few miles south-east of Curepipe. At this station for the period 1862-88 (excluding 1875 and 1876) the rainfall was :—

Annual mean fall	144.24 inches.
Highest (1877)	203.50 ,,
Lowest (1886)	95.16 ,,
Average number of days of rainfall .	243 days.
Highest (1865 and 1868) . . .	292 ,,
Lowest (1878 and 1881) . . .	181 ,,

The estimated population of Mauritius at 31st December 1889 was 372,664, of whom 254,465, or fully two-thirds, belonged to the Indian population. In 1851 the Indian population was 77,996; in 1861, five years before the first outbreak of malarial fever in Mauritius, it had risen to 192,634; and in 1889 it was 254,465. This large increase in the Indian population, due to the immigration of coolies from India for the sugar estates, has done much to render the sanitary condition of the island bad within the last

forty years. The naturally dirty habits of the Indian coolies are, from a sanitary point of view, the great drawback to a class of people whose services are indispensable in the working of sugar estates in a tropical climate like that of Mauritius.

In the Army Medical Department Report for 1866, Appendix No. xlvi., pp. 442-477, there is a very good "Report on the Malarial Epidemic Fever of Mauritius of 1866-67," by Surgeon-Major John Small and Assistant-Surgeon W. H. T. Power, B.A., 2nd Battalion 13th Light Infantry. Previous to the year 1866 malarial fever does not appear to have existed in Mauritius, although relapses of malarial fever had occurred among the Indian immigrants, and also to a small extent among the troops; but in these cases the patients had contracted the disease in other countries. Many theories have been advanced as to the origin of the first outbreak of malarial fever in an island which had hitherto been free from malaria. Of these theories the principal are the large increase in the Indian population and the consequent fouling of the soil; extensive clearance of the virgin forests; upturning of the soil during the construction of the railway, the first portion of which was opened for traffic in May 1864; the spreading of river mud on the sugar-cane fields; diminished rainfall and concurrent high temperature; and, lastly, contagion. Most of the conditions embraced in these theories are undoubtedly favourable for the production of malaria; and the burial of a large number of dead bodies, containing the specific micro-organisms of malarial fever, during the rapid increase of the Indian population subsequent to 1851, in a soil peculiarly suitable for the production of malaria, may perhaps have been the original way in which malaria was introduced into Mauritius. At p. 466 of the Army Medical Department Report for 1866, the non-contagious character of malarial fever is explicitly stated by Drs Small and Power, and their statement agrees with my own experience of malarial fever at Mauritius and Sierra Leone. I was informed by Dr A. Davidson, Superintendent of the Government Lunatic Asylum at Beau Bassin, Mauritius, that the first outbreak of malarial fever among the civil population occurred at Petite Rivière, which lies a few miles to the south-west of Port Louis. From this point the fever spread, in 1866 and 1867, north and south along the coast, invading the low lying parts of the district of Rivière Noire, Plaines Wilhems, Moka, Port Louis, Pamplemousses, Rivière du Rempart, and the northern part of Flacq. Drs Small and Powers' report is accompanied by a map of Mauritius, in which the malarial fever districts are coloured black. These districts lie for the greater part on the leeward side of the island, which is drier and hotter than the windward side. Subsequent to 1867, however, the malarial fever rapidly spread along the coast from Flacq to the districts of Grand Port and Savanne, and ever since this fever has been endemic along the coast and in the low lying parts of the island.

The following table, compiled from the Army Medical Department Reports for 1865-67 and 1889, shows the admission and death rates for malarial fever among the troops quartered in Mauritius during these years:—

Year.	Mean Yearly Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Deaths.
1865	1,882	4	2.65	0
1866	1,781	37	20.07	0
1867	1,294	1,969	1,521.63	22
1889	524	367	700.38	0

The 4 admissions in 1865 were cases of relapses in men who had contracted the disease in other countries. In 1866 there were 37 admissions, and the most of these occurred towards the end of December. In 1867, the year of the great epidemic, out of a mean yearly strength of 1,294 soldiers there were 1969 admissions and 22 deaths. Of the 22 deaths from malarial fever 1 was due to the intermittent, and the remaining 21 to the remittent, variety of the disease. The death rate from malarial fever in 1867 was 17 per 1,000 of strength among the troops, whereas among the civil population it was 88 per 1,000 for the whole island. In Port Louis, where the disease was most prevalent and fatal, the death rate for the year amounted

to 274 per 1,000 of population. The low death rate among the troops, compared with that among the civil population, was due to the better conditions under which the sick were treated, and especially to the administration of large doses of quinine. In 1889 there were 367 admissions with malarial fever among the troops, but there were no deaths from this disease. Of the 367 admissions only 17 were treated in the Station Hospital at the Line Barracks in Port Louis, and the remaining 350 cases were treated in the Station Hospital at Curepipe Camp, 1,880 feet above sea level. The climate of Curepipe is free from malaria, and it has a very salutary effect on the patients sent up from Port Louis with malarial fever; but unfortunately the damp, rainy, and changeable climate of this place often causes relapses in men who have been discharged from hospital. Thus, of the total 367 admissions with malarial fever, 169 occurred among men stationed at Curepipe. These were mostly cases of relapses, but some of them were first attacks in men who had been exposed previously to malaria in Port Louis. Reference to this subject will be made again farther on in the present report. The remaining 198 admissions occurred among the troops stationed in Port Louis, and they were mostly cases of first attacks.

The following table, compiled from the Army Medical Department Reports for 1865-67 and 1889, shows the admission and death rates for all diseases among the troops quartered in Mauritius during these years:—

Year.	Ratio of Admissions per 1,000 of Strength.	Ratio of Deaths per 1,000 of Strength.
1865	752	7.97
1866	758	14.01
1867	2,233	40.95
1889	1,389.3	7.63

In 1889, out of a mean yearly strength of 524 soldiers, there were 728 admissions for all diseases in the Mauritius command. If the 367 admissions with malarial fever, due to the climate of Port Louis, be deducted from the total 728 admissions, the number of admissions for the other diseases is 361, or a ratio of only 689 per 1,000 of strength, which is 63 less than the ratio of 752 in 1865 before the first outbreak of malarial fever occurred in Mauritius. The great unhealthiness of the troops quartered in Mauritius since 1866 has been due to malarial fever. For some years back Port Louis and Curepipe have been the only two stations occupied by the troops; and as the latter station is healthy and free from malaria, the climate of Port Louis is alone responsible for the excessive amount of sickness which has prevailed in recent years among the troops quartered in the Mauritius command.

In 1889 the mean yearly strength of the troops stationed in Port Louis was 248, or a little less than half the strength of the command, which was 524; and the total number of admissions with malarial fever, due to the climate of this station, was 367. From my own experience of Port Louis from 1887-90, I have no hesitation in stating that if all the troops were stationed in Port Louis throughout the whole year, and the sick treated in hospital there, the sick rate would probably be as high as what it was in 1867. On the other hand, if all the troops were stationed at Curepipe throughout the whole year, the sick and death rates would most probably compare favourably with those of the troops in the United Kingdom. Thus for the year 1889, excluding the admissions with malarial fever due to the climate of Port Louis, the ratio of admissions for the other diseases per 1,000 of strength was 689 at Mauritius, and 730.4 for all diseases in the United Kingdom. For the same year the ratio of deaths per 1,000 of strength was 7.63 at Mauritius, and 4.57 in the United Kingdom; but of the 4 deaths which occurred at Mauritius, 3 were in Port Louis, and the remaining 1 was a case of enteric fever which was contracted at Beau Bassin, when the man was a prisoner in the civil prison at that place.

Port Louis is situated on the north-west or leeward side of the island, on a fine harbour formed by a gap in the coral reef. The town is shut out from the full benefit of the south-east trade wind by an amphitheatre of rugged basaltic mountains, from 1,000 to 2,685 feet high. The site occupied by the town extends inland from the harbour for

about a mile, and the highest part of the town is about 80 feet above sea level. Several small streams flow from the mountain valleys through the town and discharge into the harbour. These streams receive the refuse and surface water of the town, which is conveyed into them by means of open drains along the street sides. The night soil is conveyed away in carts and used as manure on the sugar-cane plantations. The streets are laid out at right angles to one another, and the houses are built partly of stone and partly of wood. Many of the houses have small gardens attached, in which palms and other trees have been planted. Rows of trees were also planted at the sides of several of the streets, but most of these have been destroyed by the great hurricane of 29th April 1892. The part of the town bordering the harbour has been built on reclaimed land from the sea. Since 1866 a considerable extent of land has been reclaimed from the sea in the neighbourhood of Port Louis, and planted with Filaos (*Casuarina equisetifolia, Forst*); but there still exist marshy ground and brackish pools of water between Port Louis and the estuary of the Grand River North West. The estimated population of Port Louis, on 31st December 1889, was 61,170.

