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ARMY SANITARY ADMINISTRATION,

AND

ITS REFORM

UNDER THE LATE LORD HERBERT.

BY

FLORENCE NIGHTINGALE.

(Read at the London Meeting of the "Congrès de Bienfaisance," June, 1862.)

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ARMY SANITARY ADMINISTRATION,

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BY FLORENCE NIGHTINGALE.

It has been well and truly said that, in long wars, the real arbiter of the destinies of nations is not the sword, but pestilence.

It is this destroying angel which, following on the march of armies, exacts of every man to the full whatever penalties follow on the infraction of natural law.

In times past, war has been conducted in more or less forgetfulness, sometimes in total oblivion, of the fact, that the soldier is a mortal man, subject to all the ills following on wet and cold, want of shelter, bad food, excessive fatigue, bad water, intemperate habits, and foul air.

And so the waste of human life, and the destruction of human health and happiness, have been, in all ages, many times greater from disease than from actual encounter in the field.

If peace has its victories as well as war, it has also its unnecessary losses from disease and death. Only the losses of peace are greater than those of war; because they are daily and constant, while war occurs at intervals of time.

To endeavour to prevent this destruction of life is by no means to encourage war, no more than to attend on the sick and wounded in a field hospital is to encourage war.

The object is primarily one of humanity. It is to save life, and to diminish suffering. And all who engage in this work are, in the best sense, savers of men.

Highest among such must be ranked Sidney Herbert.

As years pass on, so will the work, which he was a main agent in accomplishing, become better known and followed up.

And who can tell how much systematic attempts, made by all nations to diminish the horrors of this great curse, war, may not lead the way to its total disappearance from the earth!

The faithful records of all wars are records of preventible suffering, disease, and death. It is needless to illustrate this truth, for we all

know it. But it is only from our latest sorrow, the Crimean catastrophe, that dates the rise of army sanitary administration in this country.

Royal Commission on the Sanitary State of the Army, 1857.

The losses then incurred, and the experience derived from these, induced her Majesty to issue the now famous royal commission on the "Sanitary State of the Army," composed of men qualified to grapple with the whole subject, and to suggest the necessary remedies. Sidney Herbert presided over that commission, and embodied its results in a masterly report, showing, for the first time, the great and unnecessary mortality to which the army was at all times subject, the diseases occasioning it, their removable causes, and the administrative reforms required to arrest this awful loss of life and efficiency. At that time, the death rate among soldiers from consumption and tubercular diseases *alone* (the monstrous products of breathing foul air), exceeded the *total* death rate *from all causes* among the civil population of the corresponding ages. The total mortality in the army was nearly double—in the Guards more than double—that of the civil population. It is now actually *less* than in civil life.

Sidney Herbert's report laid the foundation of army sanitary reform. Lord Panmure, aware of its price, issued, under Sidney Herbert's advice, four sub-commissions for giving effect to its recommendations:—

Barrack and Hospital Improvement Commission, 1857.

One, the Barrack and Hospital Improvement Commission, examined the barracks and military hospitals of the united kingdom, and found their sanitary condition as to overcrowding, want of ventilation, want of drainage, imperfect water supply, &c., sufficient to account for most of the excessive death rate from which the troops occupying them had suffered. These establishments have, under the direction of the commission, been provided with combined ventilation and warming, without machinery of any kind. Drainage has been introduced, or improved. Water supply has been extended, baths introduced both for barracks and hospitals, and the lavatory arrangements generally improved. The barrack kitchens have been completely remodelled: the wasteful cooking apparatus, only fit for boiling, has been replaced by improved and economical cooking ranges for roasting, &c., so that the men may now have the change of cookery required for health, instead of the eternal soup and boiled beef. Gas has been introduced into many barracks, instead of the couple of "dips," which only made the barrack room look darker still, and by the light of which it was impossible for the men to read, or to pursue any occupation except smoking. Many important structural alterations for increasing window light, circulating fresh air by removing useless partitions, for ventilating stables, abolishing ash-pits, &c., have been carried out. More simple and healthy principles for the construction of future barracks and hospitals, for ensuring better drainage, efficient ventilation, more cubic space for both sick and well, and greater facilities for administration and discipline, have been laid down, and applied in several new structures;—amongst others, in the great "Herbert Hospital" at Woolwich.

Mediterranean Stations, 1861.

The labours of the same commission have since been extended to the Mediterranean stations, where they were greatly required; and, it is to be hoped, will be farther extended to the West Indies and Canada.

The result of the improvements, already made, is that just one half of the Englishmen that enter the army die (at home stations) as formerly died.

The *total mortality* at home stations, *from all diseases*, is now actually *less* (by above one per thousand per annum) than was formerly the mortality from consumption and chest diseases *alone*. The reduction in deaths from consumption has been as remarkable: in some arms one-half, in others two-thirds of the mortality from this fatal disease has disappeared.

To shew what has already been done, I have transferred, from the Report of the Royal Commission, a diagram, shewing the death statistics of the English male population, between the ages of fifteen and forty-five, and the death statistics of the infantry of the line, serving at home, from 1837 to 1846. This is how Sidney Herbert found the army. I have added a third division, shewing the death rate of the same infantry for the three years following the introduction of sanitary improvement, 1859-60-61. This is how Sidney Herbert left the army.

School in Military Cooking.

As a supplement to the improvements in barrack cook-houses (already referred to), Lord Herbert directed a school for practical cookery to be established at Aldershot, for the training of regimental and hospital cooks; instead of taking it for granted, as was the practice, that any man could cook just as he could mount guard. This school is gradually supplying both regiments and hospitals with cooks capable of giving men a wholesome meal.

New Code of Regulations for Sanitary Service of Army, 1857-9.

The second sub-commission was appointed for re-organizing the army medical department, and for framing a code of regulations for the hospital and sanitary service of the army. This commission found that, according to existing practice, no provision was made for systematically caring for the soldier's *health*, but only for his *sickness*. The chief recognised function of the army medical officer was attending men in hospital; but in no way was it considered his duty to render it unnecessary for men to come into hospital at all.

To supply this great want, the commission drew up a code for introducing the sanitary element (for the first time) into the army, defining the positions of commanding and medical officers, and their relative duties and responsibilities regarding the soldier's health, constituting the regimental surgeon the sanitary adviser of his commanding officer, who is now bound to give effect to all sanitary recommendations made by his medical officer, unless he can assign satisfactory reasons *in writing* to the superior authority for non-compliance.

The same code contains regulations for organizing general hospitals, and for improving the administration of regimental hospitals, both in peace and during war. Formerly, general hospitals in the field had

to be improvised, on no defined principles, and on no defined personal responsibility. The wonder is, not that they broke down, as they did in all our wars, but that they could be made to stand at all. In all our wars our general hospitals have been signal failures, fatal examples of how to kill, not to cure. All this is now changed; and, with the most ordinary administrative capacity, the sick during war may now have every necessary care and comfort.

This code is the best ever framed; and, in practice, has been found to succeed in every climate, whether at home, in garrison, or in the field. It has been successfully tested in two expeditions, since issued by Lord Herbert in 1859. On the day which took him from us, its general hospital system was realized in the hospital at Woolwich, including its governor, principal medical officer, captain of orderlies, female nurses, and their female superintendent, &c., which system will be transferred to the magnificent hospital, now being built there, of which Lord Herbert was the founder, and which will bear his name. He also directed a plan to be drawn up for the organization of a second general hospital at Devonport, on the same principles, which will shortly be carried into effect.

Army Medical School at Chatham, 1857-60.

The third sub-commission was charged with organizing a practical school at Chatham, for instructing candidates for army medical service in military hygiene and other specialties.

Formerly young men were sent to attend sick and wounded soldiers, who *perhaps* had never dressed a serious wound, or never attended a bedside, except in the midst of a crowd of students, following in the wake of some eminent lecturer—who *certainly* had never been instructed in the most ordinary sanitary knowledge; although one of their most important functions was hereafter to be the prevention of disease in climates, and under circumstances where *prevention* is everything, and medical treatment often little or nothing.

The sub-commission drew up an admirable scheme; and the school at Chatham was opened by Sidney Herbert in person, in 1860. Already its results have been most satisfactory. A large number of men of high attainments have been sent from it into the army; and we may confidently expect a lower sick rate and death rate (especially on foreign stations and on field service) as one of its results, as well as higher hospital efficiency.

Army Medical Statistics, 1857-61.

The fourth sub-commission was charged with the duty of re-organizing the army medical statistics, which were then in such a condition as to afford very incomplete data, especially during war. These statistics have been reformed, and are now by far the best and most useful in Europe. They can be reduced with much less labour, and with much greater promptitude than formerly; because the manner of recording cases is now much more precise, and there is a special division in the army medical department for reducing them to obtain the results; while they enable the exact state of health, of every regiment and station, to be ascertained, and any unusual amount of disease, *with its removable causes*, to be brought at once to the cognizance of the authorities.

In the course of years they will add immensely to our knowledge of army diseases, as well as of those incident to particular climates and seasons.

Although the first annual report under the new system, being a *first* report, does not give all the data, regimental and stational, required by the instructions, yet every succeeding year's experience will render these annual reports more complete and more valuable.

Sidney Herbert.

Of all these commissions Sidney Herbert was head and centre. He superintended himself carefully every step of their procedure, and took his share of the work, as well as the responsibility attaching to it in his public capacity, by identifying himself with the reforms. In England it is so much the custom to look upon statesmen merely in their political, and not in their administrative capacity, that it is almost forgotten that they have an administrative function at all. No one thinks of a secretary of state, *e. g.*, as the head of an office which has in its hands the lives and morals of men. But Sidney Herbert, although his passion, his hereditary occupation, to which he was born and bred, was politics, yet made his administrative labours greater, set his administrative object higher, recoiled from none of its dry fatigues, and attained its highest usefulness. What has been well-advised to a rising statesman, he performed. He did not sink in politics the powers which were meant for mankind.

Army Medical Officers' Warrant, 1858.

Army medical officers had felt much and just dissatisfaction with their position in the army. The royal commission advised therefore the preparation of another warrant, ensuring to these officers the rank and emolument to which their services entitled them. It was framed by Sidney Herbert, and issued by General Peel in 1858.

Purveyor's Warrant and Regulations, 1860.

Another great reform was introduced into the Purveying Department, which, like many others, had no well-defined position, duties, or responsibilities. It was efficient or inefficient almost by chance. Like other departments, it broke down when tried by war; and all its defects were visited on the sick and wounded men, for whose special benefit it professed to exist.

To put an end to this, and to introduce method into the service, Lord Herbert issued in 1861 a new purveyor's code and regulations, re-organizing the department in accordance with the views expressed by himself, as Chairman of the Royal Commission. The regulations now define with precision the duties of each class of purveyor's officers, together with their relation to the army medical department. They provide all necessaries and comforts for men in hospital (both in the field and at home) on fixed scales; instead of requiring sick and wounded men (even in the field) to bring with them into hospital articles for their own use, and which they had lost before reaching it. These regulations have been already tried, both for home and field service, and have been found to answer every purpose.

Army Hospital Corps, 1860.

Lord Herbert also named a committee to re-organize the army hospital corps. In former times there were no proper attendants on the sick. For regimental hospitals a steady man was appointed hospital sergeant, and two or three soldiers, fit for nothing else, were sent into the hos-

pital, to be under the orders of the medical officer; who, if he were fortunate enough to find one man fit to nurse a patient, was sure to lose him by his being recalled "to duty;" sometimes, indeed, men were mounted in rotation over sick in hospital as they would mount guard over a store. And this is still done in India, and in some regiments at home.

No special training was considered necessary; no one, except the medical officer, who was helpless, had the least idea that attendance on the sick is as much a special business as medical treatment.

Unsuccessful attempts had been made to organize a corps of orderlies, unconnected with regiments: the result was most unsatisfactory. Lord Herbert's committee proposed to constitute a corps—the members of which, for regimental purposes, are to be carefully selected by the commanding and medical officers—specially trained for their duties, and then attached permanently to the regimental hospital, from which they cannot be removed to the ranks, except for proved incapacity or breach of discipline. This was carried into effect shortly after his death.

Success of all these measures in reducing Army Death rate.

The crowning testimony of the great national importance of the new system of sanitary administration, inaugurated by Lord Herbert, is to be found in the last Chinese expedition, where his reforms were first practically tested. An expeditionary force was sent to the opposite side of the world, into a hostile country, notorious for its epidemic diseases. Every required arrangement for the preservation of health was made, with the result that the mortality of this force, including wounded, was little more than three per cent. per annum, while the "constantly sick" in hospital were about the same as at home. Let us contrast with this great success what happened during a former war in China. The 26th Cameronians, a "total abstinence" regiment, and one of the finest and most healthy in the British service, was landed at Chusan, 900 strong, and left to its fate without any sanitary care. In two months only twenty men could be got together.

To take another contrast upon a larger scale. During the first months of the Crimean war, from September 1854 to March 1855, the death rate among the British troops was sixty per cent. per annum, until means were taken to prevent this fearful sweep of death. During the same months, the "constantly sick" in the hospitals were sevenfold those in the war hospitals in China.

Indian Army Sanitary Commission, 1859.

Impressed with the enormous death rate and loss of efficiency in the Indian army, Lord Herbert undertook in 1859 the presidency of the Royal Commission on the "sanitary state" of that army, called together to devise means for reducing these great losses. He was obliged to relinquish this to Lord Stanley in 1861, on account of official business, and, alas! of failing health. But by that time the evidence received from Indian stations had been sufficient to convince him that removable causes, of far greater importance and intensity than any which have been discovered in our home stations, were destroying the lives of our soldiers, and the physical efficiency of the Indian army.

Among other reforms initiated during Lord Herbert's life, but incomplete at his death, were the following:—

Committee on Barrack Works, 1861.

He had seen that the sanitary defects in barracks and hospitals had arisen from the unsatisfactory manner in which these buildings had been planned and constructed. No one engaged on them had had any knowledge of the requirements for health. If they had been made to put guns and stores in, and not men at all, or horses, they could not, in fact, have been worse. There was no recognition of the necessity even of space, or of fresh air, or of drainage, either for sick or well. To prevent this in future, Lord Herbert called together a committee, to inquire into the present system of executing barrack works, and to suggest administrative improvements.

The department, charged with spending money on buildings to keep men healthy, knew little about the principles of healthy construction, such knowledge not having been required of them.

The result of the labours of the committee, it is expected, will be a better and more economical organization, a proper training in the principles of sanitary works, and a total change in the sanitary construction of our future military buildings.

Commission for Soldiers' Day-Rooms and Institutes, 1861.

Another very important commission was also called, to consider the question how best to provide soldiers' day-rooms and institutes, in order to struggle with the great moral evil supposed to be inseparable from garrisons and camps.

Lord Herbert saw that, at present, the soldier was hardly thought of as a man at all. The effect of moral agencies upon him was practically ignored. He (Lord Herbert) had taught every one, by this time, the results of treating the soldier physically as if he were not a human being, subject to the laws of physical health. And, in the moral tone of garrisons and camps, he recognised the legitimate results of treating the soldier morally, as if he were not under the laws of moral health. Placed, as he is, under strict restraint, lodged in a crowded, uncomfortable, barrack-room—without privacy, without social intercourse, except that afforded by the canteen or by some much worse place; without home ties; without occupation or amusement, except such as is provided for him by those (and they are everywhere) who pander to his passions—the soldier has a position most unfavourable to his moral nature. And just as the soldier was formerly accused of dying unnecessarily, or because it could not be helped, the real causes being all the while ignored; so now, the consequences of overlooking moral causes go by the name of "camp vices." Not that nothing has been done in the way of direct teaching to counteract the evil; but, all the while, the immoral agencies or temptations by which the man is surrounded, have been left untouched; while no counteracting agencies of a moral kind have been provided to cope with these.

In civil life at home, it is supposed inconsistent with individual liberty to put down bad places of resort, and to prevent open temptations to profligacy; while, in certain continental states, it is *not* supposed against liberty or morals to make prostitution as little dis-

agreeable as possible—viz., by "regulating" it, to avert the consequences of this vice, leaving all the temptations just as they were.

Lately, the remedy alluded to has been repeatedly urged for Aldershot, in the face of the notorious fact that, while no proper places of resort or occupation have been created for the men, the remedy would leave the abominations of the town to go on untouched.

In dealing with this question, there are obvious principles. Governments *can* prevent this open infamous trading, as they do other open infamous trading. They *can* prevent open temptations to vice, as they can prevent open temptations to crime. They can do these things both for the civilian and the soldier. But for the soldier they can do more; and it is this which the committee on soldiers' day-rooms was called to consider by Lord Herbert.

They have shown that the men's barracks can be made more of a home—can be better provided with libraries and reading-rooms; that separate rooms can be attached to barracks where men can meet their comrades, sit with them, talk with them, have their newspaper and their coffee, if they want it, play innocent games, and write letters; that every barrack, in short, may easily be provided with a kind of soldiers' club, to which the men can resort when off duty, instead of to the everlasting barrack-room or the demoralizing dram-shop; and that, in large camps or garrisons, such as Aldershot and Portsmouth, the men may easily have a club of their own out of barracks.

The committee also recommended increased means of occupation, in the way of soldiers' workshops, outdoor games and amusements, and rational recreation by lectures and other means.

The plan has been tried with great success at Gibraltar, Chatham, Montreal. There is no reason why it should not succeed elsewhere. At all events, let it be tried.

Lord Herbert's latest act was directing an inquiry at Aldershot, as to the best means of introducing the system there. The country will support the cherished scheme of its dead statesman.

This is a short sketch of the labours and successes of Lord Herbert's last brief administration. The lesson which these reforms teach is, that the real foundation of War Office efficiency is to be laid in the efficient working of each department—in simplifying procedure, abolishing all divided responsibility, clearly defining the duties of each officer—in giving direct responsibility to each head of a department—and, lastly, in placing all the departmental heads in direct communication with the Secretary of State. It is by this procedure that the spirit which was breathed into Lord Herbert's reforms, may be expected to accomplish what *he* constantly kept before him as the great object of his official life—viz., to increase the efficiency, improve the position, and preserve the health of the British soldier.

There were indeed other important reforms made by Lord Herbert during this his last short tenure of office. But not for these, or so much for these as for the rest, will he be remembered. He will be remembered chiefly as the first war minister who ever seriously set

himself to the task of saving life—who ever took the trouble to master a difficult subject so wisely and so well, as to be able himself, and to show the way to others, to husband the resources of this country, in which human life is of more value than in any other—of more value than any thing else.

To the army, in the person of Sir John Pringle, is due the credit of first having recognised the real, ever-operating effects of physical laws on human health and life. To the army, Sidney Herbert has, a century later, bequeathed the administrative means of applying those laws, so as to mitigate or to prevent the very diseases which previous administrators ignorantly supposed inseparable from the soldier's occupations.

The results cannot fail to re-act on the whole progress of sanitary reform in civil life. Let us hope that the great lesson which has been taught, will have its weight with those charged with the duty of protecting the public health.

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EXPERIMENTAL RESEARCHES.

EXPERIMENTAL RESEARCHES

RELATIVE TO THE

NUTRITIVE VALUE AND PHYSIOLOGICAL EFFECTS

OF

ALBUMEN, STARCH, AND GUM,

WHEN

SINGLY AND EXCLUSIVELY USED AS FOOD.

BEING THE

PRIZE ESSAY OF THE AMERICAN MEDICAL ASSOCIATION FOR 1857.

BY

WILLIAM A. HAMMOND, M. D.,

ASSISTANT SURGEON U. S. ARMY; CORRESPONDING MEMBER OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

Quem sequimur? quove ire jubes? ubi ponere sedes?
Da pater augurium, atque animis illabere nostris!

PHILADELPHIA:
T. K. AND P. G. COLLINS, PRINTERS.
1857.

EXPERIMENTAL RESEARCHES.

INTRODUCTION.

From the first moment of existence to its termination, two processes are constantly progressing in the healthy organic being. The first of these, Nutrition, is that by which the several tissues of the body are primarily formed, and subsequently developed and nourished; the second, Decay, is the direct antagonist of the former, and through it, those portions of the organism which have performed the office in the economy for which they were assimilated, are decomposed into simpler substances, and after undergoing continued metamorphosis, are eventually excreted from the system. The continuation of these forces constitutes life, the cessation of either of them, for even a limited period, induces death.

The present memoir embraces the consideration of these actions, as they occur in the human system, under certain fixed conditions of alimentation, and is especially intended to show by actual experiments, in what manner they are affected by albumen, starch, and gum, when singly and exclusively used as food.

It does not comport with the character of this essay to enter into an elaborate detail of the ordinary course and phenomena of nutrition, or of the destructive metamorphosis of the animal tissues, neither would this be necessary, for, the works of Liebig, Carpenter, and Draper, and the erudite and philosophical treatise of Lehmann, are so readily accessible to the profession, as to render such a procedure a work of supererogation; yet, a few words in relation to some of the principal points connected with them, may not be altogether out of place, and with a statement of the scope of the present investigations, and of the methods employed in the necessary analyses, may serve as an introduction to the more immediate subjects of experiment.

The food which is required by man to maintain a proper degree of activity in the several functional actions of the system, and to repair the waste in the tissues induced by them, may be divided into four classes.

1st. The protein-compounds; albumen, fibrin, casein, gluten, &c., whose most important element is nitrogen, and whose office in the organism is particularly of a histogenetic character.

2d. The fats; which serve for the maintenance of the animal heat by undergoing oxidation into carbonic acid, and water, enter into the composition of the primary cells of the tissues, and are probably, active agents in the solution and metamorphosis of the nitrogenous articles of food.

3d. The carbo-hydrates; starch, sugar, gum, &c., some of which, like the fats, serve to support the heat of the body, and which, within the system, may undergo transformation into them.

4th. Inorganic substances; under which head are included water, and certain minerals which enter essentially into the composition of the blood and tissues.

Besides the above, various other substances, such as alcoholic liquors, coffee, tea, spices, &c., are frequently taken into the stomach with the food, strictly so called, which, though not contributing directly to the nutrition of the body, are yet often serviceable in promoting digestion, and restraining the too rapid waste of the animal tissues.

Though albumen (the type of the protein-compounds) contains carbon, hydrogen, and oxygen, in addition to nitrogen, and is, therefore, *par excellence*, the tissue-forming material, it has been determined by experiments upon the inferior animals, that a sufficiency of such food to sustain vitality for any length of time, cannot be assimilated by the digestive organs; and that, unless fat, starch, or some other of the respiratory aliments, together with a proper amount of inorganic salts, be also ingested, the animal soon perishes with all the symptoms of starvation.

In order, therefore, to keep the vital functions at their maximum healthy standard of action, it is essential that the food should be so adjusted in quantity and quality, as to subserve all the purposes of plastic formations, and, at the same time, maintain the calorific process at its due degree of activity.

Though instinct and experience are generally sufficient to make such an arrangement of aliments as is adequate to fulfil the ordinary requirements of the system, yet, observation is constantly

teaching us, that these guides are not of themselves always correct in their indications, and that disease, and even death, are frequently induced from the want of a more enlightened system of dietetics.

An extensive series of observations is necessary, before we can arrange such a system; before we can so proportion the different classes of food to the individual as to be able to determine, *a priori*, how much of each should be ingested under certain defined conditions and circumstances. Such investigations should especially embrace the determination of the quantities and qualities of the egesta under definite conditions of food, mental and physical exercise, sleep, &c.; repeated analyses of the blood should be made, and at the same time, note taken of all the physical, physiological, and pathological circumstances, capable of influencing the results. In addition to the correct ideas of nutrition, and the other physiological processes, which researches of this nature carried on for a long period would give us, we should also be far advanced towards the attainment of that exactness in medical science, to which all our efforts should be directed.

The theory at present received, explanatory of the process by which the disintegration and metamorphosis of the animal substance occurs, may be briefly stated as follows:—

No part or organ of the body can exercise its functions without a certain portion of the tissue entering into its composition losing its vitality. Interstitial death is thus coeval and coexistent with life.

The bodily material which has become devitalized, re-enters the circulation, and mingles with the general mass of the blood. "No organized substance, no part of any plant or animal, after the extinction of the vital principle, is capable of resisting the chemical action of air and moisture."[1] The effete tissue meets in the blood-vessels with both oxygen and water, and also with a temperature which experiment has demonstrated to be that at which decomposition most readily takes place. Under the combined influence of these agents, the worn-out material is resolved into less complex substances, and is at length, under new forms, eliminated from the system.

Your great channels serve to rid the organism of the products resulting from the decay of its component parts; the lungs, through which carbonic acid, water, and a small portion of nitrogen escape;

[1] Liebig's Letters on Chemistry, London ed., p. 211.

the skin, eliminating principally water, with some carbonic acid, and salts; the intestines, through which (in addition to the unassimilated residue of the food) decomposed bile, gases, &c., are excreted; and the kidneys, giving exit to water, salts, and especially nitrogenous substances.

As previously remarked, in order to exhibit fully the extent of the nutritious and regressive metamorphosis of tissue in a definite time, and under certain conditions, the ingesta and excreta of the same period should be carefully measured, and the nature and quantities of their several constituents exactly determined. In addition, the weight of the body should be accurately taken at stated intervals during the continuance of the investigations, and observations frequently made of the density, moisture, and temperature of the atmosphere.

The ensuing researches, though conducted generally on this plan, are yet far from being perfect, and can only be regarded as affording approximative results. In the present state of our knowledge, the difficulty, if not impossibility, of estimating accurately the total amount of oxygen abstracted from the inspired air, and retained in the system, and the loss from the lungs, and the skin separately, is a bar to precise investigation. Nevertheless, I am sensible that the experiments detailed in this memoir will prove valuable as contributing to a fuller understanding of the effects upon the human system of the different articles of food used, and as indicating the value of these substances as aliments.

The investigations were all instituted upon myself. During their continuance, no other food than that experimented with was taken into the system. An interval sufficient to restore the organism to its normal condition was suffered to elapse after each series, before the following one was commenced. During this interval, I lived upon a full and nutritious diet, and endeavored so to arrange the ingesta as to supply the economy with those substances which it most needed.

My usual manner of living, during each of the succeeding series of experiments, was as follows:—

I arose from bed at 6½ A. M., and retired at 10½ P. M. Eight hours of the twenty-four were accordingly passed in inactivity, the remaining sixteen were apportioned in the following manner. Eight were occupied in conducting the necessary analyses, and in other work of the laboratory; four were given to chemical and physiological studies; and four were taken up with the duties of

my profession, physical exercise, recreation, &c. The exercise was quite limited, consisting of walking about one thousand yards per day. Each period of twenty-four hours is reckoned from 7 A. M. to the same hour the ensuing morning.

The following determinations of the egesta were made for each period of twenty-four hours as above defined:—

I. The quantity of urine.
   - A. Water.
   - B. Solids.
     - *a.* Urea.
     - *b.* Uric acid.
     - *c.* Chlorine.
     - *d.* Sulphuric acid.
     - *e.* Phosphoric acid.
     - *f.* Residue of solid matter.

II. The quantity of feces.
   - A. Water.
   - B. Solids.
     - *a.* Ether extract.
     - *b.* Alcohol extract.
     - *c.* Water extract.
     - *d.* Insoluble residue.

III. The amount of cutaneous and pulmonary transpirations (calculated).

Besides these observations on the egesta, the weight of the body was ascertained at the close of each period. Observations were also made of the state of the pulse, and the temperature of the body, three times during the day. The latter was always determined in a room, the temperature of which was 60° F., by placing a delicate thermometer under the tongue.

The height of the barometer and thermometer (mean of three observations) is also given for each day.

On the first and last day of each series of researches, an analysis of the blood was made.

In addition to the above, microscopical and chemical examinations of the saliva, urine, and feces, were often made, which are not referred to, unless unusual results were obtained. Thus, the reaction of the saliva was always determined, but is not mentioned, unless it differed from the normal condition by being neutral, or

acid. The reaction of the urine and feces is not stated, unless it was neutral or alkaline—these excretions being usually acid. The urine was also frequently tested for the presence of albumen and sugar, and submitted to microscopical examination. The feces were likewise often examined with the microscope.

In performing the requisite analysis, I made use of the following methods. It will be seen that, wherever it was practicable, the volumetric process was employed. This was done, not only because it yields more accurate results than the method of precipitating and weighing, but also because it is more easy of execution, and requires less time. I have merely indicated the special methods, without going into detailed descriptions of them.[1]

Urine.—The whole quantity of this excretion for the twenty-four hours was accurately weighed.

The water and solids were estimated by evaporating to as perfect dryness as possible, over sulphuric acid, in the vacuum of an air-pump, a weighed portion of the whole quantity of urine passed in twenty-four hours. The loss of weight indicated the amount of water, and the weight of the residue, the quantity of solid matter contained in this portion. By simple calculation, these were found for the total amount of urine evacuated during the day. This process is open to the objection, that it is impracticable by it to deprive the specimen of urine of all its water. The quantity of this latter remaining, when a good vacuum is kept up, is, however, very small, and, upon the whole, the results obtained are more exact than when evaporation by heat is practised, as the decomposition of the urine, which always attends this latter process, is entirely avoided.

The *urea* was determined by a titrited solution of the nitrate of mercury, as originally proposed by Liebig.

The *uric acid*, by precipitation with hydrochloric acid from a known quantity of the urine, and subsequent weighing.

The *chlorine*, by Liebig's method with the nitrate of mercury.

The *sulphuric acid*, by a titrited solution of chloride of barium.

The *phosphoric acid*, by Liebig's process with a titrited solution of perchloride of iron.

[1] For full accounts of all the analytical processes made use of in these experiments, and for much other information valuable to those engaged in physiologico-chemical investigations, the reader is referred to Von Gorup-Besanez' Anleitung zur zoochemischen Analyse, a work which has not yet found its counterpart in the English language.

The *residue of solid matter* was found by deducting the sum of the above constituents from the total amount of solids.

Feces.—The whole quantity of the twenty-four hours was first accurately weighed.

The *water* and *solids* were determined by taking a known weight of the feces (when more than one stool occurred in the twenty-four hours these were previously well mixed), and evaporating it to dryness in a chloride of calcium bath at a temperature of 220° F., till upon repeated trials it ceased to lose weight. The loss showed the proportion of water, and the weight of the dry residue that of the solids in the portion submitted to examination. The amount of each in the whole quantity of feces was then calculated from these data.

The *ether*, *alcohol*, and *water extracts*, were severally determined as follows:—

A weighed quantity of the dry feces, obtained as above described, was, in the first place, exhausted with ether in Von Bibra's apparatus. The residue was then treated with alcohol of .83 specific gravity, till this substance failed to extract anything more. The substance remaining was then submitted to the action of distilled water, till it was thoroughly exhausted. The extracts obtained by these means were then evaporated, dried at the temperature proper for each, weighed, and the quantity of each in the whole amount of dry feces calculated. The sum of the whole quantity of these extracts, deducted from the whole amount of dry feces, gave the insoluble residue.

The amount of loss from the skin and lungs, collectively, was found, when the body lost weight, by adding the amount of loss to the sum of the ingesta, and subtracting from the aggregate the sum of the excretions from the kidneys and intestines. When the body gained weight, the amount of gain was subtracted from the sum of the ingesta, and the sum of the known egesta deducted as before. The result, in either case, was the loss from the skin and lungs.

The weight of the body was determined by a balance capable of turning with the hundredth of a pound, when loaded with 250 pounds.

In the analysis of the blood, I made use of Scherer's method, which embraces the determination of the *water*, *solids*, *albumen*, *extractive*, and *salts* of the *serum separately*, and the *water*, *solids*, *fibrin*, *blood-corpuscles*, *albumen*, *extractive*, *salts*, and *fat*, of the *blood as a whole*. Scherer's process, though not altogether free from ob-

jection, is pronounced by Professor Lehmann[1] to be the best we at present possess.

The microscope employed in these researches was a very fine one of Powell and Lealand's construction, with object glasses ranging from 1 to $\frac{1}{8}$ inch focal distance.

It is proper that I should state, that I am 28½ years of age, 6 feet 2 inches in height, and measure 38½ inches around the most prominent part of the chest. My weight during the last three years has ranged from 215 to 230 pounds. My habit of body is rather full, temperament sanguineo-nervous. I am of sedentary habits, rarely taking much physical exercise, unless with some specific object in view other than the exercise. I have never indulged freely in alcoholic liquors, and very seldom use them now; tobacco I do not use in any form. For the last three years my health has been excellent. For a year previous to this period, I was troubled with symptoms indicative of disease of the heart, but no organic affection could be discovered on thorough examination, and by care and change of air, I entirely recovered. At the time of commencing these experiments my health was never better.

In order to show the usual condition of my system, and of the several excretions, and thus to afford data on which to base a more correct estimate of the effects of the several articles of food experimented with than could otherwise be formed, I instituted upon myself a preliminary series of investigations, the details of which are here stated.

During this prefatory series of researches, I ate such articles of food as my appetite called for. It was, as I found by experience, almost impossible to measure the quantities of the different alimentary substances ingested, when, as in this instance, no fixed rule of diet was adopted. The liquids, however, were susceptible of easy approximate determination, and the quantities of these are accordingly stated.

The apportionment of the day, as regarded mental and physical exercise, recreation, sleep, &c., was the same as previously stated, and the conditions generally as arranged for the main subjects of inquiry were not materially altered.

In this, and in each of the succeeding series of experiments, all figures expressive of the quantities of the ingesta, egesta, and constituents of the latter, refer to Troy grains. The weight of the body is given in pounds and hundredths Avoirdupois.[1]

[1] Physiological Chemistry, vol. i. p. 593 (Am. ed.).

This series continued five days. As the total weight of the daily ingesta was not determined, no measurement of the loss from the skin and lungs could be made in these investigations.

FIRST DAY.

INGESTA.

Breakfast; hot bread and butter, and beefsteaks. *Luncheon;* cold beef, and bread and butter. *Dinner;* beef soup, roast beef, potatoes, maccaroni, and custard. During the day drank 4420 grains coffee, and 17250 water.

EGESTA.

Kidneys.

Whole quantity of urine 20258.68.

Water	19185.48	
Solids	1073.20	
Urea		628.85
Uric acid		13.27
Chlorine		124.50
Sulphuric acid		45.86
Phosphoric acid		60.13
Residue		210.59

Intestines.

Whole quantity of feces 2310.47.

Water	1702.37	
Solids	608.10	
Ether extract		75.94
Alcohol extract		111.38
Water extract		128.32
Insoluble residue		292.36

My pulse was at 7 A. M. 85 per minute, at 2 P. M. 88, and at 10 P. M. 80.—Mean 84.33.

The temperature of the body at the same hours was respectively 97.5°, 98°, and 98°.—Mean 97.83°.

At 3 P. M. 1525.73 grains of blood were drawn from the median

[1] The pound, Avoirdupois, is equivalent to 7000 grains Troy. The hundredth is consequently 70 grains Troy.

basilic vein. This, upon analysis, was found to be constituted as follows:—

1000 parts of serum—		1000 parts of blood—	
Water	908.42	Water	780.29
Solids	91.58	Solids	219.71
Albumen	76.18	Fibrin	2.41
Extractive	4.27	Blood corpuscles	143.19
Soluble salts	10.22	Albumen	65.43
	90.67	Extractive	4.02
Difference	.91	Soluble salts	9.11
			224.16
		Difference	4.35

In 1000 parts of serum were contained 11.92 of inorganic salts.

The whole quantity of inorganic salts in 1000 parts of blood was 11.68. In 1000 parts defibrinated blood were 2.24 fat.

The weight of the body at the end of the twenty-four hours was 226.45 pounds. The mean height of the barometer was 29.211 inches, and of the thermometer 43°.

SECOND DAY.

INGESTA.

Breakfast; buckwheat cakes and butter, broiled ham, boiled eggs. *Luncheon;* cold ham and bread and butter. *Dinner;* beef soup, roast beef, potatoes and beets. Drank 5000 grains of coffee, and 18200 water.

EGESTA.

Kidneys.

Whole quantity of urine 22756.37.

Water	21488.15	
Solids	1286.22	
Urea		790.11
Uric acid		10.58
Chlorine		151.28
Sulphuric acid		50.72
Phosphoric acid		66.13
Residue		199.40

Intestines.

Whole quantity of feces 2445.69.

Water	1681.68	
Solids	764.01	
Ether extract		142.40
Alcohol extract		125.18
Water extract		202.41
Insoluble residue		294.02

At 7 A.M. my pulse was 82, at 2 P.M. 90, and at 10 P.M. 83.—Mean 85.

At the same periods, the temperature of the body was respectively 98°, 98.5°, and 98.5°.—Mean 98.33°.

At the end of the twenty-four hours my weight was 226.52 pounds; showing an increase of .07 pound, or 490 grains.

The mean height of the barometer was 29.341 inches, of the thermometer 46°.

The quantity of food ingested on this day was somewhat greater than usual. Towards evening I had slight headache, which, however, disappeared before bedtime; slept well.

THIRD DAY.

INGESTA.

Breakfast; hot bread and butter, and beefsteak. *Luncheon;* cold ham, and bread and butter. *Dinner;* beef soup, roast chicken, potatoes and cabbage, rice pudding, with wine sauce. Drank in the twenty-four hours 4250 grains of coffee, and 23500 water.

EGESTA.

Kidneys.

Whole quantity of urine 21250.17.

Water	20224.47	
Solids	1025.70	
Urea		620.50
Uric acid		11.57
Chlorine		142.19
Sulphuric acid		35.71
Phosphoric acid		47.31
Residue		168.42

Intestines.

Whole quantity of feces 2041.76.

Water	1537.63	
Solids	504.13	
Ether extract		89.14
Alcohol extract		95.17
Water extract		112.35
Insoluble residue		207.47

The pulse at 7 A. M. was 81, at 2 P. M. 86, and at 10 P. M. 84.—Mean 83.66.

The temperature of the body at the corresponding hours was respectively 98°, 98.5°, and 97.5°.—Mean 98°.

At the end of the day the weight of the body was 226.42 pounds; a loss from the previous day of .10 pound, equivalent to 700 grains.

The mean height of the barometer was 29.241 inches, and of the thermometer 41°.

FOURTH DAY.

INGESTA.

Breakfast; hot bread and butter, and beef hash, highly seasoned. *Luncheon;* cold beef tongue, and bread and butter. *Dinner;* stewed beef, potatoes, maccaroni, and blanc-mange; ate also a supper at 10 P. M. of oysters (preserved in hermetically sealed cans), and bread and butter. Drank in the twenty-four hours 5000 grains of coffee, and 21500 water.

EGESTA.

Kidneys.

Whole quantity of urine 20523.45.

Water	19388.27	
Solids	1134.18	
Urea		710.62
Uric acid		10.91
Chlorine		131.46
Sulphuric acid		44.32
Phosphoric acid		53.87
Residue		183.00

Intestines.

Whole quantity of feces 2204.11.

Water	1472.89	
Solids	731.22	
Ether extract		60.39
Alcohol extract		67.48
Water extract		106.17
Insoluble residue		497.18

At 7 A. M. my pulse was 81, at 2 P. M. 84, and at 10 P. M. 82.—Mean 82.33.

At the same hours the temperature of the body was respectively 97°, 97.5°, and 98°.—Mean 97.50°.

The weight of the body at the end of the twenty-four hours was 226.50 pounds; an increase of .08 pound, equivalent to 560 grains.

The height of the barometer was 28.965 inches, and of the thermometer 40°.

FIFTH DAY.

INGESTA.

Breakfast; hot buckwheat cakes and butter, and beefsteak. *Luncheon;* cold ham, and bread and butter. *Dinner;* beef soup, roast venison, potatoes, cabbage, and maccaroni, preserved citron-melon, and milk. During the day drank 4800 grains of coffee, and 20200 water.

EGESTA.

Kidneys.

Whole quantity of urine 19634.92.

Water	18698.29	
Solids	986.63	
Urea		521.75
Uric acid		12.02
Chlorine		141.26
Sulphuric acid		49.30
Phosphoric acid		51.84
Residue		210.46

Intestines.

Whole quantity of feces 2467.58.

Water	1975.41	
Solids	492.17	
Ether extract		85.14
Alcohol extract		83.60
Water extract		98.52
Insoluble residue		224.91

My pulse at 7 A. M. was 83, at 2 P. M. 88, and at 10 P. M. 85.—Mean 85.33.

The temperature of the body at the same periods was respectively 98°, 98.5°, and 97.5°.—Mean 98°.

At 3 P. M. I abstracted 1293.25 grains of blood from the median

basilic vein, which, upon analysis, was found to possess the following constitution:—

1000 parts of serum—		1000 parts of blood—	
Water	909.57	Water	782.46
Solids	90.43	Solids	217.54
Albumen	72.21	Fibrin	2.36
Extractive	5.32	Blood-corpuscles	141.25
Soluble salts	12.14	Albumen	62.10
	89.67	Extractive	4.25
Difference	.76	Soluble salts	11.40
			221.36
		Difference	3.82

The total amount of inorganic salts in 1000 parts of serum was 14.39

The total amount of inorganic salts in 1000 parts of blood was 13.75. In 1000 parts of defibrinated blood were 2.78 of fat.