The barracks occupied by the troops stationed in Port Louis in 1889 were the Line Barracks, Fort Adelaide, and Fort George. The Line Barracks are situated near the west end of the town, about quarter of a mile from the harbour, and they are about 15 feet above sea level. The barrack enclosure is about 20 acres in extent, and the greater part of it is covered with grass. The soil is a stiff clay resting on rock. During the rainy season the subsoil water is within a few inches of the surface of the ground, and pools of water occur at some places. In the dry season the surface of the ground is much cracked from the heat and absence of moisture.

Fort Adelaide is situated on the top of a mountain spur, about 300 feet above sea level, near the centre of the town. The site is dry and airy, but the barrack accommodation is in casemates. Fort George is situated on Ile aux Tonneliers, at the north side of the entrance to the harbour. Between it and the main island a shallow sea, the Mer diseases is 361, or a ratio of only 689 per 1,000 of strength, which is 63 less than the ratio of 752 in 1865 before the first outbreak of malarial fever occurred in Mauritius. The great unhealthiness of the troops quartered in Mauritius since 1866 has been due to malarial fever. For some years back Port Louis and Curepipe have been the only two stations occupied by the troops; and as the latter station is healthy and free from malaria, the climate of Port Louis is alone responsible for the excessive amount of sickness which has prevailed in recent years among the troops quartered in the Mauritius command.

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Rouge, intervenes, in which the water is only a few feet deep. Across this shallow sea a built causeway, half-a-mile long, connects Fort George with the town of Port Louis. Ile aux Tonneliers is a small flat island, formed of coral *débris*, and the casemates in Fort George are only from $1\frac{1}{2}$ to 4 feet above the high-water level of the sea. In 1889 Fort George was surrounded by a moat, in part of which the mud was uncovered by the sea at low water twice a day. The garrison of Port Louis during the year 1889 was composed of No. 8 Battery, Southern Division, Royal Artillery, which arrived from Singapore on 24th January 1888, and suffered so severely from malarial fever at Mauritius, that it was in consequence transferred to the Cape of Good Hope on 1st July 1889; No. 4 Battery of the same Division, which arrived at Mauritius in good health, from the Cape of Good Hope, on 1st August 1889; a detachment of the 1st Battalion North Staffordshire Regiment, which arrived in good health from Natal, on 14th December 1888; and small detachments of Royal Engineers, Departmental Corps, and Garrison Staff. The Garrison Staff, Departmental Corps, and a detachment of the 1st Battalion North Staffordshire Regiment, were quartered in the Line Barracks throughout the year; and in the months of July, August, and September three companies of the latter regiment from Curepipe were accommodated in these barracks. A small detachment of the 1st Battalion North Staffordshire Regiment was quartered at Fort Adelaide; and the Royal Artillery and the Royal Engineers were stationed at Fort George.

Malarial fever was prevalent among the troops of all the corps quartered in the Line Barracks, Fort Adelaide, and Fort George. The troops quartered in these three barracks were so frequently in the town of Port Louis, where malaria abounds, that no estimate of the relative unhealthiness of the different barracks can be formed from a comparison of the number of admissions with malarial fever at the different barracks. The mean yearly strength of warrant officers, non-commissioned officers, and men of the white troops in Port Louis, for the year 1889, was 248. The total number of admissions with malarial fever for the year

was 198, of which 17 were treated at the Station Hospital in Port Louis; and the remaining 181 were forwarded direct to Curepipe, 15 miles off, and treated in the Station Hospital at that place. Very few of the malarial fever patients discharged from hospital at Curepipe during the first four months of the year returned to Port Louis before the end of the hot unhealthy season in May, so that the admissions with malarial fever among the troops in Port Louis, during the first four months of the year, were almost entirely for first attacks. During the remainder of the year the proportion of relapses to first attacks was greater, but no record was kept of the exact number of each. Frequent interchanges took place among the troops stationed at Curepipe and Port Louis during the year; and in the months of July, August, and September nearly the whole Mauritius garrison was quartered in Port Louis, only a small detachment being left at Curepipe, so that during the year almost every soldier in the command resided for a longer or shorter period in Port Louis. It is unfortunate that no record was kept of the exact number of admissions for first attacks and relapses of malarial fever; because in dealing with the relation between malarial fever and the meteorological elements of temperature, rainfall, and relative humidity, it is important to eliminate or treat separately cases of relapses, which, from the experience of Drs Small and Power, as well as that of my own, are chiefly caused by chills due to sudden falls of temperature and to exposure to sun and great fatigue in hot weather. Exposure to damp weather, when the temperature is equable, has little effect in causing relapses, compared with sudden falls of temperature and consequent chills, even when the weather is dry. However, the great bulk of the 198 admissions with malarial fever at Port Louis in 1889 was for first attacks; and this was especially the case during the first quarter of the year, when 137, or fully two-thirds, of the whole 198 admissions for the year occurred.

As there was no meteorological station in the town of Port Louis, I have compiled the thirteen tables and chart which accompany this report from the results obtained at the Royal Alfred Observatory, which is situated seven miles north-east of Port Louis. The climate of the two places is very similar, that of Port Louis being a little hotter and less rainy than that of the Observatory.

I shall now proceed to make some observations on the meteorological results recorded in the Summary 1889, and the Chart which accompanies it, and afterwards treat of the relation existing between these results and the admissions with malarial fever at Port Louis during the same year. The mean monthly temperature in the shade for 1889 was 74.0° Fah. January, February, March, April, November, and December were on an average 3.3° Fah. above the mean, with a mean monthly temperature of 77.3° Fah.; and the remaining six months, May to October, were on an average 3.4° Fah. below the mean, with a mean monthly temperature of 70.6° Fah. The hot season, therefore, lasts from November to April, and the cool season from May to October. For the four years 1885-88, the mean yearly temperature in the shade was 74.8° Fah., which is 0.8° Fah. above the mean temperature of 74.0° Fah. in 1889. The total rainfall in 1889 was 56.19 inches. The mean monthly rainfall was 4.68 inches. January, February, and March were on an average 7.10 inches above the mean, with a mean monthly rainfall of 11.78 inches; and the remaining nine months April to December were on an average 2.37 inches below the mean, with a mean monthly rainfall of 2.31 inches. The year 1889 was exceptional in having only three months above the mean, because for the fourteen years 1875-88, the six months January, February, March, April, May, and December were above the mean, and the remaining six months June to November were below the mean. The rainy season, therefore, lasts from December to May, and it begins and ends one month later than the hot season, which lasts from November to April. For the fourteen years 1875-88 on an average about three-fourths of the yearly rainfall occurred in the rainy season, and the remaining fourth in the comparatively dry season from June to November. For these fourteen years the mean yearly rainfall was 47.02 inches, which is 9.17 inches less than the 56.19 inches of rainfall in 1889.

The following table shows the rainfall, and number of days of rainfall, in each month in 1889. The total number of days of rainfall for the year was 208, which is 8 days above the mean of 200 days for the fourteen years 1875-88.

Months, 1889.	Rainfall. Inches.	Days of Rainfall in each Month.	Days of Rainfall in each Quarter.
January . . .	12.74	18	
February . . .	5.51	15	59
March . . .	17.09	26	
April . . .	4.65	23	
May . . .	1.51	13	50
June . . .	1.53	14	
July . . .	2.21	17	
August . . .	3.68	22	57
September . . .	1.53	18	
October . . .	1.20	21	
November . . .	1.78	9	42
December . . .	2.76	12	

The mean monthly relative humidity in 1889 was 76.5 per cent. of saturation. The five months January to May were on an average 3.9 per cent. above the mean, with a mean monthly relative humidity of 80.4 per cent.; and the remaining seven months June to December were on an average 2.8 per cent. below the mean, with a mean monthly relative humidity of 73.7 per cent. For the fourteen years 1875-88, the six months January, February, March, April, May, and December were above the mean; and the remaining six months June to November were below the mean. The damp season, therefore, lasts from December to May, and it exactly corresponds with the rainy season. The dry season lasts from June to November, and it exactly corresponds with the six months of least rainfall. For the fourteen years 1875-88, the mean yearly relative humidity was 73.7 per cent., which is 2.8 per cent. below the mean monthly relative humidity of 76.5 per cent. in 1889.

The year 1889 was, therefore, 0.8° Fah. cooler than the mean of the previous four years; the rainfall was 9.17 inches greater, the number of days of rainfall 8 more, and the mean relative humidity 2.8 per cent. higher, than the corresponding means for the fourteen years 1875-88.

The mean monthly ratio of admissions with malarial fever per 1,000 of strength of the troops at Port Louis in 1889 was 92. January, February, and March were on an average 187 above the mean, with a mean monthly ratio of 279; and the remaining nine months April to December were on an average 62 below the mean, with a mean monthly ratio of 30. The first quarter of the year, viz., January to March, was not only the most unhealthy one from malarial fever, but it was also the hottest, rainiest, and dampest quarter of the year. Of the total 198 admissions with malarial fever at Port Louis during the year 1889, 137 were in the first quarter of the year, and only 61 in the remaining three quarters.

The malarial fever curves correspond with the temperature curves in eight months of the year, viz., January, March, April, June, July, August, September, and October. The four exceptions are—February, when there was a slight fall of 0.4° Fah. in the monthly mean temperature, but a considerable rise of 116 in the monthly ratio of admissions per 1,000 of strength, compared with the month of January; May, when there was was a fall of 4.3° Fah. in the monthly mean temperature, but a rise of 47 in the monthly ratio of admissions per 1,000 of strength, compared with the month of April; October, when there was a rise of 3.6° Fah. in the monthly mean temperature, but a very small fall of 3 in the ratio of admissions per 1,000 of strength, compared with the month of September; and December, when there was a rise of 3.1° Fah. in the monthly mean temperature, but a very small fall of 5 in the ratio of admissions per 1,000 of strength, compared with the month of November. The monthly mean temperature in January was 78.4° Fah.; in February, 78.0° Fah.; and in March, 78.9° Fah.,—so that much stress cannot be laid on the small fall of 0.4° Fah. in February, accompanied by a considerable rise of 116 in the monthly ratio of admissions per 1,000 of strength compared with the month of January, because the monthly mean temperature in these three months was very nearly the same. For the fourteen years 1875-88, the monthly mean tem-

perature was—in January, 78.6° Fah.; in February, 78.4° Fah.; and in March, 77.7° Fah.: so that in 1889 it will be observed that, while the monthly mean temperature was 0.2° Fah. in January and 0.4° in February below the mean of these months for the previous fourteen years, it was 1.2° Fah. in March above the mean of that month for the same period of fourteen years. March was the hottest month in 1889; whereas for the fourteen years 1875-88, on an average it was 0.9° Fah. cooler than January, and 0.7° Fah. cooler than February. The fall of 4.3° Fah. in the monthly mean temperature in May, accompanied by a rise of 45 in the ratio of admissions per 1,000 of strength, compared with the month of April, was partly due to cases of relapses in soldiers returned from Curepipe to Port Louis for duty at the end of the hot season in May. The fall of 4.3° Fah. in May below the monthly mean temperature in April, was the greatest difference in the monthly mean temperature in any two consecutive months of the year; so that possibly chills may have excited first attacks in soldiers who had been exposed to malaria during the previous hot season, but who had not actually suffered from malarial fever during that season. The other two months in which the temperature and malarial fever curves did not correspond were October and December; but even in these months, when there were so few admissions, the curves nearly agree, and one more admission in each of the two months would have made the two curves coincide. It will, therefore, be observed, that during the year 1889 there was a fairly close relation between the temperature and malarial fever curves, a rise of temperature being accompanied by an increase in the number of admissions with malarial fever. The most notable exceptions were in February and May, but, as already pointed out, the rise in the number of admissions in May, compared with April, was partly due to cases of relapses. Here, again, it is unfortunate that a record was not kept of the exact number of first attacks and relapses, instead of including the two classes in one return.

The malarial fever curves correspond with the rainfall curves in six months of the year, viz., January, March, April, July, October, and November. On comparing the table at page 17 with the malarial fever curves, it will be observed that a still less relation exists between the monthly number of days of rainfall and the ratio of admissions with malarial fever per 1,000 of strength. The malarial fever curves only correspond with the curves of the monthly number of days of rainfall in four months of the year, viz., January, March, April, and July. The first quarter of the year, however, had a rainfall of 35.34 inches, or fully three-fifths of the total rainfall in 1889, which was 56.19 inches; and the number of days of rainfall in this quarter was 59, or from 2 to 17 days more than in any other quarter of the year.

The malarial fever curves correspond with the relative humidity curves in ten months of the year, viz., January and March to November, the two exceptions being February and December.

In 1889, therefore, the rise and fall of the malarial fever curves correspond with the relative humidity curves in ten months, with the temperature curves in eight months, with the rainfall curves in six months, and with the curves of the monthly number of days of rainfall in four months.

The malarial fever, temperature, and relative humidity curves all correspond in eight months of the year, viz., January, March, April, June, July, August, September, and October; whereas the malarial fever, temperature, and rainfall curves only all correspond in five months, viz., January, March, April, July, and November. The malarial fever, temperature, rainfall, and relative humidity curves, only all correspond in four months of the year, viz., January, March, April, and July.

It will, therefore, be observed, that in the year 1889 there was a much closer relation between the malarial fever curves and the temperature and relative humidity curves, than between the malarial fever curves and the rainfall curves. The relation between the malarial fever and relative humidity curves is very marked, the rise and fall of the two curves corresponding in ten months of the year. There may perhaps be some close relation between the relative humidity and the rise of malaria into the

atmosphere; for in Mauritius there is abundant proof of the accepted belief, that one is especially liable to suffer from malarial fever after exposure to the night air in malarial districts. The relative humidity of the air at night when the temperature is low, is much greater than during the day when the temperature is high. Thus, at the Royal Alfred Observatory, for the year 1888, the mean relative humidity was, at 6 a.m., 85.1 per cent.; whereas at 9 a.m. it was only 73.7 per cent., at 1 p.m. 66.3 per cent., and at 3 p.m. 67.3 per cent. At 9 a.m., therefore, the atmosphere was 11.4 per cent., and at 1 p.m. 18.8 per cent., drier than at 6 a.m.

Almost every one that resides in Port Louis at night for any length of time suffers from attacks of malarial fever; whereas those people who transact their business in the town during the day and reside at night in the elevated central plateau, from 1,000 to 2,000 feet above sea level, enjoy good health, and very seldom suffer from malarial fever. Gentlemen so situated have informed me that they never suffered from malarial fever, although they have transacted business almost daily for periods up to ten years and over. On the other hand, to sleep in Port Louis for a few nights in the hot unhealthy season is sufficient to cause an attack of malarial fever. Thus, on 19th January 1889, on account of native riots in Port Louis, 181 men of the 1st Battalion North Staffordshire Regiment were transferred from Curepipe to that place, and quartered in the Line Barracks. Of this number 134 returned to Curepipe on the 22nd of the same month, having only slept in Port Louis three nights. These men were free from malarial fever on their arrival from Natal on 14th December 1888, between which date and 19th January 1889 they had resided at Curepipe, which is free from malaria. Although the men were only exposed to malaria in Port Louis for three days, there were a considerable number of admissions for first attacks of malarial fever within a fortnight of their return to Curepipe. On referring to the monthly table for January 1889, it will be observed that during the three days that the men were in Port Louis the weather was very hot, and extremely rainy and damp. On the 19th, 20th, and 21st January, the mean daily temperature in the shade was 76.1° Fah., 80.0° Fah., and 78.5° Fah. respectively; the daily rainfall was 2.55 inches, 0.94 inches, and 2.29 inches respectively; and the mean daily relative humidity was very high, being 94.0 per cent., 89.0 per cent., and 90.9 per cent. respectively. There was little wind blowing, and the atmosphere was oppressively close and muggy.

During the year 1889 the highest ratio of admissions with malarial fever per 1,000 of strength occurred in the month of March, in which month also occurred the highest monthly mean temperature, rainfall, and relative humidity; and the lowest ratio of admissions with the same fever occurred in August, in which month also occurred the lowest monthly mean temperature and relative humidity, but not the lowest monthly rainfall, which was in October. The rainfall in August was 3.68 inches, which was higher than the rainfall in any other month from May to December. The month of February is remarkable, for in it the ratio of admissions with malarial fever per 1,000 of strength rose from 134 in January to 250; whereas, compared with January, in February the monthly mean temperature in the shade fell 0.4° Fah., the monthly rainfall fell 7.23 inches, and the monthly mean relative humidity fell 3.6 per cent.