The weight of the body at the close of the twenty-four hours was 226.41 pounds; a loss of .09 pound, or 630 grains.

The mean height of the barometer was 29.042 inches, and of the thermometer 45°.

The following table exhibits the foregoing results in a collected form.

TABLE I.

EGESTA.	1st day.	2d day.	3d day.	4th day.	5th day.	Total.	Mean.
Kidneys—							
Urine	20258.68	22754.37	21250.17	20523.45	19684.92	104493.59	20898.71
Water	19185.48	21485.15	20224.47	19388.27	18698.29	99005.66	19801.13
Solids	1073.20	1268.22	1025.17	1134.18	986.63	5487.93	1097.58
Urea	628.85	790.11	620.50	710.62	521.75	3471.83	694.36
Uric acid	13.27	10.53	11.37	10.91	12.62	58.35	11.67
Chlorine	124.50	151.28	142.19	131.46	141.26	690.69	138 13
Sulphuric acid	45.86	50.72	35.71	44.32	49.30	225.91	45.18
Phosphoric acid	60.13	66.13	47.31	53.87	51.84	229.28	55.85
Residue	210.59	199.40	168.42	183.60	210.46	971.87	194.37
Intestines—							
Feces	2310.47	2445.69	2041.76	2204.11	2467.58	11469 61	2293.92
Water	1702.37	1681.68	1537.63	1473.89	1975.41	8369.98	1673.99
Solids	608.10	764.01	504.13	731.22	492.17	3099.63	619.92
Ether extract	75.94	142.46	89.14	60.39	85.14	453.01	90.60
Alcohol extract	111.38	125.18	95.17	67.48	83.60	482.81	95.56
Water extract	128.32	202.41	112.25	106.17	98.52	647.77	129.55
Insoluble residue	292.36	294.02	207.47	497.18	224.91	1575.94	303.18
Weight of body	226.45	226.52	226.42	226.50	226.41	...	226.46
Pulse	84.33	85.66	83.66	82.83	85.33	...	84.23
Temperature of body	97.83°	98.33°	98°	97.50°	97.50°	...	97.83°
Barometer	...	...	...	...	...	...	...
Thermometer	...	...	...	...	...	...	...

I now proceed to consider the main subjects of investigation, regretting, however, that they are not treated in a more complete manner, but indulging the hope, that the time and labor I have bestowed upon them may not prove altogether without profit to physiological science, and that others more learned and with greater facilities at their command, will labor to dispel the darkness which yet obscures so many of the vital processes.

EXPERIMENTAL RESEARCHES.

I.

ALBUMEN.

It is an established fact in physiology, that nitrogen is essential to the formation of all the organized tissues of the body. The experiments of Regnault and Reiset[1] have definitely determined, what had previously been arrived at by Boussingault[2] in another way, that this substance is not absorbed into the system from the atmosphere by respiration, but that there is actually, on the contrary, a loss of nitrogen to the organism from the lungs. It must, therefore, be entirely derived from the alimentary substances ingested into the stomach.

It results, therefore, that food, to be fully available for the requirements of life, must contain nitrogen in its composition, and it was, until recently, contended by many physiologists, that the nutritive value of aliments was to be directly measured by the proportion of this element entering into their constitution. It is now, however, generally admitted, that in order to conduce to the nutrition of the tissues, the nitrogen must be introduced in the form of protein.

The proteinaceous compounds ordinarily met with in the food of man, are albumen, fibrin, casein, vitellin, gluten, and legumin. The first four of these are found in animal, the latter two in vegetable food. Both the organic kingdoms of nature thus unite in providing substances containing protein, and, accordingly, whether we consider the purely carnivorous or herbivorous animal, we find

[1] Researches chimiques sur la respiration. Paris, 1849.

[2] Mémoires de chimie agricole et de physiologie. Paris, 1854, pp. 1–47. First published in Ann. de Chim. et de Phys.

that each is furnished with aliment containing a sufficiency of nitrogen to serve all the purposes of its organism.

Though the protein aliments are of such great value as organoplastic materials, it would appear, judging from experiments upon the inferior animals, that life cannot be sustained for any considerable period upon either of them alone. Tiedemann and Gmelin found it impossible to support life in geese which they fed upon pure white of egg, and the researches of other physiologists have yielded similar results. The main difficulty appears to have been, the inability of the digestive organs of the animals submitted to experiment, to assimilate a sufficient quantity of a protein compound to afford enough carbon to compensate for the loss of this substance from the lungs. Thus, Boussingault[1] fed ducks exclusively upon albumen, casein, and fibrin, and invariably found this to be the case. Too much importance, however, should not be attached to experiments of this nature. Various temporary causes affecting the solubility of the food may have existed, and great care should be exercised, before deducing inferences, and applying them to man, from investigations instituted on the lower animals. The theory (based as it is, solely in experiments upon animals far lower in the scale of creation than man), that the digestive fluids can only dissolve a limited amount of an albuminate in a given time, and that this quantity is insufficient for the demands of the system, is far from established, and has been in a great measure disproved by the recent observations of Jones.[2]

Though differing in physical characteristics, the proteinaceous substances are probably identical in chemical constitution. Albumen, the most important of them, may be regarded as the representative of the class. It is one of the chief organic constituents of the chyle and blood, from which all the tissues are elaborated, and no doubt exists that, by some means or other, the remaining members of the group, when taken into the stomach, undergo conversion into it. I have, therefore, selected it for experiment in preference to either of the others.

The investigations into the value of albumen as an article of food, and its effects upon the system, continued ten days. During this period, no other solid food was taken into the stomach, and no liquid but water. The albumen used was obtained from the serum

[1] Op. cit., p. 233, et seq.

[2] Digestion of Albumen and Flesh, &c.—*Medical Examiner*, 1856, p. 257.

of bullock's blood, by boiling it, and was consequently ingested in the coagulated form. This was the only source at my command for obtaining albumen in any quantity. It was well washed, to remove, as far as possible, all extraneous matters, and was then subjected to a temperature of 220° F., in a chloride of calcium bath, to expel all moisture. The water drank was either distilled or obtained by melting snow. The water of this region, from the springs and streams, contains so large a proportion of salts, that, had it been used, it would have interfered materially with the results. The distilled water was always well agitated with atmospheric air before being drunk. The other conditions under which the investigations were conducted, have been fully stated in the Introduction, and need not, therefore, be dwelt upon here. I omitted, however, to state, that the feces were usually evacuated immediately after rising in the morning. All deviations from this rule are specially mentioned.

At the termination of the twenty-four hours, immediately preceding the commencement of the experiments, my weight was 226.51 pounds.

FIRST DAY.

INGESTA.

8 A.M.	Albumen	2980	Water	7528
1 P.M.	"	2562	"	6350
5 "	"	3187	"	9580
Total	"	8729	"	23458

EGESTA.

Kidneys.

Whole quantity of urine 16520.36.

Water	15363.07	
Solids	1157.29	
Urea		812.16
Uric acid		21.39
Chlorine		30.54
Sulphuric acid		28.65
Phosphoric acid		36.17
Residue		238.38

Intestines.

Whole quantity of feces 1251.70.

Water	943.41
Solids	308.29

Ether extract	26.25
Alcohol extract	89.74
Water extract	125.18
Insoluble residue	67.23

Skin and Lungs.

Total loss through these channels 15059.14.

The pulse at 7 A.M. was 82, at 2 P.M. 84, and at 10 P.M. 86.—Mean 84.

The temperature of the body at the corresponding hours was respectively 96.5°, 97°, and 98.5°.—Mean 97.33°.

At 3 P.M. I abstracted 1525.80 grains of blood from the median basilic vein, which, upon analysis, was found to possess the following composition:—

1000 parts of serum—

Water	906.28
Solids	93.72
Albumen	78.21
Extractive	6.03
Soluble salts	8.34
	92.68
Difference	1.04

The whole quantity of inorganic salts in 1000 parts of serum was 10.29.

1000 parts of blood—

Water	776.45
Solids	223.55
Fibrin	2.65
Blood corpuscles	142.09
Albumen	67.00
Extractive	5.11
Insoluble salts	6.37
	223.22
Difference	.33

The whole quantity of inorganic salts in 1000 parts of blood was 7.93. In 1000 parts of defibrinated blood were 2.39 of fat.

The weight of the body at the close of the twenty-four hours was 226.20 pounds; a loss, therefore, of .31 pound, equivalent to 2170 grains, of which 1525.80 are accounted for by the blood drawn for analysis leaving 644.20 grains as the actual loss from the excretions.

The mean height of the barometer was 29.277 inches, and of the thermometer 45° F.

My appetite on this day was as good as usual. The food was sufficient to satisfy it, and was by no means unpleasant to the taste. I had no disagreeable symptoms of any kind. Sleep was sound and refreshing, and the intellectual faculties clear.

SECOND DAY.

INGESTA.

8 A.M.	Albumen	. . . 3250	Water	. . .	8050
1 P.M.	"	. . . 2428	"	. . .	7525
5 "	"	. . . 2975	"	. . .	9200
Total	"	. . . 8653	"	. . .	24775

EGESTA.

Kidneys.

Whole quantity of urine 16937.62.

Water	15687.44	
Solids	1250.18	
Urea		922.39
Uric acid		22.47
Chlorine		21.54
Sulphuric acid		23.65
Phosphoric acid		34.17
Residue		225.96

Intestines.

Whole quantity of feces 1353.69.

Water	1070.94	
Solids	282.75	
Ether extract		18.20
Alcohol extract		75.32
Water extract		124.10
Insoluble residue		71.13

Skin and Lungs.

Total loss through these channels 15556.69.

The pulse at 7 A. M. was 84, at 2 P. M. 87, and at 10 P. M. 88.—Mean 86.33.

The temperature of the body at the same hours was respectively 98°, 98.5°, and 97.5°.—Mean 98°.

My weight at the end of the twenty-four hours was 226.14 pounds; being a loss from the previous day of .06 pound, or 420 grains.

The mean heights of the barometer and thermometer were respectively 29.098 inches, and 42.50°.

I had no unusual feelings of any kind on this day; slept well.

The feces were of a very dark brown color, and of neutral reac-

tion. Crystals of ammonio-magnesian phosphate, epithelial cells, and oil and mucus globules, visible with the microscope.

THIRD DAY.

INGESTA.

8 A.M.	Albumen	. . . 3760	Water	. . .	8325
1 P.M.	"	. . . 3000	"	. . .	8490
5 "	"	. . . 4525	"	. . .	8420
Total	"	. . 11285	"	. .	25235

EGESTA.

Kidneys.

Whole quantity of urine 18428.60.

Water	17039.02	
Solids	1389.58	
Urea		1162.39
Uric acid		28.92
Chlorine		10.45
Sulphuric acid		29.18
Phosphoric acid		48.21
Residue		110.42

Intestines.

Whole quantity of feces 1628.17.

Water	1273.91	
Solids	354.26	
Ether extract		12.40
Alcohol extract		69.27
Water extract		99.68
Insoluble residue		172.91

Skin and Lungs.

Total loss from these channels 15903.23.

My pulse was at 7 A. M. 86, at 2 P. M. 88, and at 10 P. M. 89.—Mean 87.66.

The temperature of the body at the same periods was respectively 98°, 97.5°, and 98.5°.—Mean 98°.

At the termination of the twenty-four hours my weight was 226.22 pounds; a gain over the previous day of .08 pound, or 560 grains.

The mean height of the barometer was 29.245 inches, and of the thermometer 44°.

Two evacuations of the intestinal canal occurred on this day;

one at 9 P.M., the other at the regular hour. Both were in appearance, reaction, &c., similar to the discharge of the preceding day. In the evening I had slight pains in the lower part of the abdomen, and quite severe headache. Both disappeared after the first passage from the bowels. My sleep was unquiet in the early part of the night, and I awoke in the morning with headache.

In increasing so materially the quantity of albumen ingested on this day, my main object was to test more completely the power of the digestive organs. It is seen that they were fully capable of dissolving it, and that through its assimilation, enough carbon was absorbed to supply the wants of the system. This is evidenced by the increase in the weight of the body and the augmentation in the quantity of matter eliminated through the skin and lungs.

FOURTH DAY.

INGESTA.

8 A.M.	Albumen	4200		Water	8560
1 P.M.	"	4650		"	9255
5 "	"	3875		"	6350
Total	"	12725		"	24165

EGESTA.

Kidneys.

Whole quantity of urine 17483.75.

Water	15954.25	
Solids	1429.50	
Urea		1251.32
Uric acid		27.40
Chlorine		5.37
Sulphuric acid		21.18
Phosphoric acid		22.29
Residue		101.94

Intestines.

Whole quantity of feces 1827.16.

Water	1389.73	
Solids	437.43	
Ether extract		10.36
Alcohol extract		80.29
Water extract		151.47
Insoluble residue		195.31

Skin and Lungs.

Total loss through these channels 16329.09.

At 7 A.M. my pulse was 86, at 2 P.M. 90, and at 10 P.M. 98.—Mean 91.33.

At the same hours the temperature of the body was respectively 98°, 99°, and 99.5°.—Mean 98.83.

At the end of the twenty-four hours my weight was 226.32 pounds; an increase of 0.10 pound, or 700 grains.

The mean heights of the barometer and thermometer were respectively 29.230 inches, and 47.66°.

I had severe headache the whole of this day, attended with some fever. The skin was hot and dry. My appetite was not good. After each time of ingesting the albumen there was a feeling of debility in the system, accompanied with a singular sinking sensation at the epigastrium. There was also nausea at several periods of the day. The pains in the lower part of the abdomen were very severe, especially about two hours after each meal.

The feces were similar in appearance to those of the previous day; the reaction was alkaline. Crystals of ammonio-magnesian phosphate in small quantity visible with the microscope.

The urine was of high color, and of strong acid reaction—a drop evaporated to dryness on a slip of glass and placed upon the stage of the microscope, exhibited numerous needle-shaped crystals of urea.

It is perceived from the record of these experiments, that the digestive organs were capable of dissolving the large amount of albumen ingested, and that it was fully sufficient for the support of the respiratory process, and to maintain the weight of the body. The constitutional disturbance induced, warned me, however, against a repetition of so large a quantity.

FIFTH DAY.

INGESTA.

8 A.M.	Albumen	1850		Water	8250
1 P.M.	"	2330		"	7380
5 "	"	2500		"	8650
Total	"	6680		"	24550

EGESTA.

Kidneys.

Whole quantity of urine 18738.50.

Water	17699.08
Solids	1039.42

Urea		721.26
Uric acid		18.40
Chlorine		5.01
Sulphuric acid		15.12
Phosphoric acid		17.25
Residue		262.38

Intestines.

Whole quantity of feces 1726.54.

Water	1379.30	
Solids	347.24	
Ether extract		17.29
Alcohol extract		167.52
Water extract		85.68
Insoluble residue		76.75

Skin and Lungs.

Total loss from these channels 13394.96.

At 7 A.M. my pulse was 90, at 2 P.M. 93, at 10 P.M. 104.—Mean 95.66.

At the same periods the temperature of the body was respectively 97°, 97°, and 97.5°.—Mean 97.16°.

At the end of the twenty-four hours my weight was 225.93 pounds; being a loss from the preceding day of .39 pound, equivalent to 2730 grains.

The mean height of the barometer was 29.207 inches, and of the thermometer 42.33°.

On this day I felt far from well. I had headache, and pains in the abdomen. The sinking sensation at the epigastrium was not so great as on the previous day.

Three evacuations of the bowels occurred; one at 10 A.M., one at 4 P.M., and one at 11 P.M. They were thinner, and of a darker color than previously. My physical strength was much less than usual. Appetite was not good. The sight of the albumen created disgust and nausea. Was quite restless in the night, and felt chilly towards morning. The mental faculties were not sensibly affected.

SIXTH DAY.

INGESTA.

8 A.M.	Albumen	2500	Water	7530
1 P.M.	"	1520	"	8200
5 "	"	2000	"	7550
Total	"	6020	"	23280

EGESTA.

Kidneys.

Whole quantity of urine 17530.24.

Water	16551.88	
Solids	978.36	
Urea		728.54
Uric acid		29.17
Chlorine		4.22
Sulphuric acid		12.18
Phosphoric acid		18.45
Residue		175.80

Intestines.

Whole quantity of feces 1852.15.

Water	1331.34	
Solids	520.31	
Ether extract		10.42
Alcohol extract		112.16
Water extract		136.58
Insoluble residue		261.15

Skin and Lungs.

Total loss through these channels 12927.61.

At 7 A.M. my pulse was 92, at 2 P.M. 93, and at 10 P.M. 93.—Mean 92.66.

At the same hours, the temperature of the body was respectively 96.5°, 97°, and 97.5°.—Mean 97°.

At the end of the twenty-four hours my weight was 225.50 pounds; being a loss of .43 pound, or 3010 grains.

The mean height of the barometer was 29.110 inches, and of the thermometer 42°.

I experienced on this day an increase of debility. The headache and pain in the abdomen of the preceding days were not present on this. I had very great desire for other food. The albumen was not at all relished, and it was with great effort I could bring myself to eat it. At night I slept quite well.

SEVENTH DAY.

INGESTA.

8 A.M.	Albumen	3250	Water		8000
1 P.M.	"	4000	"		8500
5 "	"	3550	"		7285
Total	"	10800	"		23785

EGESTA.

Kidneys.

Whole quantity of urine 16592.83.

Water	15911.08	
Solids	581.75	
Urea		390.60
Uric acid		11.28
Chlorine		3.61
Sulphuric acid		10.73
Phosphoric acid		13.17
Residue		152.36

Intestines.

Whole quantity of feces 3276.40.

Water	2122.60	
Solids	1153.80	
Ether extract		11.92
Alcohol extract		100.65
Water extract		75.10
Insoluble residue		955.13

Skin and Lungs.

Total loss from these channels 17476.77.

My pulse was at 7 A.M. 93, at 2 P.M. 94, and at 10 P.M. 95.—Mean 94.

At the same hours the temperature of the body was respectively 97.5°, 97.5°, and 97°.—Mean 97.33°.

At the termination of the twenty-four hours my weight was 225.10 pounds; a loss, therefore, of .40 pound, equivalent to 2800 grains.

The mean height of the barometer was 29.106 inches, and of the thermometer 35.33°.

I felt weaker on this day than on any previous one of the investigations. Otherwise, I experienced no very disagreeable sensations. My skin was moist and cool during the whole day. Mental faculties active and clear.

There were two evacuations from the bowels, one at 7 P.M., the other at the usual hour. Both were of firm consistence, of the same dark-brown color, and free from strong odor. On heating a small quantity of the urine in a test tube (as had been done each day of the investigations), a precipitate, insoluble in nitric acid, ensued. This was therefore albumen.

EIGHTH DAY.

INGESTA.

8 A.M.	Albumen	2980	Water		7900
1 P.M.	"	1855	"		8280
5 "	"	3740	"		9525
Total	"	7575	"		25705

EGESTA.

Kidneys.

Whole quantity of urine 21235.18.

Water	20407.96	
Solids	827.22	
Urea		492.20
Uric acid		18.49
Chlorine		3.35
Sulphuric acid		11.24
Phosphoric acid		11.08
Residue		290.86

Intestines.

Whole quantity of feces 3684.02.

Water	2373.10	
Solids	1310.92	
Ether extract		8.01
Alcohol extract		105.27
Water extract		122.53
Insoluble residue		1075.11

Skin and Lungs.

Total loss from these channels 12770.80.

At 7 A.M. my pulse was 92, at 2 P.M. 91, and at 10 P.M. 89.—Mean 90.66.

The temperature of the body at the same hours was respectively 97°, 96.5°, and 96°.—Mean 96.50°.

My weight at the end of the twenty-four hours was 224.47 pounds; being a decrease of .63 pound, equivalent to 4410 grains.

The mean heights of the barometer and thermometer were respectively 29.289 inches, and 35.33°.

With the exception of the debility, I felt tolerably well on this day. I did not, however, read or study any, and took no physical exercise beyond walking a few steps.

Two operations of the bowels occurred, one at 6 P.M., and the other at the usual hour. The feces were quite hard and similar in color and odor to those of the preceding days.

Albumen was precipitated from the urine by heat. The quantity was considerable.

NINTH DAY.

INGESTA.

8 A.M.	Albumen	2150		Water	5250
1 P.M.	"	2200		"	5690
5 "	"	1800		"	6000
Total	"	6150		"	16940

EGESTA.

Kidneys.

Whole quantity of urine 12325.10.

Water	11674.86	
Solids	650.24	
Urea		329.75
Uric acid		14.81
Chlorine		2.39
Sulphuric acid		8.96
Phosphoric acid		10.53
Residue		283.80

Intestines.

Whole quantity of feces 8726.50.

Water	8106.35	
Solids	620.15	
Ether extract		11.24
Alcohol extract		162.95
Water extract		50.17
Insoluble residue		395.79

Skin and Lungs.

Total loss from these sources 10018.40.

My pulse at 7 A.M. was 96, at 2 P.M. 98, and at 10 P.M. 104.—Mean 99.33.

At the same hours, the temperature of the body was respectively 96°, 96.5°, and 97°.—Mean 96.50°.

The weight of the body at the close of the twenty-four hours was 223.33 pounds; a loss of 1.14 pound, or 7980 grains.

The mean height of the barometer for the day was 29.235 inches, and of the thermometer 24.33°.

A serious diarrhœa of considerable violence commenced on this day. I had six evacuations of the intestines. The discharges were very thin, of a dark-brown color, and faint odor. The debility was much increased. There was dryness of the skin, and the urine was of high color. An increased amount of albumen was present in this latter excretion. My appetite was not good, neither was there much thirst. Mind clear, sleep very unquiet.

TENTH DAY.

INGESTA.

8 A.M.	Albumen	1785		Water	9620
1 P.M.	"	1530		"	8900
5 "	"	1500		"	9050
10 "	"	——		"	6525
Total	"	4815		"	34095

EGESTA.

Kidneys.

Whole quantity of urine 21592.87.

Water	20907.63	
Solids	685.24	
Urea		340.29
Uric acid		15.31
Chlorine		2.12
Sulphuric acid		8.36
Phosphoric acid		9.15
Residue		310.01

Intestines.

Whole quantity of feces 10257.30.

Water	9692.90	
Solids	565.10	

Ether extract	10.46
Alcohol extract . . .	182.63
Water extract	530.5
Insoluble residue . . .	318.96

Skin and Lungs.

Total loss through these sources 15319.83.

At 7 A.M. my pulse was 94, at 2 P.M. 98, and at 10 P.M. 98.—Mean 96.66.

The temperature of the body at the same hours was respectively 96.5°, 97.5°, and 98°.—Mean 97.33°.

At 3 P.M. I abstracted 1330 grains of blood from the median basilic vein. An analysis yielded the following results:—

1000 parts of serum—		1000 parts of blood—	
Water	900.09	Water	773.43
Solids	99.91	Solids	226.55
Albumen . . .	83.21	Fibrin	3.18
Extractive . . .	12.57	Blood-corpuscles .	137.10
Soluble salts . .	3.12	Albumen . . .	71.50
	98.88	Extractive . . .	11.29
Difference . . .	1.03	Soluble salts . . .	2.14
			225.21
		Difference . . .	1.34

The whole quantity of inorganic salts in 1000 parts of serum was 4.38.

The whole quantity of inorganic salts in 1000 parts of blood was 3.90. 1000 parts of defibrinated blood contained .74 of fat.

My weight at the termination of the twenty-four hours was 221.96 pounds; being a loss from the preceding day of 1.37 pound, or 9590 grains. Of this amount 1330 are accounted for by the blood abstracted for analysis, leaving 8260 as the loss by the excretions.

The mean height of the barometer was 28.593 inches, of the thermometer 45.66°.

The diarrhœa continued on this day with increased violence. I had eight evacuations of the same character as on the previous day. There was very little mucus contained in them, and no blood. A microscopical examination revealed the presence of cylindrical and scaly epithelium in considerable quantity.

The debility on this day was extreme, and I was obliged to lie down the greater portion of it. The intellectual faculties were somewhat confused. My sleep was restless.

The urine contained a large amount of albumen.

The investigations into the value and effects of albumen were now concluded. In a few days, under a proper diet, I began to recover my usual health. The diarrhœa ceased spontaneously on the third day. The albumen disappeared from the urine the second day after the termination of the experiments.

The results of the foregoing researches are contained in the accompanying consolidated table.

TABLE II.

	1st day.	2d day.	3d day.	4th day.	5th day.	6th day.	7th day.	8th day.	9th day.	10th day.	Total.	Mean.
Desserts.												
Albumen . . .	8729	8153	11264	12725	6986	6959	10909	7373	6110	6315	67322	6732.20
Water . . .	21218	27571	25315	21113	24313	24313	23753	19753	19753	24313	231425	23142.50
Total . . .	29947	35124	36579	33838	31299	29300	34662	27126	25863	30628	298747	29874.70
Excreta.												
Kidneys—												
Whole quantity of urine .	14239.36	16367.62	18428.60	17463.73	18758.50	17230.24	16502.53	21235.18	12222.10	21202.87	177396.03	17739.50
Water . . .	13263.07	15087.44	17039.02	16034.93	17099.08	16031.88	15211.08	20107.93	11674.80	20067.03	167704.27	16910.02
Solids . . .	1127.29	1256.18	1389.58	1428.80	1659.42	1198.36	1291.45	1127.25	547.30	1135.84	12155.57	1215.57
Urea . . .	1127.29	1256.18	1389.58	1428.80	1659.42	1198.36	1291.45	1127.25	547.30	1135.84	12155.57	1215.57
Uric acid . . .	21.39	23.85	26.37	27.12	31.49	22.74	24.51	21.39	10.39	21.55	230.70	23.07
Chlorine . . .	30.34	33.84	37.40	5.87	4.22	3.61	3.15	2.39	2.12	1.93	124.87	12.48
Phosphoric acid . .	26.17	29.15	32.19	15.16	17.25	15.15	13.17	11.94	9.15	9.13	167.26	16.72
Residue . . .	28.57	31.84	35.19	48.21	22.29	18.15	17.23	11.94	10.32	9.13	230.47	23.04
	255.96	285.11	315.15	110.42	102.74	273.02	252.36	240.86	219.01	216.91	2151.91	215.19
Intestines—												
Whole quantity of feces .	1231.70	1373.60	1528.17	1327.16	1736.54	1832.15	3776.40	2084.03	8726.50	10277.30	33883.05	3388.30
Water . . .	1107.51	1270.54	1412.65	1227.11	1606.31	1695.14	3493.17	1928.23	8070.51	9506.53	31337.70	3133.77
Solids . . .	238.59	267.73	314.26	437.43	317.21	420.31	1123.69	1310.92	656.15	2600.25	6600.02	660.02
Ether extract . .	28.57	18.20	12.40	10.36	17.29	10.42	11.92	5.91	10.46	146.53	145.85	14.58
Alcohol extract . .	130.14	145.93	162.53	181.47	183.66	136.58	75.10	122.58	50.17	43.93	1031.04	103.10
Water extract . .	67.23	71.13	72.91	193.31	76.72	271.15	933.13	1075.11	316.96	2139.47	5216.51	521.65
Insoluble residue .												
Skin and Lungs—	1030.14	1536.69	1903.25	1628.69	1339.96	1227.61	1747.77	1279.89	1016.49	1339.83	14750.32	1475.03
Total loss from . .												
Total ejecta . . .	33531.20	37348.80	39980.00	36198.99	33980.00	32310.00	37585.00	37080.00	31070.00	47370.00	358414.30	35841.43
Variation in weight . .	—414.20	—420.80	+566.00	+798.00	—2730.00	—3010.00	—2800.00	—4105.00	—7980.00	—8960.00	..	—28046.20
Pulse . . .	84	87.66	84	91.33	93.66	95.66	94.66	96.66	90.33	96.66	..	91.83
Temperature of body .	97.25°	98°	98.33°	98.33°	97.16°	97°	97.33°	96.50°	96.50°	97.33°	..	97.39°
Barometer . . .	29.277	29.593	29.243	29.397	29.397	29.110	29.169	29.293	29.233	29.393	..	29.139
Thermometer . . .	49°	47.50°	46°	47.66°	48.33°	48°	45.33	45.33°	44.33°	45.66°	..	46.41°

Upon a consideration of the results of the foregoing investigations, and comparing them as far as possible with those obtained whilst I was living on a normal and ordinary diet, it is seen that the following effects in the mean ensued :—

Kidneys.—The *whole quantity of urine* was lessened, as were also the absolute amounts of *water* and *solids*. Relatively, the solids were increased in quantity. The urine was, therefore, more concentrated.

The quantity of *urea* was increased, though not so much so in the mean as was to have been anticipated.

The amount of *uric acid* eliminated was very much increased.

The proportion of *chlorine* was greatly reduced.

The *sulphuric* and *phosphoric acids* were lessened in quantity.

The *residue* was increased in amount.

Intestines.—The *whole quantity of feces* was augmented. This result was entirely due to the diarrhœa of the 9th and 10th days. More than half of the whole amount of feces was passed on these days. Throwing them out of the calculation, and it is seen that the mean quantity of feces for the remaining eight days was less than the mean of the five days of the standard series.

The *water* of the feces was greatly increased. This was owing to the same cause as the augmentation of the whole quantity of feces.

The *solids* were reduced in amount.

The *ether extract* was much lessened. It is seen, however, that there was a considerable quantity, notwithstanding no fat was ingested.

The *alcohol extract* was rendered greater in amount.

The *water extract* was diminished in quantity.

The *insoluble residue* was increased.

Skin and Lungs.—No comparison of the losses from these channels during the two series of investigations can be made; as, in the first series, they were not determined. It is perceived, however, that the general effect of increasing the amount of albumen ingested, was to augment the proportion of loss from these sources.

The *weight of the body* is seen in the mean to have materially declined.

The *pulse* was increased in frequency.

The *temperature of the body* was slightly reduced.

The effects of an exclusively albuminous diet upon the consti-

tution of the *blood*, will be more clearly perceived from the following table of the first and tenth days' analysis:—

TABLE III.

1000 parts of serum—	1st day.	10th day.	1000 parts of blood—	1st day.	10th day.
Water	906.28	900.09	Water	776.45	773.43
Solids	93.72	99.91	Solids	223.55	226.55
Albumen	78.28	83.21	Fibrin	2.65	3.18
Extractive . . .	6.03	12.57	Blood-corpuscles .	142.09	137.10
Soluble salts . .	8.34	3.12	Albumen	67.00	71.50
			Extractive . . .	5.11	11.29
Whole quant. inorg. salts	10.29	4.38	Soluble salts . . .	6.37	2.14
			Whole quant. inorg. salts	7.93	3.90
			Fat in 1000 parts defibrinated blood	2.39	.74

From this table it is perceived, that under the diet of albumen, the *water*, *soluble* and *whole quantity* of *inorganic salts* of the *serum* were diminished, and the *solids*, *albumen*, and *extractive* increased in quantity. In the *whole blood* there was a diminution of the *water*, *blood-corpuscles*, *soluble* and *total amount* of *inorganic salts*, and *fat*, whilst there was an augmentation of the *solids*, *fibrin*, *albumen*, and *extractive*.

The main results of the foregoing investigations I propose to consider more at length under the following heads:—

1. The capability of the digestive organs to dissolve and the absorbents to assimilate, a sufficient quantity of albumen to support the calorifacient process.

2. The relation which the nitrogen of the urea and uric acid excreted, bears to the amount absorbed with the albumen.

In relation to the first head, physiologists are not disposed to accord a high value to albumen as an article of respiratory food. The elementary analysis of albumen shows that it does not contain all those substances which enter into the composition of the tissues of the body. It cannot, therefore, of itself, support life or health. and the functional derangements which attended its use during the foregoing investigations, abundantly establish this fact. I am very far, therefore, from claiming for it any such power. Nevertheless, I think it is fully proven, that before the general health becomes injured by a too long exclusive use of albumen, enough of this substance can be assimilated to repair the waste of the tissues, and support the respiratory function.

According to Liebig,[1] an adult man daily consumes $13\frac{5}{16}$ ounces (a little over 6000 grains) of carbon, which passes from the system by the lungs and skin as carbonic acid gas. Scharling[2] states, as the result of his researches, that a powerful adult man exhales from the lungs 867 grammes (about 13,438 grains) of carbonic acid daily. This quantity of carbonic acid is equivalent to 3664.90 grains of carbon. According to Andral and Gavarret,[3] a man twenty-six years of age exhales daily 4065 grains of carbon. Carpenter[4] is of the opinion that 3840 grains is the average daily amount of carbon given off through the lungs of a well-grown adult man.

From a series of researches instituted upon myself, with the object of ascertaining the effects of alcohol and tobacco upon the human system, I found that an average of 11674.98 grains of carbonic acid (equivalent to 3185.44 grains of carbon) were daily exhaled from the lungs. The method of determination was, however, imperfect, and the absolute amount was doubtless greater than is stated.

The preceding experiments with albumen show, that on the first and second days of the series, the body slightly decreased in weight, and that on the third and fourth days a small increase ensued. On these days, the quantity of albumen ingested was greater than on the first two days; and, that an increased amount was assimilated is evident from the comparatively small quantities of water extract and insoluble residue obtained from the feces. The fact that the bowels were regularly evacuated, shows that the increase of weight observed was not due to any obstruction of the intestinal canal, and consequent accumulation of matter in that channel. Besides the above facts, the great increase in the amount of urea eliminated by the kidneys on the days referred to, is also indicative of an augmented assimilation of albumen.

On the fifth day, the body commenced rapidly to lose weight. The effects of so exclusive a regimen began to act injuriously upon the system, while febrile excitement, and other symptoms indicative of derangement of the health, were present; and on the seventh day, notwithstanding a great increase in the quantity of albumen ingested, a loss of weight to the extent of 2800 grains occurred. Albumen appeared in the urine on this day, and of the

[1] Letters on Chemistry, p. 315, Lond. ed.
[2] Lehmann's Physiological Chemistry, vol. ii. p. 435, Amer. ed.
[3] Quoted in Carpenter's Physiology, p. 526.
[4] Physiology, p. 526.

amount taken into the stomach, over 1000 grains were recovered from the excrement. The loss from the skin and lungs was unusually great.

The following table, showing the amount of albumen daily absorbed into the system from the intestinal canal, and the quantity of carbon entering into its composition, will serve to place the subject in a more evident light. The proportion of assimilated albumen is found by deducting the collective amount of water extract and insoluble residue of the feces, from the total quantity of albumen ingested. In the estimation of the carbon contained therein, I have adopted the analysis of Dumas and Cahours,[1] of the albumen derived from the serum of beef's blood.

TABLE IV.

	1st day.	2d day.	3d day.	4th day.	5th day.	6th day.	7th day.	8th day.	9th day.	10th day.	Mean.
Absorbed albumen	8336.59	8455.77	13012.41	12318.22	6317.57	5622.27	9769.76	6377.36	3704.04	4442.98	7895.69
Absorbed carbon	4339.53	4515.37	5860.62	6577.92	3480.33	3092.23	5118.60	3406.51	2043.93	2372.53	4216.30

According to the above table, on only one day (the 4th), did the amount of absorbed carbon equal the wants of the system, if we accept Liebig's estimate of the quantity ordinarily given off by the skin and lungs. On the 3d day, the proportion of carbon entering the system did not fall much below Liebig's standard. On these two days only (as we have seen) did the body gain weight. On all the remaining days, except the 7th (and on this day it was nearly 900 grains less than Liebig's estimate calls for), the quantity of the absorbed carbon was much below the requirements of the organism, and in the mean, was 1800 grains less than the average amount excreted through the skin and lungs, as stated by Liebig.

Leaving, however, all deductions based upon the estimates of others, the broad fact appears, that on the 3d and 4th days of the foregoing researches, not only was enough albumen assimilated to compensate for the total loss from the excretions, but new matter was deposited in quite an appreciable amount. On the 3d day, too, the temperature of the body was fully up to the natural standard, and on the 4th, very materially exceeded it. Without entering further into the details of this point, I think the conclusion is fully supported, that the digestive organs can dissolve enough albumen

[1] Violette et Archambault, Dictionnaire des Analyses Chimiques, p. 62.

to supply the system with the necessary amount of carbon. If the albumen ingested during these experiments had been conjoined with such mineral substances, in such quantities as the blood and tissues require, in order that nutrition may be perfect, it would doubtless have been better borne by the system, and could have been taken in much larger quantities. Under such circumstances, no good reason can be given, why albumen should not have answered all the purposes of plastic formations, and at the same time, have sustained the heat producing function at the proper degree of action.

Whether the opinion of Bidder and Schmidt,[1] that the gastric juice is not secreted in sufficient quantity to dissolve and metamorphose the necessary amount of albumen for the above purposes, and that the intestinal juice[2] is equally as important an agent in effecting these changes, or whether the view of Frerichs and Lehmann,[3] who could discover no such power in the latter fluid, be correct, did not come within the range of these investigations to determine. Contrary, however, to Boussingault's[4] conclusions, based upon his experiments on ducks, and to the indorsement of his view by Lehmann,[5] I think the deduction drawn from the present researches is fully supported by the direct results obtained—at least, so far as regards man, whose physiology it is of the greatest importance thoroughly to understand.

2d. The relation which the nitrogen of the urea and uric acid excreted, bears to the amount absorbed with the albumen.

The relation which the nitrogen excreted by the kidneys has to that taken into the system with the food, is far from being definitely determined, notwithstanding the numerous experiments made with the object of settling the point.

Two views in regard to the origin of urea are held by those who have investigated the subject; one party, of which Lehmann, Frerichs, and Bidder and Schmidt, are specially to be mentioned, maintaining that it is derived both from the decomposition of the tissues of the body and from the oxidation of the albuminates taken as food, whilst the other, of which Liebig and Bischof are the heads, claiming that it is solely derived from the former source.

[1] Die Verdauungssaefte und der Stoffwechsel.—Vom Magensafte, p. 29.
[2] Op. cit.—Vom Darmsafte, p. 260.
[3] Physiological Chemistry, vol. i. p. 510.
[4] Mémoires de Chimie Agricole et de Physiologie, pp. 235, 236.
[5] Physiological Chemistry, vol. ii. p. 495 (Am. ed.).

Whether nitrogenous food is first converted into tissue before its elimination as urea, or whether it undergoes oxidation into this substance whilst still in the blood, it would seem impossible in the present state of our knowledge to decide. The foregoing investigations, whilst they cannot be considered as determining this point, afford some very striking results, and throw some additional light upon the subject.

The following table exhibits for each day of the series, the proportion of nitrogen in the absorbed albumen, the amount excreted with the urea and uric acid, and the ratio which the nitrogen contained in these substances bore to 100 parts of the quantity which was taken into the organism.

TABLE V.

	1st day.	2d day.	3d day.	4th day.	5th day.	6th day.	7th day.	8th day.	9th day.	10th day.	Mean.
Absorbed nitrogen	1340.24	1311.55	1728.94	1933.86	1023.23	882.69	1533.85	1001.24	955.53	897.54	1235.87
Excreted with urea	378.95	430.38	542.37	583.86	336.53	310.67	182.24	385.98	153.87	314.58	364.94
Excreted with uric acid	7.13	7.49	9.64	9.13	6.13	9.72	3.76	6.16	4.93	5.10	6.91
Total	386.08	437.87	552.01	592.99	342.66	320.39	186.00	392.14	158.80	319.68	371.85
Excreted for each 100 parts absorbed.	29.55	33.38	32.50	30.66	33.48	39.69	12.12	39.16	17.53	45.81	30.08

From the above table it is seen that the greatest proportional elimination of nitrogen, in the form of urea and uric acid, occurred on the 6th, 8th, and 10th days, and the smallest on the 7th and 9th. In the mean, 30.08 parts per hundred taken into the system, appeared again in the urine, as urea and uric acid.

This result, certainly varies greatly from those obtained by any other observer to whose investigations I have had the opportunity of referring. The experiments of Rigg[1] and of Barral,[2] gave results most nearly in accordance with my own, but there is still a wide difference. The former of these physiologists found that for every 100 parts of absorbed nitrogen, 50.8 were excreted in the urine; the latter, for 100 parts of nitrogen entering the system, found 42.07 in this excretion.

Other physiologists have arrived at results yet more at variance with mine. Lehmann[3] found, that whilst living on a purely animal

[1] Lehmann's Physiological Chemistry, vol. ii. p. 497, 498.
[2] Ibid. [3] Ibid.

diet, five-sixths of the nitrogen taken into the system was given off again by the kidneys. Bidder and Schmidt[1] found, that in a cat, which in 24 hours absorbed 8.604 grammes of nitrogen, 7.786 grammes appeared in the urine. Bischof[2] (among other examples) found, that of 54.09 grammes of nitrogen entering the system of a dog, 29.45 grammes were contained in the excreted urea. It is true, Boussingault[3] recovered from the urine but 37.8 grammes of nitrogen of 139.4 contained in the food of twenty-four hours of a horse, but the excess was in this instance, discharged as a constituent of the feces.