Although a fairly close relation has been shown to exist between the monthly ratio of admissions with malarial fever per 1,000 of strength and the corresponding monthly mean temperature and relative humidity, I am not in a position to state definitely what relation exists between the prevalence of malaria and these meteorological conditions, because the period of incubation in malarial fever is so uncertain, and probably varies considerably in duration in different individuals and at different seasons of the year. Thus, in the case of the men who were exposed to malaria for three days in Port Louis in January 1889, the period of incubation varied from a few days up to a fortnight and probably longer; whereas Drs Small and Power record two cases in which the period of incubation was at least five and six months respectively (*see* "Army Medical Report, 1866," pp. 466-7). External conditions, such as

exposure to chills, sun, and great fatigue in hot weather, have probably considerable influence in exciting attacks of malarial fever in persons' systems in which the malaria is latent. Thus, although the headquarters of the 2nd Battalion 13th Light Infantry, numbering 24 officers and 391 men, had been exposed to malaria in Port Louis from December 1866 to 1st April 1867, when it was transferred to non-malarial Flat Island, Drs Small and Power state that "most of the men and officers composing the headquarters of the regiment had had no fever till after their arrival in Flat Island, and then, from exposure to sun and great fatigue, numbers of them were struck down soon after with fever; indeed, far more were attacked with fever in a short time than had been the case in Port Louis itself, where the amount of duty and work was very slight." (*See* "Army Medical Department Report, 1866," pp. 455 and 466). I do not think that any very trustworthy information can be obtained from the monthly tables which accompany this report, by trying to trace any relation between the admissions with malarial fever and the meteorological elements for less periods than a month, for the following reasons:—

1st. The number of troops stationed in Port Louis was very small, especially in the hot malarial season.

2nd. The uncertainty of the duration of the period of incubation of malarial fever.

3rd. The troops at Port Louis and Curepipe were frequently interchanged between these two places.

4th. The men attacked with malarial fever did not always report themselves sick on the day on which the fever began.

5th. The admissions on the day following Sunday and public holidays included those men who had reported themselves sick and were "detained" on those days, when the patients could not be "admitted" and placed on regular "hospital diet," on account of the contractors' shops for hospital supplies being closed.

In 1889 the highest monthly number of admissions with malarial fever among the troops in Port Louis occurred in March, whereas in the epidemic of 1867 it was in April, and in 1890 in May. In the hot season of 1890 the great bulk of the troops stationed in Port Louis had been exposed to malaria at that station during the previous year, so that the proportion of relapses to first attacks would have been much greater in 1890 than in 1889.

In 1890 the ratio of admissions with malarial fever per 1,000 of strength rose from 167 in April to 322 in May; whereas the monthly mean temperature fell from 75.3° Fah. in April to 70.9° Fah. in May, and the rainfall fell from 10.24 inches in April to only 0.2 inches in May. In 1889 malarial fever among the troops in Port Louis was most prevalent in March, which was the hottest, rainiest, and dampest month of the year; whereas in 1890 the fever was most prevalent in May, which was exceptionally cool and dry, the mean temperature in the shade being 1.0° Fah. below the mean, and the rainfall 3.97 inches below the mean for the fourteen years 1875-88. The number of days of rainfall in the month was only 7 in 1890.

Malaria probably exists at Port Louis during the whole year, but it is especially abundant in the hot, damp, rainy season. Ever since the first outbreak of malarial fever in 1866 this disease has been endemic in Mauritius, and every year it has caused a very large amount of sickness and invaliding among the troops quartered in the command. Since the first outbreak among the troops in 1866, the Army Medical Officers stationed in Mauritius have uniformly recommended the construction of new barracks on the elevated central plateau of the island, and the transfer thereto of the whole garrison, as the only effectual method of preventing the occurrence of malarial fever among the troops. New barracks to accommodate all the white troops have been quite recently constructed at Curepipe Camp, 1,880 feet above sea level. If all the troops are kept there throughout the whole year, and proper care taken of the sanitary arrangements of the barracks, it is most probable that in future years the health of the troops quartered in the Mauritius command will compare favourably with that of the troops in the United Kingdom. In time of war the whole garrison will be transferred to Port Louis for the purpose of manning the forts which defend the harbour

and coaling station; and in time of peace the troops will probably be stationed there annually for a few months in the cool season for drill purposes. In the latter case, the months of July, August, and September would be the best time of the year, when the weather is cool and little malaria prevails.

I think that there is little doubt but that the high sick rate from malarial fever in Port Louis is due to the malaria produced in the soil of the town itself and its immediate neighbourhood, and not to malaria carried from any great distance by the wind. I am, therefore, of opinion that the health of the town could be much improved by constructing a complete system of water-sewerage and drainage for the town, combined with subsoil drainage of the town itself and the surrounding country within a mile of the outskirts of the town. In this area all marshy and swampy land should be reclaimed, pools of brackish water should be drained and filled up with earth, undergrowth of rank vegetation should be cleared away and permanently kept under, and selected species of trees planted in suitable localities. Subsoil drainage, by lowering the level of the underground water, and thereby diminishing the relative humidity of the atmosphere, is the improvement most likely to lead to the greatest reduction of malaria. Trees also, by absorbing moisture through their roots, would contribute to the drainage of the soil and the lowering of the level of the underground water.

On 12th March 1885 the Honourable Charles Meldrum, Director of the Royal Alfred Observatory, Mauritius, published a report on "The Mortality from Malarial Fever compared with the Rainfall, Temperature, and Relative Humidity, for the period 1871 to 1883, and for the year 1883," for the whole island of Mauritius, and also for the Pamplemousses district. For the thirteen years 1871-83, the highest monthly mean temperature was in January and the lowest in July; the maximum monthly rainfall was in March and the minimum in October; the highest monthly mean relative humidity was in April and the lowest in October; and the maximum monthly mortality from malarial fever was in May and the minimum in November.

It will, therefore, be observed, that for the period 1871-83 the maximum mortality from malarial fever was in May, or four months after the maximum temperature, two months after the maximum rainfall, and one month after the maximum relative humidity. For the same period the minimum mortality was in November, or four months after the minimum temperature, and one month after the minimum rainfall and relative humidity.

With reference to the chart which accompanies Dr Meldrum's report, he states that "the temperature curves differ so little, and those of mortality from fever differ so much, that the great variations in the amount of the mortality can hardly be supposed to be due to variations of temperature," and "the humidity curves have, as might be expected, a strong resemblance to the rainfall curves; but the latter have a greater rememblance to the mortality curves than the former have."

Dr Meldrum's report refers only to mortality statistics derived from tables prepared by the General Board of Health and the Registrar-General of Mauritius, whereas my present report refers only to the statistics of admissions for attacks of malarial fever. All the military patients admitted into hospital with malarial fever at Port Louis in 1889, were seen and treated by medical officers well acquainted with malarial and enteric fever, so that there is no doubt about the accuracy of their diagnosis. Of the total 367 admissions with malarial fever in the Mauritius command in 1889 there was not a single death; so that among the troops for the year 1889, there are no mortality statistics to compare with those given in Dr Meldrum's report, which refers to the civil population of Mauritius. Among the troops in the epidemic of 1867 the maximum number of admissions with malarial fever occurred in April; but the maximum mortality from this disease was in the following month of May, when 11 of the 22 deaths occurred.

For the period 1871-83 the mean annual population of Mauritius was about 335,000, among whom during this period the maximum mean monthly number of deaths from malarial fever was 625.4 in May, and the minimum 317.1 in November. Among the civil population residing

in the malarial districts, one can understand why the maximum death rate from malarial fever should occur towards the end of the hot malarial season, when the sufferers' vitality has been lowered by extreme heat and frequent successive attacks of malarial fever; but it appears strange that there should have been such a high mortality from malarial fever among the civil population in the cool season of the year, when, judging from military statistics, this season is comparatively healthy and free from malaria. Among the troops stationed at Port Louis in 1889, the ratio of admissions with malarial fever per 1,000 of strength for the first half of the year was 905, but in the second half of the year it was only 111. In the epidemic of 1867 four-fifths of the admissions, and all the deaths, from malarial fever occurred in the first half of the year, and only one-fifth of the admissions and no deaths in the second half. On the other hand, for the period 1871-83 the mean half-yearly mortality from malarial fever among the civil population was 3023.3 in the first half of the year, and 2210.0 in the second half. Only about three-fifths, therefore, of the deaths occurred in the first half of the year, and two-fifths in the second half.

The annual Army Medical Department reports record admissions for, and deaths from, enteric fever among the troops quartered in Mauritius before and after the first outbreak of malarial fever in 1866. Cases recorded in these reports as typho-malarial fever, were simply cases of enteric fever and malarial fever co-existing in the same patient. The Army Medical officers serving in Mauritius have had no doubt about the occurrence of enteric fever among the troops; but up to the time I left Mauritius in 1890, few of the civil practitioners, numbering between sixty and seventy qualified gentlemen, appear to have fully recognised the disease among the civil population. Taking into consideration the long existence of enteric fever among the troops, and the highly insanitary condition of the towns and villages in Mauritius, together with the pollution of the drinking water, I have no doubt but that a considerable number of the deaths attributed to malarial fever in the Registrar-General's returns were really due to enteric fever.