In the present experiments, but a small portion of nitrogen could have been discharged by the urine, as a constituent of other substances than urea or uric acid. The amount of residue, whose exact composition was undetermined, was never very large till towards the last, and although albumen was discovered in the urine after the sixth day, the quantity was not such as to make much difference in the proportions given in Table V. The amount of nitrogen eliminated by the feces was of course very small. (It is to be recollected in this connection, that in estimating the quantity of albumen entering the organism, the unassimilated residue found in the feces, is deducted from the gross amount ingested.)

69.92 grains of nitrogen in every 100 entering the circulation were excreted from the system under some other form than as urea or uric acid, or that proportion, formed new combinations, and was retained within the organism. It is difficult to perceive how this enormous amount could have been given off by the lungs and skin, especially as the most exact observations upon animals have determined the loss of nitrogen through these channels to be exceedingly small.

Frequently, during each day of the investigations, I held a glass rod previously dipped in hydrochloric acid, in the current of the expired air, and, though the white fumes of chloride of ammonium were sometimes produced, this was very seldom, and never in any considerable amount. The skin, during the experiments, had no ammoniacal odor, which would have been present if ammonia in any quantity had been given off.

In view of these facts, I cannot think that the excess of nitrogen escaped from the system as ammonia.

[1] Die Verdauungssaefte und der Stoffwechsel. Tab. v. s. 306.
[2] Der Harnstoff als Maas des Stoffwechsels, s. 65.
[3] Mémoires de Chimie Agricole et de Physiologie, p. 15, et seq.

The only conclusion remaining is, that the greater part of the absorbed nitrogen continued in the organism either as albumen or under the form of other combinations. The decrease of weight in the body, which occurred on every day but the third and fourth, was doubtless mainly owing to the oxidation of a portion of the fat, and is not incompatible with the formation of new matter of an entirely different character.

On a reference to Table II., it is seen that the nitrogenous matters of the blood (fibrin, albumen, and extractive) were very materially augmented in quantity, and that the fat was greatly diminished. These facts constitute a strong additional argument in favor of the supposition advanced above, and tend to support the view of Bischof,[1] that the albuminates of the blood must pass through other processes before they can, merely by the action of oxygen, undergo metamorphosis into urea.

In view of these circumstances, I am disposed to conclude:

1st. That the proportion of nitrogen eliminated by the kidneys to that absorbed into the circulation is, in man, much less than is generally supposed.

2d. That even when the body is losing weight from the oxidation of its fat, the excess of nitrogen over that escaping by the kidneys is retained in the system, both in its original form, and under that of other combinations.

One of the most important results of the foregoing experiments was the discovery of the presence of albumen in the urine. This it is seen was not made until the seventh day, from which time, this substance was not absent during the researches; and subsequent observations showed, that it was a constituent of the excretions for four days after the conclusion of the series.

The fact that albumen is found in the urine has been before noticed in other connections than as associated with granular degeneration of the kidneys. Professor Walshe[2] is of opinion, that it may occur from other diseases, and from the use of certain articles of food. Begbie[3] states, that it may be present in the urine of perfectly healthy persons, in certain conditions of the system (as pregnancy) in certain acute and inflammatory diseases, after eating particular kinds of food (as pastry) after certain remedies (as juniper), and after the application of blisters. Bernard[1] mentions the case of a man, who, after eating a large number of raw eggs after fasting, had albumen present in his urine. Bernard, however, is of opinion, that it is only under such conditions, viz., an empty state of the digestive organs, and the sudden ingestion of a large quantity of albuminous food, that such an event can ensue, and Rees[2] denies entirely, that this substance is ever found in the urine as the result of an albuminous diet.

[1] Der Harnstoff als Maass des Stoffwechsels, s. 141.

[2] London Lancet, 1849, p. 416.

[3] British and Foreign Medico-Chirurg. Review, July, 1853, p. 46.

The present researches show, that albuminuria is produced by the continued use of highly albuminous food in large quantities, and that it was not (so to speak) until the system was saturated with albumen, that it made its appearance in the urine.

Without stopping to discuss the other points of these experiments, I proceed to detail the results of the second series, with starch.

II.

STARCH.

The amylaceous substances were, until recently, regarded as being peculiar to vegetable bodies, and the fact of a being presenting distinct evidences of containing them, was sufficient to deny it all claim to an animal existence. This distinctive test, however, can no longer be relied upon. C. Schmidt first showed that cellulose (a substance isomeric with starch) existed as a constituent of the mantle of certain of the tunicata. Gottlieb discovered paramylon (also isomeric with starch) in the body of the infusorium (?) *Euglena viridis*, and other observers, among whom Kölliker, Loewig, Schacht, and Huxley,[3] are to be mentioned, have fully demonstrated the truth of Schmidt's discovery.

Within a short period, Virchow[4] has carried the investigation still further, and has shown that the corpora amylacea of the human

[1] Leçons de Physiologie expérimentale. Cours de semestre d'hivers, 1854—1855.

[2] London Medical Gazette, vol. xiii. 1851, p. 49.

[3] For translations of Schacht's and Virchow's papers, and Huxley's original article, see Quarterly Journal of Microscopical Science, Nos. 1, 2, 6, 12, and 14.

[4] Ibid.

brain are composed of cellulose, and that this substance is also met with in other parts of the body as the result of a certain diseased condition, which he designates as amyloid degeneration.

Busk,[1] however, who has examined this subject very attentively, is of the opinion that the corpuscles in the brain, designated as cellulose by Virchow, are, in fact, starch, "possessing all the structural, chemical, and optical characters of this substance, as it occurs in plants." It may therefore be assumed as a physiological truth, that amylaceous substances are not peculiar to vegetables, but are also constituents of the bodies of man, and other animals.

From the fact that starch contains no nitrogen in its composition, it cannot contribute to the nutrition of the tissues. Its value, therefore, is generally regarded as resting solely on its heat producing power. In this respect, its easy digestibility renders it superior to fatty substances, although the latter contain a greater proportion of combustible material. Boussingault[2] fed a duck exclusively upon bacon, and found that enough was not assimilated in a given time to repair the loss through the respiratory process. Another duck, fed upon starch, absorbed nearly twice as much as was sufficient to furnish carbon for the wants of the system.

With regard to the process by which starch is digested, much light has been afforded by the labors of recent investigators. Leuchs first established the fact that the saliva possesses the property of changing starch into sugar. Bidder and Schmidt[3] state, as the result of numerous experiments, that when the saliva of adult men was mixed with a solution of starch, the conversion into sugar began instantaneously. They also show, that other juices, and certain tissues of animals, possess the faculty of effecting this metamorphosis.

On the other hand, Bernard,[4] whilst believing that the saliva, under favorable circumstances, out of the body, is capable of transforming starch into sugar, denies it this power within the system, by reason of the short time it is in contact with the food in the mouth, and the fact that the metamorphosis in the stomach is entirely prevented by the gastric juice. He is of opinion that the

[1] Quarterly Journal of Microscopical Science, No. vi. p. 115.
[2] Mémoires de Chimie agricole et de Physiologie, p. 230.
[3] Die Verdauungssaefte und der Stoffwechsel. S. 17.
[4] Leçons de Physiologie expérimentale. Cours de semestre d'été. 1855, p. 155 et seq.

change of starch into sugar is almost solely due to the action of the pancreatic and intestinal juices.

Mialhé[1] combats these views of Bernard, and whilst admitting that the conversion of starch into glucose, initiated by the saliva, may be arrested in the stomach by the acid of the gastric juice, contends, that the former fluid exercises a very powerful influence in effecting the transformation.

Some recent experiments of Professor F. G. Smith,[2] of Philadelphia, would seem to determine this point. Prof. S. found in the case of Alexis St. Martin (the individual upon whom Dr. Beaumont's experiments were instituted), that after eating farinaceous food, sugar was invariably discovered in the contents of the stomach, and concludes "that the human gastric juice does not prevent the conversion of starch into grape sugar, and that this change may take place in the stomach independently of the action of the saliva." His investigations appear to have been conducted with great care, and I shall therefore adopt his conclusions.

The change which is commenced by admixture of the amylaceous food with the saliva in the mouth, is continued in the stomach, by the quantity of this secretion swallowed with the aliment. The gastric, pancreatic, and intestinal juices, especially the second named, assist in the process, and eventually, through the combined influence of these several secretions, the starch is brought into a fit form for assimilation. The greater part is absorbed into the circulation as grape sugar, a portion undergoes continued metamorphosis into lactic and butyric acids, and occasionally another part, which has escaped alteration, is discharged with the alvine dejections.

Such is a very condensed outline of some of the principal points of interest connected with the substance under consideration. I now proceed to state my own investigations.

The starch used in these experiments was of the form generally known as corn-starch, and being manufactured for table use, was of a purer quality than the ordinary article. It was always cooked before ingestion, but was taken free from any other substance than the necessary amount of water. The figures in the following pages expressive of the quantity of starch ingested, refer to the dry substance before it was cooked; those relating to the amount of water, refer both to that portion of this liquid taken with the starch, and

[1] Chimie appliquée à la Physiologie, etc., p. 38, et seq.
[2] Medical Examiner, September, 1856, p. 513, et seq.

the quantity drank. The water used was either distilled, or snow or rain water.

The investigations were performed under the same conditions (other than the food) as the former series, and as stated at length in the introduction. Such deviations from the standard course as were unavoidable, are specially noted. The researches continued ten days.

Thirty days elapsed from the conclusion of the experiments with albumen till the commencement of the present series. In that time, my health had entirely recovered, and the weight of the body had undergone a small, but steady increase.

At the end of the twenty-four hours immediately preceding the commencement of the following researches, my weight was 224.87 pounds.

FIRST DAY.

INGESTA.

8 A.M.	Starch	3000		Water	8550
1 P.M.	"	4000		"	8500
5 "	"	2500		"	7450
Total	"	9500		"	24500

EGESTA.

Kidneys.

Whole quantity of urine 14339.51.

Water	13588.69	
Solids	750.82	
Urea		421.57
Uric acid		6.34
Chlorine		85.26
Sulphuric acid		30.45
Phosphoric acid		27.18
Residue		180.02

Intestines.

Whole quantity of feces 1041.86.

Water	816.96	
Solids	224.90	
Ether extract		49.72
Alcohol extract		50.29
Water extract		30.18
Insoluble residue		94.71

Skin and Lungs.

Total loss through these channels 19798.34.

My pulse at 7 A.M. was 80, at 2 P.M. 82, and at 10 P.M. 84.—Mean 82.

The temperature of the body at the above hours was respectively 98°, 97.5°, and 97°.—Mean 97.50°.

At 3 P.M. I abstracted 1480.29 grains of blood from the median basilic vein. The following is the analysis:—

1000 parts of serum—

Water	907.34
Solids	92.66
Albumen	75.02
Extractive	6.18
Soluble salts	10.72
	91.92
Difference	.74

The whole quantity of inorganic salts in 1000 parts of serum was 11.98.

1000 parts of blood—

Water	779.33
Solids	220.77
Fibrin	1.99
Blood-corpuscles	141.18
Albumen	63.66
Extractive	4.84
Soluble salts	9.31
	220.98
Difference	.21

The whole quantity of inorganic salts in 1000 parts of blood was 10.42. In 1000 parts of defibrinated blood was 1.83 of fat.

The weight of the body at the end of the twenty-four hours was 224.49 pounds; being a loss of .38 pound, or 2660 grains; of which 1480.29 are represented by the amount of blood drawn for examination, leaving 1179.71 as the excess of loss from the excretions.

The mean height of the barometer for the twenty-four hours was 29.276 inches, and of the thermometer 1.66°.

On this day I had no abnormal symptoms of any kind. My appetite was very good, and the starch was relished as a pleasant article of food. At night, slept well. I took but very little physical exercise on this day, owing to the extreme coldness of the weather.

SECOND DAY.

INGESTA.

8 A.M.	Starch	3000		Water	6250
1 P.M.	"	3500		"	10000
5 "	"	4000		"	10000
Total	"	10500		"	26250

EGESTA.

Kidneys.

Whole quantity of urine 14970.83.

Water	14327.62	
Solids	643.21	
Urea		369.15
Uric acid		5.42
Chlorine		31.04
Sulphuric acid		19.68
Phosphoric acid		25.97
Residue		183.95

Intestines.

Whole quantity of feces 1076.53.

Water	858.18	
Solids	218.35	
Ether extract		51.36
Alcohol extract		39.12
Water extract		24.39
Insoluble residue		103.48

Skin and Lungs.

Total loss through these channels 21122.64.

My pulse was at 7 A.M. 83, at 2 P.M. 85, and at 10 P.M. 84.—Mean 84.

At the same periods the temperature of the body was respectively 98°, 98.5°, and 98°.—Mean 98.16°.

The weight of the body at the end of the twenty-four hours was 224.43 pounds; a loss of .06 pound, or 420 grains.

The mean height of the barometer was 29.086 inches, and of the thermometer 3°.

No unusual symptoms of any kind occurred. Appetite good, sleep sound and refreshing. At about 9 P.M., through inadvertence, I drank two ounces of hot whiskey punch.

THIRD DAY.

INGESTA.

8 A.M.	Starch	3300	Water	8900
1 P.M.	"	3500	"	9526
5 "	"	4500	"	10500
Total	"	11300	"	28926

EGESTA.

Kidneys.

Whole quantity of urine 19785.24.

Water	19296.09	
Solids	439.15	
Urea		225.06
Uric acid		5.18
Chlorine		14.27
Sulphuric acid		12.07
Phosphoric acid		26.61
Residue		155.96

Intestines.

Whole quantity of feces 925.01.

Water	724.47	
Solids	200.54	
Ether extract		45.13
Alcohol extract		28.74
Water extract		35.41
Insoluble residue		91.26

Skin and Lungs.

Total loss from these channels 18585.75.

My pulse at 7 A.M. on this day was 82 per minute, at 2 P.M. 84, and at 10 P.M. 85.—Mean 83.66.

The temperature of the body at the same hours was respectively 98°, 98°, and 98.5°.—Mean 98.16°.

My weight at the end of the twenty-four hours was 224.57; showing an increase over the preceding day of .14 pound, or 980 grains.

The mean height of the barometer was 29.213 inches; that of the thermometer was 4.66°.

Notwithstanding the increase of weight, I felt somewhat weak on this day. My appetite was excellent, and the starch was still relished. The urine was of a somewhat darker color than usual. Numerous starch granules were discovered in the feces by the microscope.

FOURTH DAY.

INGESTA.

8 A.M.	Starch	. . .	3000	Water . . .	8500
1 P.M.	"	. . .	3500	" . . .	9500
5 "	"	. . .	5500	" . .	11000
Total	"	. .	12000	" . .	29000

EGESTA.

Kidneys.

Whole quantity of urine 20245.10.

Water	19787.10	
Solids	458	
Urea		204.29
Uric acid		7.53
Chlorine		8.41
Sulphuric acid		10.55
Phosphoric acid . . .		18.29
Residue		216.74

Intestines.

Whole quantity of feces 1438.15.

Water	1013.08	
Solids	425.07	
Ether extract		40.26
Alcohol extract . . .		29.13
Water extract		28.64
Insoluble residue . . .		327.01

Skin and Lungs.

Total loss through these channels 18476.25.

My pulse at 7 A.M. was 82, at 2 P.M. 84, and at 10 P.M. 84.—Mean 83.33.

At the same hours the temperature of the body was respectively 98.5°, 99°, and 99°.—Mean 98.83°.

At the termination of the twenty-four hours my weight was 224.79 pounds; an increase over the preceding day of .12 pound, equivalent to 840 grains.

The mean height of the barometer was 29.366 inches, and of the thermometer 0.66°.

I felt a good deal of debility during this day, my mind was not active, and there was great indisposition to physical exertion. The appetite was good, but, for the first time, there was some little dis-

taste for the starch, and a great desire to mix salt with it. I experienced at intervals during the day a feeling of oppression about the lungs, which was only relieved by a full inspiration; at night had frequent dreams of falling from precipices, and awoke several times with a sudden start. I also noticed, that the saliva was unusually thick and ropy. Under the microscope, an extraordinarily large number of epithelial cells and mucus globules were discovered. It was neutral to test paper.

FIFTH DAY.

INGESTA.

8 A.M.	Starch	. . .	3000	Water . . .	8000
1 P.M.	"	. . .	3800	" . . .	9000
5 "	"	. . .	4000	" . .	10000
Total	"	. .	10800	" . .	27000

EGESTA.

Kidneys.

Whole quantity of urine 18275.82.

Water	17885.11	
Solids	390.71	
Urea		160.47
Uric acid		7.26
Chlorine		8 03
Sulphuric acid		6.70
Phosphoric acid . . .		10.55
Residue		197.70

Intestines.

Whole quantity of feces 1145.90.

Water	937.68	
Solids	205.22	
Ether extract		35.78
Alcohol extract . . .		30.65
Water extract		20.50
Insoluble residue . . .		118.29

Skin and Lungs.

Total loss through these channels 18518.28.

My pulse at 7 A.M. was 85, at 2 P.M. 87, and at 10 P.M. 87.—Mean 86.33.

The temperature of the body at the same hours was respectively 98.5°, 99°, and 99.5°.—Mean 99°.

At the end of the twenty-four hours my weight was 224.77 pounds; showing a loss of .02 pound, or 140 grains.

The mean height of the barometer was 29.510 inches, and of the thermometer 1°.

On this day I felt exceedingly feeble. The mind was dull, and it required an effort to fix it upon any subject. Scarcely any physical exercise was taken. The feeling of oppression at the chest had increased, and there was a good deal of sighing respiration. At 12 M., and at 4 P. M., had slight palpitation of the heart. There was some pain in the abdomen through the day, and a large quantity of flatus was discharged with the feces. Slept better than on the previous night, but awoke in the morning with a most intense pain over the left supraorbital arch. This was so severe that I was unable to endure it, and I took forty grains of magnesia with almost instantaneous relief; showing that in all probability the headache was caused by acidity of the stomach. The saliva was of the same character as on the previous day. The microscope still showed an unusual amount of epithelial scales and mucus globules. Reaction neutral.

The urine passed, on rising from bed, was of a darker color than at any time previous during this series of experiments. On testing it for sugar, by Trommer's method (as had been done every day during the investigations), there was a clear and well marked precipitate of the suboxide of copper. The fermentation test, and examination with the microscope for the *torula cerevisiæ*, were both subsequently applied with affirmative results.

SIXTH DAY.

INGESTA.

8 A.M.	Starch	2500		Water	6200
1 P.M.	"	3500		"	9050
5 "	"	4000		"	10000
Total	"	10000		"	25250

EGESTA.

Kidneys.

Whole quantity of urine 15160.06.

Water		14631.87
Solids		528.19
Urea		176.28
Uric acid		8.49
Chlorine		6.22
Sulphuric acid		4.12
Phosphoric acid		5.64
Residue		347.84

Intestines.

Whole quantity of feces 1097.

Water	910.47	
Solids	186.53	
Ether extract		29.89
Alcohol extract		34.75
Water extract		14.65
Insoluble residue		107.24

Skin and Lungs.

Total loss through these channels 18782.94.

The pulse at 7 A.M. was 85 per minute, at 2 P.M. 85, and at 10 P.M. 90.—Mean 87.66.

At the same periods the temperature of the body was respectively 99°, 99°, and 99.5°.—Mean 99.16°.

At the termination of the twenty-four hours my weight was 224.81 pounds; an increase of .03 pound, or 210 grains.

The mean height of the barometer was 29.426 inches, and of the thermometer 9.33°.

The debility was still present. Notwithstanding the magnesia taken the previous day, there was considerable torpor of the bowels. Mental phenomena unchanged. The skin was hot, and there was some fever towards night. The oppression at the chest had, in a measure, subsided. The palpitation of the heart, however, still remained, and was very annoying. I was also troubled a good deal with pyrosis. Rested well at night.

All the urine discharged on this day exhibited (with the tests previously employed) undoubted evidences of containing sugar. The saliva was more natural in its character, though of very feeble alkaline reaction.

My friends noticed, by this time, a change in my personal appearance. My countenance was unusually pale, and my lips of a slight bluish tinge; showing deficient aëration of the blood, or an excessive accumulation of carbonaceous matter in the system.

SEVENTH DAY.

INGESTA.

8 A.M.	Starch	2500	Water	7000
1 P.M.	"	3500	"	8000
5 "	"	3500	"	9300
Total	"	9500	"	24300

EGESTA.

Kidneys.

Whole quantity of urine 15282.25.

Water	14856.45	
Solids	425.80	
Urea		157.05
Uric acid		8.36
Chlorine		4.74
Sulphuric acid		3.81
Phosphoric acid		5.70
Residue		244.14

Intestines.

Whole quantity of feces 946.17.

Water	750.70	
Solids	195.47	
Ether extract		33.76
Alcohol extract		34.29
Water extract		27.42
Insoluble residue		100.

Skin and Lungs.

Total loss by these channels 17921.58.

At 7 A.M. the pulse was 87, at 2 P.M. 89, and at 10 P.M. 93.—Mean 89.66.

At the above hours, the temperature of the body was respectively 98°, 98.5°, and 98.5°.—Mean 98.33°.

At the end of the twenty-four hours the weight of the body was 224.76 pounds; a decrease of .05 pound, or 350 grains.

The mean height of the barometer was 29.141 inches, that of the thermometer 12.33°.

The palpitation of the heart was very troublesome on this day, as was also the pyrosis. Debility excessive, especially in the muscles of the back. The desire for other food was very great. The starch was by this time exceedingly disagreeable. One or two

slight scratches, which I had received on the hand the day before, became painful, and showed a tendency to inflammation and suppuration. Such a thing had never happened to me before; my flesh always healing readily after such injuries. I did not sleep well, was quite feverish during the night, and awoke in the morning with severe headache.

The urine was still saccharine, of a dark-brown color, and very acid reaction. Saliva natural.

Numerous starch granules were discovered with the microscope in the feces. This excretion was also very acid in its reaction, and of a dark, almost black color.

EIGHTH DAY.

INGESTA.

8 A.M.	Starch	2225	Water	5700
1 P.M.	"	2525	"	10000
5 "	"	3500	"	10000
Total	"	8250	"	25700

EGESTA.

Kidneys.

Whole quantity of urine 20130.87.

Water	19781.62	
Solids	549.25	
Urea		185.33
Uric acid		7.94
Chlorine		4.30
Sulphuric acid		3.09
Phosphoric acid		5.86
Residue		342.73

Intestines.

Whole quantity of feces 900.61.

Water	758.88	
Solids	141.73	
Ether extract		30.13
Alcohol extract		25.37
Water extract		12.60
Insoluble residue		73.63

Skin and Lungs.

Total loss from these channels 14048.52.

At 7 A.M. my pulse was 92, at 2 P.M. 94, and at 10 P.M. 94.—Mean 93.33.

The temperature of the body at the above hours was respectively 98.5°, 99.5°, and 99°.—Mean 99°.

My weight at the end of the twenty-four hours was 224.57 pounds; a loss from the preceding day of .19 pound, or 1330 grains.

The mean heights of the barometer and thermometer were respectively 29.105 inches, and 15.33°.

Violent headache was present during the whole day. The mind was somewhat confused; an almost constant twitching of the left superior eyelid was experienced, and caused me a great deal of annoyance. The oppression of the chest had returned, and was only relieved by frequent, full, and deep inspirations. There were also griping pains in the lower part of the abdomen, attended with the discharge of much flatus. The pyrosis still continued. Palpitation of the heart less violent and frequent. Several boils made their appearance on various parts of the body.

The urine, when tested, as before mentioned, exhibited the same characteristic signs of the presence of sugar as previously. Reaction strongly acid. Starch granules in the feces.

NINTH DAY.

INGESTA.

8 A.M.	Starch	3500	Water	7600
1 P.M.	"	3500	"	9500
5 "	"	4500	"	10500
Total	"	11500	"	27650

EGESTA.

Kidneys.

Whole quantity of urine 23352.11.

Water	22879.95	
Solids	472.16	
Urea		132.58
Uric acid		9.47
Chlorine		3.01
Sulphuric acid		2.61
Phosphoric acid		5.50
Residue		318.99

Intestines.

Whole quantity of feces 1256.45.

Water	1043.21	
Solids	213.24	
Ether extract		21.36
Alcohol extract		18.51
Water extract		15.74
Insoluble residue		157.63

Skin and Lungs.

Total loss from these channels 13631.44.

At 7 A.M. on this day my pulse was 90, at 2 P.M. 93, and at 10 P.M. 95.—Mean 92.66.

The temperature of the body at these hours was respectively 99.5°, 99.5°, and 100°.—Mean 99.66°.

The weight of the body at the end of the twenty-four hours was 224.70 pounds; an increase of .13 pound, or 910 grains over the previous day.

The mean height of the barometer was 29.252 inches, and of the thermometer 13°.

The symptoms observed on this day did not differ materially from those of the day before. I was obliged, however, from weakness and general indisposition, to go to bed at 8 P.M. Did not sleep well.

The urine was still highly saccharine, and of the same clear brown color as before noticed.

TENTH DAY.

INGESTA.

8 A.M.	Starch	2200	Water	6000
2 P.M.	"	4525	"	11500
5 "	"	3500	"	9000
Total	"	10225	"	26500

EGESTA.

Kidneys.

Whole quantity of urine 22785.

Water	22272.43
Solids	512.57

Urea		121.77
Uric acid		9.36
Chlorine		1.89
Sulphuric acid		2.26
Phosphoric acid		5.31
Residue		340.59

Intestines.

Whole quantity of feces 1250.27.

Water	945.42	
Solids	204.85	
Ether extract		25.63
Alcohol extract		25.80
Water extract		17.43
Insoluble residue		135.49

Skin and Lungs.

Total loss from these channels 12599.73.

My pulse at 7 A. M. was 91, at 2 P. M. 90, and at 10 P. M. 93.—Mean 91.33.

The temperature of the body at the same hours, was respectively 99°, 99.5°, and 99.5°.—Mean 99.33°.

At 3 P. M. I abstracted 1350 grains of blood from the median basilic vein, and, upon analysis, found it to be constituted as follows:—

1000 parts of serum—		1000 parts of blood—	
Water	920.81	Water	796.49
Solids	79.19	Solids	203.51
Albumen	63.45	Fibrin	3.15
Extractive	12.35	Blood-corpuscles	132.60
Soluble salts	2.12	Albumen	55.96
	77.92	Extractive	11.25
Difference	1.27	Soluble salts	1.87
			204.83
		Difference	1.32

The whole quantity of inorganic salts in 1000 parts of serum was 2.89.

The whole quantity of inorganic salts in 1000 parts of blood was 2.05. In 1000 parts of defibrinated blood were 2.74 of fat.

The weight of the body at the end of the twenty-four hours was 224.53 pounds; being a loss of .18 pound, or 1260 grains. As, however, 1350 grains of blood were taken from the body, there

was an actual increase of 90 grains, or, more properly, would have been, but for the loss of blood.

The mean height of the barometer was 29.155 inches, and of the thermometer 12.66°.

The general symptoms observed were of the same character as those of the last two days, but more strongly marked.

The urine was highly saccharine, and of the same brown color; resembling Madeira wine.

The immediate effect of the slight abstraction of blood was to relieve the feeling of oppression at the chest; but in an hour it returned with increased violence. The debility was very great.

The experiments with starch were now at an end. Immediately on their termination, I ate a hearty breakfast, but my stomach was in so weak and disordered a condition, that the food was almost instantly rejected. I found that I was obliged to resume my ordinary diet with some degree of caution. After a few days, I became free from all unpleasant symptoms, and rapidly regained my usual good health. It is remarkable, however, that for the first few days after the conclusion of the experiments, I steadily lost weight, so that on the tenth day, I weighed but 223.18 pounds. Sugar was detected in the urine till the morning of the sixth day.

The accompanying table embraces the main results of the foregoing investigations:—

TABLE VI.

	1st day.	2d day.	3d day.	4th day.	5th day.	6th day.	7th day.	8th day.	9th day.	10th day.	Total.	Mean.
Insects.												
Starch	8500	19500	11300	13000	18800	10000	8300	8350	11300	10223	108573	10857.30
Water	21500	28250	29925	29000	27000	21250	24500	27550	27540	20300	259078	25907.80
Total . . .	30000	39750	40725	44000	37800	30250	32800	35900	39180	30723	368651	36865.10
Kidneys.												
Whole quantity of urine	14330.51	14070.83	12705.24	20245.19	16273.82	13160.06	15262.25	20130.97	23932.11	22784.00	184276.79	18427.67
Water	13588.09	13427.42	12295.10	19737.10	15981.71	12931.57	14845.45	19741.25	23672.45	22712.43	181656.98	18165.69
Solids	742.42	643.41	410.14	508.09	292.11	228.49	416.80	389.72	259.66	121.57	4119.81	411.98
Urea	423.37	369.15	235.06	294.29	165.47	175.28	157.05	183.33	182.58	121.77	2133.55	213.35
Uric acid . . .	6.34	5.42	3.16	7.23	4.26	6.23	6.78	7.54	5.47	3.36	75.19	7.51
Chlorine . . .	45.51	41.36	26.04	31.87	17.93	8.74	8.74	4.84	3.61	1.56	190.11	19.01
Sulphuric acid .	29.45	19.68	11.07	10.53	6.70	4.12	3.41	2.91	3.09	2.26	97.34	9.73
Phosphoric acid .	27.14	25.37	16.41	14.79	8.50	4.64	3.13	2.91	3.09	0.51	126.67	12.66
Residue . . .	110.02	153.93	104.96	217.18	127.07	317.84	244.14	312.79	315.09	245.61	2150.63	215.06
Intestines.												
Whole quantity of feces	1041.86	1078.53	921.01	1458.15	1155.60	1007.00	946.17	960.61	1256.45	1250.27	11077.85	1107.80
Water	816.86	858.18	734.47	1013.08	810.17	827.68	756.70	758.88	1043.21	945.42	8892.15	889.21
Solids	224.99	216.35	186.54	445.07	345.43	179.32	189.47	201.73	213.24	304.85	2211.69	221.16
Ether extract .	21.73	21.38	20.13	20.65	21.75	21.75	21.75	21.75	21.75	21.75	217.50	21.75
Alcohol extract .	30.12	28.74	20.15	31.75	31.75	31.75	31.75	31.75	31.75	31.75	317.50	31.75
Water extract .	24.39	23.41	15.30	17.63	17.63	17.63	17.63	17.63	17.63	17.63	176.30	17.63
Insoluble residue	101.45	91.39	85.03	171.24	127.10	109.00	75.63	75.63	135.49	135.49	1207.04	120.70
Skin and Lungs.												
Total loss by these channels	10758.34	21122.64	15583.73	18476.35	18514.28	14782.94	17701.58	14248.32	13631.44	13980.73	170803.07	17080.30
Total egesta . . .	33178.71	37170.00	29246.00	40550.00	37920.00	33560.00	31150.00	33220.00	38020.00	30920.00	349010.71	34901.07
Variation in weight of body	—1178.71	—420.00	+680.00	+510.00	—180.00	+210.00	—350.00	—130.00	+910.00	+80.00	—359.71	—35.97
Pulse	82	84	83.86	83.66	84.33	87.66	88.06	83.33	92.66	91.33	...	87.42
Temperature of body	97.59°	98.16°	98.15°	98.83°	99°	99.16°	98.33°	99°	99.66°	99.33°	...	98.84
Barometer . . .	29.276	29.086	29.213	29.366	29.510	29.426	29.141	29.105	29.242	29.115	...	29.253
Thermometer . . .	—1.66°	3°	—4.66°	—0.66°	1°	9.33°	12.33°	11.33°	13°	12.66°	...	6.03°

A consideration of the foregoing investigations, and comparison of the results with those of the standard series, show that under the use of food consisting only of starch and water, the following effects ensued.

Kidneys.—The whole quantity of urine was lessened, as was also the amount of its solid matter, and that of each constituent (urea, uric acid, chlorine, and sulphuric and phosphoric acids). The residue of solid matter remaining after the deduction of the sum of the above named substances was, however, greatly increased.

The diminution in the quantity of urine eliminated, was partly due to the fact that there was a less amount of fluids ingested than during the preliminary series, and partly, that the food was not of a character to maintain the several solid constituents at their ordinary normal amounts. It was from this latter cause that so great a reduction took place in the quantity of urea, uric acid, chlorine, and sulphuric and phosphoric acids. During the present investigations, these substances must have been entirely derived from the disintegrated tissues of the body; the food containing no matter from which they could have been elaborated.

The increase of solid residue was probably owing to the sugar present, and, perhaps, to some other substance containing a large proportion of carbon. The increased depth of color observed in the urine, supports this latter hypothesis. Recent investigations have almost completely established the fact, that the coloring matter of the urine is a vehicle for the removal of carbon which has not been eliminated by other channels.[1]

The fact that sugar was detected in the urine after a few days' use of the starch, is important physiologically, and must have no little bearing upon the pathology of a disease as yet but little understood.

According to Bernard,[2] sugar in the animal economy has an internal and external origin, the liver being the organ by which it is formed in the system, and the food furnishing that derived from without. This physiologist is, however, of opinion (and he adduces many striking experiments in support of this theory), that normally the sugar taken into the system with the food, and which enters the portal vein, never reaches the general circulation, but is destroyed

[1] Bird. Urinary Deposits, p. 88.

[2] Leçons de Physiologie expérimentale. Cours de semestre d'hivers, 1854, 1855. The reader is referred to this work for Bernard's views in full.

by the liver, and transformed into an emulsive substance, possessing none of the chemical or physical characteristics of sugar. The sugar of the food, therefore, is never normally found as a constituent of the urine. To this rule he makes an exception as regards cases of fasting, and the subsequent ingestion of a large quantity of sugar. Then, he states, absorption from the intestines taking place with increasing energy, a great quantity of sugar is thrown upon the liver, and, being more than it is able to transform, the excess passes into the main circulation, and is found in the urine.

The present investigations, it is seen, are entirely opposed to Bernard's doctrine of the perfect destruction of the alimentary sugar by the liver, as it is not probable the sugar found in my urine could have had any other origin than the food which was transformed into this substance in the intestines, and absorbed as such into the circulation.

In obtaining this result, I am not altogether alone. Von Becker has definitely established the fact, that the amount of sugar in the blood is influenced by the character of the food, and Uhle and Lehmann found it to appear in the urine of rabbits after the injection of a solution containing it into the blood.

I am disposed to regard the appearance of sugar in the urine, ensuing upon the excessive use of amylaceous food, to be due to a deficient relative amount of oxygen in the blood. This hypothesis may be more clearly set forth by recalling the facts, that before assimilation, the starch taken as food is transformed into dextrin, then into glucose or grape sugar, and is chiefly under this form absorbed into the system. The sugar, after its entrance into the blood-vessels (provided a sufficient amount of oxygen be brought into chemical contact with it), is, after undergoing continued metamorphosis, entirely decomposed into carbonic acid and water, and, as such, is eliminated from the pulmonary mucous membrane. A deficiency of oxygen causes a partial interruption of this process, and a portion of the sugar is merely metamorphosed into fat, and under this form remains in the system. A still greater deficiency of oxygen, or, what amounts to the same, a corresponding increase of the quantity of sugar in the blood, would cause a portion of this latter substance entirely to escape metamorphosis, and this portion would make its appearance as a constituent of the urine if augmented beyond a definite amount. In support of this theory are to be adduced the numerous carefully conducted investigations of Dechambre, from which it appears that sugar is constantly to be

met with in the urine of the aged as an effect of deficient hæmatosis. It is well known that the use of feculent food invariably increases the proportion of this substance in diabetic urine.

Intestines.—The quantity of feces was reduced, as was also that of each of its constituents determined.

The decrease in the total amount of feces was due to the facts, that starch is a substance of easy digestibility, and that no indigestible substances were taken into the system.

The reduction in the amounts of ether, alcohol, and water extracts, was also mainly owing to the character of the aliment. As no fat was taken with the food, it would seem that the first of these was present in greater amount than could have been expected, unless we adopt the hypothesis that farinaceous food is converted into fat in the intestines; to which theory the experiments of Boussingault on ducks are directly at variance.

The weight of the body is seen to have declined altogether 469.71 grains, not counting, in this calculation, the weight of the blood abstracted for analysis. This loss is much less than the drain from the waste of the nitrogenous tissues, and shows that a very considerable amount of new matter must have been deposited within the system. The chemical constitution of starch forbids the idea that this material could have been of a nature to serve for the renovation of the worn-out tissues of the body. It must, on the contrary, have consisted of fat, derived from the metamorphosis of the amylaceous food. The slight loss of weight observed shows, therefore, that the starch was assimilated not only in quantity sufficient for the immediate wants of the system, but also in such an amount as to allow the deposition of fat to such an extent as, within a few grains, to compensate for the total loss through the nitrogenous constituents of the excretions. The actual increase observed in the temperature of the body, and several of the pathological occurrences, also show that there was no deficiency of carbon in the system.

Effect upon the Constitution of the Blood.—The annexed table exhibits the results of the analysis of the blood on the 1st and 10th days of the experiments.

TABLE VII.

1000 parts of serum—	1st day.	10th day.	1000 parts of blood—	1st day.	10th day.
Water	907.34	920.81	Water	779.33	796.49
Solids	92.66	79.19	Solids	220.77	203.51
Albumen	75.02	63.45	Fibrin	1.99	3.15
Extractive . . .	6.18	12.35	Blood-corpuscles .	141.18	132.60
Soluble salts . .	10.72	2.12	Albumen	63.66	55.96
			Extractive . . .	4.84	11.25
Whole quant. inorg. salts	11.98	2.89			
			Soluble salts	9.31	1.87
			Whole quant. inorg. salts	10.42	2.05
			Fat	1.83	2.74

From this table it is seen that, in the serum, the water was increased in quantity, and the solids proportionally diminished. The albumen and salts were reduced in amount, whilst the extractive was very much increased.

In the whole blood, the proportion of water was likewise increased, and that of the solids lessened. The fibrin, extractive, and fat, were augmented; the blood-corpuscles, albumen, and salts diminished.

Most of these results were to have been anticipated. The most important of them are the increase in the fibrin, extractive, and fat.

So many different views of the value and character of the fibrin of the blood are held by physiologists, that I merely state the fact of its occurrence in this fluid in increased amount after farinaceous diet, without attempting to account for it. Whether fibrin is a substance of the ascending or descending grade of metamorphosis, is as yet far from determination.

The increase in the amount of fat is sufficiently accounted for by the character of the food, and might have been anticipated, if the theory given explanatory of the cause of the presence of sugar in the urine be regarded as correct. The diminished amount of fat in the blood after the albuminous diet, and its increase after an amylaceous one, show that the proportion of this substance in the circulating fluid is subject to variation with the character of the ingesta; a circumstance with which the experiments of Boussingault[1] are at variance.

The increase in the proportion of the extractive, was probably due to some carbonaceous substance present in augmented quantity.

[1] Op. cit., p. 281, et seq.

Upon the whole, if further evidence of the incapability of starch to sustain for any length of time health or life in the human subject were wanting, the present investigations would appear to furnish it. The value of starch is, however, very great, for, notwithstanding the derangement of the health, both physical and mental, produced by strict adherence to a diet of this substance, it is perceived that but slight loss of weight occurred. This latter fact, resulting as it did from the deposition of fat, is not to be regarded as an entirely normal result. Nevertheless, it is a most valuable indication that farinaceous food fulfils the condition of supplying a sufficiency of carbon to the system.

III.

GUM.

The chemical constitution of gum differs from that of starch, only in containing two additional atoms of both hydrogen and oxygen. It is never found as a component part of the bodies of animals, and of the vegetable substances ordinarily used as food by man, few, if any, contain it. It is, however, occasionally employed in the sick-room, from an idea, formerly very prevalent and not yet entirely extinct, that it possesses great nutritive power, and is sometimes met with as an ingredient of certain sweet-meats.

Notwithstanding that it is exceedingly soluble in water, the recorded experiments of several physiologists tend to show, that gum is possessed of little or no nutritive value, or capability of supporting respiration, owing to its almost complete indigestibility. Thus, Boussingault[1] fed a duck with fifty grammes of gum Arabic, and found forty-six in the excrements, and Frerichs, Blondlot, and Lehmann,[2] found that neither the saliva nor gastric juice exercised any digestive effect upon this substance.

With the object of contributing to the more complete elucidation of the subject, the following investigations were instituted. My original intention was to have continued them, if possible, ten days, as in the former two series; but, owing to the debility and great

[1] Mémoires de Chimie agricole et de Physiologie, p. 232.

[2] Lehmann's Physiological Chemistry, vol. ii. p. 386.

derangement of health produced, I was obliged, very much to my regret, to discontinue them at the end of the fourth day.

Pure gum Arabic was the article used during these investigations. It was ingested dissolved in water (the proportion of this liquid entering into its composition having been previously ascertained). The figures relating to the gum refer to the dry substance, and those indicating the quantity of water, to the whole amount of this liquid taken into the stomach uncombined, and with the gum. The water was distilled, or rain-water. No other food was taken.

The conditions of physical and mental exercise, sleep, &c., were as far as possible the same as in the previous series. I was unable, however, to adhere as rigidly to the standard system as I desired. The deviations are noticed in the proper places. Twenty-five days elapsed between the termination of the starch series of investigations and the commencement of the present. At this latter time my health appeared to be very good. At the end of the twenty-four hours immediately preceding my weight was 225.33 pounds.

FIRST DAY.

INGESTA.

8 A.M.	Gum	2300	Water	9000
1 P.M.	"	3000	"	10000
5 "	"	3000	"	10000
Total	"	8300	"	29000

EGESTA.

Kidneys.

Whole quantity of urine 20728.61.

Water	20157.03	
Solids	571.58	
Urea		330.15
Uric acid		7.45
Chlorine		46.28
Sulphuric acid		21.57
Phosphoric acid		24.13
Residue		142.

Intestines.

Whole quantity of feces 8529.14.

Water	3284.34	
Solids	5244.80	
Ether extract		31.55
Alcohol extract		30.27
Water extract		5030.36
Insoluble residue		152.62

Skin and Lungs.

Total loss through these channels 12422.94.

My pulse at 7 A.M. was 80, at 2 P.M. 84, and at 10 P.M. 89.—Mean 84.33.

At the same hours, the temperature of the body was respectively 98.5°, 98°, and 97.5°.—Mean 98°.

At 3 P.M. I took 1359.31 grains of blood from the median basilic vein. This, upon analysis, was found to be constituted as follows:—

1000 parts of serum—		1000 parts of blood—	
Water	907.43	Water	778.04
Solids	92.57	Solids	221.96
Albumen	77.36	Fibrin	2.05
Extractive	5.15	Blood-corpuscles	138.22
Soluble salts	9.22	Albumen	66.32
	91.73	Extractive	4.08
Difference	.84	Soluble salts	7.96
			218.63
		Difference	3.33

The whole quantity of inorganic salts in 1000 parts of serum was 11.01.

The whole quantity of inorganic salts in 1000 parts of blood was 10.49. 1000 parts of defibrinated blood contained 2.13 of fat.

The weight of the body at the end of the twenty-four hours was 224.57 pounds; being a loss of .82 pound, or 5740 grains; of which 1359.31 are to be ascribed to the blood abstracted for analysis, leaving a balance of 4380.69 grains as the actual loss from the excretions.

The mean height of the barometer on this day was 28.324 inches, and of the thermometer 31.33°.

About the middle of this day I felt quite hungry. After eating the gum at 5 P.M., this feeling subsided, but returned again in the course of the evening. I had severe colicky pains in the lower part of the abdomen after eating the second meal of gum. Had two evacuations from the intestinal canal; one at 9 P.M., and one at 6½ A.M. The feces of both were hard, of a dark brown color, and of a very strong acid reaction.

SECOND DAY.

INGESTA.

8 A.M.	Gum	2150	Water		9300
1 P.M.	"	2100	"		10000
5 "	"	3000	"		10050
Total	"	7250	"		29350

EGESTA.

Kidneys.

Whole quantity of urine 21385.97.

Water	20934.74	
Solids	451.23	
Urea		301.24
Uric acid		8.20
Chlorine		21.15
Sulphuric acid		12.05
Phosphoric acid		13.35
Residue		95.24

Intestines.

Whole quantity of feces 9350.28.

Water	3975.09	
Solids	5375.19	
Ether extract		17.43
Alcohol extract		12.84
Water extract		5297.62
Insoluble residue		47.20

Skin and Lungs.

Total loss through these channels 11883.75.

At 7 A.M. on this day my pulse was 88, at 2 P.M. 88, and at 10 P.M. 94.—Mean 90.

At the corresponding hours the temperature of the body was respectively 97°, 97.5°, and 97.5°.—Mean 97.33°.

At the termination of the twenty-four hours my weight was 223.65; a loss of .86 pound, or 6020 grains.

The mean height of the barometer was 28.706 inches, and of the thermometer 8°.

The feeling of hunger was very strong on this day, and I experienced a good deal of debility. Both the hunger and weakness became less a short time after eating, but they soon returned. The pains in the abdomen still continued. They became more severe

after eating. Two evacuations of the bowels occurred, one at 2½ P.M., the other at 7 P.M. They were both hard, and were of a much lighter color than on the previous day. Reaction strongly acid. At night my sleep was disturbed by unpleasant dreams, and I awoke in the morning with severe headache and high fever.

The saliva was scanty, and of a slight acid reaction to litmus paper.

THIRD DAY.

INGESTA.

8 A.M.	Gum	2000	Water		10000
1 P.M.	"	2150	"		9890
5 "	"	3150	"		10230
Total	"	7300	"		30120

EGESTA.

Kidneys.

Whole quantity of urine 23721.50.

Water	23334.71	
Solids	386.79	
Urea		282.64
Uric acid		9.27
Chlorine		6.33
Sulphuric acid		6.97
Phosphoric acid		7.09
Residue		74.49

Intestines.

Whole quantity of feces 9783.56.

Water	3152.09	
Solids	6631.47	
Ether extract		10.72
Alcohol extract		9.55
Water extract		6581.40
Insoluble residue		29.80

Skin and Lungs.

Total loss from these channels 10704.94.

At 7 A.M. my pulse was 104, at 2 P.M. 112, and at 10 P.M. 110.—Mean 108.66.

At the same hours the temperature of the body was respectively 99.5°, 101°, and 101°.—Mean 100.50°.

At the end of the twenty-four hours my weight was 222.68;

showing a loss from the preceding day of .97 pound, equivalent to 6790 grains.

The mean height of the barometer was 29.264 inches, and of the thermometer 19°.

The debility and hunger were extreme on this day. There was also considerable febrile excitement, attended with heat and dryness of the skin, and headache. I was too much indisposed to read any, and the physical exercise was likewise reduced. In the afternoon, I was obliged to lie down, and at that time slept about one hour.

Three operations from the bowels occurred, one at 12 M., one at 4½ P. M., and one at 7½ P. M. The feces were very solid, and of a light clay color. I was very much annoyed by the abdominal pains. At night I was restless, and slept but little. In the morning, awoke feverish, and unrefreshed.

FOURTH DAY.

INGESTA.

8 A.M.	Gum	2000	Water		9000
1 P.M.	"	2400	"		9500
5 "	"	2500	"		11500
Total	"	6900	"		30000

EGESTA.

Kidneys.

Whole quantity of urine 20516.31.

Water	20163.88	
Solids	352.43	
Urea		274.50
Uric acid		9.35
Chlorine		3.20
Sulphuric acid		3.90
Phosphoric acid		4.55
Residue		56.93

Intestines.

Whole quantity of feces 10964.73.

Water	3529.71	
Solids	7435.02	
Ether extract		10.14
Alcohol extract		8.30
Water extract		7390.10
Insoluble residue		26.48

Skin and Lungs.

Total loss by these channels 12656.45.

At 7 A.M. on this day my pulse was 102, at 2 P.M. 99, and at 10 P.M. 108.—Mean 103.

At the corresponding hours, the temperature of the body was respectively 97.5°, 98°, and 97.5°.—Mean 97.66°.

Perceiving that I should not be able to continue the investigations after this day, I abstracted at 3 P.M., 1272.51 grains of blood from the median basilic vein. The analysis yielded the following results:—

1000 parts of serum—		1000 parts of blood—	
Water	912.84	Water	784.35
Solids	87.16	Solids	215.65
Albumen	72.40	Fibrin	2.71
Extractive	8.23	Blood-corpuscles	135.64
Soluble salts	5.11	Albumen	62.20
	85.74	Extractive	7.39
Difference	1.42	Soluble salts	4.01
			211.95
		Difference	3.70

The whole quantity of inorganic salts in 1000 parts of serum was 6.89.

The whole quantity of inorganic salts in 1000 parts of blood was 6.37. 1000 parts of defibrinated blood contained 1.80 of fat.

The weight of the body, at the end of the twenty-four hours, was 221.63 pounds; a loss, therefore, of 1.05 pound, or 7350 grains; of which, 1272.51 are accounted for by the blood abstracted, so that there remain 6077.49 grains as the loss by the excretions.

The mean heights of the barometer and thermometer were respectively 29.369 inches, and 8°.

The hunger, debility, and febrile excitement were very great on this day; but not more so than on the previous day. The pains in the abdomen were severe, and lasted nearly the whole period of twenty-four hours. There was also some tenderness of the abdomen on pressure. Eating the gum failed now to relieve, even for a short time, the sensation of hunger. Four evacuations occurred from the intestinal canal; one at 11 A. M., one at 3 P.M., one at 9 P. M., and the other at the regular hour. All were very solid, and of a light clay color. It required a good deal of straining to eject the feces. I omitted all study on this day, and took but a trifling amount of physical exercise. The greater part of the afternoon was passed in bed. At night, I did not sleep at all well.

Fearful of inducing disease if I persevered with the experiments, and also what was perhaps a more powerful inducement, unable longer to refrain from other food, I discontinued them at the end of this day.

About 4 P. M. of the fifth day from the commencement I felt great weight and pain in the rectum, but was unable to pass anything at stool. I therefore took an enema of warm water, and in a few minutes ejected a large quantity of hard fecal matter streaked with blood. The water extract of this amounted to 3352.45 grains. No other examination of the excrement was made.

I felt very much indisposed for several days after the conclusion of the researches, but by care, and prudence in diet, no very untoward result ensued.

The results of this series are contained in the accompanying table:—

TABLE VIII.

	1st day.	2d day.	3d day.	4th day.	Total.	Mean.
INGESTA.						
Gum	8300	7250	7300	6900	29750	7437.50
Water	29000	29350	30120	28000	118470	29617.50
Total	37300	36600	37420	34900	148220	37055.00
EGESTA.						
Kidneys—						
Whole quantity urine	20728.61	21385.97	23721.50	20516.31	86152.39	21538.09
Water	20157.03	20934.74	23334.71	20163.88	84590.36	21097.59
Solids	571.58	451.23	386.79	352.43	1762.03	440.50
Urea	339.15	301.24	282.64	274.50	1188.53	297.13
Uric acids	7.45	8.20	9.27	9.35	35.27	8.81
Chlorine	46.28	21.15	6.33	3.20	76.86	19.21
Sulphuric acid	21.57	12.05	6.97	3.90	44.49	11.12
Phosphoric acid	24.13	13.35	7.09	4.55	49.12	12.28
Residue	142.00	95.24	74.49	56.93	288.66	67.16
Intestines—						
Whole quantity feces	8529.14	9350.28	9783.56	10964.73	38627.73	9656.93
Water	3284.34	3975.09	3152.69	3529.71	13941.23	3485.30
Solids	5244.80	5375.19	6631.47	7435.02	24686.50	6171.62
Ether extract	31.55	17.43	10.72	10.14	79.84	19.96
Alcohol extract	30.27	12.84	9.55	8.30	60.96	15.24
Water extract	5030.36	5297.62	6581.40	7390.10	24299.48	6074.87
Insoluble residue	152.62	47.20	29.80	26.48	255.10	63.71
Skin and Lungs—						
Total loss by these channels	12422.94	11883.75	10704.94	11496.45	47668.08	11917.02
Total egesta	41880.59	42620.00	44210.00	42977.49	171688.08	42922.02
Variation in weight	—4580.59	—6020.00	—6790.00	—6077.49	—23268.18	—5817.04
Pulse	84.33	99	108.66	103	...	96.49
Temperature of body	98°	97.33°	100.50°	97.66°	...	98.37°
Barometer	28.324	28.706	29.264	29.369	...	28.915
Thermometer	31.33°	8°	19°	8°	...	16.58°

In considering these investigations, it is seen that the following effects ensued:—

Kidneys.—The whole quantity of urine and the proportion of water were increased; the solids and amounts of each constituent were very much reduced.

Intestines.—The whole quantity of feces, the water, solids, and water extract were enormously increased over the normal average and the means of either of the other series of researches. The ether and alcohol extracts were decreased in quantity.

Skin and Lungs.—The loss from these sources was less than under either the albumen or starch series, and was probably also below the normal extent.

The loss of weight in the body was very great.

The pulse was increased in frequency, as was also the temperature of the body.

The following table shows the alterations induced in the composition of the blood:—

TABLE IX.

1000 parts of serum—	1st day.	4th day.	1000 parts of blood—	1st day.	4th day.
Water	907.43	912.84	Water	778.04	784.35
Solids	92.57	87.16	Solids	221.96	215.65
Albumen	77.36	72.46	Fibrin	2.05	2.71
Extractive	5.15	8.23	Blood-corpuscles	138.22	135.64
Soluble salts	9.22	5.11	Albumen	66.32	62.20
Inorganic salts	11.01	6.89	Extractive	4.08	7.39
			Inorganic salts	10.40	6.57
			Fat	2.13	1.80

From this table it appears that in the serum the proportion of water was augmented, and that of the solids was diminished, and that the albumen and salts were reduced in amount, and the extractive increased. In the whole blood, the same effects ensued with the addition that there was a slight increase in the amount of fibrin, and a decrease in the blood-corpuscles and fat.

It is evident from these researches that but little, if any, of the gum taken into the stomach was absorbed into the circulation. In all, 29,750 grains of gum were ingested. The water extract of the feces, which consisted almost entirely of gum, amounted during the four days of the investigations to 24,299.48 grains. To this sum should of course be added the water extract obtained the day after

the conclusion of the experiments (3352.45 grains), making a total of 27,651.93 grains, which, with the exception of very small quantities of other matters, consisted entirely of gum. A balance of 2098.07 grains remains, but it is probable that a considerable portion, if not the whole of this, was subsequently passed from the bowels, as hard lumps continued to be discharged from this channel for several days.

The great loss of weight (nearly 3.33 pounds) is not surprising after a knowledge of the above facts. Water was always taken in such quantities as desired, or of course the decrease of weight would have been much greater. The fever, hot skin, &c., were indicative of irritation and debility.

If we admit the non-absorption of the gum, the solid constituents of the urine must have been entirely derived from the effete tissues of the body. The amounts of each are therefore probably such as would have been excreted had no food been taken into the stomach. The carbonic acid of the expired air could have had no other source than the oxidation of the fat of the body, which also furnished a portion of the aqueous vapor expired.

The alterations in the proportions of the several constituents of the blood are also doubtless such as would have taken place under inanition. The increase observed in the quantity of extractive and fibrin is important, but may have been accidental.

From these researches I conclude that gum, so far from having any value as an alimentary substance, is positively injurious, owing to the fact of its clogging the intestines, and thus proving a cause of irritation. As an article of food for the sick, its use should be especially condemned.

In order to facilitate comparison of the results of the several foregoing series of experiments, the following table of the means of each course is subjoined:—

TABLE X.

	Ordinary diet.	Albumen.	Starch.	Gum.
INGESTA.				
Solid	...	8343.20	16357.50	7437.50
Water	...	24598.80	26507.60	29617.50
Total	...	32942.00	36865.10	37055.00
EGESTA.				
Kidneys—				
Whole quantity of urine	20898.71	17738.50	18427.67	21538.09
Water	19801.13	16919.62	17910.69	21097.59
Solids	1097.58	988.87	516.98	440.50
Urea	694.63	715.19	215.35	297.13
Uric acid	11.67	20.76	7.53	8.81
Chlorine	138.13	8.86	16.71	19.21
Sulphuric acid	45.18	16.92	9.73	11.12
Phosphoric acid	55.85	22.04	13.66	12.28
Residde	194.37	215.19	252.86	67.16
Intestines—				
Whole quantity of feces	2293.92	3558.36	1107.80	9656.93
Water	1673.99	2968.35	886.21	3485.30
Solids	619.92	590.02	221.59	6171.62
Ether extract	90.69	13.65	36.30	19.96
Alcohol extract	95.56	114.58	31.65	15.24
Water extract	129.55	102.35	22.69	6074.87
Insoluble residue	303.18	358.94	130.95	63.71
Skin and Lungs—				
Total loss by these channels	...	14475.65	17348.54	11917.02
Total egesta	...	35841.42	36879.07	42922.02
Variation in weight[1]	...	—2894.20	—4697.00	—5817.04
Pulse	84.23	91.83	87.42	96.49
Temperature of body	97.83°	97.39°	98.81°	98.37°
Barometer	...	29.139	29.253	28.915
Thermometer	...	40.41°	6.63°	16.58°

Résumé.

From the preceding investigations, I think the following conclusions (several of which, however, are already well established) fairly deducible, and applicable to the human subject:—

1. That albumen may be assimilated into the system in such quantity as to furnish a sufficiency of both nitrogen and carbon to the organism.

2. That under the use of an exclusively albuminous diet the nitrogenous constituents of the urine are increased over the ordi-

[1] Owing to neglect to ascertain the weight of the body before commencing the preliminary series of experiments, the mean variation cannot be given.

nary average amounts, though not in proportion to the quantity of albumen absorbed into the circulation.

3. That either some other means than the urine exist for the elimination of nitrogen from the system, or the excess (over two-thirds) is retained in the organism, even when the body is rapidly decreasing in weight.

4. That the continued use of albumen as an article of food increases the proportion of this substance (and of fibrin) in the blood, and in a short time causes it to appear in the urine.

5. That whilst pure albumen cannot be regarded as of itself adequate to supply the several wants of the system, there is no reason why, when associated with suitable inorganic matters, it should not support both life and health.

6. That starch can be assimilated by the absorbents in more than sufficient quantity to sustain the respiratory function.

7. That under its use the nitrogenous constituents of the urine are very much reduced in amount, even below what would probably occur during inanition, and, that although starch is not capable of nourishing the tissues, it is yet serviceable, aside from its heat producing power, in retarding their destructive metamorphosis.

8. That the continued use of highly amylaceous food causes the appearance of sugar in the urine.

9. That under the use of such aliments the nitrogenous constituents of the blood are diminished, and the carbonaceous increased.

10. That gum is altogether incapable of assimilation, and therefore possesses no calorifacient or nutritive power whatever, but is, on the contrary, a source of irritation to the digestive organs.

11. That in consequence of the above fact, the solids of the urine during the immediately preceding researches, were entirely derived from the waste of the tissues of the body, and the carbon exhaled by the lungs from the consumption of its fat.

12. That gum, when exclusively used as food, from the irritation it causes in the intestinal canal, and the fact of its non-assimilation, induces more constitutional disturbance than either starch or albumen, and that under a similar condition starch is more productive of ill consequences than albumen.

The investigations which it was the special object of this memoir to detail, are now concluded, and are respectfully submitted to the Association.

In an essay of this character, whose chief aim is to add to the sum of knowledge, the labors of others could at most receive but a slight notice, and must of necessity frequently be passed over without even a word of recognition. Yet no one appreciates more highly than myself the self-devotion and constant striving to enlarge the bounds of science, which animate so many physiologists of the present day, and which have already yielded such brilliant results. Had I, however, attempted to do justice to even a tithe of their contributions, I should have converted this memoir into a treatise, and might have lost sight of all originality in my efforts to make a successful compilation. With what success I have prosecuted these inquiries is not for me to determine. I cannot, however, think them valueless, for, if they only excite others throughout our land to investigate in living beings the operations of nature, they will still be beneficial to the cause of that science which constitutes the basis of all medical knowledge. From the united labors of those who seek by original investigations to build up a positive science, where there is yet so much darkness and uncertainty, what may we not expect? May we not confidently look forward to the perfect enlightenment of our minds in regard to the most obscure of the vital processes? Though we may often be led astray by experiments conducted without due care, and with insufficient knowledge, they yet afford the only means by which we can successfully work out the sublime problems which the Great Creator of all has proposed for our solution.

THE HEALTH OF THE BRITISH ARMY, AND THE EFFECTS OF RECENT SANITARY MEASURES ON ITS MORTALITY AND SICKNESS.

From the Journal of the Statistical Society of London, December, 1861.

The Health *of the* British Army, *and the* Effects *of* Recent Sanitary Measures *on its* Mortality *and* Sickness. *By* Dr. Farr, F.R.S.

[Read before Section (F), at Manchester, on Saturday, 7th September, 1861.]

Lord Herbert of Lea, in the prime of life and in the midst of his labours to improve the Health of the British Army, is dead, and his loss has been felt by his countrymen, who justly appreciate the services of their departed statesmen.

The defects which had before been expressed in the lifeless figures of returns struck every heart when they appeared in the thinned ranks before Sebastopol, in the sick-freighted ships of the Black Sea, and in the hospitals of Scutari. From his position, Mr. Herbert felt these defects more poignantly than any of us, and since that time, neglecting the enjoyments which high rank and a splendid fortune placed at his command, he devoted himself to the sanitary reform of the army—first in a Royal Commission, then in commissions for carrying out its recommendations, and, lastly, as Secretary of State for War in Lord Palmerston's administration. Notwithstanding the heavy duties of that office, he continued to act in a Royal Commission; and some of his last recorded words were inquiries into the means of saving the lives of our soldiers who perish in hundreds from the bad sanitary arrangements, rather than from the climate of India.

His frank and winning manner, his knowledge, and his eloquence enabled him to overcome many obstacles; and he had some courageous colleagues, among whom I must name as the foremost Florence Nightingale who shares without diminishing his glory. The difficulties he encountered can only be understood when the history of these years is written. Labour keeps us alive, so I cannot presume to say whether his life was cut short by his harassing work; but Sidney Herbert was animated by the feelings of him in his ancestral line,* who, when he lay on the battle-field fainting and thirsty from the loss of blood, resigned the glass of water to the dying soldier with the words, "Thy necessity is yet greater than "mine." Lord Herbert—I appeal to all who knew him—loved the soldier so well, that for his sake, and to promote the efficiency of the British army, he would willingly have laid down his own life.

Happily before his death he witnessed some of the results of his measures: he learnt the marvellous sanitary success of the China expedition, he received the first annual report of the Director-General of the Medical Department of the Army, showing "a

* Sir Philip Sidney.

"remarkable reduction in the mortality of all classes of troops," and, as a good and faithful servant of the Crown, he received a signal mark of the gracious approbation of his Queen.

Lord Herbert did not think it enough to point out evils in a report; he got commissions of practical men nominated by Lord Panmure, placing himself at their head, to put an end to these evils. The results of one of these commissions are described in a report by Dr. Sutherland, Dr. Burrell, and Captain Galton, and its measures for improving the sanitary condition of barracks and hospitals are so well conceived, that they deserve to be studied by all who take an interest in the health of armies. The sanitary and medical reports of which Dr. Logan and Dr. Mapleton give samples, with the accompanying papers, will every year increase in value. The commission for introducing improvements in the vital statistics of the army, consisting of Lord Herbert, Sir Alexander Tulloch, and myself, laid down an elaborate plan for the observation, record, and analysis of the sickness, diseases, and casualties of the army at home and abroad, in peace and in war. That plan is in operation; and I request your attention to some of the results deducible from the first report.

Under the new system, an exact account is kept of the diseases of every soldier from the day he enters to the day he leaves the army; and the returns are so arranged as to exhibit the diseases of every regiment separately, as well as the amount of disability, invaliding, and death produced by each malady, and, as far as possible, by each conspicuous cause. At the end of every week the Director-General receives from each corps a return of its state and of its changes. The contrast at Aldershot on trial was found to be remarkable in different regiments, and so clearly demonstrates the utility of publication, that I trust this remarkable weekly table will ere long be promulgated. The variable sanitary state of the army is thus brought clearly before the eyes of the Medical Department, the commanding officers, the Commander-in-chief, and the Secretary of State, so that evils, instantly known, can often be suppressed as they arise. The books are now made portable, and so simplified, that they can be kept in the field as well as in barracks.

The annual report is to contain a classification of all the observations of the year, in the nosological form adopted by the Registrar-General. The first report has been prepared, with his wonted ability, by Dr. Balfour, from the old returns partially; and, therefore, presents an incomplete view of the whole subject. But the results, so far as they go, are as interesting as they are important.

The army is not in England a repressive police force: with the gallant volunteers, the militia, and the royal navy, it guards our coasts, protects the empire, and is ready to put forth the great

power of England, should the peace of Europe ever be madly broken. The lives, the industry, the wealth, and the honour of the country are safe under its standards. Friendship with all our neighbours is the desire of the whole nation; but surrounded as we are by great warlike Powers, and by dynasties kept afloat on military glory, the importance of the efficiency of the army cannot be overrated. Now that efficiency depends primarily on the health of the troops; the health being expressed by the relative numbers of healthy, sick, and dying, out of a given strength.

I first request your attention to the state of the army at home. That consists of different arms, and with embodied militia, its strength in 1859 was (omitting commissioned officers) 90,763, including, besides complete corps, detached companies of regiments in India and elsewhere, in what are called depôts; of which the advantages are, to say the least, very equivocal. The army consists of men in the prime of life, between the ages of 20 and 40, very much under control in every respect, but generally unmarried, and living hitherto together in barracks. We contended that, whereas 17 in 1,000 of these men at home had died annually, a body so selected, well fed, well lodged, and well handled, morally and physically—admitting only recruits satisfactory to the examining medical officer, and parting constantly with its invalids—should not experience a higher rate of mortality than that expressed by 8 in 1,000; the rate of mortality actually experienced by the population at the corresponding ages in the healthy districts of England. This result was nearly achieved in the corps at home in 1859. The mortality of the Foot Guards had been 20 per 1,000 (1837-46), and fell to 9; that of the infantry of the line had been 18, and fell to 8; which was also the mortality of the cavalry, the engineers, and the artillery. Some obvious sanitary arrangements were introduced, and instead of being shut up in towns, many of the men were sent to healthy camps: the above are some of the results. The annual deaths among all arms of the service at home had been 17·5; the deaths at Shorncliffe and Aldershot in the three years 1857-58-59, were at the rate of 5 in 1,000.* The previous excess was referable to zymotic diseases, such as fevers, cholera, diarrhœa—and to consumption; the effects of crowding in barracks, of bad ventilation, bad water, bad drainage, badly chosen sites, bad cooking arrangements, and the absence of the means of cleanliness.

The sanitary measures were commenced at home, but in Canada and the North American stations, in the Mediterranean, in the West Indies, in St. Helena, in the Mauritius, and in Ceylon, improvements are observable. India, where we have 80,000 English troops, remains to be dealt with by the India commission.

* "General Report of Barrack and Hospital Commission," p. 12.

The colonies of North America, Australasia, and the Cape of Good Hope, are for British troops genial climates, differing much in their meteorology, however, from England. In Newfoundland, Nova Scotia, New Brunswick, and Canada, where 4,789 troops were stationed, 43 died; and the mortality was at the rate of 9 in 1,000. Comparing the rates of mortality in the ten years, 1837-46, with those of 1859, we have these results: the rate in Newfoundland fell from 11·5 to 4·8; in Nova Scotia and New Brunswick from 16·0 to 7·2; in Canada from 17·4 to 10·4. The proportion of sick was greatly reduced at the same time. Exposure to aguish ground, the bad sanitary state of the towns, excess of spirit drinking, and overcrowding in the barracks, are noted evils in North America. A most successful expedition of troops to found the capital of Columbia was dispatched, and the selection of the site, the food, clothing, employment, instruction, and amusement were excellent; so that out of 150 men only one died, by accidental drowning. The women and children, equally well provided for, were equally healthy. Dr. Seddall gives an interesting account of this model military expedition into a new country.

The sway of the Secretary of State for War extends over the continent of North America—from Newfoundland to Fraser's River and Vancouver's Island, and it also reaches the southern hemisphere, where, in Australia and New Zealand, 2,839 troops were stationed, of whom 26, or 9 in 1,000, died.

At the Cape of Good Hope the average strength was 4,322. The mortality per 1,000 was at the rate of 11 among 3,096 men on the eastern frontiers, 12 among 562 men in Natal, and 32 among 664 in Cape Town. The latter high rate was the result of the introduction of the 59th regiment from China; so if we exclude that regiment, the mortality of the army in the Cape Colony was 12 against 16 in former years. The sickness of the 59th rapidly declined shortly after its arrival at the Cape.

Bermuda—in the Atlantic, lying between Canada and the West Indies—enjoys a delicious climate; yet there, in the year 1843, yellow fever had cut off one-sixth part of the troops serving at St. George's; and the mortality in the years 1837-46 was at the rate of 34 in 1,000. 1,074 troops were stationed on the island in the year 1859, and the deaths were at the rate of 14. The barracks are defective, and half of the force in the summer months was placed under canvas, with most salutary results.

In St. Helena—another small island, but within the tropics—465 men were stationed, and 4 died,—two by accident—the fall of a rock, and of a tree. Two invalids sent home also died. The mortality, exclusive of invalids, which was at the rate of 17 fell to 9 in 1,000. A regimental garden furnishes abundance of vegetables; and

fresh beef or mutton is issued on three days instead of two. The inferior salt beef and pork from the Cape, is to be superseded by better articles from England for the other four days of the week. The relief of the crowded barracks by encamping the men does not appear to have been resorted to: cases of fever and intemperance are noticed.

The Mediterranean stations have an island character, and the temperature is much higher than it is in England. In this sea we have 14,123 troops,—5,153 in Gibraltar, the western gate of the Mediterranean; 5,310 in Malta, interposed between Sicily and the north of Africa, on the way to Egypt; 3,660 in the Ionian Islands, lying against Greece and the opening of the Adriatic. The mortality in Gibraltar, which had been at the rate of 14, was at the rate of 8 in 1,000 in 1859. Malta was as fatal to its garrison as it had been before; 19 in 1,000 died. Out of a strength nearly equal, 40 men died in Gibraltar, and 101 in Malta. The fevers in Gibraltar were apparently increased by over-crowding; and it is worthy of remark that the 25th Regiment, 1st battalion, encamped on the isthmus, had the least number of attacks of continued fever (55 per 1,000), while the 100th regiment, recently raised, suffered in the barracks to the greatest extent (194 per 1,000). The water supply is limited and the drains are defective. But in Malta, continued fever, dysentery, and diarrhœa were much more fatal, as they caused 10 of the 19 deaths per 1,000. The water in the tanks was bad; the barracks were overcrowded; and the heat was excessive in the third quarter of the year, when the epidemic was most fatal. It was not the hot African winds that slew these troops, for the mortality was localized, falling most severely on the Rifle Brigade and on the 2nd battalion of the 23rd Regiment, quartered in the lower part of the fort of St. Elmo, which, almost on the sea-level, is inclosed so as to exclude the breezes. Across the small parade ground in front of the barrack pass the contents of the sewers from the military prisons, accumulate there, and infiltrate the earth in the neighbourhood. Offensive gases escape, and their liberation was facilitated by turning up the earth to lay down gas pipes. The fever raged until the rain began to fall, and cool weather set in.*

In the Ionian Islands also, although the general mortality fell from 18 to 13, fever prevailed in Corfu; so that while of 997 men in Paxo, Santa Maura, Cephalonia, Zante, Ithaca, and Cerigo, only 2 died; out of 2,663 in Corfu and Vido 41 died. The troops are everywhere affected by the sanitary state of the population near which they are stationed; and the sanitary state of Corfu is most defective: the sewage renders the tideless sea putrescent, and sometimes the offal of fifty cattle is thrown in a day into the seething waters from the slaughter-house at Fort Neuf. Now troops are

* See Report, p. 38—39.

stationed in that fort. Little can we wonder, then, that typhoid fever and scarlatina smote the men; so that by the former 16 per 1,000 died in the 2nd battalion of the 4th Regiment. The 2nd battalion of the 2nd Regiment had two companies under canvas at Fort Abraham, and the mortality of the regiment by this disease was at the reduced rate of 5 in 1,000.

Their causes are declared by the zymotic character of the diseases of the force in the Mediterranean: dysentery, diarrhœa, fever (typhoid or typhus), and ophthalmia. The invaliding from the stations is considerable (·008); Malta sent 20 men home with bad eyes.

One of Lord Herbert's last acts in office was to dispatch Dr. Sutherland and Captain Galton to inspect the barracks, where so large a force has hitherto suffered so much; and we heartily wish them success. They may, perhaps, by sanitary teaching in commanding points, throw light on the regions where the rulers spread ignorance and fatalism, fever and plague, around the Mediterranean sea; for those beautiful lands have in them all the elements of abounding health and life.

In the West Indies 3,659 troops were stationed, and the mortality was at the rate of 16 in 1,000; varying from 6 in Barbadoes, 14 in Jamaica, 14 in British Guiana, to 90 in Trinidad, and 20 in the other islands. The coast of tropical America is the native soil of yellow fever; and these islands of the west, extending from the Gulph of Florida to Trinidad at the mouth of the Orinoco, are subject to its visitations, as they are to earthquakes and hurricanes; but by ascending from the fertile alluvial coasts through rich valleys and magnificent forests to the heights of the mountains, we pass into salubrious fields, and breathe under a purer sky. The British troops, therefore, may, either by a happy selection of stations, be so placed as to be in little danger; or, they may be exterminated in bad barracks in the close malarious marshes of the plain. The high mortality of the troops in Trinidad was the result of yellow fever, which was apparently generated in St. James's Barracks, with its faulty drains,—scarcely ever flushed except during the heavy rains. The epidemic ceased when the troops were encamped on the savannah, and it did not spread over the island. A commission was subsequently appointed to select a hill-site; and, if troops are to be kept at all on such an island, the site about 2,200 feet above the sea-level, selected by Dr. Jameson, appears to be the most eligible.

Vegetables are furnished in sufficient abundance everywhere in the command except in St. Lucia; and the commissariat supplies fresh meat on six days, salt beef or salt pork on one day of the week. Formerly salt meat almost exclusively was given, which, by generating thirst, was an incentive to spirit drinking,—that bane of men living a listless life in the tropics.

In the twenty years, 1817-36, owing to evident causes, the mortality of British troops so moderate comparatively in 1859, was dreadful; they died through these long years at the average annual rates per 1,000 of 59 in Barbadoes, of 123 in St. Lucia, of 106 in Trinidad, of 84 in British Guiana, of 61 up to 307 in Jamaica!! At that time the troops in Jamaica "*were almost entirely quartered* "*in the plains*, where the sources of fever abound;" whereas during 1859 three-fourths of them were stationed at Newcastle, on the hills 3,800 feet above the sea, where their mortality was at the rate of 8 in 1,000; while the mortality of the few men retained on the lowlands was still at the rate of 35. This remarkable improvement in the West Indies originated in the army medical reports instituted by Sir James McGrigor in 1816, but first digested by Mr. Marshall, Sir Alexander Tulloch, Dr. Balfour; and it dates back to, and adorns the present Earl Grey's administration of the War Office. Much, however, remains to be done if the present force is to be retained in the islands, or in Guiana on the continent. Ophthalmia and miasmatic diseases will recur unless the whole of the sanitary arrangements are revised and placed on a sound footing.

The tropical island of the Mauritius, over against Madagascar, on the way to the East Indies, is, like Jamaica, mountainous, well irrigated, fertile, and the centre of storms. 1,254 troops stationed there lost twenty men by death; so the mortality was 16 in 1,000, and half of it by miasmatic disease, namely, fever, diarrhœa, and dysentery. The fever portion of this was mainly brought from India; the diarrhœa and dysentery supervened in the 2nd battalion of the 5th regiment on arriving from England. The site of the hospital at Port Louis is objectionable; but the selection of a better depends upon the colonial funds, which we may hope will be forthcoming, if 1,254 of the best British troops are kept there, for, among other reasons, the protection of the islanders.

In Ceylon 913 British troops were stationed in 1859; and the mortality, which in 1837-46 had been at the rate of 42, fell to 32 in that year. This tropical island, covered with verdure, flowers, trees, and the most varied forms of animal life, has a low maritime belt, and a table-land surmounted by lofty summits, down which perennial streams flow—or fall in cascades—through the gorges of the valleys into placid rivers. Yet the diseases—diarrhœa, dysentery, and cholera—imply that the troops get bad water; and they were in fact stationed in great numbers at Trincomalee, and on the peninsula of Colombo, where the water supply is defective. While 76 was the rate at Trincomalee, the mortality at Kandy, 1,467 feet above the sea, was at the rate of 7 in 1,000; and there can be no doubt that by good arrangements the health of the troops in future years may be sustained at a high standard in this "jewel of the Eastern seas."

We have arrived now on the frontiers of the Indian empire, where more than eighty thousand British troops are distributed over the presidencies and provinces around the Ganges and the Indus. However successful the East India Company may have been in the acquisition of territory and revenue, they did not discover the secret of maintaining in health the European troops in India. The men perished at the rate of 70 in 1,000 annually down to a recent date; and now that their numbers have been so largely augmented, the question has grown in importance. The Secretary of War had no direct control; so the army in India does not figure in the Report. Lord Herbert knew the full importance of the question as well as its difficulties; and by the command of Her Majesty a commission was constituted to inquire and to report on the sanitary improvement of the Indian army. Lord Herbert had served on commissions under administrations of which he was not a member; and with like patriotism Lord Stanley accepted the office of chairman. The sanitary reform of the Indian army Lord Herbert bequeathed, not vainly, I believe, to Her Majesty's Government.

The report, glances at China, and displays the deplorable destruction of our troops at Hong Kong, even in the year 1859. It also records the fact that, in conformity with the New Medical Regulations for Field Service, a sanitary officer was attached to the Quartermaster-General's Department to the expeditionary army, which marched unscathed through an insalubrious country on Pekin; all the wisest sanitary arrangements having been made at home, and efficiently carried out by the medical officers in China in conformity with their instructions. The commanding officers, Sir Hope Grant and Sir Robert Napier,* being men of the highest intelligence, made the new sanitary system an element of military success.

This was Lord Herbert's crowning work.

He left much unfinished abroad; and the army in India is devastated by zymotic disease. So constituted was he that his own short-comings dwelt on his mind. Still a great result had been realized in his lifetime: in England hundreds of lives had been saved; indeed, the numbers of a battalion living in arms at the end of the year 1859 would, at the previous rates, have then lain buried in their graves. Severe sickness also decreased, and the vigour of the whole body of healthier men no doubt increased in proportion.

The Report accounts for a part of the reduction in the mortality by the excess of recruits, and we know that the health of masses

* This distinguished officer, when in England, became acquainted with the sanitary proceedings in England.

fluctuates from year to year. It may go back, and the army may fall into its former unhealthy state, which was held by some people to be quite in the order of nature, as the same diseases had produced the same proportion of deaths from time immemorial. Statistics have been cited in support of the doctrine, that everything occurring successively in equal intervals through long periods of time, being governed by a law, is unalterable. The reasoning, "It has so hap-"pened in my days and my father's, and it cannot happen other-"wise," has thus received an apparent sanction from science. But true science teaches another creed. If the causes remain the same the effects are the same; and it is only when the causes are beyond human control that the effects are inevitable. Now, upon examination it is found that the great causes of the excess of deaths in the army are completely under control in all ordinary circumstances, and as they vary their effects vary, so that if the measures that have been begun, be carried out we have no fear of the result: besides, if the causes of disease be studied—under the new system of observation established by Lord Herbert—new means of guarding the exquisite mechanism of the human frame will undoubtedly be discovered.

The success of this system of observation will depend on the efficiency of the Medical Department; so after re-organizing it on a sound basis, Lord Herbert established a Professorship of Hygiene in the New Army Medical School. In his opening address at Chatham, he dwelt on the advantage of giving the medical officers such a position in the army as would enable them to apply their noble art to the prevention as well as to the cure of disease. He had made Mr. Alexander, who ably seconded all his efforts, Director-General; and, on the death of that fine and devoted officer, nominated Dr. Gibson his successor, who has offered, as the first fruits of his office, the report upon which I have commented.