This is also the opinion of Surgeon-Colonel C. A. Maunsell and the other medical officers who have served with me at Mauritius. In an island like Mauritius where malarial fever is so very prevalent, where many of the natives are attended by quacks, and where enteric fever, which undoubtedly exists among the civil population, is not fully recognised by the majority of the civil practitioners, it is probable that malarial fever in Mauritius has a much higher death rate attributed to it than it is really entitled to. For these reasons I think that the conclusions arrived at in Dr Meldrum's report should be taken with some qualification; and in future years, when enteric fever is more fully recognised and accurately diagnosed in Mauritius, more reliable statistics will be obtained of the mortality from malarial fever, and a better comparison made of the relation existing between this mortality and the meteorological elements of climate at the different seasons of the year.

To arrive at an accurate knowledge of the relation which may exist between the prevalence of malarial fever and the meteorological elements of climate in a malarial district, it would be necessary to keep a daily record, extending over a number of years, of the following particulars:—

1st. Strength of the troops under observation.

2nd. Number of attacks from malarial fever, distinguishing first attacks from subsequent attacks and relapses, under the two varieties of remittent fever and intermittent fever.

3rd. Mean, maximum, and minimum temperature in the shade, and maximum temperature in the sun's rays, with special reference to any exposure of the troops to the sun or to great fatigue in hot weather.

4th. Atmospheric pressure, with special reference to diurnal variation. Thus, at the Royal Alfred Observatory, Mauritius, from hourly observations throughout the thirteen years 1875-87, it was found that the mean variation of the atmospheric pressure from the daily mean was from 0.001 to 0.017 inch below the daily mean between the hours of 1 a.m. and 6 a.m. This lowering of the atmospheric pressure would favour the rise of the humid malaria-bearing ground air into the lower strata of the atmosphere at night time. From the same observations, it was found that

between the hours of noon and 6 p.m. the mean variation of the atmospheric pressure from the daily mean was from 0.003 to 0.039 inch below the daily mean; but, as is pointed out at page 24 of this report, the relative humidity of the atmosphere in the afternoon in Mauritius is about 18 per cent. lower than what it is at 6 a.m. (*See* "Islands of the Southern Indian Ocean," p. 297, by Captain H. A. Moriarty, R.N., C.B.)

5th. Direction and velocity of the wind.

6th. Rainfall, and number of days of rainfall.

7th. Relative humidity of the atmosphere at 6 a.m. and 1 p.m., and the mean relative humidity.

8th. Level of subsoil water below surface of the ground.

At Mauritius full and accurate meteorological results are published in the annual reports of the Royal Alfred Observatory, and the level of the subsoil water could be ascertained daily by means of a well sunk in the ground in a suitable locality. In the case of first attacks of malarial fever, a record should be kept of the time which has elapsed between the date of the man's arrival in the malarial district and the date of his attack.

Accurate observations, of the nature above indicated, and extending over a number of years, would probably afford sufficient data to enable one to trace some definite relation between the greater prevalence of malarial fever at different seasons of the year, and in different months in different years, and the varying meteorological elements of climate in different years and at different seasons of the same year, at the same station. Malarial fever was most prevalent among the troops in Port Louis in March 1889, April 1867, and May 1890; and it would be interesting to know how far the maximum monthly sick rate in these different months, in different years, depended on the meteorological elements of climate.

Accurate statistics of first attacks of malarial fever in men who have not been exposed to malaria previous to their arrival in the malarial district, and a knowledge of the period of incubation, are essential before one can be in a position to trace any definite relation which may exist between the production of malaria and the meteorological elements of climate at any particular season of the year. If the usual period of incubation could be ascertained at any particular station, then the prevalence of malarial fever at any particular date must be referred to the amount of malaria existing at a previous date, which would depend on the duration of the period of incubation. Concurrently with the foregoing observations, it would be very desirable to carry out laboratory experiments with reference to the growth and development of the pathogenic micro-organism of malarial fever.

HENRY HALCRO JOHNSTON.

LEITH FORT,
SCOTLAND, *1st August* 1894.

MONTHLY TABLES, showing the Daily Strength of the Troops, Admissions with Malarial Fever, Ratio of Admissions per 1,000 of Strength, Mean Temperature, Rainfall, and Mean Relative Humidity, at Port Louis, Mauritius, for the year 1889.

JANUARY 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade. Fah. deg.	Daily Rainfall, Inches.	Mean Daily Relative Humidity, Saturation =100.	Remarks.
1	199	...	...	78.8	...	84.0	Public Holiday.
2	197	...	...	80.0	...	74.3	Public Holiday.
3	197	1	5.08	80.1	...	77.8	
4	197	2	10.16	78.3	0.09	77.6	
5	197	...	...	78.4	...	73.7	
6	194	...	...	78.9	...	71.2	Sunday.
7	196	...	...	73.4	...	88.0	
8	199	3	15.08	77.2	0.29	70.1	
9	195	2	10.26	72.3	...	77.3	
10	195	...	...	73.5	...	76.7	
11	196	1	5.10	76.5	...	71.8	
12	201	1	4.98	79.9	...	75.9	
13	200	...	...	82.9	0.01	80.7	Sunday.
14	200	2	10.00	82.6	0.09	82.6	
15	198	6	30.30	76.7	0.56	85.5	
16	197	...	...	76.2	...	88.7	
17	196	1	5.10	76.4	0.72	90.5	
18	196	...	...	77.1	0.31	90.5	[from Curepipe.
19	391	3	7.67	76.1	2.55	94.0	181 men arrived
20	391	...	...	80.0	0.94	89.0	Sunday.
21	391	2	5.12	78.5	2.29	90.9	[to Curepipe.
22	257	...	...	80.6	0.08	80.5	134 men departed
23	239	...	...	79.6	...	84.8	
24	239	...	...	76.3	0.26	90.5	
25	239	...	...	75.4	1.17	93.2	
26	223	...	...	78.9	2.77	88.3	
27	224	...	...	81.9	0.18	81.0	Sunday.
28	224	...	...	81.6	0.03	78.4	
29	221	2	9.05	80.6	0.12	80.8	[to Curepipe.
30	172	2	11.63	80.9	0.28	81.5	51 men departed
31	171	2	11.70	80.7	...	74.9	
	224	30	133.93	78.4	12.74	82.1	

FEBRUARY 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade, Fah. deg.	Daily Rainfall, Inches.	Mean Daily Relative Humidity, Saturation = 100.	Remarks.
1	170	1	5.88	79.4	0.01	79.1	
2	187	...	...	80.8	0.02	79.4	
3	187	...	...	78.2	0.20	77.6	Sunday.
4	187	5	26.74	78.7	...	80.5	
5	184	2	10.87	80.0	0.22	77.9	
6	183	...	...	78.9	...	74.9	
7	178	5	28.09	79.3	...	73.2	
8	178	4	22.47	79.1	...	75.8	
9	192	...	...	80.5	0.01	74.3	
10	192	...	...	80.0	...	75.9	Sunday.
11	186	6	32.26	76.1	...	73.4	
12	184	2	10.87	77.3	0.06	77.3	
13	179	1	5.59	72.8	...	81.5	
14	176	3	17.05	76.1	0.09	78.5	
15	177	2	11.30	76.4	...	72.0	
16	169	2	11.83	77.4	...	75.9	
17	166	...	...	74.2	...	78.6	Sunday.
18	150	3	20.00	79.7	...	76.7	
19	149	...	...	76.1	...	87.5	
20	162	...	...	79.9	0.08	73.6	
21	160	...	...	79.4	0.08	80.8	
22	160	...	...	79.1	0.16	77.0	
23	161	2	12.42	79.2	...	62.5	
24	160	...	...	76.4	0.03	81.0	Sunday.
25	161	4	24.84	78.7	0.03	84.3	
26	158	...	...	75.1	1.00	93.3	
27	158	...	...	78.0	1.67	89.0	
28	166	1	6.02	78.2	1.85	90.7	
	172	43	250.00	78.0	5.51	78.5	