The evidence before the Royal Commission proved that the health of the British army at home—of the warriors of the nation—was below the national standard; indeed, the deaths were doubled among the troops at home, quadrupled and septupled in the army abroad, including officers. The inefficiency from sickness was equally excessive; so that of *two hundred thousand men* in the estimates, probably more than *fourteen thousand* would be habitually in hospital in time of peace. In war, our armies invincible when in health, were weakened, paralyzed, or destroyed by disease. More than 21 per cent. of the victorious force in the Peninsula were in hospital;* the expeditions in the French war under the Duke of York, the Walcheren expedition, Sir John Moore's retreat, and finally the Crimean disasters, revealed the deplorable imperfections of our

* *Statistical Journal*, vol. xix, p. 247.

sanitary arrangements. The machine broke down precisely when its services were wanted.* With the evils of this rooted system Lord Herbert grappled. Unlike Candide, he did not allow that

* Marlborough possessed that real *elixir vitæ*—the art of preserving a British army in good condition; but it was lost in the eighteenth century; and this as much as the incompetency of the generals was the main cause of our military failures. Sir James McGrigor, in his autobiography, presents us with a type of the British army in the French war. He joined it at Chatham in 1794, and soon embarked for Jersey. His regiment, the Connaught Rangers (88th), infected in Chatham, was "overwhelmed with fever in Jersey," before it saw the enemy; and he, attacked by disease, had barely recovered in the country when he was ordered to embark for Ostend. Several officers and upwards of 100 men were left behind unfit for duty. At Breda fever broke out again, and 200 sick men altogether were under treatment instead of being in the ranks. The other British regiments suffered with not less severity. They were obliged to take chapels and all sorts of places for the sick. Here he saw the Duke of York. Fever again prostrated him; and after a narrow escape from death he embarked for home, convalescent. The fever-soldiers were collected at Norwich. He subsequently embarked for the West Indies. The 56th and other corps *arrived* in this unhealthy climate broken up with fever. Here he got dysentery, which then prevailed among the troops. The terrible yellow fever reduced whole regiments to skeletons. The first question put to an officer on entering the coffee room was, "who has died in "the night?" After returning to England he embarked for the East Indies. "Scarcely a month at Bombay," he says "I accumulated an *hospital full of sick*, "the prevailing diseases being *dysentery* and *hepatitis*." In 1801 he went with the British expedition to Egypt, and there he had a fever, which it was thought would be "plague," by which his regiment was smitten; and he adds, "by the blessing "of Providence alone I escaped." The army suffered also from ophthalmia, and brought the epidemic to England, where it attacked many people. At Windsor, he says "the King, from under a green shade, looked at me; I expressed my regret "to see his Majesty suffering in his eyes. 'Aye, aye!' replied he, 'this is one of "'the fruits of the expedition to Egypt.'" The British army, after it had fought the battle of Corunna (January 14, 1809), was wretchedly crowded in transports and ships of war, and upon its disembarkation filled Portsmouth with fever, which spread to the militia and the surrounding districts. The expedition to Walcheren landed upon that island on August 15th, 1809; on September 23rd, 9,046 men were sick, and after immense losses the remnant of the shattered forces embarked for England. Sir James McGrigor was dispatched to their aid, and this time was not himself disabled. Made chief medical officer under the Duke of Wellington in the Peninsula, he saw the British army attain,—after immense losses by disease and death,—vigour and health before it passed the Pyrenees. The brigade of Guards, cut up by fever and disease, was sent to Oporto, and only rejoined the army after the battle of Vittoria.

The men always fought well, even under the most incapable officers that ever commanded armies. And the terrible necessities of war are necessarily fatal to large numbers; but neither the retreat of Sir John Moore, nor the retreat to Burgos, did a tenth part of the mischief directly resulting from the bad sanitary organization of the British army, which like the late Director-General had its typhus at home,—its remittents in the Netherlands—its yellow fevers in the West Indies—its dysenteries in the East Indies—its plague and ophthalmia in Egypt—a mixture of these diseases in Spain—its fevers and dysenteries everywhere in the field. The Crimea was the culminating point; for there 39 per cent. of the force was sick on an average during seven months; and the destruction of life was enormous. A British army in health, under the command of generals of genius, such as the country always produces in small numbers, is irresistible; and as the inefficiency of the army from sickness in its expeditions retarded its triumphs, it added millions to the National Debt. Nothing is so expensive as an unhealthy military force.

he was living in the best of worlds possible. He listened not with a frown, but, as his manner was, with a smile to the antiquated pleas for antiquated abuses. He positively refused to believe in the divinity of the Guards' tub of which a Swift alone might tell the tale—in the foul latrine—in the boiled beef for the soldier's stomach seven days in the week—in the close air of barracks—in the gangrene of hospitals—or in any of the idols which had been heretofore worshipped: all were remorsely questioned, and as many as gave no satisfactory answer will ere long disappear; if they be not preserved in the United Service Museum as dread curiosities, which have, down to this date, destroyed more men in the British army than either the glittering steel, or the flashing artillery of its foes.

In his investigations Lord Herbert availed himself of the latest methods of analysis, and took counsel with scientific men; for he had no conceit, and no pretension to see by intuition what can only be acquired by the labours of a life. His opinions were therefore drawn from experience, and rested upon a scientific basis. In dealing with the soldier he had also another guide. Gentle culture, knowledge, intellect, genius, distinguish men from each other, but Lord Herbert knew that these distinctions did not separate mankind into classes of different natures, for he ever held that the rank and file of the English army were men of like passions with ourselves. He consequently seems always to have applied this test to the past practices, and to proposed plans for their moral as well as their physical improvement: "How should I feel under the same circumstances? " or how would an officer regard such a measure as applied to him?" It was a simple appeal; and to this helm his generous heart ever answered faithfully.

I have thus given you a sketch of the results of some of Lord Herbert's labours.

The worth of many men is known only to their intimate friends, as in the memorable instance of him who is enshrined in the lays of Tennyson. And the value of the measures of some of our greatest statesmen can only be expressed in general terms; but, fortunately, the deeds of Lord Herbert, if they do not dazzle us by their splendour, can be exactly appreciated, and will be expressed in figures as long as the British army shall exist. The debt which the country owes him will accumulate from year to year.

As modest in death as in life, he lies quietly in his tomb at Wilton; and what memorial, either in bronze or in marble, it may be thought right by his friends or his country to dedicate to his memory I do not know; but that which occupied the solicitude of his last hours, and which, I dare affirm, would be dearest to his soul, would be the consummation of the good work, of which it was not given him to say, It is finished: and then his everlasting monument will be a living, healthy army.

APPENDIX.

Comparative View of SICKNESS *and* MORTALITY *of the British Army in* 1837-46 *and in* 1859.

Description.	1859.			Ratio per 1,000 to Strength.				Invalided under the Terms of Completed Service. (Infantry, 21 yrs.) (Cavalry, 24 yrs.)		Constantly Sick in Hospital per 1,000.
	Strength.	Admissions.	Deaths, including the Deaths of Invalids.	1859.		1837-46.		1859.	1837-46.	1859.
				Admissions.	Deaths.*	Admissions.	Deaths.			
1	2	3	4	5	6	7	8	9	10	11
United Kingdom—	Total.	Total.	Total.	p. 1,000.	p. 1,000.	p. 1,000.	p. 1,000.	p. 1,000.	p. 1,000.	p. 1,000.
Household Cavalry	1,213	653	10	538	8·24	—	11·09	7·42	14·73	28·70
Dragoon Guards and Dragoons	8,059	7,908	64	981	7·94	962	13·64	14·64	19·87	51·13
Royal Artillery	11,508	14,877	92	1,293	7·99	1,189	13·92	—	—	—
„ Engineers	1,243	1,579	9	1,270	7·24	—	—	—	—	—
Military Train	1,139	1,439	7	1,263	6·14	—	—	—	—	71·82
Foot Guards	5,939	4,701	54	791	9·09	862	20·43	19·87	17·17	51·76
Infantry regiments	19,621	18,915	149	964	7·59	1,044	17·89	10·41	—	50·91
Depôt battalions	22,993	26,421	311	1,148	13·52	—	—	—	—	—
MILITIA	19,048	17,483	119	918	6·27	—	—	—	—	—
Mediterranean Stations—										
Gibraltar	5,153	4,889	40	949	7·76	939	13·58	10·48	—	45·90
Malta	5,310	6,446	101	1,214	19·02	1,120	19·36	8·29	—	51·81
Ionian Islands	3,660	3,225	46	881	12·57	1,139	17·94	4·64	—	44·46
North American Stations—										
Bermuda	1,074	577	15	537	13·95	1,187	33·79	4·65	12·3	35·11
Nova Scotia and New Brunswick	1,798	1,003	13	558	7·23	900	16·00	7·23	14·1	22·39
Canada	2,782	1,516	29	545	10·42	982	17·42	7·91	15·2	28·27
Newfoundland	209	278	1	1,330	4·8	781	11·54	43·01	48·3	37·10
British Columbia	150	85	1	814	6·67	—	—	—	—	—
West Indian Stations—										
Jamaica	624	833	9	1,335	14·42	—{	61 to 300	4·8	—	58·08
West Indies—										
Barbadoes	786	826	5	1,051	6·36	—	58·59	4·9	—	49·38
St. Lucia	96	113	—	1,177	—	—	122·89			
Trinidad	190	276	17	1,453	89·53	—	106·33			
British Guiana	143	156	2	1,091	13·98	—	84·07			

* In comparing the mortality of 1859 with that of previous years, Dr. Balfour has, in some cases, made corrections for difference of age. (See "Report.")

† Average annual mortality in the twenty years, 1817 to 1836.

Comparative View of Sickness *and* Mortality *of the British Army—Contd.*

Description.	1859.			Ratio per 1,000 to Strength.				Invalided under the Terms of Completed Service. (Infantry, 21 yrs. Cavalry, 24 yrs.)		Constantly Sick in Hospital per 1,000.
	Strength.	Admissions.	Deaths including the Deaths of Invalids.	1859.		1837-46.		1859.	1837-46.	1859.
				Admissions.	Deaths.*	Admissions.	Deaths.			
1	2	3	4	5	6	7	8	9	10	11
	Total.	Total.	Total.	p. 1,000.	p. 1,000.	p. 1,000.	p. 1,000.	p. 1,000.	p. 1,000.	p. 1,000.
Southern Stations—										
St. Helena	465	373	6	802	12·90	943	16·62	—	—	36·23
Cape of Good Hope—										
Cape Town	664	1,286	21	1,937†	31·6†	} 945	16·54	—	—	—
Natal	562	513	7	913	12·41					
Eastern frontiers	3,096	2,838	35	923	11·30					
Australasian Stations—										
Australia	1,380	913	16	662	11·6	—	—	} 9·86	—	—
Tasmania	{ 262 / 334 }	139	5	531	15·0	732‡	11·87‡			
New Zealand	1,125	716	5	636	4·5	518§	11·61§			
China	1,550	4,314	92	2,783	59·35	—	—	—	—	129·35
Mauritius	1,254	1,540	20	1,237	16·04	910‖	22·38‖	8·0	—	48·76
Ceylon	913	1,546	32	1,693	35·1	1,444	41·74	—	—	70·14

* In comparing the mortality of 1859 with that of previous years, Dr. Balfour has, in some cases, made corrections for difference of age. (See "Report.")

† The very high rate of mortality and of admissions into hospital in *Cape Town Station*, is accounted for by the fact that the 59th regiment which had broken down by disease in China, was sent to Cape Town on the 19th January, 1859, from which date till the end of the year it furnished 1,096 admissions and 18 deaths out of an average strength of 641 men.

‡ For the years 1839-55. § Ibid., 1846-55. ‖ Ibid., 1838-54.

Mortality amongst the Native Troops in the British Army in the Year 1859.

Stations.	Strength.	Admissions.	Deaths.	Ratio per 1,000 to Strength.	
				Admissions.	Deaths.
				per 1,000.	per 1,000.
Jamaica	807	1,034	25	1,281	30·95
Barbadoes	754	766	12	1,016	15·9
St. Lucia	103	95	1	922	9·7
Trinidad	102	78	6	765	58·8
British Guiana	301	337	2	1,120	6·6
Honduras	322	274	2	851	6·2
Bahamas	322	268	13	832	40·3
Sierra Leone	356	193	5	542	14·02
Gambia	314	205	8	653	25·44
Gold Coast	279	162	7	581	25·06
Ceylon	1,564	1,133	16	724	10·19
China	2,009	3,283	109	1,634	53·7

X.—*On the Influence of Atmospheric Changes upon Disease.*

By Arthur Ransome, M.B., *B.A. Cantab.* M.R.C.S., *and* George V. Vernon, F.R.A.S., M.B.M.S.

Read April 17th, 1860.

Two hundred years ago the remark was made to Sydenham,* and the statement holds true now, that "no physician hitherto has attentively considered the force and influence of the atmosphere upon human bodies; nor yet has he sufficiently ascertained the part it plays in prolonging human life."

From very early ages men have observed that certain diseases prevail most during certain seasons, and have ascribed to atmospheric changes an important influence upon health, but, until recently, no solid foundation of accurately observed facts had been laid.

Most of the old medical writers deal with the subject—some of them very carefully. Hippocrates devoted one of his works to "Airs, Waters and Places;" and his writings upon epidemics, and his aphorisms, abound with remarks on the influence of various states of the air upon the human frame. Since his time many others have very fully noticed the coincidence between these phenomena, as

* Letter to Dr. Sydenham, from Dr. Thos. Brady. — *Sydenham Society's Transactions*, vol. ii. p. 1.

Aretæus,* Sydenham,† Boerhaave,‡ Vitet, Ramazzini.§ Baglivi,‖ and more modern authors. Still, owing perhaps to the imperceptible and apparently mysterious way in which atmospheric changes take place, and more to the necessity for well organized and simultaneous observations in both branches of the inquiry, little further progress towards a true science of medical meteorology has been made until lately. The first attempt upon a comprehensive plan to advance this subject was made in January 1844, by adding meteorological tables, furnished by the Astronomer Royal, to the weekly returns of the Registrar General, these returns being for London only. Somewhat later, monthly returns were obtained from stations in different parts of England, and appended to the quarterly returns of the Registrar General; and from the year 1849 these stations have gradually increased in number, and at the present time there are about sixty in England and Wales. Similar returns from about forty-five stations are now added to the monthly and quarterly returns of the Registrar General for Scotland.

Some years after these returns were commenced, it was thought that more useful information might be obtained by similar comparisons with respect to disease; and in 1853 an attempt was made by some members of the Provincial Medical Association to compare meteorological tables for different places, with the diseases prevalent in those districts, but unfortunately these records were not continued for more than two years and a quarter.

In 1857 the General Board of Health in London took up this question; and from the week ending April 11*th*

* περι Αἰφαιος Ἀναγωγῆς.
† *Observationum Medicarum.*
‡ *Causes of Disease.*
§ *De principium valetudine tuenda*, cap. iii.
‖ *De aeris influxibus investigandis ac perdiscendis, ad morbos dignoscendos et curandos.*

1857, to the week ending November 6*th* 1858, they published a carefully compiled weekly return of new cases of disease in London, furnished by the voluntary efforts of upwards of two hundred gentlemen connected with the medical profession. The tables are accompanied by meteorological observations made at six stations in and out of London, and although not perfectly accurate, yet they are of great value; it is much to be regretted that they were carried on for so short a period.

Hitherto careful collation of the two classes of facts recorded in these tables seems to have been wanting; and in the present paper we have endeavoured to supply the deficiency, and to deduce from the comparison some general conclusions.

We must here state that our inquiry originated in some investigations which were made for the Manchester and Salford Sanitary Association by a committee consisting of Messrs. Curtis, Ransome and Vernon.

The method we have employed in making the necessary comparisons of the two series of observations has been as follows:

1*st*. We have projected the medical and meteorological returns upon separate charts, so as to form curves, which represent the prevalence of the disease or the state of the atmosphere at any particular time; and then, by comparing the two charts, and noticing any evident coincidences, we have been led to the conclusions specified in the paper, respecting the following diseases: Diarrhœa, dysentery, pneumonia, bronchitis and catarrh, pleurisy, continued fever, rheumatic fever, measles, whooping cough, and scarlatina.

Diarrhœa.

A high mean temperature (above 60°) would seem to have a powerful influence in predisposing to this disease;

when continuous, causing a rapid increase in the number of cases.

A temperature below 60° appears to be unfavourable to its progress.

The above action is generally most evidently shown when the temperature is above or below the average of the season.

In the spring of 1857, from April 11*th* to June 20*th*, there is a gradual, and at first scarcely perceptible, rise in the diarrhœa curve, the number of cases being comparatively very small.

The temperature in April and the early part of May is much below the average (8° on May 2*nd*), although, on the whole, gradually rising.

From June 20*th* to July 11*th* the rise of the disease curve to 2,000 cases is more rapid — the temperature is above 60°, and on June 27*th* 7° above the average.

From July 18*th* to August 15*th* there is a very great increase in the number of cases (even to 5,600), but from the latter date until September 12*th* the curve sinks at nearly the *same rate* to 2,200 cases.

The number of cases then continues to diminish, but at a rather slower rate, until October 10*th*, when it is 600.

The mean temperature during the *whole of this period*, from July 18*th* to October 10*th* is above 60°, and considerably above the average, sometimes as much as 7°. In the weeks ending July 18*th* and 25*th*, it is stationary at 68° (the highest point this year), but it then gradually falls to 63·5° on August 15*th*; and after a temporary rise in the week ending August 29*th* it continues to fall until October 10*th*, thus throughout bearing a close relation to the disease.

From the week ending October 10*th* (the temperature being 1·5° below the average) the number of cases still

remains low (still diminishing as the temperature falls until January 9*th*), and it does not again rise until May 22*nd*, 1858.

In the two weeks preceding May 22*nd* 1858, the temperature is below the average as much as 6°, but it now begins rapidly to rise, and from May 29*th* to June 26*th*, 1858, it is considerably above the average (on June 5*th*, nearly 10°).

In accordance with the rise of the temperature curve the number of cases increases, and continues to increase steadily, as in the preceding year, until July 10*th*, when it is 1,200 (on July 1*st* 1857 it was 1,400).

But a remarkable difference between the two years must now be noticed, as it affords a striking illustration of proposition (*b*).

In 1857 the disease runs on after July 11*th* to an amazing prevalence, but in the present year (1858) there seems to be a sudden arrest, the number of cases remains almost stationary for a fortnight, and then slightly diminishes until August 7*th*. When we inquire into the causes of this difference, we find that whereas in 1857, from June 20*th* to September 26*th*, the mean temperature never sinks below 60°; in 1858, for the first two weeks in July, the mean temperature is below 60°; and on July 10*th* nearly 6° below the average. It seems as if the germs of the disease were so far destroyed by the unusual cold, that even the moderate warmth that follows could not again rouse them into activity.

The mean temperature in 1858 does not remain above the average, as it did in the preceding year.

From August 7*th* to August 28*th* 1858, the diarrhœa curve rises and falls with the mean temperature, but on August 28*th* the thermometer again sinks below 60°; and although it again rises in September to 63·5°, it is accompanied by no corresponding increase in the number of

cases, — the diarrhœa agent has again received a check from which it does not recover.

Dysentery

(1) Seems to be influenced by the variations in the mean temperature, but in less degree than diarrhœa, the effect not being generally traced in the lesser undulations of the curve.

(2) Increased atmospheric pressure seems to be unfavourable to the progress of the disease, high readings of the barometer being nearly always accompanied by diminished prevalence of dysentery.

The dysentery curve rises, on the whole, from the week ending April *11th* to the week ending September *12th*. Fostered by the unusual warmth of the season, the disease seems to gather such strength that for a fortnight after the mean temperature begins to decline, it rushes on to still greater prevalence, and reaches its highest point when the mean temperature has fallen from 68° to 60·5°.

The diminishing autumnal temperature, however, seems at length to produce an opposing influence, for the disease from this point gradually subsides, with occasional fluctuations, until the week ending January *16th*. There is then a sudden temporary rise in the disease curve, the mean temperature being now above the average, but having been very variable in the preceding three weeks.

During February 1858, there is a rapid increase in the number of cases which is associated with a temperature very much *below* the average (as though great cold as well as great heat were favourable to the disease); but it must be noticed at the same time that the barometric reading during the month was very low.

The disease curve now falls until April *17th*, and continues low until June *19th* (nearly the same date as that

on which the disease took its first decided rise in the preceding year). The mean temperature has now been very high for a fortnight (from 8° to 10° above the average); and the number of cases rapidly increases until July *10th*, when it may be noticed that the mean temperature falls suddenly to 56° (6° below the average), and the further progress of the disease is checked.

After a short rise on July *24th* (the mean temperature having then again risen 5° above the average for the week) the dysentery curve now gradually subsides, with many fluctuations, until October *2nd*; and it may be noticed that the most decided rise is in the week ending September *25th*, following the unusually high temperature of the preceding week (64° or 6·5° above the average).*

Pneumonia

Seems to be very greatly influenced by the mean temperature, the disease curve rising as the temperature falls, and *vice versâ*.

The above statement receives its best illustration in the spring, summer, and autumn of the year 1857.

In the early part of the year, while the temperature remains low, the disease is still prevalent, but as the

* Hippocrates, *Aph.* 22, book iii., speaks of dysentery as an autumnal disease: "With regard to the seasons, if winter be of a dry and northerly character, and the spring rainy, and southerly, in summer there will necessarily be acute fevers, opthalmies, and dysenteries, especially in women, and in men of humid temperament." — *Aph.* 3, xi.

Sydenham mentions dysentery, amongst other diseases, "which commencing in August run on to winter."

In the report upon the status of disease, drawn from returns made at the time of the census of Ireland for the year 1851, Messrs. Donnelly and Wilde conclude that diarrhœa and dysentery prevail more in the summer and autumn than at any other season.

"They occur in the season of summer; next in autumn; less in spring; least of all in winter." — Aretæus, *On the Causes and Symptoms of Chronic Diseases*, book ii. ch. ix.

warm weather advances it gradually declines, and remains low throughout the unusually warm summer, being least prevalent when the mean temperature is highest in July and August. The number of cases begins to rise in the latter end of August, and reaches its maximum on November 28*th*, the mean temperature being then 42°.

During this period, the way in which the two curves of mean temperature and pneumonia supplement one another is very remarkable. From April 11*th* to November 28*th* (thirty-four weeks) there are only seven exceptions to this rule, and when we examine these we find that most of them may be accounted for without much difficulty.

The first of the exceptions occurs in the week ending May 9*th*, when the disease curve rises considerably, the temperature also rising, but it must be remarked that the temperature is still 7° below the average, and that in the preceding week it was 7·5° below the average.

In the week ending May 23*rd* another, but very slight, deviation from our rule may be noticed, — the pneumonia curve continues to descend, while there is a slight fall (half a degree) in the temperature.

In the week ending June 20*th* there is a temporary rise in the number of cases, together with the mean temperature, but this seems again to be accounted for by the occurrence of a temperature 2° below the average in the preceding week.

In the week ending August 29*th* there is a slight rise in the number of cases, which cannot be accounted for by any fall of the mean temperature (68° or 9° above the average). (The N.E. winds prevailed this week, following a long continuance of S.W. winds, and the degree of humidity rapidly fell.)

In the week ending September 26*th* the number of cases diminishes during a falling temperature, but in the preceding week the mean temperature was 5·5° above the

average. Lastly in the week ending November 7*th* the onward course of the disease does not seem to be checked by the temporary but unusual heat.

In the spring of 1858 the very close accordance between the two curves is not observed. Although the mean temperature falls lower than it has yet done, and the number of cases of pneumonia is still very great, yet it never again reaches the height that it did in November.

It must, however, be observed that the highest point of the curve this season corresponds with the period of the greatest cold, the week ending March 13*th* having a temperature of 35° (6° below the average), the preceding week being still colder (32° or 8·5° below the average). The waves of the disease curve apparently lay behind those of the mean temperature. (The humidity is now diminishing, and N.E. winds very prevalent.)

The mean temperature now begins to rise, and the disease diminishes in prevalence on the whole until August 21*st*, many fluctuations intervening, until with the advancing cold of the autumn an increase again takes place.

In the lesser modulations of the two curves from April 10*th* to June 26*th* (eleven weeks) there is again a very close correspondence, there being only one exception in the week ending May 8*th*; the disease curve then falling, after a short rise, while the mean temperature continues to diminish.

From June 26*th* to July 24*th* there is apparently an important departure from our rule. In the weeks ending June 26*th*, July 3*rd*, while the mean temperature is falling, the number of cases of pneumonia continues to diminish. It seems probable, however, that this may be owing to the unusual heat of the preceding week (69° or 8·5° above the average), and the discrepancy in July seems to be due to the disease curve rolling up behind that of temperature, the rise in the pneumonia curve following the unusual fall

in the mean temperature of the preceding week (to 6° below the average).

In the week ending August 21*st* the departure from our rule is very slight; the disease curve continues to fall together with the temperature, apparently in consequence of the continued influence of the heat of the preceding week, which is 3·5° above the average.

In the week ending September 18*th* the disease curve rises, and in that ending October 2*nd* it falls in accordance with the curve of temperature, but in the latter instance the preceding high temperature seems to display its influence.

Out of the seventy-nine weeks which we have now examined, twenty-three (29 per cent) exhibit departures from exact accordance with our rule; but, as we have seen, most of these are still to be accounted for on the supposition that the mean temperature influences the progress of the disease; but it seems probable that other elements, such as N.E. winds, also exercise some effect.

Bronchitis and Catarrh.

The curve of these diseases, although drawn from ten times the number of cases, is almost identical with that of pneumonia, its highest and lowest points coinciding exactly with those of the pneumonia curve.

It will be unnecessary, therefore, to trace it throughout its course, since it is evidently affected by temperature in much the same way as pneumonia.

The correspondence of the mean temperature curve with that of bronchitis is even closer than with that of pneumonia, the exceptions being only 26½ per cent.

It may be observed that in the year 1857, when the disease curve marks a deviation from the rule of temperature, it may generally be ascribed to a change in the degree of humidity, the disease curve rising as the amount of moisture diminishes, and *vice versâ*.

The chief discordance between the pneumonia and the catarrh-bronchitis curves takes place in the latter end of September and in October, which may possibly be due to the greater influence of the moisture upon bronchitis and catarrh than upon pneumonia; the degree of humidity at this time rises rapidly.

In June and July 1858, the catarrh-bronchitis curve seems to answer more rapidly to the influence of the temperature than the pneumonia curve does.

Pleurisy.

This disease is too irregular in its course to yield any information in the present investigation, as the meteorological elements under consideration do not appear to have any apparent connexion with it.*

Continued Fever.

It is difficult to trace any connection between the progress of this disease and the meteorological elements under consideration, but on the whole high temperatures seem rather favourable to its production, and extreme cold is probably opposed thereto.

From April 11*th* 1857, the *fever curve*, frequently fluctuating, on the whole ascends until November 7*th*, when a sudden fall takes place, and it sinks rapidly until February 13*th*. In the first part of its course, from May 9*th* to August 29*th*, it accompanies the rise of the mean temperature, but after the latter begins to fall the fever curve goes on rising as steadily as before for two entire months, and is not affected by the advancing cold until the week ending November 14*th*, when the thermometer stands at 45°.

* Among the seasons of the year, winter more especially engenders the disease, next autumn, spring less frequently, but summer most rarely.—Aretæus, *Causes and Symptoms of Acute Diseases*, book i. chap. x.

As though the heat had called into activity some agent which resisted moderate fall of temperature, but which was destroyed by the cold of November, December, and January.*

During the whole time of the gradual increase of the disease the mean temperature is throughout above the average.

From February 1858 the fever curve does not rise much until the week ending June *5th*, when a sudden increase of 110 in the number of cases accompanies a rise of 12° in the mean temperature.

From April *11th* 1858 to October *23rd*, there is the same gradual advance in the disease curve as in the corresponding period of 1857, with the exception of the month of June 1858. The temperature this month was excessive, and to this in a great measure must be attributed the sudden rise in the number of cases. The month of July, which followed, had a temperature considerably below the average, and this checked the rapid advance of the disease for a time; but it will be seen that leaving the month of June out of the question (as being abnormal) the curve gradually ascends up to October *23rd*, when our observations end.

Of the lesser modulations of the fever curve 61 per cent take place in accordance with the variations of the mean temperature, the disease rising and falling with the temperature; and in many of those weeks which present deviations these seem to be due to the lagging of the disease curve behind that of temperature; as in the weeks April 18, 25, May 2, June 6, 13, August 15, 22, 29, and September 5 and 25, 1857; also March 27, May 1, June 26, September 4, 11, 1858.†

* Drs. Donnelly and Wilde remark that fever, although very prevalent in spring, seldom rises to its intensity until summer and autumn.

† It takes birth when spring passes into summer, and it rises towards maturity as the year advances; with the decline of the year it declines also. Finally the frosts of winter transform the atmosphere into a state unpropitious to its existence. — Sydenham, *Medical Observations*, iii. 2 (5).

Rheumatic Fever.

The curve of this disease is not sufficiently extended to admit of accurate comparison with the meteorological curves, and therefore no decided conclusion can be drawn respecting it.

Our data, however, would bear out the observation of Sydenham: "This disease may come on at any time; it is commonest, however, during the autumn." — *Obs. Med.* vi. 5 (1).

Measles.

In its chief undulations, the measles curve seems to rise with the fall of the temperature, and *vice versâ*; and the influence of this element is best marked when it is above or below the forty-three years' average.

These two propositions will be proved by the following observations.

In the spring 1857 the largest number of cases occurs in the week ending May *2nd*, when the temperature reaches its minimum (42°) this season, and when moreover it is 7·5° below the forty-three years' average. The disease curve then gradually declines as the temperature rises until August, when there is a sudden temporary increase in the number of cases (of whooping cough also), and a considerable fall from the July temperature, although the latter is still above the average, and remains so throughout the autumn. After this temporary deviation the temperature rises to 68° (7° above the average), and the number of cases diminishes again, but continues to do so for a fortnight after the temperature begins to fall.

From September *12th* the disease curve rises gradually

while the temperature falls, and it continues to rise until November *7th*, and then falls until November *21st*, as though checked for a time by the temporary rise in the temperature of the preceding week (when it is 8° above the average). The disease attains its maximum in the week ending March *13th*,* the temperature having reached its lowest point in the week preceding, and being moreover 7·5° below the average.

The temperature now rises, and the disease diminishes in prevalence during the month of April: the week ending April *10th* alone has a temperature below the average, and the number of cases again slightly increases for that one week.

During the month of May the disease increases in prevalence, although accompanied by an advancing temperature which, however, is below the average; but after the week ending June *5th*, which has a mean temperature no less than 10° above the average, the disease curve gradually declines until July *10th*. The temperature in the week ending July *10th* sinks to 56° (6° below the average), and from July *24th* to August *7th* it is 2·5° below the average; and in all these instances a slight rise in the number of cases follows. With these exceptions, however, the disease curve rapidly declines until the week ending October *2nd*; this week the temperature sinks to 51° (slightly below the average), and the depression is immediately succeeded by a rapid increase in the number of cases.†

Comparisons of the daily mean barometer readings, during the period April 1857 to October 1858, tend to show that during the time this disease was most prevalent

* "They begin as soon as January; they increase gradually; they reach their height about the 24*th* of March; they then gradually decline, so that, with the exception of a few that may attack isolated individuals, they disappear by midsummer." — Sydenham, *Med. Obs.* i. 3.

† Dr. Mühry states that measles in the temperate zone experiences no change with the temperature.

the fluctuations in the atmospheric pressure were far greater than when it was less rife.

Measles seem to be much influenced by the same conditions as whooping cough, since it is usually most prevalent during the same seasons; and yet it is evident that this relation is not exact, since in many of the lesser undulations of the measles-curve the variations take place in the opposite direction to those of whooping cough. (This is the case in twenty-nine out of the seventy-five weeks noticed, about 38 per cent.)

On comparing the curve from April 1857 to March 1858 with the degree of humidity, it seemed that this element had some effect upon the lesser undulations of the disease-curve, since the number of cases rose and fell with the humidity in 72 per cent of the weeks; but on comparing the second period, from April 1858 to October 1858, this hypothesis is not borne out, and the coincidence may be accidental, since in one half the weeks the variations went with the degree of humidity, in the other half they went in the opposite direction. Moreover, although in October, while the degree of humidity is rapidly rising, the disease prevails very greatly, yet in March 1858, when the number of cases reaches its maximum, the degree of humidity is very low; and in September and October 1858, when the relative amount of moisture in the air is the greatest, the number of cases is at its minimum.

Whooping Cough

Seems to be much influenced by the extremes of heat and cold, the curve, on the whole, rising with the fall and sinking with the rise of temperature.

The disease remains apparently unaffected by the gradually increasing warmth of the spring of 1857, but a decided diminution of the number of cases follows as soon as the mean temperature of the week rises to 67°, which takes place in the week ending June *27th* 1857.

From June 27*th* until October 3*rd* the temperature remains high (above the forty-three years' average nearly every week), and during this time the disease is at its minimum (between forty and fifty cases per week).

The number of cases does not again increase until the sudden fall of temperature in October and November, after which the weekly average remains pretty constant until February 13*th*, unaffected by the great fall of temperature in the week ending January 9*th* 1858, but it again rises rapidly after the extreme cold of February and March (which was much below the forty-three years average).

It remains very prevalent during the spring of 1858, but the remarkably warm June appears to check its progress, just as it did in the preceding year.

It is important also to notice that an increase in the number of cases again takes place in July, the temperature being much below the average; the year before the curve declined much more regularly and continuously.

During the summer of 1858 the disease remains almost stationary, as in the preceding year; but while it may be observed that the temperature is never so high as then, the number of cases never sinks so low (seldom below sixty).*

Scarlatina.

A large amount of aqueous vapour in the air appears greatly to facilitate the formation and action of the peculiar scarlatinal poison, especially when this is accompanied by sudden fluctuations in the atmospheric pressure as shown by the barometer; a diminished pressure being favourable to the disease.

It is rather difficult to separate the influence of temperature from that of humidity, but a moderately low temperature seems to be favourable to the progress of the disease, whilst the extremes of both heat and cold seem often to exert a disturbing influence one way or the other; a temperature above the average generally diminishing, cold increasing the number of cases.

* Drs. Donnelly and Wilde remark that spring affords rather more than the average amount of small pox, measles, scarlatina, and whooping cough. *Census of Ireland for* 1851.

From May 9*th* to August 8*th* 1857, the degree of humidity remains low (below 0·7), although fluctuating considerably, and the number of cases is small; but in the lesser fluctuations the two curves rise and fall together in a remarkable manner. In the seventeen weeks from April 11 to August 8, 1857, there are only three exceptions to this observation; the first two exceptions occur together in the weeks ending May 23*rd* and 30*th*, the number of cases increasing while the degree of humidity falls, and it may be noticed that the first decided rise in the temperature occurs in the preceding week; the mean temperature then rose from 45° to 56°, and during that week and the next it remained nearly 6° above the average — the barometer regularly descending for three weeks.

The second exception is in the week ending June 27*th*, and at this time again the perturbing influence of heat seems to act, the mean temperature rises 7°, and is 7° above the average. The humidity increases, and the barometer goes down, but the number of cases diminishes.

On July 18*th* the scarlatina-curve begins to rise, and on the whole continues to do so until October 31*st*, thus accompanying very closely the degree of humidity; but in the week ending August 29*th* there is a sudden fall both in the degree of humidity and in the number of cases, the mean temperature being very high (68°) and 7° above the average.

From August 29*th* there is a steady rise in the number of cases until October 3*rd*, but the following week a slight

fall occurs, and it may be noticed that in the two preceding weeks there has also been a slight fall in the degree of humidity, and in the week ending October *10th* there is a great diminution of atmospheric pressure (barometer 29·4ins, the lowest this year), and this is at once followed by a further rise in the degree of humidity and the number of cases.

From October *10th* until November *21st*, both the curves remain high, but in their secondary undulations, instead of being in accord, they supplement one another.

In the week ending November *14th*, the highest degree of humidity accompanies a decline in the disease curve, but is followed in the week after by an increase in the number of cases. The two curves then decline on the whole until December *5th*, when the returns of disease are discontinued for six weeks.

In the spring of 1858 the degree of humidity remains tolerably high, without any great prevalence of the disease; but here again may be noticed for twelve weeks an almost exact accord between the rise and fall of the secondary waves of the two curves. There are two exceptions to this rule: First, in the week ending March 6, the number of cases continues to fall after the sudden depression of the degree of humidity has ceased. In this week the atmospheric pressure is again very small (29·6ins), and the week following there is again a sudden rise in both the disease and the humidity curve.

In the week ending March *20th* there is no material change in the degree of humidity, but the mean temperature rises 13°, and is 6° above the average, and the scarlatina-curve descends again.

During April the number of cases diminishes gradually, and on the whole the humidity-curve declines, but fluctuates remarkably, the scarlatina-curve marking these fluctuations by slighter variations in accordance with them.

An apparent exception to the rule which we have hitherto noted now takes place. From May *8th* the disease-curve begins on the whole to rise, while the degree of humidity with great fluctuations seems to descend until the middle of June (as in the preceding year the secondary undulations corresponding with those of the disease). At the same time, however, it must be noticed that the mean temperature in the beginning of May is very low (46° or 6° below the average), and it does not rise materially until the week ending June 5.

For a fortnight after this date the temperature rises, and remains very high (66°), nearly 10° above the average, while the number of cases diminishes during the same time.

From June *26th* the humidity and disease curves on the whole rise until October 23; but from July 10 to July 24 the degree of humidity falls as the disease curve rises; and here again we may perhaps trace the disturbing influence of temperature, the week ending July *10th* having a mean temperature of 56·5° (6° below the average).

In the week ending August *7th* the disease-curve rises very rapidly (sixty cases), while the degree of humidity remains low; but the preceding week the mean temperature has been 2.5° below the average.

During the four following weeks the variations in temperature would seem to have the chief influence upon the disease, the rise and fall of the fluctuations of temperature and scarlatina supplementing one another very closely.

In the week ending September 4, the barometer is very low, and the following week the degree of humidity rises considerably, while the temperature remains stationary, but there is a rapid rise in the disease curve.

The number of cases again falls greatly in the week ending September 18, probably from the action of the unusual heat, the temperature rising to 63·5° (6·5° above

the average), while the degree of humidity continues to rise.

From this time, however, until October 16*th*, the humidity again appears to exert its influence, and the curves are in accordance.

The disease curve reaches its highest point for the year (200 cases) in the week ending October 16*th*, the degree of humidity rising rapidly until October 23*rd*, but the temperature not descending much, and remaining 2° above the average.

It is interesting to observe the manner in which the curve of scarlatina supplements the curves of whooping cough and measles. "Thus they vex humanity by turns, as the constitution of the year and the sensible temperature of the air most assist the one or the other." — Sydenham.*

In the foregoing examination into the effects of the several meteorological elements upon scarlatina, it will be seen that we have ascribed to humidity the chief influence. but at the same time have carefully noted the effects of variations of temperature and pressure of the atmosphere; but it may be that we have not sufficiently indicated the reasons for our opinion.

Without very close comparison it would be very difficult to decide whether temperature or humidity had the greatest influence upon this disease. First, if we take the correspondence of the curves during the same times, we shall find that in 64 per cent of the weekly periods the number of cases rose and fell with the fall and rise of the thermometer, and in 63 per cent with the rise and fall of the degree of humidity; in 42 per cent of the periods

* Sydenham states that scarlet fever may appear at any season, but oftenest towards the end of summer. — *Med. Obs.* vi. 2, 1. He also speaks of one epidemic being driven out by another "ut clavum a clavo." — *Med. Obs.* ix. 1, 7.

these two elements might act together, the temperature falling as the degree of humidity and disease-curve rise, and *vice versâ*. Of the weeks in which the degree of humidity and temperature rise and fall together, the apparent effects, as shown in the rise and fall of the disease-curve, are almost exactly balanced, there being fifteen points of agreement with the temperature, sixteen with the humidity-cure. The fact of accordance between the rise and fall of the curves, however, must be of little importance in determining the influence of the element upon the disease, compared with observations upon the *actual state* of the air at the time of prevalence or absence of the disease.

A few instances will, we think, show that the temperature, although by no means inactive, exerts less influence than the humidity.

While the degree of humidity is at its lowest point in 1857, between June 6 and July 18, the number of cases is also the least, scarcely rising above thirty. During the corresponding period in 1858, between April 1 and July 10, although the disease is rather more prevalent than in the year before, yet the number of cases rarely exceeds fifty, and does not increase until the degree of humidity begins on the whole to rise.

Both in 1857 and 1858, when the amount of moisture in the air is greatest, the disease-curve is at its highest point.

On the other hand, a low degree of temperature accompanies both the smallest and largest number of cases in both 1857 and 1858, and the same is true of a high temperature; *e.g.* on July 18, 1857, the mean temperature is 68° while the disease is at twenty-five, and in August 1858, with the mean temperature above 60°, the number of cases remains above 100. Notwithstanding this remark, however, many of our observations will prove that temperature has an important modifying action.

Thus far has our investigation carried us. We already trace, though often but faintly, the influence of the few meteorological elements which we have studied. Taken in connection with large numbers of cases of disease, although a clearly defined and exact accordance cannot be found, still we perceive a certain general relation existing between them, and enough may perhaps have been done to prove the value of such an inquiry. The returns for several of the weeks, especially those ending August 22*nd* and 29*th*, 1857, and March 6*th*, 1858, are very imperfect; but after careful examination we do not find that these deficiencies affect the conclusions at which we have arrived. In each instance, when appreciable, the probable amount of error arising from this source had been marked in pencil upon the chart.

Before closing this paper we must state that it seems very desirable that many other branches of meteorological research should be included in the inquiry, and compared with disease; among these may be mentioned winds, electricity of the atmosphere, rain, microscopical and chemical analyses of the atmosphere. Under the last-named head regular series of observations, made at various stations with the sepometer of Dr. R. A. Smith, F.R.S., would be of very great importance.

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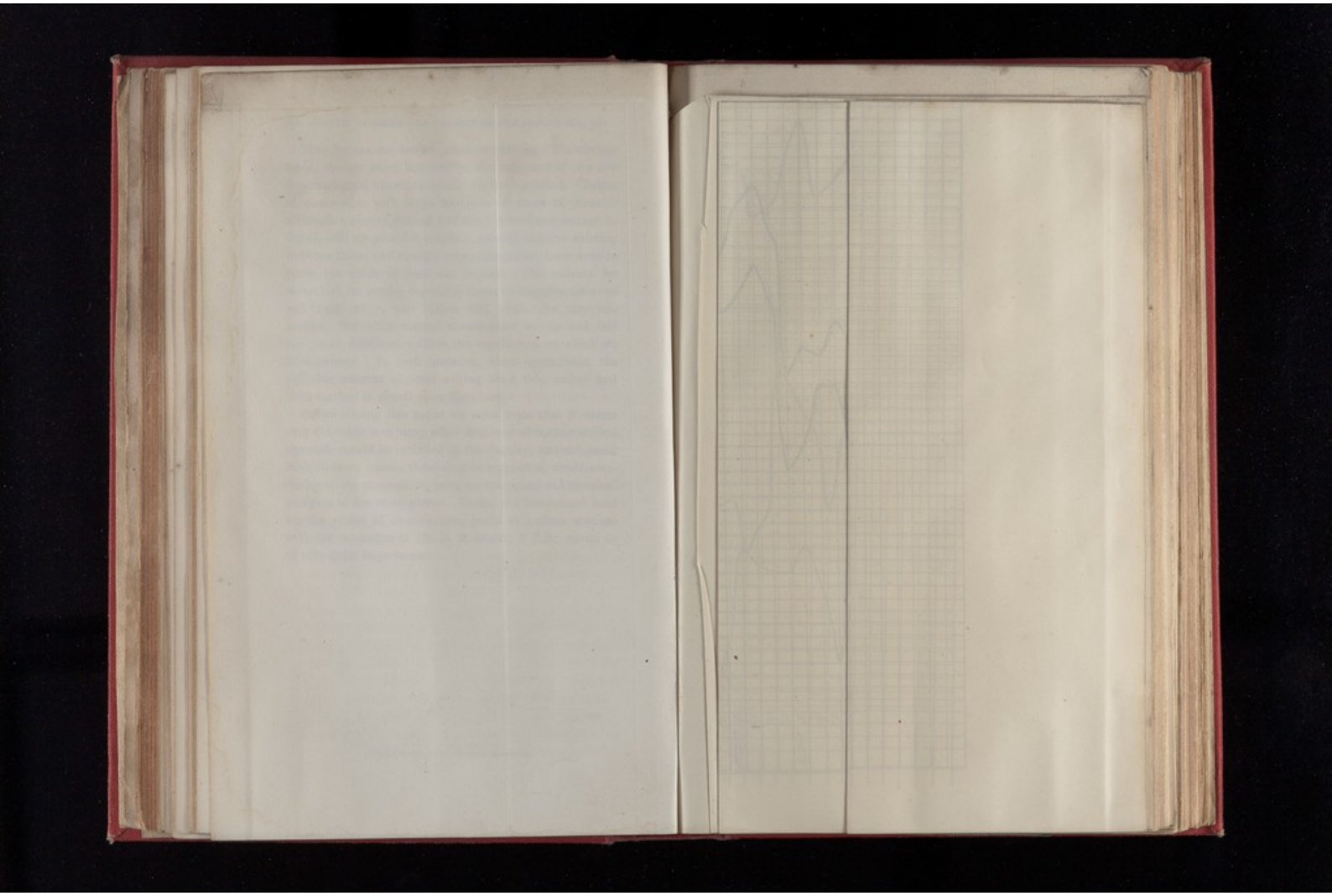

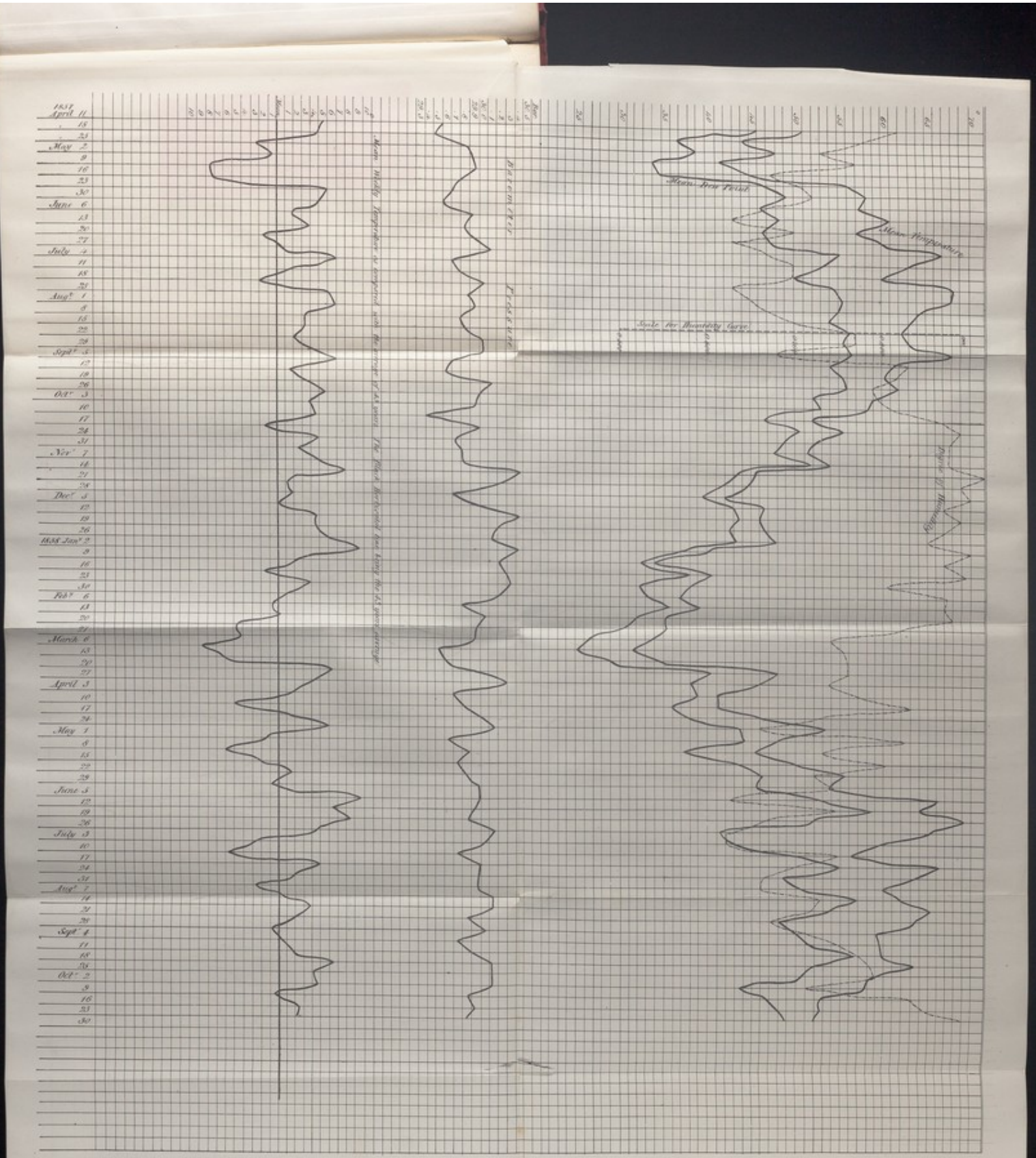
1837
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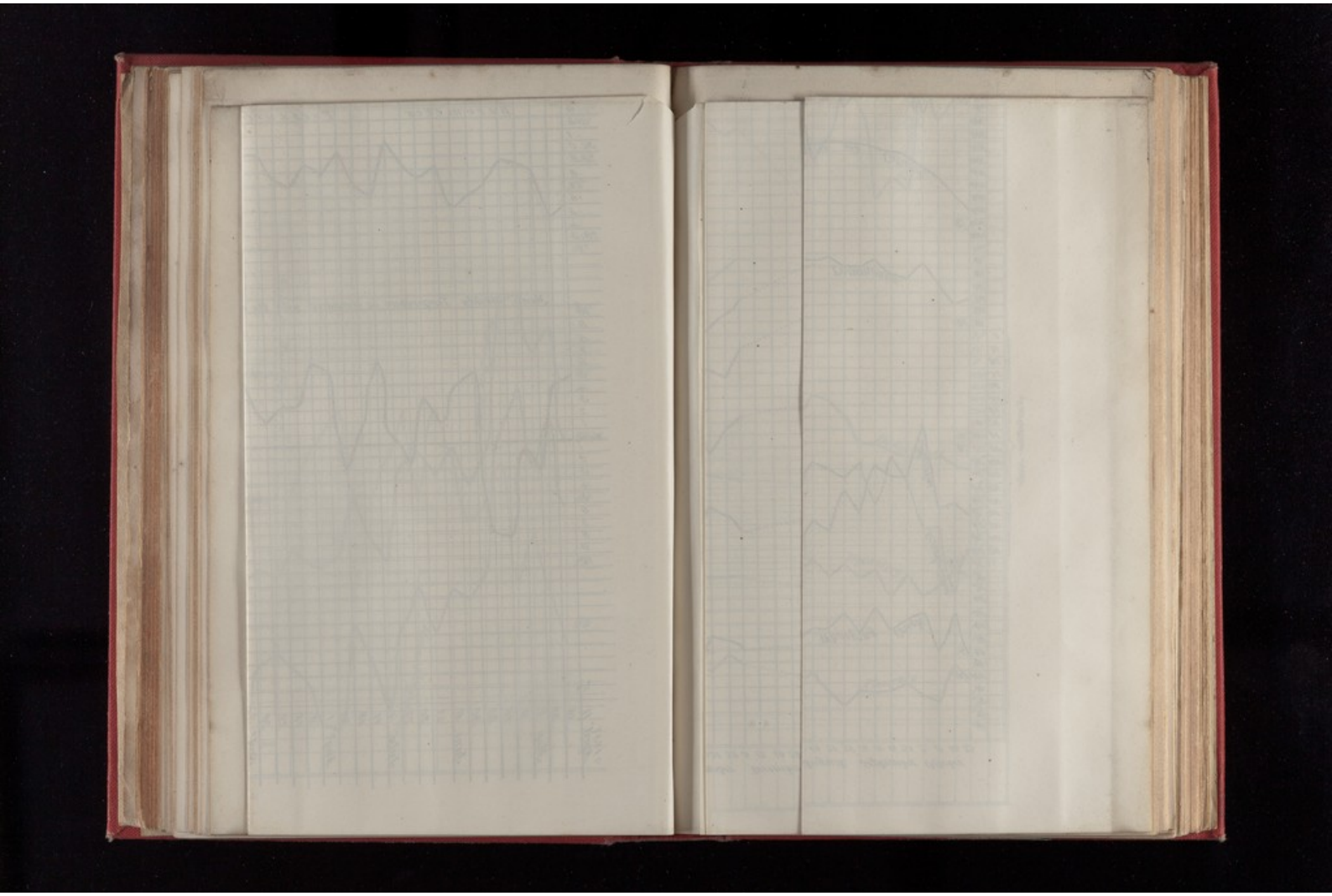
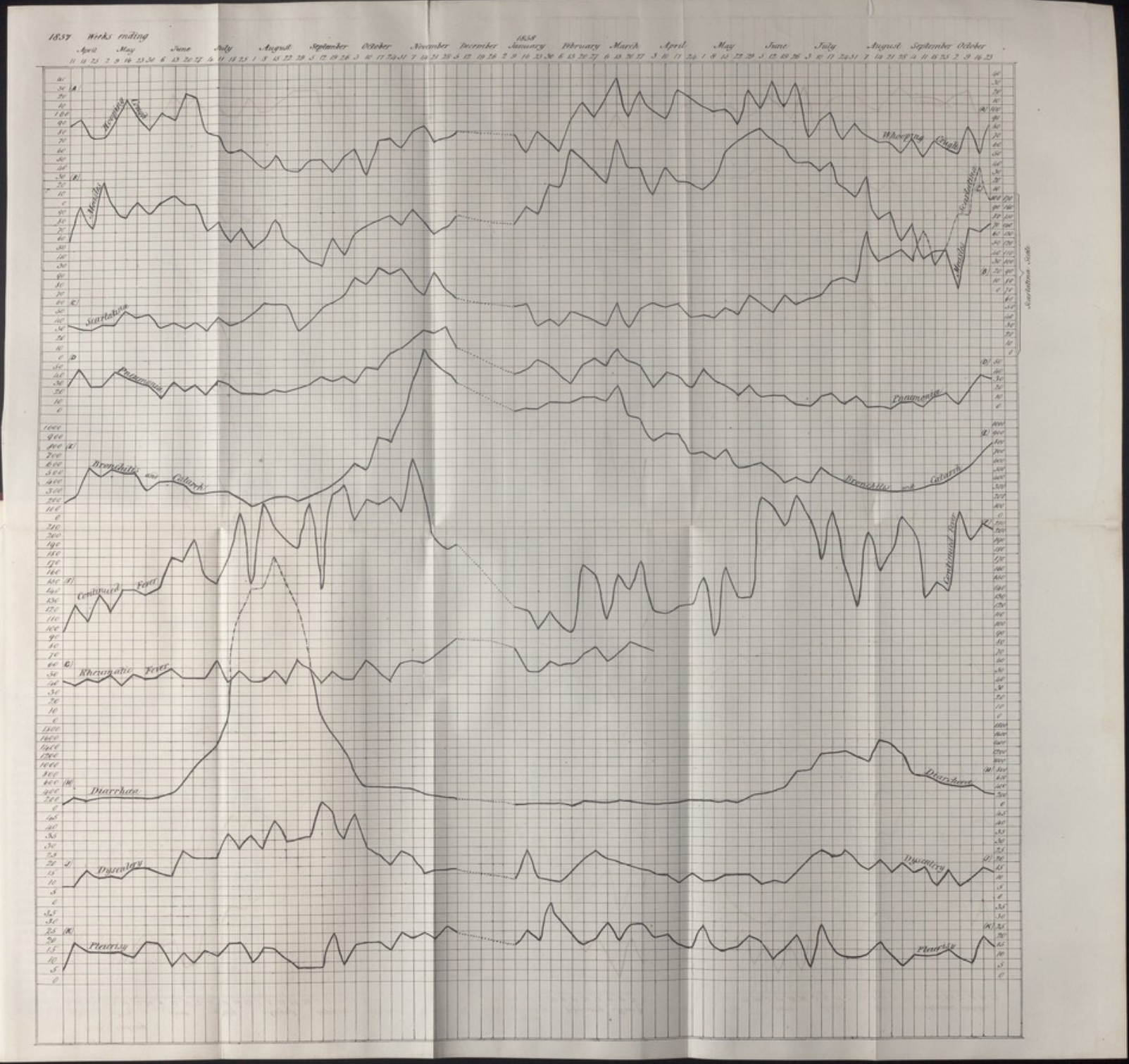
Mean Weekly Temperature as compared with the average of 15 years. The Black Perpendicular lines being the 15 years average
Barometer
Mean Weekly Temperature
Mean Dew Point
Mean Temperature
Scale for Boundary Curve
Mean Temperature of Evaporation




1857 Weeks ending
April May June July August September October November December
1858
January February March April May June July August September October
Measles
Typhoid
Measles
Scarlatina
Pneumonia
Bronchitis and Pulmonary
Continued Fever
Rheumatic Fever
Diarrhœa
Dysentery
Pleurisy
Whooping Cough
Measles
Scarlatina
Pneumonia
Bronchitis and Catarrh
Continued Fever
Diarrhœa
Dysentery
Pleurisy
Scarlatina Scale

By Dr. Fyffe
5th Dragoon Guards

A Practical Treatise on Military Surgery. By FRANK HASTINGS HAMILTON, late Surgeon, Thirty-third Regiment, Fourth Brigade, New York State Artillery; Professor of Military Surgery, and of Diseases and Accidents incident to Bones, in Bellevue Medical Hospital, &c., &c. New York: Baillière Brothers. 1861. pp. 232.

THE term "military surgery" has in these days a larger and more extended signification than it had some fifty years ago; it now embraces topics which then did not occupy much of the attention either of military authorities or of the medical officers of the service themselves. During the long peace which succeeded Waterloo, this branch of medical science made no progress, that is to say, while the purely surgical element, differing in little or nothing from the practice of civil life, increased and improved equally with it, the various other subjects embraced in military surgery,—the important questions of equipment of field ambulances, of transport of sick by sea and land, and the many subjects of vital moment involved in military hygiene and sanitary science in general,—remained neglected and unattended to. Although there had been mistakes enough in the Peninsular war, although men's lives were sacrificed in large numbers there, for the want of proper administration on these important matters, yet when that war was ended, and peace established, no effort was made to prevent the recurrence of such misfortunes, no steps were taken to establish a better system. After a forty years' peace we found ourselves suddenly plunged again into war; we took the field; British pluck and endurance were still the same; but from want of forethought, from want of taking timely advice and listening to the voices of men of experience and wisdom, every department upon which the efficiency and health of the army depended broke down, and failed utterly. How full of mean-

ing and warning are those words of Guthrie, in the introductory lecture of his Commentaries! He says, in speaking of the war in Spain:—"I have always intended, at some distant day, to notice the errors committed in the arrangement of the medical department during that war, by which so many lives were lost. Seven-and-thirty years have passed away, and the fitting time has not yet arrived. My old friends, whether civil, military, or medical, will not depart in peace; and lest I should give offence to the humblest in pretensions, I shall continue to defer my remarks until perhaps we may all go together, when it will be too late. Whenever another Continental war shall take place, similar errors will in all probability be again committed, with the same disastrous results, as far as regards the health, the happiness, and the lives of many who might be spared their miseries, if the great authorities of this country would only be pleased to allow themselves to be taught from the experience of those who have have been obliged to learn."

What a series of telling commentaries Bulgaria, with its fever, cholera, and scanty medical comforts; the Alma, without its ambulances; the transport service, without an hospital ship; and Scutari, with all its filthy horrors, furnish to those words.

If, then, we did not profit by the mistakes of the Peninsular campaign, has the war with Russia in recent years passed over, and left us still without any of the benefits of bitter experience? Have we profited by our lessons? Is the medical department of the British army more efficient than it was? Have our military surgeons more means at their disposal for the care and treatment of the sick and wounded. If we had to fight another Alma six months hence, should we require to borrow the ambulances of our allies to carry our wounded from the field; or should it happen, as we once knew to be the case, that a regimental surgeon, when visiting his sick, some sixty in number, suffering from fever and dysentery on the heights above Sebastopol, was obliged to say to them, with tears in his eyes, "My men, I can do nothing for you; I have neither comfort nor medicine to give you," verifying the statement of Guthrie, that a surgeon without his apparatus and equipment is little better than a battery of artillery without ammunition? Has anything been done to prevent on future occasions the medical officers of the British army from being charged with inefficiency not their own, or being made responsible in any way for the mistakes of a system which they cannot control?

We rejoice to know that steps are being taken to gather the fruits of past experience. The education of the rising generation of military surgeons is receiving much attention, and they are now taught the special duties of their position with care and ability. The army medical school at Chatham is an important step in the right direction. The young medical officer coming from it will join his regiment not entirely ignorant of the duties he has to perform—not the medical man *merely* (though we would never wish him for one moment to forget the importance of his purely professional duties), but the officer in whose hands are vested the obligations, not so much of skilfully curing disease as of preventing it, and of keeping those under his charge in an efficient state.

One of the best results, however, of the dearly bought experience of late years has been to call out, not only from our own countrymen, but from men of science and ability in other lands, the expression of their views on the questions embraced in military medical science. Baudens has given us the result of his experience in the French army. We have now before us, from America, a work of a practical man on the same subject. We have perused it with much satisfaction, though not without disappointment. The chapters, though pithy and to the point, are very short. There is not much new matter upon the subjects purely medical or surgical, but we have gathered together in its 213 pages all the questions of special interest to the military surgeon. To be a good and efficient military medical officer, it is requisite to combine the acquirements of a practitioner with those of a hygieist; and, when the higher grades of the profession are reached, those also of an administrator, on whose shoulders lies a grave responsibility. We, therefore, receive with pleasure this work, small though it be, which places before the student of military medical science a statement of his varied duties, and instructs him upon subjects which he will find it too late to learn when the enemy is in his front, and emergencies are arising constantly, which he must be able to meet. It is true, there may be many things in the American service different from our own, yet from these pages much that is useful and practical may be derived. There is here and there, indeed, a little touch of "Yankeeism," which sounds strange to our ears. Very many things have been omitted that should be found in such a treatise, but we nevertheless commend it to our military readers as worthy of their perusal.

The book commences with an introductory lecture on military surgery, delivered by the author at Bellevue College, in 1861. Various subjects are touched upon in this lecture. The object and end of military surgery in softening the frightful aspects of war, and mitigating its horrors, are pointed out; the importance of the army as a valuable school of surgical practice is dwelt upon,—a hint, by the way, which our own military surgeons, and those who have charge of the medical and surgical reports of the army, might do well to take advantage of. There is no doubt that the records of military medical science are very valuable, but they have seldom been given to the public. There are tomes, ponderous ones, comfortably bound and brightly lettered, standing in imposing rows on the book-shelves in Whitehall-place, from which much that is valuable and interesting might be culled. The varied experiences of well-educated and scientific men, who have recorded their views on subjects of interest to science at large, have been lying for years dusty and moth-eaten. What can be more disheartening to a medical officer, who, when on foreign service, at much labour and trouble, prepares a valuable topographical report, elaborately and carefully written, involving questions which many scientific men at home would be glad to read, than to feel that his pages are "acknowledged with thanks," pasted into the aforesaid ponderous tomes, but never read, or at best merely scanned over, and then consigned to oblivion? We do not blame the Director-General, or the officers under him at Whitehall—they cannot help it; they have had no time hitherto to do justice to the literary attainments of the officers of the department; but we know that this feeling has prevented many an able surgeon from using his pen; his efforts, he knew, could never see the light, nor add a jot to his reputation, or a farthing to his pay.

At last, however, an effort has been made to remedy this state of things; and the first yearly report of a series has been published by the War Office, containing reports on questions of sanitary, statistical, and medical science, carefully selected by the officers presiding over these branches from papers drawn up at various periods by military medical officers. This pamphlet, although it is in the form of a "blue book," a term generally sufficient to frighten away any reader, is now open to the medical officers of the army, and we do hope they will take advantage of it, and write more than they have hitherto done.

The character of Mr. Hamilton's introductory lecture is practical. He first points out the contrast between military

and civil surgery, showing that the principles are the same, that it is only in matters of detail there is any difference, the exigencies of war demanding frequent departures from the ordinary rules of practice. He teaches in clear and distinct language how the military surgeon must always be prepared for emergencies, ready to act promptly and vigorously with small means and impromptu appliances, never at a loss in moments of danger, when there is little time to think, or, rather, where thought and action must follow in rapid succession. He thus writes on this point:—

"In civil practice, the time occupied in any operation, especially since the introduction of anæsthetics, is generally regarded as a matter of secondary importance. And that mode which possesses even trifling points of superiority with reference to the final result, even though more tedious in its execution, justly claims the preference. Here we may properly apply the maxim, 'sat cito, si sat bene.' But in military practice, at least in most operations made upon the field, and where, as is usually the case, the number of surgeons is small in proportion to the number of wounded, time is of the first importance, and minor preferences must yield to major necessities. It will not do to let one man die of hemorrhage from the femoral artery because you wish to apply a ligature very methodically to the ulnar artery of another; nor to amputate a limb by circular incisions, when by oval incisions it can be done in half the time. Armand, whose noble sentiments one is frequently compelled to admire, speaking of his experience as surgeon to the ambulance of the Imperial Guard during the Crimean war, observes, 'In ordinary times of the siege, the local barracks, or the tents, sufficed. In the grand engagements, the encumbrance of the wounded was such that it became necessary to gather them into groups here and there; and God knows, then, how painful was the mission of the surgeons, who were compelled to multiply themselves to succour the hundreds, the thousands of the wounded, constantly imploring their aid!' There was but one precept then, '*Cite!* citissime!'

"General treatises upon surgery, and surgical teachers, assume that both the patient and his medical attendant are placed always under the most favourable circumstances: that ample time is allowed for a careful diagnosis; and, in view of an operation, that the patient is brought up to the best possible condition of preparation: that he is at least comfortably lodged, suitably nourished, and that his surgeon has at his command all the instruments and appliances which can render the execution of the operation more easy, and its success more certain. No man who has had much experience in teaching, and in examining medical students, can have failed to notice the danger of suggesting inferior alternatives for exceptional cases, which, through inattention or carelessness, are often substituted in

the minds of the pupil for the general law; and it is with much propriety, therefore, that these omissions are generally made.

"It is the special province of military and naval surgery to supply these deficiencies; instructing the pupil how, by a multitude of extemporaneous expedients, he may succour the wounded and relieve the sick when the usual resources fail, or are not at hand; how he may make the products of every country contribute to his necessities, and a single cruse of oil minister miraculously to a thousand."

In speaking of the practice in the American services, when a man falls in action, of sending two or three sound men from the ranks to carry him to the rear—it is not the practice in the British service—Mr. Hamilton thus writes:—

"The only real question then is as to the best mode of getting the soldiers wounded in battle to the hospital depots.

"A considerable proportion find no difficulty in reaching the depots without assistance; and it is wonderful sometimes through how small a wound a large amount of courage will ooze out. The slightest prick of a bayonet or the loss of a finger will cripple some men, and send them halting to the rear. These soldiers will take care of themselves.

"But when a man falls who is seriously wounded, and not killed outright, it is a common practice in both the American and British service for the officer in command to order a couple of soldiers to carry him off. This withdraws three men from the line, instead of one. But unfortunately it is well known that soldiers do not always wait for this authority. The commanding officer is not always where he can observe the conduct of all his men; and impelled by the instinct of humanity, they, in many instances, cheerfully anticipate the supposed wishes of their officers, and, seizing their fallen comrade, they bear him hastily from the field. The effect of this is most demoralizing; for while it actually and materially diminishes the force of the column, it diverts the attention of the soldiers and of the officers from their first purpose, especially by substituting the more delicate and enervating sentiments of humanity for those coarser but more stimulating passions, *revenge* and *ambition*, by which the courage of troops is chiefly sustained."

Now, however true it may be that men *do* fall out *very willingly* to carry a wounded comrade to the rear, and though we perfectly agree with the writer in the absolute necessity of having a special corps of men for this purpose alone, we certainly object to the spirit of the concluding sentences we have quoted. Revenge and ambition are not the feelings which actuate soldiers (at least not British soldiers) in action.

We believe it to be perfectly true that if the trumpet of peace were to sound in the midst of the fiercest engagement, among civilized troops, the opposing hosts would lay down their arms, and shake hands as friends.

But Mr. H.'s remarks upon the subject of having in the field a number of men available, in every battalion, for the purpose of carrying the wounded to the rear, and attending to them alone, are sound and practical, and have our fullest concurrence. Hitherto, in the British, as well as in the American service, this duty has devolved upon the regimental band, a duty to which these men are wholly unaccustomed, and entirely unfitted; it necessitates their leaving their band instruments in the rear, where they are lost or damaged, and they are called upon to perform duties from which many brave men shrink. In our own service a better system is about to be established; we had some lessons on this point in the Crimea, which we will not forget; the country, at all events, has not forgotten the corps of "Fogies," with Dr. Andrew Smith's large and unwieldy ambulance carriages, which came out to join the army under Lord Raglan. In three months this corps was annihilated; scarcely a man of those ancient heroes, who would have been better sitting in their own arm-chairs in Chelsea and Kilmainham, was left. Then we had the Medical Staff Corps, enlisted suddenly, and formed of vagabonds picked up anywhere, and packed off, untaught in these special duties, in batches to Scutari, and the hospitals in front, to tend sick and wounded men; no wonder Miss Nightingale called them a "set of sweeps." They too have been gradually absorbed; and now we have the Army Hospital Corps, which in time, it is hoped, will be efficient: a commission has recently sat in London for the purpose of regulating the duties of this corps, both in the general and regimental service. The recommendations of that commission have been fully approved by the War Office and Horse Guards, and are now officially published for future guidance, and we have no doubt, when sufficient time has elapsed to allow the system to establish itself, that much comfort to the sick and wounded on future occasions will result.

Mr. H. argues, in able terms, the claims of the medical officers of the American army and navy to a better social position. They appear to suffer in America from very much the same disadvantages our own officers labour under; and the acts of an enlightened legislature for their improvement seem to have been met with jealousy and opposition, from the same source as

in our own service. It is a well-known fact that the bitterest foes to the advancement of the medical officer are his own executive brother officers, his social companions at the mess, the men who have shared danger and discomfort with him, and at whose bedsides he has, many a time, watched with an anxiety for which he got little credit and less thanks. In our service these questions of rank and pay have long been discussed; the warrant of 1858 placed medical officers in a better position, but the privileges of rank and position excited a hurricane of jealousy among their brethren of the sword, and attacks were made on all sides on this warrant, the result of which has been that it has been shorn of its best parts, and tampered with, to meet the views of those who found that it affected their own selfish wishes. That which was considered an inviolable compact between the government and a scientific body of men has been broken, and the confidence of the medical department in their rulers and lawgivers has been destroyed. For this the Director-general is not to blame; both Dr. Gibson and his lamented predecessor have done their utmost to prevent it; and we do not hesitate to say, that if such narrow-minded policy be persevered in, the medical department of the British army will fall in efficiency and credit, and its ranks will not be filled by men of education and ability. The words of Lord Dalhousie, quoted at page 29 of Mr. H.'s introductory lecture, should be well considered by our Government.

The second chapter, on the examination of recruits, is very clear and concise; Mr. H. enters into a minute detail of all the causes of rejection. The examination of the recruit is one of the most important duties of the regimental surgeon; he can scarcely be too particular or careful in its performance; for his own sake he will be so, and it is necessary for him to have his mind fully instructed upon all the different causes which may render a recruit ineligible, sometimes difficult to detect, and often purposely concealed. We particularly notice the mode of examining a recruit copied from a Manual prepared by Dr. Tripler, U. S. A., as affording a systematic plan of inspection:—

"We have remarked that certain defects can be ascertained only by questioning the man himself, and that, in order to avoid all subsequent evasions, the answers to these questions should be recorded on the spot. We shall now suggest a method of effecting this object, as well as of making it sure that no important part shall escape inspection through any slip of the memory.

"The following printed form is to be furnished, upon which the observations of the inspecting surgeon are to be recorded as they are made.

"Recruit A. B.
"Age Years,
"Occupation,
"Born in
"Presented by
"1. Have you ever been sick? When, and of what diseases?
"2. Have you any disease now? (Such as diarrhœa, cough, and the like.)
"3. Have you ever had fits?
"4. Have you ever received an injury or wound upon the head?
"5. Have you ever had a fracture, a dislocation, or a sprain?
"6. Are you in the habit of drinking? or, have you ever had the 'horrors'?
"7. Are you subject to the piles?
"8. Have you any difficulty in urinating?
"9. Have you been vaccinated? or, had the small-pox?

"Head.
"Ears.
"Face.
"Eyes and appendages.
"Nose.
"Organs of mastication and voice.
"Neck.
"Chest.
"Abdomen.
"Genital and urinary organs.
"Vertebral column.
"Superior extremities.
"Inferior extremities.

REMARKS.

"(Approved or rejected as the case may be.)
"Date.
"Rendezvous.

"*Inspecting Surgeon.*"

We think, however, the author has made one mistake in not touching upon the question of the discharge of soldiers. We do not know the rules by which this important part of the duties of medical officers is guided in the American service, but we cannot help regretting that some remarks were not made upon this subject, for the benefit of his younger readers.

In the third chapter, on the general hygiene of troops, a matter which of late has occupied much of the attention of our own government, the author considers, in four short sections,

the questions of diet, cleanliness, dress, and exercise. We must here observe, that it is evident this book is intended principally for the guidance of medical officers serving in the field, else we cannot think Mr. Hamilton would have been silent on many of the most important points of hygienic management. For example he has not touched at all on the subject of vaccination, and re-vaccination of soldiers; he has omitted also to speak of venereal disease, the curse and bane of every army: we would have been glad to have known if any measures had been adopted in the American service to stay this plague, when we reflect that more than half the sick of our own army, at home, are suffering from this malady, and that hundreds of young soldiers are discharged, yearly, from the service in consequence of it; and judging that matters may be somewhat the same with our cousins, we cannot but regret that we have not been favoured with the views of an experienced surgeon upon a question of such vital importance to the efficiency of an army.

On the subject of diet, in the first section of this chapter, we think it a pity the author did not introduce the scale of the soldiers' daily rations, and hospital diet, used in the U. S. Army. In our own service, the soldier in time of peace has sufficient food, and generally of good quality; the great drawback to his comfort is bad cooking; the men are not properly taught to cook. Aldershot professes to do it; flying brigades march from that camp, in the summer-time, on expeditions of a week's duration, to Woolmer Forest, Sandhurst, and other places in the neighbourhood; and it is likely the men learn in their marches something about the preparation of their own food; but the instruction is insufficient. We are not a nation of cooks, like our neighbours in France; few of us, even in Ireland, know how to boil a potato; and when we have seen the messes of our soldiers in the barrack-room, we have had great reason to regret that they have not been better taught upon a subject so nearly connected with their comfort. We are very glad to observe in the appendix to the work before us, at page 215, ample instruction on the subject of camp and hospital cooking. This may be considered a matter beneath the notice of a medical man: it is not so; the military surgeon, who has passed much of his time in active service, well knows how much of the comfort and health of the troops under his care, as well as that of the sick themselves, depends on an efficient cuisine.

The second section, on *cleanliness*, is very short and meagre. This is an important item in the sanitary condition of troops: no one unaccustomed to soldiers, would believe the amount of dirt which often lies hid under that array of pipe-clayed belts,

and polished buckles, and tightly-fitting tunics. When soldiers are quartered in barracks not supplied with baths, or where they cannot have the advantages of river or sea-bathing, dirt accumulates rapidly on their persons. We wish Mr. H. had enlarged on this point, and given the weight of his authorship in impressing upon military authorities in general the importance of providing ample bath accomodation in every barrack.

The section on dress is interesting; but it is evident the question has not been so publicly discussed in America as in England; and yet, in what have all our discussions ended? The old institution of the "leather stock" remains *sacred*. The guardsman holds like grim death to his bear-skin, and in consequence occasionally drops dead in the ranks on the march. Our semi-denuded friends, the Highlanders, still strut in the "garb of old Gaul,"—very picturesque, it may be, but not always useful or comfortable, and certainly never decent. We have seen many a stalwart Scot under arms, his teeth chattering with cold, trying in vain to pull his scanty petticoats over his shivering knees, realizing too well the play upon words, that the difference between an Irishman and a Highlander before Sebastopol was, that the latter was cold with the *kilt*, while the former was *kilt* with the cold? We were much amused the other day, when witnessing a sham-fight, with a column detached from Aldershot, near Woolmer Forest,—a distinguished Highland regiment was advancing up a hill over very rough heathery ground, well studded with thistle and furze; the regiment was ordered to "lie down," as the enemy had opened fire in their front; it was easier said than done, for men so scantily protected with garments; whereupon the colonel apologised to the general, that it was rather an uncomfortable spot for kilties to squat in and certainly Sandy seemed to think so himself. Surely sufficient nationality might be maintained without subjecting the men to so much discomfort. Let the deer-stalker wear it if he likes; let Cameron, and Farquharson, and Frazer, perform their war-dances in their native glens, in whatever war paint they choose; but, in the name of common sense, and comfort, and decency, give the soldier his *trowsers*, and cover his legs like those of other men.

We pass over the chapters on hutting, barracks, and hospitals, which do not contain much that has not been already openly discussed in our public journals; and that on the hygienic management of troops on the line of march, which we think the best and soundest, most useful and practical in the

book. The young medical officer may study it with much advantage, there being few places where his forethought and carefulness are more required, than when troops are marching.

The next chapter, on the conveyance of sick and wounded soldiers, is one of interest; the subject is all-important; any medical officer who served in the Crimea, and marched with the army from its landing to the heights of Inkerman, must have seen the misery caused by insufficient means for the conveyance of disabled men; and yet, strange to say, this question is not settled yet by our own authorities. It is true, in the medical regulations of the British army it is laid down that each battalion in the field of 850 strong is to have the following—

For medical panniers, ...	1 mule.
Cart for surgical equipment, ...	2 Do.
Ambulance car, to follow in rear of the battalion, and capable of carrying from 6 to 8 sick, with 14 stretchers, and light operating table,	2 Do.

And so on for a brigade of three regiments, and a division of six regiments, in proportion; but, to the best of our belief, these equipments exist on paper only; we do not believe the pattern of the cart, or the car, is even decided upon; and we cannot but fear that, if preparations of this kind are not made to some extent at least in time of peace, they will not be forthcoming when required for war.

In Mr. Tufnell's museum, established by him with so much industry and care, and most generously transferred by him to the army medical school at Chatham, very many specimens of inventions for the conveyance of sick and wounded are collected; mechanical contrivances of varied kinds in the shape of cars and carts, stretchers, ships' bunks, panniers, portable operating tables, tents, and huts, and apparatus for field cookery; and scarcely a week passes without some new invention arriving at Whitehall Yard for the inspection and patronage of the Director-general. With regard to the ambulance car to follow every battalion on field service, we know nothing better than the one invented by Mr. Tufnell himself; we have seen this ambulance, and believe it is at present in the carriage department at Woolwich, where we hope it will be taken as a pattern for the regimental equipment. It is in a form familiar to Irish readers, namely, a Bianconi's car, and is furnished with every particular requisite for a battalion. We would be glad, not only for the credit of our fellow-citizen, but for the advantages it would bring to the service, to see it paraded in the rear of every regiment proceeding on active service.

The difficulty of obtaining a field-stretcher or litter, sufficiently portable and light to be easily carried, and at the same time strong enough to bear a man's weight, has long been felt; invention seems almost exhausted on this matter. As a rule, the simpler these contrivances, the better. In the equipment of the army hospital corps, we trust the authorities will see the necessity of furnishing them well in this particular. We have seen lately a litter invented by an officer in the household of the Emperor of the French, which is one of the best that has come under our notice. The stretcher consists of two parts; each man carries a "half" attached to his knapsack; and when any two men meet, the stretcher is complete. It is strong, and very portable; we have seen it tested, and believe it to answer the purpose admirably; and we hope to see it permanently introduced into the service of the army.

In section 4 of this chapter, on conveyance of sick and wounded, there is a description which we quote of a wheeled ambulance invented by Mr. Cherry, which appears to possess many advantages, and has met with the approval and commendation of Sir George Ballingall.

"Of the various plans, Ballingall thinks that the carriage invented by Mr. Cherry is by far the most ingenious which he has seen. It is intended as a 'hospital and commissariat' transport at the same time; and since the wounded need generally to be carried in a direction opposite to that in which the provisions, forage, etc., are to be carried, this may convey the latter to the army and bring back the former.

"It is a light single-horse cart, so constructed as to be readily adapted either to the carriage of stores and provisions, or to the conveyance of wounded men; for these two different purposes a great part of the frame-work is moveable, and capable of being adapted to the object required. A number of moveable spars or poles are stowed on the outside of the cart, which may in a few minutes be unpacked and placed upright round the frame-work, adapting it to the carriage of bulky articles of forage, such as hay or straw. Some of these spars, again, are fitted to be placed as ridgepoles on the top of the uprights, for the purpose of supporting a canopy for the protection of the sick or wounded. It now becomes a most commodious sick-cart, capable of conveying one person lying at length on a board within, or four men sitting erect on seats, which are suspended from a rope running round the interior of the cart, and giving the advantage of its elasticity in addition to the springs. The seats, when not used for this purpose, form a moveable part of the bottom of the cart, under which are boxes for containing the bearer and canopy when not wanted for

their respective purposes. The most ingenious part of the contrivance is that by which the ordinary springs of a cart or other carriage may be protected from injury when carrying heavy loads, while at the same time it admits of their free use when light loads are carried. This is effected by two moveable blocks sliding along the axle-tree; and which, by means of a lever connected with them, may either be moved outwards under the frame-work of the cart, so as to make its weight bear directly on the axle without injury to the springs, or, by turning the lever in an opposite direction, the blocks may be withdrawn from under the side-pieces of the cart into the hollow space formed by their thickness, and the springs thus again brought into action."