MARCH 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade, Fah. deg.	Daily Rainfall, Inches.	Mean Daily Relative Humidity, Saturation = 100.	Remarks.
1	166	1	6.02	78.6	0.57	88.5	
2	164	...	...	75.3	1.19	92.8	
3	163	...	...	76.5	1.85	92.2	Sunday.
4	162	...	...	80.2	0.37	89.2	
5	159	...	...	79.5	0.06	89.9	
6	158	4	25.15	79.0	...	61.3	
7	167	...	...	76.1	...	75.7	
8	167	1	5.99	76.8	...	81.9	
9	143	6	41.96	75.0	1.52	88.7	
10	143	...	...	76.8	1.45	87.0	Sunday.
11	142	3	21.13	75.8	0.92	95.4	
12	141	...	...	79.4	3.23	86.7	
13	140	5	35.71	82.3	0.01	83.3	
14	142	2	14.08	81.2	1.47	82.5	
15	142	2	14.08	79.6	0.15	83.8	
16	122	3	24.59	82.1	0.02	87.4	
17	122	...	...	79.4	0.30	87.9	Sunday.
18	125	10	80.00	77.2	1.03	86.0	
19	126	4	31.74	81.1	0.02	86.0	
20	127	6	47.24	79.9	0.37	85.2	
21	123	1	8.13	79.2	0.14	81.3	
22	124	2	16.12	79.5	0.54	81.7	
23	126	1	7.93	78.5	...	75.2	
24	126	...	...	79.8	0.34	85.7	Sunday.
25	124	6	48.38	79.3	0.27	77.8	
26	125	1	8.00	78.3	0.02	84.6	
27	127	2	15.75	82.8	0 .03	84.1	
28	128	1	7.81	81.2	0.01	84.3	
29	128	3	23.43	79.8	0.80	83.6	
30	157	...	...	79.7	...	80.3	
31	156	...	...	76.6	0.41	84.5	Sunday.
	141	64	453.90	78.9	17.09	84.3	

APRIL 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade, Fah. deg.	Daily Rainfall, Inches.	Mean Daily Relative Humidity, Saturation =100.	Remarks.
1	135	...	...	78.9	0.12	84.9	
2	134	1	7.46	79.3	0.05	74.0	
3	134	...	...	79.4	...	76.8	
4	134	...	...	77.7	...	84.9	
5	134	1	7.46	79.5	0.78	81.6	
6	134	...	..	76.5	0.01	75.5	
7	135	...	...	77.2	...	80.8	Sunday.
8	135	1	7.41	77.0	0.01	88.2	
9	133	...	...	78.0	0.73	73.6	
10	132	...	...	77.1	...	72.3	
11	133	...	...	77.4	0.05	85.0	
12	133	...	...	76.9	0.10	74.6	
13	141	1	7.09	77.0	...	66.2	
14	141	...	...	75.3	0.04	67.2	Sunday.
15	140	1	7.14	76.2	0.06	73.5	
16	140	1	7.14	75.1	0.18	78.9	
17	140	...	...	76.4	0.12	76.8	
18	140	...	...	77.3	0.01	70.7	
19	140	...	...	77.0	...	63.0	Public Holiday.
20	147	...	...	76.2	0.04	77.7	
21	146	...	...	71.5	0.02	84.2	Sunday.
22	145	...	...	77.5	0.14	80.1	Public Holiday.
23	146	...	...	75.6	0.26	83.6	
24	147	...	...	76.9	0.04	79.3	
25	144	...	...	74.2	0.37	83.6	
26	146	...	...	75.5	0.02	79.3	
27	165	...	...	77.3	0.03	78.1	
28	167	...	...	77.3	...	81.4	Sunday.
29	167	...	...	76.5	0.69	82.0	
30	166	...	...	76.5	0.78	79.9	
	142	6	42.25	76.8	4.65	78.0	

MAY 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade, Fah. deg.	Daily Rainfall, Inches.	Mean Daily Relative Humidity, Saturation =100.	Remarks.
1	166	...	...	76.8	0.02	80.1	
2	167	1	5.99	76.7	...	80.8	
3	165	...	...	76.8	0.07	83.0	
4	187	...	...	75.6	0.08	79.4	
5	190	...	...	76.2	...	79.3	Sunday.
6	189	...	...	73.2	...	71.4	
7	189	...	...	73.2	0.12	78.9	
8	189	...	...	73.6	0.02	78.1	
9	189	...	...	70.3	0.03	69.4	
10	189	...	...	73.3	..	78.4	
11	197	3	15.23	72.1	...	83.5	
12	198	...	...	77.0	0.07	80.4	Sunday.
13	194	1	5.15	71.6	...	81.1	
14	194	1	5.15	73.0	...	83.8	
15	195	...	...	75.0	0.09	83.7	
16	195	1	5.13	75.6	0.15	78.2	
17	195	2	10.26	75.5	0.08	77.9	
18	191	...	...	72.4	...	83.0	
19	192	...	...	71.8	...	79.9	Sunday.
20	193	...	...	71.1	0.01	77.3	
21	192	...	...	70.2	...	82.3	
22	191	3	15.70	71.1	...	83.2	
23	191	...	...	72.6	...	72.9	
24	191	...	...	70.0	...	73.4	Public Holiday.
25	196	..	...	67.2	...	80.3	
26	196	...	...	68.6	...	75.2	Sunday.
27	196	...	...	68.8	...	82.1	Public Holiday.
28	194	1	5.15	69.6	...	75.7	
29	194	...	...	64.3	...	85.8	
30	195	2	10.26	70.2	0.76	76.8	
31	194	2	10.31	72.9	0.01	76.2	
	190	17	89.47	72.5	1.51	79.1	

JUNE 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade, Fah. deg.	Daily Rainfall, Inches.	Mean Daily Relative Humidity, Saturation =100.	Remarks.
1	207	...	...	70.2	0.04	84.4	
2	207	...	...	72.4	0.39	87.4	Sunday.
3	207	...	...	75.5	0.07	79.0	
4	207	...	...	73.8	0.13	79.2	
5	207	...	...	73.0	0.05	83.9	
6	207	...	...	71.5	0.05	73.4	
7	207	...	...	66.9	...	73.7	
8	201	...	...	69.3	...	73.0	
9	201	...	...	68.1	...	68.6	Sunday.
10	201	2	9.95	68.1	...	68.5	
11	202	...	...	68.4	...	70.5	
12	202	...	...	69.0	...	70.8	
13	203	...	..	70.5	...	74.8	
14	204	...	...	70.4	...	60.4	
15	210	...	...	69.4	...	71.0	
16	210	...	...	72.4	...	79.3	Sunday.
17	212	...	...	72.4	...	70.8	
18	212	...	...	66.1	...	71.3	
19	211	...	...	69.0	...	69.4	
20	211	...	...	67.6	...	78.8	
21	211	...	...	71.5	...	77.8	
22	234	...	...	70.7	0.09	77.5	
23	234	...	...	71.1	0.03	77.2	Sunday.
24	234	...	...	68.3	0.05	83.3	
25	235	...	...	73.1	0.25	77.9	
26	234	...	...	69.9	0.05	78.0	
27	234	1	4.27	69.5	0.28	74.9	
28	234	...	...	64.2	...	74.8	Public Holiday.
29	234	...	...	67.7	0.03	66.4	
30	234	...	...	66.7	0.02	70.6	Sunday.
	215	3	13.95	69.9	1.53	74.9	

JULY 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade, Fah. deg.	Daily Rainfall, Inches.	Mean Daily Relative Humidity, Saturation =100.	Remarks.
1	155	...	...	68.4	0.03	60.7	79 men departed
2	154	...	...	66.7	0.09	73.1	to South Africa.
3	427	2	5.68	68.5	0.01	67.7	273 men arrived
4	427	2	5.68	66.1	0.01	71.9	from Curepipe.
5	427	...	...	69.5	...	56.6	
6	407	...	...	67.1	...	66.6	
7	407	...	...	68.8	0.03	74.8	Sunday.
8	407	...	...	70.2	...	83.4	
9	407	...	...	70.5	0.06	91.3	
10	403	...	...	70.6	0.34	84.8	
11	403	...	...	72.6	...	70.1	
12	403	...	...	68.0	...	69.0	
13	403	...	...	69.6	...	66.4	
14	403	...	..	69.9	0.14	83.4	Sunday.
15	400	2	5.00	70.9	0.06	78.1	
16	400	...	...	69.5	0.04	67.8	
17	398	...	...	72.7	0.15	83.5	
18	398	...	...	73.1	0.10	79.5	
19	398	2	5.03	72.2	0.04	81.9	
20	391	...	...	71.9	...	79.2	
21	391	...	...	70.4	...	75.0	Sunday.
22	387	2	5.17	71.4	...	79.6	
23	397	1	2.52	66.9	...	84.1	
24	397	...	...	72.0	0.40	74.9	
25	397	...	...	71.6	0.10	75.5	
26	397	...	...	69.6	...	76.0	
27	388	1	2.57	71.5	0.35	84.6	
28	388	...	...	71.2	0.26	76.3	Sunday.
29	390	...	...	68.3	...	78.8	
30	397	...	...	70.5	...	67.6	
31	397	...	...	70.8	...	67.0	
	385	12	31.30	70.0	2.21	75.8	