This closes the author's examination of those subjects not purely medical or surgical,—the adjuncts, as it were, of military surgery, without a competent knowledge of which, the surgeon, be his professional skill what it may, is only half-instructed, only half-prepared to meet the exigencies of a battle-field, or to contribute to the maintenance of the efficiency of those committed to his charge.

In chapter 9, on gunshot wounds, Mr. Hamilton first treats of the eccentric course which balls sometimes take after impinging upon the surface of the body; he does not cite any cases from his own experience, but relates the well-known one reported by Hennen, of a ball which struck the pomum Adami, and was found at the orifice of entrance, having gone completely round the neck.

Balls are easily deviated from a straight course after striking the body, especially if they come in contact with bone. Surgeon-major Matthew, in the report of the army medical department for 1859, relates a case of a soldier of the 86th regiment who was wounded at Jhansi by a musket-ball, which perforated the left triceps muscle, from without inwards, apparently grazing the humerus, and thus obtaining a rotatory motion, then entered the left side of the belly, over the eleventh rib, does not appear to have injured the rib, but to have hugged the skin, and made exit towards the opposite side of the body, and after a passage of 9 inches, making its exit through the muscles arising from the internal condyle of the right humerus; in this case, complete paralysis of extension of the little finger, and partial paralysis of the ring-finger of the left hand ensued.

The question may here be asked, Has the character of gunshot wounds been altered or modified by the changes and improvements which of late years have taken place in projectiles? Mr. Hamilton states his opinion on this point thus:—

"The peculiar shape, great velocity, and rotary motion of conical balls impress certain characteristics upon the wounds which they inflict. They seldom deviate from a direct course after entering the body, nor do they often split; they produce great comminution of the bones; and when the range is short, the wound is generally smaller than that made by the round ball; but if the range is great, and the part thinly covered with soft tissues, then the wound is larger, especially at the point of exit; and more lacerated."

While we agree in some respects with this statement, we have at the same time reason to believe that the wound produced by such a bullet as that used in the Enfield rifle, which generally expands as it leaves the barrel, is larger and more lacerated than that inflicted by the circular ball.

With regard to the extraction of bullets, Mr. H. speaks highly of a forceps invented by Tiemann of New York. He gives a sketch of the instrument, but he also plainly states the great disadvantage belonging to it; namely, that the blades being furnished at their points with small teeth, like the incisors of a mouse, intended to pierce the projectile, without the necessity of grasping its entire calibre, are consequently available only for the extraction of leaden balls, and would be useless in the removal of splinters of shell or small grape-shot. There have been numerous inventions and improvements in this important instrument of late years. Mr. Weiss has invented an excellent one; Coxeter has produced his; Mr. Tufnell has likewise contributed to the surgeon's armoury in this particular; they have each their separate advantages and peculiarities. Without stating our preference, we think that no military surgeon should be content with having only one description of bullet-extractor in his case: if he fail with one, he may succeed with another.

The following is the author's procedure in arresting hemorrhage, after the removal of the missile. To this treatment we have nothing to object, save the use of the persulphate of iron: if, as Mr. H. asserts, he has seen evil consequences arise from its use, we think it had better be omitted:—

"Having removed the missile, it may become necessary, yet such is not often the fact, to take measures to arrest the hemorrhage. If it is slight and proceeds from small vessels, cold or iced water may suffice; or if it is more considerable, we may sometimes resort to moderate compression; or, what is usually much better, to the persulphate of iron. This, diluted one-half or more, may be injected into a deep wound by the syringe with which I have supplied my field-case, or it may be laid undiluted on an open bleeding surface with a camel's hair brush. I have seen the persulphate of iron, injected into the cellular structure produce inflammation; it is not, therefore, so innocuous as that it can be thrown into the long track

of a bullet, without some chance of its doing mischief. When the vessel is too large for the bleeding to be restrained by these means, we must at once proceed to tie the artery from which the hemorrhage proceeds—in the wound if we can—and perhaps that can be done by laying it freely open; but if we cannot reach it here, we must cut down and tie above.

"If a tourniquet becomes necessary, we prefer the ordinary screw tourniquet, invented by J. L. Petit.

"In an emergency we may employ as a substitute the simple field tourniquet, composed of a strap and buckle, either with or without a pad; or a simple cord, twisting it tightly with a stick, a pistol, or any short weapon.

"Ordinarily no other treatment or dressing is necessary for a gunshot wound, than to lay upon it a piece of lint saturated with cool or cold water. Sometimes, however, the condition of the parts demands that the applications should be warm, so as to encourage the return of its vitality.

"Baudens, who served in the Crimea, recommends ice as a first application. The English surgeons in the same expedition employed the water dressings to the exclusion of almost everything else; but Surgeon McLeod thinks that 'when inflammation and suppuration are present, *hot* applications will always be found of most good.'

"If water irrigations are employed, a very simple method is to bore with a gimlet a hole in the side of a pail, near the bottom, but not so near as that the dirt which settles in the pail will escape through the hole. Insert into the opening a piece of a goose-quill, and draw through this a few threads of common candle wicking. Placing the pail upon a table, or suspending it above the limb, the candle wick terminating upon the piece of patent lint with which the wounded member is covered, the water diffuses itself gently and equally over the whole surface."

With regard to gunshot wounds of the head, the author cites the following most extraordinary case:—

"Gunshot wounds of the head are generally fatal, whether the ball passes entirely through or remains within the skull, and this is especially true of gunshot wounds of the anterior half and base of the brain. Yet the exceptions to this rule are numerous. One of the most extraordinary cases of recovery upon record, probably, is that of the man Gage, who was shot through the head with a tamping iron, three feet seven inches in length, one inch and a quarter in diameter at its largest end, and weighing thirteen pounds and a quarter.

"The accident occurred in 1848; and Dr. Harlow, of Cavendish, Vermont, in whose practice the case occurred, described the wound as commencing just anterior to the ramus of the inferior maxillary bone of the left side, taking a direction upward and backward toward the median line, passing through the left anterior lobe of the cerebrum, and making its exit at the junction of the coronal and sagittal sutures; lacerating the longitudinal sinus; extensively fracturing the frontal and parietal bones; breaking up a large portion of the brain, and protruding the globe of the left eye from its socket by nearly one-half its diameter.

"In 1860 this man was still living, and in the enjoyment of good health, with no impairment whatever of his mental faculties."

After this, we think, no case of injury of the head need be despaired of; truly the freaks of nature are very remarkably illustrated in cases of this kind. In the Pathological Museum of the British Army at Fort Pitt, there are some curious specimens of severe injuries of the head which did not cause death at the time. There are several instances of fracture of the cranium with extensive depression of the inner table, but which were not fatal at the period of the infliction of the injury; and the writer of this review remembers to have met a soldier late in the evening of the action of the Alma, walking about the village of Bulganak, with a bullet driven into the centre of his forehead. Such cases are inexplicable; it is difficult, if not impossible, to assign a reason why one man will be rendered insensible, and death will result from a fracture of the skull which can scarcely be discovered; while another, who has suffered an injury so severe that at first sight hope seems extinguished, will recover safely and rapidly.

Mr. Hamilton analyses at considerable length the relative merits of hot and cold applications to gunshot wounds, giving the opinions of experienced men upon the subject. When we reflect upon the difficulty of obtaining any other than cold applications on the field, we can hardly imagine how there can be any choice in the matter.

The chapter closes with some practical remarks upon penetrating wounds of the thorax—these are trying cases; the surgeon can do little in the way of manual interference; but Mr. H.'s views are sound and clear:—

"The examination will therefore consist, generally, in a limited exploration of the track of the wound, especially with a view to determine whether any pieces of clothing have been carried in, and in an inspection or careful digital manipulation of the opposite side of the thorax. Auscultation is only serviceable at a later period, nor can it be practised satisfactorily during the agitation usually consequent upon such an injury. Bloody expectoration furnishes almost positive evidence that the structure of the lungs is penetrated. The absence of this sign, however, is not proof so positive that the lungs have not been penetrated.

"The treatment consists in covering the wound with a pledget of lint, saturated with cool water, the employment of sedatives, and of antiphlogistics. The patient must be requested to lie upon the wounded side, or in such a position as that the orifice shall be depending, unless the wound is on the front of the chest. Often this is impracticable, certain positions being more painful and interfering more with the respiration than others. We have no choice then but to leave the patient to adopt that position which he finds most comfortable."

His remarks upon the "expectant" treatment of wounds of the abdomen are also of value:—

"To give to our patient, therefore, the best chance of recovery, we have to pursue an almost expectant plan. He must be laid upon his back, with his body a little flexed; a piece of adhesive plaster should be made to close the wound completely; he should be allowed no drink or food for several hours, unless it be a little ice-water or small pieces of ice at intervals. Everything received into the stomach, however bland, is apt to excite peristaltic motion, and to endanger extravasation; no cathartic or even enema; he should not be permitted to turn to the right or to the left in bed, or get up for any reason whatever. If he suffers much pain, opiates and poultices may be necessary; and eventually leeches or the lancet may be demanded."

But on two points we differ from him entirely—first, as to closing the wound with adhesive plaster, which, when the intestine may be perforated, should never be done. The wound, on the contrary, should be left open, and, if necessary, enlarged, to favour the exit of extravasated matters; for the viscera of the abdomen so completely fill the abdominal cavity, that if there be free exit through the wound, there is little danger of any matters effused from a wound of the intestines passing into the general sac of the peritoneum; and, secondly, we would have recourse to the free use of opium from the very beginning.

We now proceed to the question of amputation, discussed in chapter 10, which contains many points of practical importance. In the first instance Mr. Hamilton lays down the cases demanding amputation in army practice:—

"There are several questions relating to amputations, which need to be considered briefly, and in their proper order.

"First.— *What conditions of the limb in army practice demand amputation.*

"Simple fracture of a limb, it is unnecessary to say, does not demand amputation.

"A fracture complicated with considerable laceration of the skin, or of the skin and muscular tissue, does not of necessity demand amputation.

"A fracture, with laceration of the main arterial trunk supplying the limb, does not necessarily demand amputation. If the artery can be tied, the limb may be saved, and the fracture treated successfully.

"A fracture, accompanied with the laceration of one or more of the principal nervous trunks, does not always demand amputation, yet it is a graver accident than the one last supposed.

"A fracture, complicated with a destruction of both the principal arterial and nervous trunks, occurring in the course of a large limb, like the thigh, the leg, the arm, or the forearm, renders amputation necessary.

"Similar lesions, without a fracture, render amputation almost equally imperative.

"Comminuted fractures, accompanied with extensive lesions of the soft parts, or with a rupture of either the principal artery or the principal nerves, in the case of large limbs, generally demand amputation in army practice.

"Compound fractures, with either of the above complications, in large limbs, generally demand amputation.

"Compound fractures of the *femur*, without other complications, in army practice, *generally* demand amputation.

"Fractures accompanied with extensive and violent contusion, demand amputation oftener than the same fractures accompanied with open laceration.

"In army practice, gunshot wounds which penetrate the shoulder-joint, the elbow-joint, or the wrist-joint, demand either amputation or resection. (Guthrie says, that an arm will endure almost any amount of injury, without demanding amputation.)

"Gunshot wounds penetrating the hip-joint are generally fatal, yet amputation may be practised under some very favourable circumstances. Resection also presents a feeble ground for hope.

"Gunshot wounds of the knee or ankle-joint demand either amputation or resection. The knee more certainly than the ankle; and amputation is more often required than resection. Guthrie has seen no recovery from a gunshot wound of the knee-joint, unless the limb was amputated. Nearly all army surgeons confirm this experience.

"Gunshot wounds, in which the ball does not actually enter the joint, but in which the bone is struck above or below, and the line of fracture extends into the joint, are subject to nearly the same rules as that class of cases in which the ball enters the joint; but the rule is less imperative.

"Gunshot wounds penetrating the carpal bones do not generally exact amputation; but the same wounds penetrating the tarsal bones, generally render amputation necessary.

"Gunshot wounds through or between the phalanges of the fingers or toes, or through the bones themselves, are often cured without amputation. Similar wounds of the fingers or toes do not in general result so favourably; but the rule in this latter case cannot be stated very positively."

In reference to the practice of conservative surgery in cases of gunshot injury of the thigh, we have read with special interest the statistics bearing upon this point, as set forth in the Statistical, Sanitary, and Medical Report of the British Army Medical Department for 1859. These statistics are furnished by J. R. Taylor Esq., C. B., Inspector-general of Hospitals, and the cases were under the care of Surgeon-major Matthew. We copy some of his remarks, and one of the tables he has drawn up on the point.

"The preceding tables show, of the Indian wars as compared with the Crimean war, that the thigh-stump cases arrived home from India are a fraction more numerous than those from the Crimea, in proportion to the total arrived by all wounds; and that the recovered cases of gunshot fracture of the femur also arrived are, in proportion to the total wounded, four times more numerous from India than from the Crimea. In other words, the proportion of thigh-stump cases being so nearly the same, the gunshot fracture of the femur cases from India, over and above the proportion from the Crimea, may be received as representing the proportion of cases of this description of wound lost there by amputation, or by less favourable circumstances of service. The difference, I believe, is to be explained by the better appliances and means attending field hospitals in India, and the less frequent practice there of amputation in this description of wound. The difference is not to be explained by difference of missiles; for in the Peninsular war, where no other than the 16 to the pound bullet was used, the impression of surgeons experienced in the surgery of that war was, that in only few exceptions should a gunshot fractured thigh not at once be amputated. This rule greatly influenced the practice of surgery in the Crimean war, and hence, in a considerable measure, I believe, the less favourable results thence than from the mutiny in India, when surgeons were not only deterred from amputation of the thigh by the Crimean experience of the fatality attending that operation, but were more inclined to attempt preservation of the limb by the better means at hand for the conveyance and treatment of such compound fractured thigh cases.

"I subjoin brief extracts of ten of the cases of gunshot compound fracture of the femur, and of the thirteen thigh-stump cases referred to in the preceding remarks:—

ABSTRACT OF TEN CASES OF GUNSHOT COMPOUND FRACTURE OF THE FEMUR.

	Rank, Name, Regiment, Age, and Service.	Place and Date of receipt of Wound.	Description of Wound, and site of Fracture.	Results, as observed at Fort Pitt.
1	Private Patrick Carty, 64th Regt., aged 28. Total service 10.	On the advance to Lucknow, 29th July, 1857.	Musket ball penetrated right thigh in region of trochanter major, fracturing the bone at or just below that process, and again at middle third, where the ball appears to have lodged.	April, 1858.—Wound long since healed, and fractures firmly united. Limb shortened about 2½ inches, but in other respects good, and he walks well, with little lameness, and without crutches or stick. Sent to modified duty, 6th Sept.—Discharged to pension, 22nd Dec., 1859, by Horse Guards' order.
2	Private John Ashworth, 53rd Regt., aged 29. Total service 9 11/12.	On the 1st Nov., 1857.	Musket ball perforated right thigh, fracturing the femur in its upper third.	July, 1859.—Wounds healed and bone firmly united, leaving so good a limb that he was sent to modified duty on 6th Sept. The shortening was under 2 inches. June 1860.—Limb, with the exception of shortening, perfectly good, but he is now discharged to pension, being unfit for all duties.
3	Private Joseph Hewitt, 52nd Regt., aged 27. Total service 9 11/12.	At Goodespore, 12th July, 1857.	Musket ball penetrated front of left thigh, fractured the femur in its upper third, and was cut out behind at lower edge of gluteus.	July, 1858.—Wounds healed, bone firmly united, 1½ inches shortening; but there remains a good useful limb. Discharged to pension, 22d July, 1858.
4	Corp. Edward Collins, 75th Regt., aged 32. Total service 14 7/12.	Delhi, 8th June, 1857.	Perforated musket ball wound, fracturing the femur in its upper third. Ball recorded to have been extracted.	July, 1858.—Wound healed, bone united, ends overlap, and callus large; 2½ inches shortening; has, nevertheless, a good useful limb, and he walks well. Passed to modified duty, 6th Sept., 1858, but discharged to pension by Horse Guards' order.
5	Private James Burke, 53rd Regt., aged 26. Total service 9 1/12.	Lucknow, 16th Nov., 1857.	Musket ball penetrated front of left thigh, fractured femur at middle third, and was cut out at inner and posterior aspect of limb.	Aug., 1858.—Wound healed, fracture united, 1½ inches shortening. Has a good useful limb, and walks so well that he was sent to modified duty on the 16th Sept., 1858. Discharged to pension, 10th June, 1859.

ABSTRACT—*continued.*

	Rank, Name, Regiment, Age, and Service.	Place and Date of receipt of Wound.	Description of Wound, and site of Fracture.	Results, as observed at Fort Pitt.
6	Private Samuel Hunter, 93rd Regt., aged 21. Total service 3.	Cadjee, 1st November, 1857.	Musket ball perforated left thigh, fracturing bone at junction of middle and lower third.	Sept., 1858.—Apertures of entrance and exit of ball healed, but there is a sinus through which dead bone is detected; 1 inch shortening; great deposition of callus, obstructing motions of knee joint. Discharged to pension, 5th December, 1858.
7	Private William Cunningham, 1st Bat. 8 Foot, aged 31. Total service 13 $\frac{6}{12}$.	Delhi, 14th September, 1857.	Gingall had passed across front of left thigh, fracturing the femur at junction of upper and middle third.	April, 1859.—Wound healed. This is an unfavourable specimen of recovery with the limb on, because of the fractured ends having been allowed to overlap and unite at an angle, causing 4$\frac{1}{2}$ inches shortening; but with the help of a mechanical contrivance furnished by Mr. Bigg, the man is able to get about. Discharged to pension.
8	Private Samuel Shaw, 53rd Regt., aged 36. Total service 15 $\frac{5}{12}$.	Lucknow, 23rd Feb., 1858.	Perforating musket ball wound, fracturing the femur in the lower third.	May, 1859.—Wound lately healed, bones firmly united; 1$\frac{1}{2}$ inches shortening; knee joint stiff; walks, however, very well. Discharged to pension, June, 1859.
9	Private George Williams, 24th Regt., aged 29. Total service 10.	Umritsir, 18th October, 1857.	Musket ball entered right groin below Poupart's ligament, external to the vessels, and passed out behind great trochanter, fracturing the femur, probably through the trochanter.	June, 1859.—Opening of entrance and exit healed, but a sinus open behind, leading to dead bone. There is about 1$\frac{1}{2}$ inches shortening. The man remains in Fort Pitt, having lately suffered erysipelas of the injured limb, which no doubt, however, will be eventually good and useful. He is now in good health.
10	Private John Curtis, 86th Regt., aged 35. Total service 14 $\frac{6}{12}$, of which 13 years in India.	Mundesoor, 23rd Nov., 1857.	Musket ball entered left groin, and passed out obliquely near great trochanter, fracturing the femur just below that process.	June, 1859.—Necrosis of fractured ends; openings not quite healed; 3$\frac{1}{2}$ inches shortening; health good. This soldier remains at Fort Pitt to be fitted with an apparatus like that given to private Cunningham.

Such statistics as these are strong inducements to practise conservative surgery; at the same time it is possible to carry it too far, and Mr. Matthew gives judicious warning on the subject. He instances a case of compound comminuted fracture of the femur in a private of the 8th Foot, and describes it as being "a very unfavourable example of the results of treatment of this description without amputation; the limb is only an incumbrance, the shortening is from 4$\frac{1}{2}$ to 5 inches, and there is great deformity."

In reference, also, to cases of gunshot wounds through the phalanges of the fingers or toes, which Mr. Hamilton declares are often cured without amputation, Mr. Matthew cites the following case:—

"Private Patrick Kennedy, 1st Battalion, 5th Foot, was wounded on the 2nd December, 1858, at Mohee, by a musket-ball through the web of the ring and middle finger of the left hand, shattering the adjacent phalangeal and metacarpal bones. I call attention," says Mr. Matthew, "to this case, because it well illustrates the malpraxis, to which I am sorry to have to say, the abuse of the fashionable term, 'conservative surgery,' often leads. If both the metacarpal bones were shattered, there can be no doubt the finger should have at once been amputated, and the fragments cleared away. Had this been done, in all probability the forefinger and little finger would have remained useful; as it is, all the fingers are now stiff in the extended position: the ring-finger, by bony anchylosis to the metacarpus, and the others by adhesions of tendons; the hand is almost utterly useless, and there is little or no prospect of improvement. It appears to me," adds Mr. Matthew, "that this is 'conservative surgery' in the wrong direction."

We cannot, however, dismiss the question without calling to mind one of the triumphs of conservative surgery, in the case of a private soldier upon whom the operation of resection and removal of the head and a large portion of the shaft of the femur was performed by Mr. O'Leary, surgeon of the 68th Regiment, in the Crimea.

We saw this man after his return to England; and the writer was present when he was examined by Guthrie, then fast sinking into the grave, who seemed to derive great satisfaction from contemplating the success of an operation which he had advocated twenty years before.

The "method" of amputation is also considered by the author in this chapter, and the relative merits of the flap and circular operations discussed.

He states, which we believe to be the case, that preference is generally given to the former in the field; on this point the surgeon must be guided by the peculiar circumstances under which he finds himself placed; no rule can be laid down; if he is much hurried, as in retreat, and he is required to move

his wounded at short notice, and if they are pouring in rapidly upon him, he must then, undoubtedly, have recourse to that operation, which will save time, and enable him to attend to a larger number of cases. If, on the other hand, he is with an advancing column, with well-organized field hospitals in his rear, and good transport at hand, it is our belief, with that of Mr. Hamilton, he will find the circular method—at all events, as regards the thigh and arm—less hazardous than the flap, and more likely to secure for the patient a useful stump.

On the question of the use of anæsthetics in the field, Mr. Hamilton, after analysing the opinions of several military surgeons in the English, French, and American services, sums up his opinion in these words:—

"Finally, after comparing our own experience with that of others, we will state our belief and conclusions as follows:—Anæsthetics are of inestimable value in their effects as remedial agents, and in their power to extinguish sensibility, temporarily, and especially during the performance of severe surgical operations; but we prefer ether to chloroform, as being the least liable to destroy life; and we would never employ either when the system was greatly prostrated by disease, or by the shock of a recent injury, unless the patient exhibited an unconquerable dread of the pain of the operation, or the operation was likely to prove exceedingly painful.

"It is our opinion, also, that anæsthetics sometimes, and especially chloroform, prevent the union of wounds by adhesion, or by 'first intention.'"

We mainly concur with the author in his view of this highly important matter, and we think most military surgeons who have seen much active service will, to a great extent, corroborate his statements; here, again, the surgeon must be guided by circumstances. For example, in a general action, where large numbers of wounded are brought in rapid succession to the surgeon's rendezvous, many requiring immediate operation, all more or less suffering from the depressing effects of the "shock," with the prospect of their being exposed, perhaps for nights, with but indifferent shelter, or having to undergo the suffering and fatigue of transport, we think, under such or similar circumstances, the surgeon will do well to pause ere he exposes such cases to the additional depressing effects of so powerful an agent as chloroform. But we cannot, however, endorse the author's opinion with regard to anæsthetics preventing union by the first intention: we do not think this statement is borne out by experience either in military or civil practice.

Our readers, doubtless, have not forgotten that most unhappily worded memorandum issued by Sir John Hall, the principal medical officer of the Crimean army, previous to the battle of the Alma. Although, in common with the whole medical profession, we deprecate the manner in which his views on the use of chloroform were couched, we cannot but admit at the same time that in principle they were not erroneous.

We by no means wish to convey the idea that we object to the use of that which we cannot but regard as one of the greatest blessings ever conferred on suffering humanity; and while we would advocate its administration in all cases—unless specially contra-indicated—where the patient can be housed and kept at rest, and in some measure of comfort, we cannot too strongly combat its indiscriminate application to the urgent cases and sudden emergencies of a battle-field where troops are in motion.

We will now close our observations on this volume, with a few remarks on the chapter relating to "dysentery;" and we might here inquire of the author why he has omitted the subject of cholera from his pages?

If dysentery can be classed under the category of "military surgery," so may cholera. If, as Dr. Watson asserts, "there is no malady which is so crippling to an army in the field," surely cholera may be considered equally so. Who that saw the numbers of men who dropped to the rear, and died on the march to Sebastopol, or witnessed the hospital tents crowded with hopeless inmates after the Alma, or remembers how many strong men succumbed to this disease on the heights of Inkerman, can doubt that its onset is more deadly than the bullets of the enemy. It is true, perhaps, Mr. Hamilton could not have thrown much additional light on the subject of its treatment; but a chapter on this question would have been a good addition to his book, and might have drawn the attention of the young medical officer to at least the preventive measures most likely to be of use during an epidemic of this most fatal malady.

On the treatment of dysentery, Mr. Hamilton advocates strongly the use of opium in large doses, after the judicious administration of saline purgatives, and states that he has witnessed the successful exhibition of "the sulphate of morphia in doses of a grain *hourly*, continued during the twenty-four hours for several days, in a case of severe epidemic dysentery, without the production of any of the phenomena of narcotism."

We do not intend to criticize this mode of treatment; we would rather draw the attention of our military readers to what

we think a safer and surer method, as set forth in a paper by Dr. Massey, surgeon, 2nd Dragoon Guards, reported at page 280 of the Army Medical Report of 1859, and having special reference to the treatment of acute dysentery by large doses of ipecacuanha: this treatment was first used by Mr. Docker, surgeon, 7th Fusiliers, in the Mauritius, in 1855; and his views were published in the Lancet of the 3rd July, and the 4th August, 1836.

Speaking of his success, Mr. Docker says:—"In all constitutions, robust as well as delicate, under all circumstances, the result is the same;" and Surgeon Massey endorses that opinion in the following terms, and gives a detail of his plan of treatment:—

"In nearly every case of acute dysentery, when first seen, half an ounce of castor oil is at once given, with a view of clearing out scybalæ and vitiated secretions. As soon as the oil has freely acted, say in from four to six hours, a drachm of ipecacuanha is given in a little water, a mustard plaster having been applied to the stomach about half an hour previously, at which time, likewise, thirty drops of laudanum are given. Mr. Docker's view on this point seems to be that the mustard plaster and laudanum tend to enable the stomach to retain the ipecacuanha. I regret to be at issue with him in any portion of his remarks, but I have not found the same tolerance of the stomach for large doses of ipecacuanha that he seems to have experienced. I sometimes have encountered difficulty in this respect; but it seldom happens, I imagine, that the entire drachm can be thrown up, even when sickness is quickly induced. When one dose is rejected, I usually give a second soon after; this generally succeeds, but if not, by waiting a few hours the object is often readily effected. If great sickness and retching are caused by the medicine when given in fluid, it is often retained if given with a little opium in five grain pills, three or four at a dose; and two or three drops of hydrocyanic acid, given a little before the ipecacuanha, often assists its retention. I have likewise exhibited it frequently in the form of infusion in enema with tinct. opii, but I am not satisfied that I have seen very marked benefit from this mode of exhibition. It has commonly been as an adjunct to medicine given by the mouth. I have no case to record of treatment solely by enemata of ipecacuanha. The ingenuity of the prescriber may be taxed to provide that a sufficiency of the drug be retained, but by a little management it has hitherto always occurred to me to succeed. I have noticed that intolerance of the stomach to large doses of ipecacuanha was more

frequently encountered in weakly men than in the more robust; and when dysentery had existed for a few days, there has been less power in retaining the medicine than in cases submitted to early treatment. Mr. Docker's statement to the effect, that if the medicine is retained for even a quarter of an hour before sickness is induced, it seems to exert its beneficial influence, is to be borne in mind. This, doubtless, results in a great measure from the circumstance that only a portion of the ipecacuanha is thrown up. Whenever tolerance from the first prevailed, a speedy cure, thorough and complete, was the result.

"In cases of acute dysentery the effect of one or two large doses of ipecacuanha is usually to produce one or two feculent motions, and the disease terminates. There is in general no gradual alteration of secretion or other symptoms, the disease seeming simply to end; confinement to the recumbent position for a day or two and farinaceous diet are alone necessary; pain, tormina, tenesmus, procidentia ani, blood, mucus, jelly-like secretion, all cease; the appreciable action of the medicine, being a few bilious loose motions. But in some instances the ipecacuanha does not act so speedily, or with such decided benefit, and its exhibition at stated invervals may be necessary for two or even three days. Not infrequently the intolerance of the stomach for the medicine prolongs the treatment.

"Again, though the dysentery is cured, a degree of looseness of the bowels may continue for a short time; and in cases where dysentery has prevailed for some days before treatment is sought for, the cure is usually somewhat protracted. I have also seen occasionally a troublesome symptom continue, I allude to the formation of scybalæ. This tendency, or at least the condition that creates it, is so liable to lead to the invasion of fresh symptoms of acute disease, that, as long as it lasts, it is always to be watched and prescribed for; but, as has been before observed, the remedy finally succeeds.

"Numerous cases might easily be quoted from the Hospital Register, but it will probably be deemed equally conclusive to present two short returns, the one embracing the period included by the General Return of 1858, and the other that of the year 1859. In the year 1858 the ordinary treatment practised in India of late years was pursued, consisting chiefly of leeching, preparations of mercury with small quantities of ipecacuanha, opiate enemata, counter-irritants, &c. In the year 1859, the treatment was exclusively that by large doses of ipecacuanha. In 1858, 103 cases of acute dysentery were

admitted into the regimental hospital, 7 of chronic, and 5 cases remained over from the previous year, making in all 115. Of these, 14 died, and 3 were invalided to England, being a loss to the service of something less than 1 in 6 from deaths and invaliding. In 1859, there were admitted 115 cases of acute dysentery, 3 of chronic, and 2 remained over from the previous year, giving a total of 120 treated. Of these, 2 died and none were invalided, causing a loss to the service by deaths and invaliding of 1 in 60. The return of 1859, therefore, shows a great contrast with that of the previous year; and still more is it deserving of notice, from the fact that of the two deaths recorded in 1859, one occurred in a thin weakly man, who had frequently suffered from dysentery before; and the second, though included in the return as dying under the head of acute dysentery, actually died suddenly from heat apoplexy when a patient in hospital for the former disease.

"How, then, does this medicine act? A feasible idea appears to be that the portal system is relieved by action upon the liver and small intestines; the free feculent bilious motions would argue this; but then the portal system can be relieved in other ways, yet the dysentery remain uncured. Leeches to the anus will unload the vessels to some degree; mercurial purgations often produce a cholagogue effect, which would tend to relieve the portal circulation; yet these means do not cure dysentery as ipecauanha does.

. . . . . .

"Dr. Corrigan, of Dublin, has pointed out the value of ipecacuanha in emetic doses in jaundice. Considerable experience has convinced me of the truth of Dr. Corrigan's statements on this subject, but I have long held the opinion that the ipecacuanha exerted other influence than the mere mechanical effect of an emetic. It appears to me, that no other means so effectually or so speedily produce an action on the liver and small intestines as ipecacuanha, in large doses, without inducing other deleterious effects. Mercury, it is true, acts as a cholagogue, but it also often acts as a drastic purgative. It irritates the inflamed mucous membrane.

"In addition to the effects of ipecacuanha just mentioned, it seems to be powerfully sedative. It lowers the pulse, and induces diaphoresis, possibly by the nausea it creates. Possibly in a similar way may be produced its influence upon the peristaltic action of the bowels, which is often the most remarkable immediate effect. Frequent purging and straining are allayed on taking ipecacuanha, often as soon as one large free motion occurs. It is difficult to suppose that the entire power

of the medicine is expended upon this secretion, or that a single motion could give rise to such immense results, unless there was some marked sedative action."

Our task is now done, and we close this little work, which, as we have said, presents a few imperfections, some serious omissions, and possesses, perhaps, but little originality; but, so far as it goes, we believe the views of the author to be in general sound and practical. We close it in hope—first, that it may be followed by larger and more extended editions; and, secondly, that it may act as the pioneer to other works on the same subject from our own countrymen. The Army Medical Service is sadly in want of literature bearing upon questions of great public importance; we know there are medical officers in the service, of experience and ability, who are quite able to fill up the blank in this particular. A sound practical work is required, not purely on military surgery, "*per se*," but upon military medical science in its entirety, embracing every point likely to meet a medical officer in the performance of his duty in peace and war. In proportion as medical officers are conversant with their professional and official duties, and prompt and energetic in the discharge of them, in the same proportion will they be regarded with respect by those in command. No class of men have more faithfully served their country, or more nobly discharged their arduous, and often thankless labours; they earn no golden rewards; but when we reflect upon how many breasts of such "non-combatants" the Victoria Cross glitters; when we remember that in the ranks of the medical department there are such men as Jee, and Mowat, and Sylvester, who have not obtained the emblem of courage and valour by any act of reckless daring from motives extraneous to their professional calling, but in the holy cause of saving human life, we congratulate the British soldier, that amid the smoke, and din, and blood of battle, such help is likely to be found.

"Patent certantibus campi—manat undique cruor—salus una restat moribundis,

"Ecce chirurgus!"

Lecture given at the Royal United Service Institution in March 1862.

ON THE CAUSES OF SICKNESS IN THE ENGLISH WARS, AND ON THE MEANS OF PREVENTION.

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It is quite a truism to say that the great losses in war are not owing to shot or steel, but, like many other truisms, it is more often repeated than comprehended. Even to the mind of the soldier, the strife and peril of the battle-field throw into shade the more secret yet deadlier foes by which oftentimes campaigns are really decided and victories are really won. And yet, if there be anything a soldier ought to study out of his immediate profession, it should be those conditions which, in so many wars, have caused such losses by disease, that plans the best considered have been abandoned, courage the most heroic has been baffled, and causes the most sacred have been lost.

Our own army does not, perhaps, offer so many examples of these disasters as the armies of other states, but even with us there is a long and sad catalogue of unfortunate and unhappy enterprises, and a terrible list of soldiers' lives which have not been taken on the battle-field. As it is manifestly a matter of greater interest to review our own history than to turn to the larger and darker experience of other nations, I shall venture to attempt the enumeration of the chief causes which have led to great losses by disease in some of our wars. The subject is, however, too vast to be treated in a single lecture, and all I can venture to do is to give a rapid summary, and to illustrate it by a few examples.

As far as diseases are concerned, the history of almost all our wars presents a remarkable sameness. The same results on a larger or smaller scale repeat themselves. We are taught with what a terrible precision the same causes have stamped their marks on successive generations of soldiers, and how the pitiable history of one campaign might almost be stereotyped for nearly all the rest. Nor are these causes in any way peculiar, recondite, or mysterious. We are astonished to find how simple they are, how obvious, how apparently inadequate to produce such large results.

A writer, in giving an account of the great loss on one occasion among British troops, when, out of 7,000 men, 5,000 men were sick at one time, after enumerating the very simple conditions which had led to this end, says,—

"And yet when anxiously asked by the officers in command, what extraordinary cause could be assigned for an amount of sickness and

mortality truly alarming, something of incredulity has stolen over the countenances of my hearers while the natural causes above described were detailed, so little are we disposed to believe that great effects can be produced by the action of common causes."

But so it has always been. That the causes are common is the secret of their strength; they are ever at hand; even waiting, so to speak, for opportunities; apparently weak, they are in reality all-powerful; they are like the geni, who, in the story in the "Arabian Nights," the fisherman let out of the vase. At first there was a little cloud, which he could enclose with his hand, but presently there appeared a gigantic shape, clothed with power and irresistible in strength.

Of the early English wars the record is so imperfect that it would be waste of time to refer to them. Even of the wars of Marlborough we have but scanty medical accounts. We know that Marlborough had the reputation of being very careful of his wounded men, and it is said that he made a point of paying frequent visits to his hospitals. Doubtless he brought his extraordinary administrative powers to bear upon the medical, as on all other parts of his army. But of the exact losses by disease in his campaigns I believe little or nothing is known. They are supposed to have been small, as he was always able to bring a large number of men into the field, and England, at that time so comparatively thinly peopled, seems to have easily supported the drain both of men and money.*

Of the wars in Flanders and Germany in 1742, and of all subsequent wars, we possess tolerably good accounts, although the exact statistical reports and tables of our own day were quite unknown, and it is only from chance passages that we can form a rude numerical idea of the amount of sickness and mortality. The description of the diseases however, and of their causes, is for the most part both full and accurate.

1. Of the earlier expeditions after the wars of Marlborough, perhaps none was attended with greater losses, or excited more strongly the public feeling, than the unfortunate attack on Carthagena in 1741, under Vernon and Wentworth. It was not the first of the western tropical expeditions in which enormous losses had occurred, but the failure was so sudden and so overwhelming that it created an unprecedented sensation. To the military features of the campaign I need not refer; the dissensions between the commanders of the land and sea forces; the feeble movements of the general, and the vain courage of the troops, are sufficiently known.

Scarcely had the troops disembarked than sickness commenced. The diseases were malignant malarious fevers, scurvy, and bloody flux. The Spaniards looked down from their walls which they were scarcely called on to defend, watching curiously the dwindling away of their besiegers, till the rainy season of 1741 set in. The diseases then increased at a rate so fearful, that, to avoid complete annihilation, the force was hastily re-embarked. It is said that no less than 3,425 men perished in two days. In a few weeks, in fact, the army had been almost destroyed, and we are told that "its poor remains were afterwards almost totally cut up in the sickly season in the island of Cuba."

* The greatest losses appear to have occurred during the sieges, especially those of Tournay in 1709, and of Aire in 1710. In this latter siege the killed and wounded of the allies were said to be 7,000, and the sick double that number.

The causes of this tremendous catastrophe were matters of common talk and tradition among army surgeons for many years afterwards. Two grand errors were committed; errors which we must put in the first rank among those conditions from which British forces have largely suffered in war.

The first of these was that old error, a most imperfect commissariat. We are not acquainted with the exact rations issued at Carthagena, but the presence of scurvy, which prevailed both in the army and navy, but most in the former, proves at once that fresh meat and vegetables were entirely wanting. The scorbutic dysentery, which soon succeeded, shows us, as certainly as if the diet lists were before us, that hard salt beef and pork and biscuit formed the miserable allowance, scarcely deserving the name of food, which was issued to these men.

The effect of insufficient food of this kind is to cause some diseases; to predispose to many more. It is in this last circumstance that its great strength lies; malarious fevers are intensified by it; slight atmospheric vicissitudes, and other common agencies which fall harmless on the well-nourished body, tell with fatal effects on the enfeebled frame.

In a great number of the English wars an inefficient commissariat has been the bane of the army: I will select two or three other instances of the same fact. Perhaps the expeditions to Burmah, in 1824, and to China, in 1840, offer the best examples. In both cases the scene of operation was to some extent malarious, and in Burmah the worst time of the year, at the commencement of the south-west monsoon, was unfortunately chosen for the commencement of operations. But in both cases the cause of the immense mortality which ensued, or at least by far the most potent cause, was the food which was issued to the men. In both cases it was thought that men could be maintained not only in health, but in fighting condition, upon a diet so bad that no slave-owner in any part of the world or in any age of the world would have given it to his slaves. Wretched cattle hastily purchased and driven to Calcutta were there as hastily salted, and on this wretched meat and on almost as wretched biscuit the troops were kept, when within a few days' sail there was a land of wheat, of rice, and of fresh vegetables without end. To the immense mortality in the Burmese war I need scarcely refer. In three or four months some of the regiments lost half their strength; in eleven months 1,311 men died out of 2,716. The 13th Foot lost by disease 341 out of 608 men, or 56 per cent. So general was scurvy that the surgeons were in the habit of examining the gums of the men before a skirmish, to prevent any men having symptoms of the disease from advancing, as wounds received in that condition of body are most intractable. Malignant malarious fever, intensified by the state of the body, and scorbutic dysentery were the great agents of destruction.

Twenty-six years later, in the expedition to China, the same tragedy was repeated almost without variation. The history of the Cameronians may be taken perhaps as a type of the fate of the whole force, although the amount of sickness was greater than that which prevailed in some other regiments. The Cameronians landed at Chusan, a splendid body of men, 900 strong, on the 5th of July, 1840; in the first week in August 500 were in hospital; towards the end of August less than 100 mustered

on parade; later in the season the *débris* of the regiment, under 200 men, were sent to Manilla to recruit, and of these but a fraction ever saw their colours again. The bloodiest battle would have been mockery to this. Doubtless they were to a certain extent in a malarious country, but the malaria was not sufficiently intense to cause so great a loss. Again the simple cause is to be found in the diet. Nothing lives so long as a departmental tradition, and the errors of the last naval expedition from India were repeated in this case without variation. I have selected these two campaigns as the strongest examples of the paramount influence of diet, but many other instances also exist in our wars of the effect of an insufficient commissariat. Even in such comparatively slight operations as the first two Caffre wars a large proportion of the men became scorbutic; and in the first year of the Crimean war a diet so insufficient that any one accustomed to the subject would have been able at once, on being informed of the amount, to foresee the inevitable result, was deemed sufficient to support the strength of the men in the most trying and exhausting of wars.