AUGUST 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade, Fah. deg.	Daily Rainfall, Inches.	Mean Daily Relative Humidity, Saturation =100.	Remarks.
1	494	...	...	69.9	1.06	80.8	97 men arrived
2	491	...	...	72.0	0.15	71.3	from S. Africa.
3	495	1	2.02	69.5	...	74.0	
4	495	...	...	69.3	0.03	80.0	Sunday.
5	493	2	4.07	71.0	0.61	75.1	
6	490	...	...	71.0	0.03	70.3	
7	490	...	...	70.8	0.55	66.6	
8	489	...	...	70.3	0.06	72.5	
9	470	...	...	68.1	0.02	67.6	19 men departed
10	465	...	...	69.8	...	74.6	to South Africa.
11	465	...	...	69.8	...	68.4	Sunday.
12	467	...	...	66.3	...	63.6	
13	469	...	...	69.2	...	60.6	
14	463	...	...	68.1	...	55.0	
15	463	...	...	69.3	...	57.2	Public Holiday.
16	463	...	...	65.3	0.03	72.3	
17	491	...	...	67.0	0.06	75.3	
18	491	...	...	68.8	0.06	77.5	Sunday.
19	490	1	2.04	68.4	0.07	80.9	
20	490	...	...	68.6	...	69.0	
21	491	...	...	68.8	0.39	73.6	
22	488	...	...	68.1	...	62.5	
23	488	...	...	69.1	0.07	69.8	
24	456	...	...	68.2	0.03	72.9	
25	456	...	...	69.5	0.01	65.6	Sunday.
26	456	...	...	69.3	0.04	77.4	Public Holiday.
27	461	...	...	69.0	0.30	79.8	
28	461	...	...	69.6	0.05	71.2	
29	461	...	...	70.1	0.04	74.8	
30	461	...	...	71.8	0.01	75.0	
31	463	...	...	69.3	0.01	74.8	
	476	4	8.40	69.2	3.68	71.4	

SEPTEMBER 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade, Fah. deg.	Daily Rainfall, Inches.	Mean Daily Relative Humidity, Saturation =100.	Remarks.
1	463	...	...	69.2	0.10	73.7	Sunday.
2	466	...	...	67.5	0.02	72.8	
3	466	...	...	69.5	0.01	70.3	
4	464	...	...	70.0	0.06	73.1	
5	461	...	...	71.7	0.04	73.1	
6	461	...	...	68.6	0.07	85.1	
7	457	1	2.19	69.6	0.09	70.8	
8	457	...	...	71.2	...	74.6	Sunday.
9	457	...	...	73.3	0.11	72.8	
10	457	...	...	72.5	0.08	69.7	
11	457	...	...	67.5	...	73.6	
12	457	...	...	65.7	...	82.6	
13	457	1	2.19	70.9	...	71.4	
14	451	...	...	72.9	...	69.3	
15	451	...	...	70.8	0.02	71.5	Sunday.
16	451	...	...	69.7	...	68.1	
17	451	...	...	70.9	0.06	72.5	
18	457	1	2.19	67.8	0.14	71.3	
19	452	...	...	68.7	0.11	66.7	
20	452	...	...	67.1	0.08	67.9	
21	450	...	...	69.0	...	65.9	
22	450	...	...	70.1	...	73.7	Sunday.
23	447	1	2.44	69.7	0.03	71.2	
24	427	...	...	69.2	0.12	78.9	
25	426	...	...	72.5	0.04	74.7	
26	425	...	...	68.7	...	77.3	Public Holiday.
27	425	...	...	63.4	...	85.7	
28	433	1	2.31	69.2	0.35	77.0	
29	431	...	...	72.8	...	77.2	Sunday.
30	431	1	2.32	69.9	...	75.2	
	450	6	13.33	69.7	1.53	74.1	

OCTOBER 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade. Fah. deg.	Daily Rainfall. Inches.	Mean Daily Relative Humidity, Saturation =100.	Remarks.
1	431	...	...	67.3	...	85.5	
2	431	1	2.32	73.2	0.01	77.4	
3	191	...	...	73.5	0.01	74.7	350 men departed
4	192	...	...	73.8	...	69.3	to Curepipe.
5	193	...	...	72.7	...	71.0	
6	193	...	...	72.5	0.03	69.9	Sunday.
7	193	..	...	72.3	0.01	67.7	
8	194	...	...	73.8	...	70.8	
9	194	...	...	73.4	...	72.1	
10	194	...	...	73.3	0.12	70.4	
11	194	...	...	74.7	0.03	68.1	
12	192	...	...	73.1	0.09	70.9	
13	192	...	...	73.6	0.13	67.9	Sunday.
14	192	...	...	72.3	...	73.1	
15	192	...	...	72.0	0.01	76.4	
16	192	1	5.21	71.3	...	80.0	
17	192	...	...	74.0	0.04	71.1	
18	192	...	..	73.5	0.12	73.5	
19	191	...	...	71.6	0.01	69.9	
20	190	...	...	71.9	0.01	73.3	Sunday.
21	190	...	...	74.0	0.02	74.4	
22	189	...	...	75.2	..	70.3	
23	191	...	...	76.0	0.02	71.6	
24	191	...	...	74.5	0.14	74.9	
25	191	...	...	75.0	...	68.3	
26	193	...	...	72.5	0.10	74.9	
27	193	...	...	73.2	0.01	74.6	Sunday.
28	193	...	...	73.9	...	69.6	
29	193	...	...	73.3	0.04	67.9	
30	193	...	...	74.3	0.05	70.2	
31	193	...	...	75.5	0.20	66.2	
	208	2	9.61	73.3	1.20	72.2	

NOVEMBER 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade. Fah. deg.	Daily Rainfall. Inches.	Mean Daily Relative Humidity, Saturation =100.	Remarks.
1	193	...	...	72.0	...	75.3	Public Holiday.
2	196	...	...	76.8	0.07	70.8	Public Holiday.
3	195	...	...	74.9	...	67.2	Sunday.
4	192	...	...	72.2	...	70.6	
5	191	...	...	73.3	...	71.7	
6	191	...	...	71.9	...	77.1	
7	190	...	...	68.6	...	80.1	
8	190	...	...	71.8	...	75.4	
9	188	...	...	74.1	...	65.7	Public Holiday.
10	188	...	...	77.5	...	68.8	Sunday.
11	188	...	...	77.3	...	67.8	
12	188	...	...	77.7	...	67.5	
13	188	...	...	75.1	...	68.4	
14	188	...	...	78.4	...	62.6	
15	188	...	...	73.5	...	70.6	
16	185	2	10.81	69.8	0.16	81.4	
17	185	...	...	71.9	0.31	82.1	Sunday.
18	185	...	...	71.7	0.07	79.1	
19	185	...	...	72.0	...	75.0	
20	185	...	...	75.5	...	67.5	
21	185	1	5.41	75.1	...	61.9	
22	185	...	...	74.2	..	66.3	
23	181	1	5.53	74.0	0.01	78.5	
24	181	...	...	78.1	0.20	71.1	Sunday.
25	181	...	...	77.0	...	74.1	
26	180	1	5.55	72.7	0.28	87.9	
27	180	...	...	75.3	0.60	75.1	
28	180	1	5.56	78.0	...	71.9	
29	181	...	...	74.8	...	78.4	
30	158	...	...	73.6	0.08	73.2	
	186	6	32.26	74.3	1.78	72.9	

DECEMBER 1889.

Date.	Daily Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Daily Temperature in the Shade. Fah. deg.	Daily Rainfall. Inches.	Mean Daily Relative Humidity. Saturation =100.	Remarks.
1	158	...	...	78.0	0.02	68.7	Sunday.
2	166	...	...	76.6	0.06	71.0	
3	166	...	...	78.0	...	72.0	
4	166	...	...	80.0	...	71.1	
5	177	...	...	74.1	...	70.5	
6	177	...	...	77.9	...	69.2	
7	176	...	...	74.9	...	70.5	
8	176	...	...	77.3	...	68.2	Sunday.
9	176	...	...	77.8	...	65.6	
10	176	...	...	77.3	...	74.0	
11	179	...	...	79.7	...	73.7	
12	178	1	5.62	80.0	0.02	74.5	
13	178	...	..	78.6	0.14	78.9	
14	188	...	...	74.7	0.03	81.0	
15	187	...	...	72.0	...	81.4	Sunday.
16	187	...	...	77.6	0.03	72.6	
17	187	...	...	78.6	0.02	68.1	
18	187	...	...	77.7	...	74.6	
19	187	...	...	77.2	...	74.5	
20	185	1	5.41	75.1	...	73.3	
21	196	1	5.10	78.0	...	76.8	
22	196	...	...	75.5	...	86.8	Sunday.
23	196	1	5.10	75.2	1.77	89.1	
24	196	...	...	79.4	0.09	78.0	
25	196	...	...	79.5	...	70.0	Public Holiday.
26	196	...	...	75.1	...	70.2	Public Holiday.
27	195	...	...	74.5	0.15	85.0	
28	194	1	5.15	79.1	0.24	75.4	
29	193	...	...	78.4	...	78.3	Sunday.
30	192	...	...	80.4	0.19	79.1	
31	190	...	...	81.0	...	77.9	
	184	5	27.17	77.4	2.76	74.8	

SUMMARY of the Monthly Tables and Chart of Malarial Fever, Temperature, Rainfall, and Relative Humidity at Port Louis, Mauritius, for the year 1889.

SUMMARY OF THE MONTHLY TABLES.

MONTHLY ABSTRACT.

Month.	Mean Monthly Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Monthly Temperature in the Shade, Fah. deg.	Monthly Rainfall, Inches.	Mean Monthly Relative Humidity, Saturation = 100.	Monthly Order of Unhealthiness from Malarial Fever.	Mean Monthly Ratio of Admissions with Malarial Fever per 1,000 of Strength = 90.
January .	224	30	134	78.4	12.74	82.1	3	Above.
February .	172	43	250	78.0	5.51	78.5	2	Above.
March .	141	64	454	78.9	17.09	84.3	1	Above.
April .	142	6	42	76.8	4.65	78.0	5	Below.
May .	190	17	89	72.5	1.51	79.1	4	Below.
June .	215	3	14	69.9	1.53	74.9	9	Below.
July .	385	12	31	70.0	2.21	75.8	7	Below.
August .	476	4	8	69.2	3.68	71.4	12	Below.
September	450	6	13	69.7	1.53	74.1	10	Below.
October .	208	2	10	73.3	1.20	72.2	11	Below.
November	186	6	32	74.3	1.78	72.9	6	Below.
December	184	5	27	77.4	2.76	74.8	8	Below.

QUARTERLY ABSTRACT.

Quarter.	Mean Quarterly Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Quarterly Temperature in the Shade, Fah. deg.	Quarterly Rainfall, Inches.	Mean Quarterly Relative Humidity, Saturation = 100.	Quarterly Order of Unhealthiness from Malarial Fever.	Mean Quarterly Ratio of Admissions with Malarial Fever per 1,000 of Strength = 255.
1st . .	179	137	765	78.4	35.34	81.7	1	Above.
2nd . .	182	26	143	73.1	7.69	77.3	2	Below.
3rd . .	437	22	50	69.6	7.42	73.7	4	Below.
4th . .	193	13	62	75.0	5.74	73.3	3	Below.

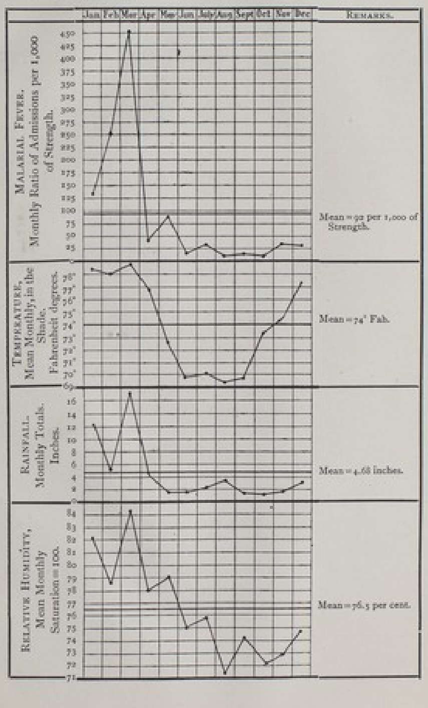
HALF-YEARLY ABSTRACT.

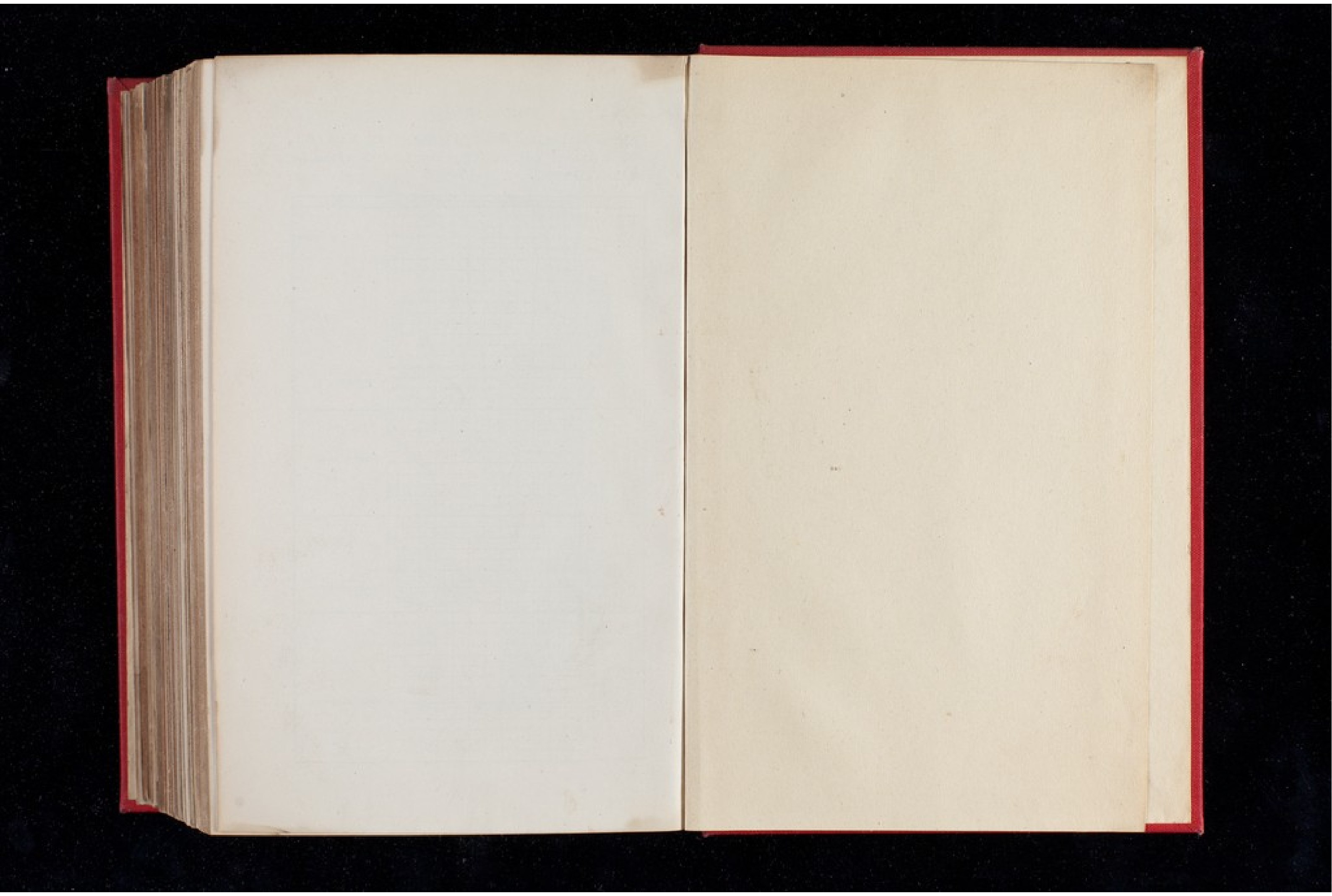
Half-year.	Mean Half-yearly Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Half-yearly Temperature in the Shade, Fah. deg.	Half-yearly Rainfall, Inches.	Mean Half-yearly Relative Humidity, Saturation = 100.	Half-yearly Order of Unhealthiness from Malarial Fever.	Mean Half-yearly Ratio of Admissions with Malarial Fever per 1,000 of Strength = 558.
1st . .	180	163	905	75.7	43.03	79.5	1	Above.
2nd . .	315	35	111	72.3	13.16	73.5	2	Below.

YEARLY ABSTRACT.

Year.	Mean Yearly Strength of Troops.	Admissions with Malarial Fever.	Ratio per 1,000 of Strength.	Mean Yearly Temperature in the Shade, Fah. deg.	Yearly Rainfall, Inches.	Mean Yearly Relative Humidity, Saturation = 100.	—	—
1889 .	248	198	798	74.0	56.19	76.5	...	...

Chart of MALARIAL FEVER, TEMPERATURE RAINFALL, and RELATIVE HUMIDITY, at Port Louis, Mauritius, for the Year 1889.





PAMPHLETS

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