In the wars of Marlborough, and in Flanders and Germany in 1742 and in 1760, the men were better fed than in many later campaigns; salt meat seems happily to have been little used. The colonels of the regiments appear to have been the chief purveyors: each colonel contracted with butchers, who drove with the army herds both of sheep and oxen for slaughter. Fresh meat, at any rate, was thus procured, and we know from the writings of Donald Munro that in 1760 the army surgeons strongly insisted on the issue of bread and fresh vegetables; fruits also were largely used, and in this way the ravages of scurvy appear to have been almost prevented.

In the wars towards the end of the century and up to the long peace the commissariat arrangements appear to have been inferior to those of eighty or sixty years before. Some of the mortality in the Peninsular war may be certainly ascribed to an inefficiency in this respect. It would seem unnecessary to allude to a point so self-evident as this of insufficiency of food, did not the repetition of the error prove that it is one which must be expected to recur. The first rule in war must be to provide a diet in the highest degree strengthening and nutritious; the diet of peace is quite unequal to maintain the forces of the body when exhausted by the mental and physical exertions of war. It may seem an expensive matter to provide a diet which is sufficiently varied and sufficiently strengthening, but it is not so really. A great army surgeon has said "Economy of lives is the truest economy of the state," and no saving can be more like waste than the saving which sacrifices men's lives.

2. The second great error committed at Carthagena was undertaking operations in an unhealthy site and with an unhealthy season impending. Of course one can understand that a military officer, for the purpose of accomplishing some military end, may deliberately occupy an unhealthy site and knowingly sacrifice a certain number of men. There are examples of this in our wars; for example, in the attack on Java in 1811, when a marshy site was occupied at the outset; but even here the military arrangements were obliged to be somewhat modified and hastened in consequence of the rapidly increasing diseases among the

troops. But unfortunately there are many instances in which unhealthy sites have been chosen without any forethought, without any deliberation, and apparently either in the belief that men were made of iron and could not be injured, or that the stories of diseases being produced by locality were mere foolish inventions and old wives' tales. Although Vegetius tells us that the Romans, the great masters of the art of war, took the extremest care to choose good encamping grounds, and even appear to have made the plans of their campaigns subsidiary to this prime necessity, the point has been too much neglected in all modern wars, and even in the English army. Of the many examples of this I will select one or two only. In 1796 a body of troops about 9,000 strong were ordered to San Domingo; some of the regiments were collected from the West Indies and others from Ireland. The Irish regiments had been rather hastily recruited and typhus prevailed among the men, but it was thought that if time were allowed this disease would be got rid of; time, however, could not be given, and the expedition was launched against San Domingo. Now in 1780 Donald Munro, an army surgeon of reputation, had described with some care the unhealthy and the healthy places of San Domingo, and in 1793 portions of the island had been occupied by our troops. It can therefore be scarcely credited that the most unhealthy spot in the whole island, Port-au-Prince, was chosen for the encamping ground. There were not wanting those who supposed that the general had been deceived by persons interested in the choice of the site: be this as it may, the troops were crowded together on a low marshy alluvial plain, where good water could not be procured, which was shut out from the sea breezes by hills, and was completely exposed to the land-winds. As if this was not sufficient, the diet was bad, and salt meat without bread and fresh vegetables formed the staple of the food. With a view of increasing the strength of the body, an old custom of the English army was in full force, and the men received large rations of rum. Of all the errors committed in our service this seems to be the most persistent and the most ineradicable. Although the best army surgeons had at that time protested against the use of rum in hot climates, although in the American War of Independence the uselessness of rum had been proved almost immediately before, although at San Domingo the immense amount of sickness showed that it was producing no good result, the fatal practice was persevered in. That army had everything against it, and the result was certain; it was almost literally annihilated by yellow fever and dysentery. A writer who saw the sad catastrophe calls San Domingo "the grave of the British army," and says "The army languished and dwindled away without the least service to the cause it was meant to support." It is impossible to know the exact amount of the mortality. Many regiments 800 and 900 strong had only fifty or one hundred men left. All lost largely, and it is probable that few of that gallant force ever did the State more service.

The expedition to Walcheren gives perhaps a still better example of the effect of a marshy and malarious locality. In 1747 Sir John Pringle, one of the most celebrated in the long list of illustrious army surgeons, described the great unhealthiness of South Beveland and of Walcheren. So great was the sickness that in many corps 6-7ths of the men were in hospital at that time.

This low tract of ground, won in almost modern times from the sea, which is everywhere swampy, and where good water cannot be procured, had not lost its ancient and well-known reputation, when in 1809 the finest expedition that ever left the British shores landed in the highest health and vigour. They found there a Dutch regiment which in three years had lost 715 men out of 800: this was the type of their own fate. This great force, nearly 40,000 men in all, was destined to attack Antwerp; it never even approached that fortress. It sailed on the 28th of July from England, invested Flushing with 17,000 men on the 7th of August and took it on the 15th: twelve days later, the men were falling sick so rapidly that the guards had to be relieved twice daily. On the 14th of September, seven weeks after leaving England, out of the 15,000 men in Walcheren 10,000 were in hospital. The deaths at last reached sixty daily, at which rate the whole force would have been destroyed in 250 days. Four months after landing, the army, utterly disorganised, was hastily re-embarked. "The expedition"—to use the words of an eye-witness—"had been productive of nothing but mortification, misery, and disgrace." The diseases were malarious fever and dysentery.

Let me take another example on a smaller scale. In the American War of Independence, two battalions of the 71st Regiment were encamped, contrary to the advice of Robert Jackson, the prince of army surgeons, and of the inhabitants of the country, on the marshy banks of the Pedee river. The men fell sick so rapidly, that the post was ordered to be abandoned. It was then found that it was almost equally difficult either to keep or leave the post. At length, after a great deal of trouble, boats were collected, the sick men were placed in them and were sent down the river, and it is said that few of them were ever seen again. The rest of the force retired from the banks of the river, and, to show the deadly nature of the encamping ground, it was said that the men improved vastly in health even on the march.

The same mistake of a malarious locality being taken as an encampment, was seen in the second American War in 1814, at the siege of Fort Erie. And there are other instances too numerous to bring before you. Even the great Duke himself was said to have crippled his forces by a prolonged sojourn in the marshy plains of Estremadura.

As in the case of food, it may be said to be impossible that errors of this kind can occur again—that, with the present organisation of the service, before any campaign is undertaken the country will be investigated, its features known, and its influences estimated, and that the campaign will be entered upon with a full knowledge of all the circumstances which can affect the men. But we have unfortunately evidence that the immense influence of a malarious locality is not even now sufficiently appreciated by our soldiers. Under some circumstances indeed it is impossible but that campaigns must be undertaken in unhealthy localities and in marshy countries. In that case certain precautions must be adopted; these precautions have relation chiefly to the arrangements of the camps and bivouacs so as to shelter the men as much as possible from unhealthy emanations; to arrangements of guards, so as to expose the men, especially at certain hours of the night, as little as possible; to the use of an extremely nutritious diet, for that has been

found to have a great effect in lessening the susceptibility of the body to malaria; to the supply of good water, and to the employment of various drugs which have been proved to produce, more or less, immunity from attacks of malaria. If malarious countries are entered, and these and similar precautions are taken, the troops will escape with as little harm as can happen under the circumstances.

3. I must now pass on to another condition. The wars in Flanders in 1742 and in Germany in 1760 have been very carefully recorded; perhaps more so than any other war, with the exception of the Russian war of 1854-5. In both these wars, at certain periods, the men were exposed greatly to inclemencies of weather. It was then seen that if men are well fed and can be kept dry they can bear great cold. The winter of 1742 was extremely severe, and in April, when the troops commenced their march, there were extraordinary snows for seventeen days. The troops marched through these storms, but were every night received into warm houses. Out of the 16,000 men not twenty were lost. Again, in the German war in 1760, some regiments made a winter campaign on the borders of the Lower Rhine; they were exposed to great inclemencies of weather, to great hardships, and to extreme cold, yet they were very healthy, much more so than the troops left in the fixed camp at Warburg, who, it may be supposed, must have been in the possession of much greater comforts. This was owing to their good food and good clothing. At that time, 1760, every soldier wore a flannel waistcoat, a custom which has now unfortunately disappeared. This custom was commenced by gifts from the Quakers to the army in 1745-6, and it was found to be attended with the greatest possible benefit. In 1760 the Government issued warm clothing of this description, and in addition there was a very large private subscription in England, and blankets, great coats, underclothing, shoes, stockings, &c., were given to the men. The men's blankets were carried on horses, and were wrapped in waterproof clothing. Each company had its own horses, which kept up with the men on the march.

The same fact, that men can bear great exposure to cold if properly fed and clothed, was also established in the American War of Independence. Some of the Rangers were out during the winter, and escaped almost entirely the diseases produced by cold. They attributed their immunity in a great measure to the use of hot ginger tea. Every man carried a piece of ginger in his pocket, and would on no account be without it. With this they made hot tea, and they found this much more comforting than spirits, which appear to have been in a great measure disused among them. Hot infusions of garlic and infusions of horseradish were also used for this purpose, until the more common employment of hot tea and coffee supplied us with means which may perhaps be considered even better adapted to protect the body against exposure to weather.

The same fact was again seen in the American War of 1814; in the partial winter campaign, the men bore the cold without great difficulty, being very carefully protected from the weather.

The same fact was again shown in the celebrated marches in Canada in the rebellion of 1837, and similar marches appear to have been repeated with as much success during the last few months.

Although, however, it appears to be quite certain that if men are well

fed, and if the surface of the body be kept thoroughly dry, they can bear great exposure, yet few armies have been so well cared for; and exposures to inclemencies of weather must be put down as the third cause which has been productive of disease in our campaigns. Even the campaigns of Flanders and Germany to which I have referred give many examples of this; one of the best, perhaps, is the often-quoted case of what occurred after the battle of Dettingen. Previously the men had been extremely healthy, after the battle they were exposed to wet and cold for two or three days; the consequence was that an attack of dysentery occurred, and was so general that half the army were affected; had this occurred a few days previously it is by no means improbable that the strenuous exertions which alone won the battle of Dettingen would have been impossible. So also in 1760 there was at times a considerable amount of sickness from exposure to weather, in spite of the great care which was taken of the men. In 1799 another campaign in Flanders owed its chief disasters to the inclemency of the weather, and the gallant force of the Duke of York was, in fact, beaten by the elements.

It is impossible that a general in command can ever protect his men perfectly from inclemency of weather; armies must be expected to suffer from this to a considerable extent; the diseases it produces are of course catarrhs, inflammation, rheumatism, and dysentery. But it is satisfactory to know what great effect the measures to which I have referred can have: if men are well fed and are well clothed and covered with water-proof clothing (which will probably be found the greatest boon which has ever been given to the soldier, but which is not yet sufficiently appreciated in our army), if hot liquids are provided for them, and spirits kept from them, or at any rate issued in the greatest moderation, there is no reason to think but that troops will bear a great deal of exposure to inclemencies of weather. Even the winter in the trenches before Sebastopol, had these means been available, might certainly have been met with comparatively little loss. But if from poverty or from defect of transport the warring nation cannot clothe and feed its troops, its plan of campaign must be adjusted to its circumstances, or it must be prepared to encounter a great mortality.

4. But catarrhs, slight dysentery, rheumatism, and inflammations are not the only diseases which affected the troops in the wars in 1742 and 1760; in both cases they suffered, though to a comparatively slight extent, from the spotted typhus and the putrid dysentery—diseases which have been the grand scourges of armies in temperate climates, in the same way as cholera and yellow fever have been the destructive agents in the tropical wars. The spotted typhus, the great typhus of armies, is, perhaps, the most terrible disease of all; wherever men are closely crowded together in ill-ventilated, unwholesome dwellings it is sure to appear. If scurvy be also present, it then attains its greatest intensity, and commits ravages which are truly astonishing. It has often passed from the army to the civil population, and has half dispeopled towns and even districts. Its ravages in the English army have never been comparable to those which have occurred in foreign forces, and, to give an idea of its powers, permit me to allude to a few examples of the effect of this disease among some continental troops.

In 1620 the Bavarian army in a few months lost in Bohemia not less than twenty thousand men from spotted typhus, and the disease being carried into other parts of Germany, obtained the name of "the Bohemian disease," just as, in the same way, on a later occasion, the typhus carried back from Hungary received the name of "the Hungarian disease." In 1628 and 1632 the Swedish army under Gustavus Adolphus carried typhus into Northern Germany, and the population was so destroyed that fifty or sixty years later villages remained without inhabitants. The wars of Louis XIV. were always followed by this disease, and the losses of the French army were enormous. But it was in the wars of 1812 and 1813 that its greatest ravages were seen. In May, 1812, the Bavarian army serving among the French numbered 28,000 men; in February, 1813, there were only 2,250 under arms. The great destroyer was typhus. In August, 1813, the first Prussian army consisted of 37,728 fighting men, in November of the same year it reached the Rhine with 11,515 men, having lost 16,000 men by the sword, and 10,000 men by disease, almost entirely typhus. Even this was trifling compared with the enormous losses among the French army. Not only the army but the civil population suffered fearfully. It is impossible to enumerate the hecatombs of victims; in Mayence alone the French lost in six months 17,000 men from typhus. It is impossible to overlook the effect which this must have had upon the fortunes of the campaign.

In later wars the same fact has occurred. I need scarcely refer to the great losses, even yet not perfectly known, of the Russian army in the Crimean War, and to the losses of the French army in the spring of 1856, when more than 17,000 men perished in less than three months, and when the highest authority stated that the safety of the whole French army was endangered by the outbreak. In the war in Flanders in 1742, and again in 1760, the great cause of the spread of typhus appeared to be the state of the hospitals. If typhus once enters a hospital, unless that hospital be extremely well adapted for the treatment of this disease, and if it once attains any proportions, it spreads among the patients with astonishing rapidity, and the hospital becomes a veritable pest-house. The only plan to adopt under these circumstances is that which was carried into effect by Sir James M'Grigor in the Peninsular War. Typhus had broken out in some of the hospitals; Sir James M'Grigor broke them up and distributed the sick among the villages, and in this way, in spite of bad food, in spite of bad attendance, and in spite of exposure, the disease was arrested. Anything indeed is better than a deficiency in the supply of air. There is no doubt that with proper sanitary precautions, the spotted typhus, terrible as it is, may be almost entirely put a stop to. It must, however, be considered as taking the fourth place in the causes which have produced disease in the British army.*

* Whether or not the circumstances to which I have referred, viz. great overcrowding and vitiation of air from organic impurities derived from respiration, will absolutely generate typhus *de novo*, is yet uncertain. In all the English wars, there has always been plenty of typhus-poison, waiting for favourable conditions to assume activity. This arose from the peculiar system of recruiting. Even in the Crimean War, we saw the relics of a system constantly resorted to in the last century to raise men. Commissions and commands of regiments used to be given to those who collected a certain number of men. Every low

It has never been absent from any considerable European war till the wise sanitary measures adopted in the Crimea showed us an army with scarcely a case, while two other armies under the same circumstances lost numbers of men.

5. The other disease to which I have referred, the putrid dysentery, is one which has prevailed to a still less extent, in the English army, than the spotted typhus. It prevailed to a certain amount in the wars of 1742 and 1760, and in the Peninsular War during a short time. Arising from various causes, from exposure to cold, from bad weather and bad food, it is also propagated by contagion, and appears, indeed, to give us an example of a disease acquiring contagious properties. This fact appears to have been first indicated clearly by Sir John Pringle, but it has been subsequently confirmed by a great number of observations in the French wars, and in other cases. As in the case of typhus, there is no reason to doubt that proper sanitary measures will lessen the spread of putrid dysentery. It must, however, I believe, take the fifth place among the diseases which have caused losses in the English wars.

6. I must now pass on to another condition, which possibly might have come before one or two of the others. In 1760 the head-quarters of the troops in the German war were at Paderborn in Westphalia. There was much sickness, and great dissatisfaction was expressed in England much in the same way as in the winter of 1854–5. The diseases were putrid dysentery to a slight extent, spotted typhus to a considerable extent, and other forms of fever, among which doubtless was the disease now known by the name of typhoid fever. These malignant fevers arose at the standing camp at Warburg, and were carried to Paderborn. They were produced by the condition of the camp, which had been inhabited for a very considerable time. Both it and the whole country around were covered with putrid remains. We are told that dead men and horses lay around in "infinite numbers," and that the bodies were only thinly covered by earth.

The unhealthiness of standing camps—unless the greatest care be taken to cleanse them—is one of the best known facts of army hygiene. The frequent shifting of encamping grounds is almost the only rule which has come down to us by means of which Alexander the Great so marvellously preserved the health of his men. The Romans also took the most special care for the cleanliness of their camping grounds, as indeed in all other matters connected with the health of their men.

Unfortunately, in modern armies the grand rule of paying the greatest attention to this duty has been too little regarded. In the English army it has perhaps been more attended to than in other armies, but even with us it is impossible to read the accounts (unfortunately too short) of the

purlieu, every infamous haunt, every jail even, used to be ransacked for recruits. Wherever these men went, they carried typhus, at that time the constant scourge of our towns and our jails. It gives one a strange idea of the making of a soldier, to read in Donald Monro's essay, published in 1764, a caution "that particular regard be paid to those soldiers picked up in the streets, or who have been taken out of the Savoy or other jails. All dirty rags from such people should be thrown away or burnt." Complaints of the introduction of typhus from this source are frequently found in the writings of army surgeons of the last century. Typhus was several times carried to the West Indies, and even prevailed there apparently to some extent.

camps even in the Peninsular War without perceiving what prolific sources of disease they were.

Let me take another instance of the effect of bad encamping grounds, as it illustrates one or two other points. In 1801 a force of 4,000 Europeans and 4,000 natives landed in Egypt from India. In June they commenced their march across the desert; they underwent hardships which Sir James M'Grigor thinks were never exceeded by any army. The heat was intense, the thermometer in the tents marked 118°, and at nine o'clock in the morning at three feet depth in the ground the thermometer marked no less than 69° Fahrenheit. Owing to the difficulty of carriage, no spirits were issued. In spite of all this the men were remarkably healthy, proving, what our Indian campaigns have also shown, that with proper precaution, and if spirits are avoided, great heat can be borne without risk. Having reached the Nile, the army descended that river for 400 miles, and landed at Ghiza. There they found the 89th Regiment very sickly; scarcely fifty men mustered on parade. This ought to have attracted attention, inasmuch as the 89th should have been considered to be the touchstone by which the sanitary condition of Ghiza was to be judged. However, the army was there disembarked, being then, to use the words of Sir James M'Grigor, "uncommonly healthy." In less than a week they sent into the hospital ten per cent. of their force; in three weeks there were a thousand sick out of the eight thousand men; in four weeks there were twelve hundred sick: then the army moved to Rosetta. We must therefore consider that no less than fifteen per cent. of that force had in that short space of time been in the hospital, and one-fourth of the duty-men in all probability must have passed through the hospital. The diseases produced in this short time were attended with very slight mortality; they were chiefly fevers which appear not to have been of malarious origin, but chiefly of that kind, yet little investigated or understood, which are known by the name of the bilious remittent, or the bilious typhoid, and the bilious relapsing fevers of the Mediterranean and Egypt. There were also slight dysenteries, and some ophthalmia, but no plague till afterwards, when the army got to Rosetta.

It was supposed at one time that the diseases produced at Ghiza were owing to the marshes in the neighbourhood, but this is rendered improbable; first from the fact that, as far as can be known from the accounts of the diseases, which are very short and imperfect, the malarious taint did not form any grand element in these diseases, and secondly from the following fact—Ghiza for months had been an encamping ground of a succession of bodies of troops—Turks, Mamelukes, French, and then English. The whole country was covered with putrid effluvia. At a subsequent period, when time had been given for the perfect dissipation and complete decomposition and elimination of all these putrid remains, Ghiza was again occupied and was found to be healthy; therefore it would appear certain that the condition of the camp was the cause which led to the great amount of sickness in the expeditionary force.

Filthy standing camps, then, giving rise to various forms of fever, typhoid being among the chief, and to other forms little understood, also to dysentery, and to cholera in some regions, must be put down as the next cause which has given rise to mortality in English wars. It is probable that this

cause will never again produce any great amount of sickness in our forces, inasmuch as not only is the necessity of the most perfect cleanliness in camps well understood, but in the present organization of the medical department, sanitary officers are appointed, whose special duty it is to insure the perfect and continued cleanliness of the camps.

7. I will now pass on to another head. The fatigues in war are excessive, and can only be borne by men whose frames are matured by age and constant physical exertion. Boys and immature young men are speedily destroyed, or only throng the hospitals. In campaigns every soldier ought at least to be twenty-one years old, and should have been accustomed to the most constant physical exertion and open-air exercise. Before a regiment goes on a campaign, it should be weeded of its immature men, who should form a corps of reserve, and be subjected to a thorough course of training, and be then sent on to join their regiment, when deemed fit to encounter the hardships of the campaign. The effect of exposing immature troops to the hardships of campaigns has been frequently illustrated. Some of the heaviest mortality in the Peninsular War was among regiments thus hastily recruited. In the Crimean War, during the second winter the troops were fortunately not called upon to undergo great exertion. Had they been so, in spite of all sanitary precautions, that young and untried army must necessarily have suffered very considerable mortality. Perhaps the best example in our annals of the effect of this cause is to be found in the history of the British Legion in Spain, in 1837, as given by Mr. Alcock. This body of men consisted of about 7,000 persons, hastily recruited, comprising Englishmen and Scotchmen, chiefly drawn from towns, and Irishmen who were more largely drawn from the open country. Almost all the force were either too young or too old. They landed in Spain during the winter. In the first few months after landing, one-third of the English, one-fifth of the Scotch, and one-eighth of the Irish were "rapidly swept into the hospitals." During the six months which succeeded their landing, they lost the "lives and services of 2,000 men," and the whole force was enfeebled and crippled for six months; no doubt they underwent very great hardships, were exposed to the weather, had bad food at some part of the time, and bad shelter; but they were not exposed to greater hardships than have often been met with little loss by seasoned troops. The great cause of their losses is to be found in the quality of the men, and it is worth observation how comparatively easily the Irishmen, drawn from the country and accustomed to open-air life and to the physical exertion of agriculture, bore the hardships which prostrated so rapidly the town recruits drawn from Scotland and England.

The often-quoted marches of Napoleon may be just alluded to here in reference to this point. In 1805 the so-called "Army of England" marched across France, a distance of 450 or 500 miles, with scarcely a straggler, and with scarcely any sick. In 1812 and 1813 the French army was an army of recruits, "boys who died by hundreds on the roadside." The Emperor bitterly complained, but his complaint met with no response. He had exhausted France by fifteen years of glory, and seasoned, hardened veterans were not procurable.

But even seasoned and veteran troops may be too highly taxed. Of this

there are not many examples in the history of English warfare. There are a considerable number in the history of continental armies, as in the army of Prussia in the time of Frederick the Great, and later.

Properly to train his men, to train them so that they shall be ready for great emergencies, to save them when saving is practicable, so that when necessary their whole strength may be called upon, must be one of the most striking powers of a great commander. The exposure, then, of immature young men to the hardships of war, hardships which must be undergone, must form the next series of causes which have given rise to disease in the English wars.

8. But now, supposing that the provident care of the Government and the skill of the general have succeeded in meeting all these conditions—have succeeded in providing well trained and seasoned men, in properly feeding them, in properly clothing them, and protecting them as far as can be done against inclemencies of the weather, in looking out for, anticipating, and providing for the causes which produce typhus, the causes which produce putrid dysentery, the causes which produce typhoid and other forms of fever—supposing that all this could be done, would an army be healthy?

In answer to this it may be said that it would be, that it must be, in a great measure, healthy. But there are still some causes which the soldier himself calls into action, and from which his officers can only in a very slight degree protect him The agencies which the soldier himself thus calls into action are, especially, the want of cleanliness, which is so difficult to be enforced in war, the excessive use of spirits, and debauchery.

During any exertion it is an important matter to keep the skin perfectly clean. There are those who underrate the importance of this point, but they are mistaken. It is a point of prime necessity. Now in war such cleanliness is hardly possible to be enforced. Water cannot be procured, time perhaps cannot be given, and the soldier necessarily becomes extremely dirty. Hence there is a certain amount—no great amount, but a certain amount—of ill-health proceeding from this cause alone.

Whenever an army has been kept from spirits, although it has been placed otherwise under unfavourable conditions, its health has been good. Some striking examples of this may be taken from the American War of Independence, among the American troops. At first the American troops in the revolutionary war were unhealthy. After a time they ceased to be paid—funds were not forthcoming to pay them: They then became very much healthier—in fact extremely healthy. The same thing occurred in 1814. In that war the American troops were also unhealthy at first. They ceased to be paid, they ceased to purchase spirits, which previously they had indulged in, and again they became healthy. A surgeon who witnessed both these campaigns states, and very truly states, that "when the soldier is poor in money he abounds in health." The same effect of abstinence from spirits being attended with an improved state of health of the troops has been witnessed often in the English army. The case of the "illustrious" garrison of Jellahabad is a striking instance. Another most striking instance is given by Sir John Hall in the last Caffre war. The troops were exposed to great hardships and inclemency of weather, and yet remained extremely healthy, in consequence, mani-

festly, as appears from all the circumstances of the case, of the fact that spirits could not be issued to, or procured by them. But perhaps the most interesting example of this fact is to be found in the celebrated Cornwallis campaign of 1781, in which a body of men made a long and fatiguing march of more than 2,000 miles, were exposed fully to inclemencies of weather, were supplied by a commissariat which was rather indifferent, and yet remained extremely healthy. Dr. Chisholm, the surgeon of the 71st Highlanders, shall however narrate this case. I will read an extract from his book giving an account of this celebrated march. He calls it "the most remarkable campaign of the American Revolutionary War, owing to the dangers, fatigues, and privations sustained by the army in the course of it:"—

"They effected a march of nearly 2,000 miles through a poor country, inhabited by inveterate enemies, always more than 200 miles from their resources; forded many large, deep, and rapid rivers at the hazard of their lives; fought one pitched battle against thrice their number; were almost constantly engaged in skirmishes; were deprived of rum or any strong liquors; were for weeks successively reduced to the scanty support which a few heads of Indian corn, and a precarious very limited allowance of lean fresh beef afforded them; had no shelter from the inclemency of the weather, or the damps of the earth and night, but a single blanket and a few boughs of trees hastily put together in the form of wigwams. These hardships, fatigues, and privations they were enabled to support by the example shown them by their excellent and amiable commander; by the exercise of marching being alternated by rest every third day, when practicable; by parading in clean linen once every marching day and twice every halting day, being obliged to clean and bathe themselves every day; by the men being obliged to wash their shirts and waistcoats and pantaloons themselves; by a necessary abstinence from strong liquors; and, finally, by what may be considered as not the least cause, their pursuing, not flying from, an enemy. The regiment I was surgeon to, the 71st Highlanders, composed a part of this truly gallant army; they consisted of about 600 men, and the average number of their sick during this arduous service was about twenty-five, exclusive of wounded, and they were all trifling cases."

Now here the great immunity from sickness may be considered to be dependent,

1. Upon abstinence from liquors.
2. Upon the enforced cleanliness.
3. Upon the rest every third day.

The commissariat, though indifferent, was not extremely bad; the men had fresh meat, at any rate, and appear also to have had corn, and possibly other vegetables. Of these causes the abstinence from strong liquors must be put down as the most important. In the long catalogue of wars I have not been able to find a single instance in which the use of spirits has been proved to be useful, and there is a very large number in which it has been proved to be detrimental. There are only three ways of keeping men from the excessive use of spirits. The first is to supply them with good malt liquor, and with red wines which contain a small per-centage of alcohol. The supply of red wines of this kind was

formerly strongly urged by Sir Gilbert Blane, the celebrated naval surgeon. The use of these wines is not merely negative as a substitute for spirits, but also positive, for by their use a large number of salts, neutral and acid vegetable salts, are supplied to the body, which are of the highest importance to the nutrition of the system, and are themselves no mean antiscorbutics. The second mode of preventing men from getting spirits is of course by camp regulations. We have seen this attempted in the present American War, for a special Act has been passed by Congress for the purpose of hindering the men from purchasing spirits—a plan, however, which is always liable to considerable evasion. A third means by which men might be kept from the excessive use of spirits, would be to teach them how really ineffective and inoperative their use is in preventing them from suffering from diseases, and how many diseases the excessive, or indeed the even moderate, use of spirits may itself give rise to.

The third cause, which the soldier brings upon himself, and which has caused a great deal of sickness in some campaigns, has been debauchery. This, of course, is a point which can only be prevented, as far as it can be prevented, by camp and police regulations.

Such are the eight different and principal causes of mortality in our wars. I have arranged them in the order in which, looking over the history of English campaigns, I find they have produced the greatest amount of sickness. I have considered them separately or enumerated them separately for the sake of convenience, but in almost all campaigns two, or three, or four, or perhaps all of them, have been acting together.

There is no doubt that to a great extent these causes are preventible, but to prevent them would require that those in authority should fully recognise their existence and meet them with continued energy. To prevent them requires no special science, no peculiar appliances, but only the exercise of common sense and of knowledge which every soldier ought to have. The Romans certainly applied and acted upon rules which we must also apply, and acting upon them they appear to have escaped, at any rate to a considerable extent, those immense losses and tremendous catastrophes which have so often befallen modern armies. Their forces penetrated many countries and underwent many difficulties; the forest, the marsh, the desert, the cold mountain pass, the torrid plain, were traversed by them with impunity. Shall we, who boast a dominion as extensive and a knowledge more subtle and profound, fall short of the results obtained by those old masters of the world? If so, it will not be because our difficulties are greater, nor because our knowledge is less, but because we refuse to hearken to the lessons proclaimed to us from the camps and battle-fields of those thousands of British soldiers who in times gone by have fallen victims to the preventible diseases of campaigns. We must not suppose, because those lessons are so obvious, that they can be suffered to be forgotten. A writer whose name will assuredly be hereafter placed by the side of those of Robert Jackson and of Henry Marshall, says, "All errors should be treasured up in our memories. Although the past cannot be redeemed, it ought to suggest lessons for the future."

And Ranald Martin goes on to cite those memorable words of Samuel

Johnson, which, written in 1771, are still full of meaning, and have lost nothing of their truth and force.

"The life of a British soldier," wrote Johnson, "is ill represented by heroic fiction. War has means of destruction more formidable than the cannon and the sword Of the thousands and tens of thousands that perished in our late contests with France and Spain, a very small part ever felt the stroke of an enemy. The rest languished in tents and ships, amidst damp and putrefactions, pale, torpid, spiritless, and helpless; gasping and groaning, unpitied among men, made obdurate by long continuance of helpless misery, and were at last whelmed in pits, or heaved into the ocean without notice, and without remembrance. By incommodious encampments and unwholesome stations, where courage is useless and enterprise impracticable, fleets are silently dispeopled and armies sluggishly melted away. Thus is a people gradually exhausted, for the most part with little effect. In this last war Havannah was taken, and at what expense is too well remembered. May my country be never cursed with such another conquest."

It is now ninety-three years since these memorable words were written, and it is only now that we may venture to hope that this country will not again be cursed with conquests that are scarcely less disastrous than defeats. Now at last an enlightened policy has been initiated, and the health of the soldier is, as Robert Jackson said it ought to be, "a primary consideration of the State." I venture to prophecy that in after times few reforms will be thought more important than that with which the names of Lord Herbert and Miss Nightingale, and others scarcely less distinguished, are now for ever connected; a reform in which the State both recognises a duty, and, as a reward, reaps an untold advantage. But it must be for the army at large and for the general public to support exertions which, without their aid, would languish and disappear. It must be for us, in fact, not to forget the teachings of the past, but to make them ever-living, that their warnings shall not be forgotten, and that their lessons shall not be unfruitful.

THE CHAIRMAN: I hope you will allow me to convey to Dr. Parkes your best thanks for his eloquent and most instructive lecture.

Dr. Parkes

OBSERVATIONS

ON

YELLOW FEVER.

BY ROBERT LAWSON,

DEPUTY INSPECTOR-GENERAL OF HOSPITALS.

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MDCCCLXII.

OBSERVATIONS ON YELLOW FEVER.

Division I.—Influence on the Secretions.

Having been stationed in Jamaica from September, 1856, till June, 1860, I was enabled to examine some of the peculiarities of yellow fever as it occurred there during that period. Part of the results have appeared already in the pages of the 'British and Foreign Medico-Chirurgical Review;' the present communication embraces observations on the secretions during, and the morbid appearances left by, the disease, which are of importance both in practice and in giving more precise notions as to its nature. Many of the subjects in the following remarks were mentioned by Blair in his papers on the Yellow Fever at Demerara; others have been alluded to by La Roche, in his work on 'Yellow Fever;' but I have endeavoured to push the observations further, and to trace the connexion between the different phases of the disease more fully than either, or than I have seen elsewhere.

Urine.—The liability to suppression of urine in yellow fever, and the serious consequences resulting therefrom, have long been known; but it is only of late years that the composition of the secretion has been receiving attention, and as yet it is far from having obtained what its importance demands. In fact, men in practice have their time so fully occupied, especially during the prevalence of an epidemic, that anything beyond the most simple examination is out of their power.

The urine during the first days of yellow fever presents the ordinary characters seen in febrile affections. Its quantity is rather less than natural; its colour somewhat higher, though clear, and of moderate specific gravity. From the third to the fifth day of the disease, the quantity is often diminished to fifteen, or even twelve ounces, or less, in the twenty-four hours; its colour from six to seven of Vogel's scale, and specific gravity from 1018 to 1030 at 60°; it continues acid, and presents more or less sediment. Should the patient survive the fifth day, the quantity generally increases and often becomes copious—fifty, sixty, or even eighty ounces being passed in twenty-four hours. With this increase the colour becomes lighter, unless when obscured

by blood or bile, and the specific gravity less; and as the patient convalesces, the secretion gradually assumes its usual appearance.

Suppression of urine is most common from the fourth to the sixth day of the disease; but this period may pass, the flow become copious, and yet suppression occur many days later. At either period the result is almost universally fatal.

A cloudiness appears in the urine on the morning of the fourth day of the disease; and if a specimen, obtained at this time, be allowed to stand for an hour or two in a cylindrical vessel, a sediment will subside, frequently amounting to one-fourth the bulk of the fluid, or even more. On examination with the microscope, this is found to be composed almost exclusively of scaly epithelium from the bladder. On the morning of the fifth day, an equally copious deposit will occur, but differing from that of the previous day in being composed of granular tube casts from the kidneys, frequently with but a trace of scaly epithelium. The solid transparent casts called waxy are not uncommon at this period. After the sixth day the casts become gradually more hyaline, the quantity diminishes, and in a few days thereafter they nearly disappear. When it was possible to fix the date of the first accession of the fever, the desquamation of the bladder seemed fairly developed on the morning of the fourth day; while the casts from the kidneys, though probably formed at the same time, were not copious in the urine before the morning of the fifth day. It is possible these might occur earlier in some cases, but I have not met with any in which this was ascertained satisfactorily. In cases of mixed typhoid fever, presenting on post-mortem examination the distinct raised ulceration of Peyer's glands in the ileum, and which terminated with suppression of urine, albumen and granular tube-casts were found in it, but these occurred longer after the first accession of the disease than in pure yellow fever.

The casts are usually 1·0 to 1·3* in diameter. They are highly granular from the first, with few traces of the outline of the original epithelium. The solid waxy casts are of the same sizes; if these be illuminated with a pencil of small angle, and viewed with an object-glass of large angle of aperture, epithelium more or less granular can always be seen in them. The substance connecting the granular and epithelial matter in both descriptions of casts is soluble in caustic potash; acetic acid dissolves it in the granular casts, but seems not to affect the waxy. These reactions induce me to believe the waxy part of the casts is casein, which, it will be shown below, is common in the urine in yellow fever.

It is rare to find a blood-globule in the tube-casts, even at the commencement, and many cases of the disease run their course without a single globule being detected in the urine. In others there may be hæmorrhage from the kidneys or urinary passages, in which case blood-

* In this method of expressing microscopic measurements, the thousandth of an English inch is taken as the unit, and its fractional parts are given decimally, which offers far greater facilities for comparison, and for conversion into foreign measures, and *vice versâ*, than the method by vulgar fractions usually employed in this country. See Beale's Archives of Medicine, No. 8 (April, 1861), p. 292.

globules are found in the secretion, or in the casts. A third series occurs in which the urine is of the colour of blood, without a globule being found in it; in these the epithelium and substance surrounding the granular matter of the casts are deeply impregnated with hæmatine, though not a single entire globule can be detected among them.

If the case proceed favourably, the casts diminish in number, and become less granular and more hyaline on the sixth or seventh day, and soon disappear altogether. If it run on to suppression of urine at this period, they maintain their granular character; but if the flow of urine be increased after the fourth or fifth day, and the suppression do not occur until a later period, the casts become less granular and less numerous until just before that event takes place.

The urine is frequently coloured deeply by bile. This may be distinguished from hæmatine by the brownish-yellow colour a thin stratum gives with transmitted light, while urine coloured by hæmatine always presents a blood red. The former gives a green colour with nitric acid, varying in depth from a light pea-green to a greenish black, and occasionally, when not too deep, the usual changes to the violet and red can be perceived; while with the latter this acid produces a coagulum, from a dirty brownish grey to a dark liver colour. The two, however, may exist in the same specimen, when the reaction will partake of both characters.

The discharge of blood, whether in the form of globules or of hæmatine, and that of bile, in the urine, usually occur from the fourth to the sixth day, and either may continue for several days thereafter. The excretion of bile in this way is always beneficial. Blood, if in the form of globules—constituting hæmorrhage, in short—is generally beneficial, from whatever organ it proceeds, if the flow be not so copious as to depress the vital powers too much, and with its appearance unpleasant symptoms are often dissipated. When originating in the kidneys, it seems to act as a local depletion, obviating that engorgement of these organs so liable to arise at this period, and favouring the flow of urine. It is very different when the discharge is in the form of hæmatine without globules; then it seems to be strictly a secretion, for the epithelium of the casts, and that in the convoluted tubes of the kidneys themselves, is deeply impregnated with it, while blood globules are not to be seen either around the Malpighian bodies or inside the tubes. This form of discharge is often copious, always unmanageable, and almost of fatal import.

The colour of the urine has been stated already to be as high as from 6 to 7 of Vogel's scale, from the fourth to the sixth day. This arises from its ordinary colouring matter, the uræmatine. In addition, this secretion sometimes contains, for long periods, and in healthy persons as well as those labouring under disease, a large amount of uroxanthine, or its derivatives, urrhodine and uroglaucine. These do not deepen the colour, but as they seem connected with some peculiarities in the form of yellow fever, I notice them here.

The presence of urrhodine, or uroglaucine, may be determined by adding a few drops of urine cautiously to a drachm of hydrochloric

acid in a small test-tube, when a colour will be developed where the fluids meet, varying from red through purple to blue, according to the predominance of either of these pigments, and more or less intense according to their quantity. Their presence is indicated in another way. If a portion of urine treated with nitric acid, in the usual manner for the detection of albumen, be set aside for some hours, if containing more than a trace of urrhodine it will become of a deep reddish-brown colour, while the tint of uræmatine is not altered materially by this process. While these pigments were present in small quantity only, fever seemed to have less of the epidemic character, though the cases which presented themselves displayed an earlier and more serious implication of the liver, and more intense jaundice, than when they were more general and more copious. Just previous to my leaving Jamaica, the nitric acid gave the deep colour pretty generally, after having been absent from the early part of 1859. Upon this I stated the probability that the following season would be unhealthy, which prediction has proved correct.

If urine when heated, or treated with nitric acid, present a coagulum, this is generally believed to be albumen; but it may contain other matters which coagulate when so tested, and in yellow fever it does so very commonly. Globuline is coagulated by heat, and casein by nitric acid, as well as albumen, and these are by no means infrequent in the urine of fever in Jamaica. The following table shows the reactions of these three substances with different tests, and affords the means for distinguishing them:

	Heat.	Nitric acid.	Acetic acid.	Heated with dilute solution of carb. soda.
Albumen .	Coagulates at 146° Fahr.	... Coagulates	... Unaffected	... Unaffected.
Globuline .	Coagulates at 200° Fahr.	... Coagulates	... Unaffected	... Dissolves.
Casein . .	Does not coagulate.	... Coagulates	... Coagulates	... Dissolves.

In examining urine it was, in nearly every instance, passed through a paper filter, to remove epithelium, tube casts, mucus, or other extraneous matters; portions were then placed in three test-tubes, one of which was heated, another treated with nitric acid, and the third with acetic acid in a similar manner. The indications at the time were noted, and again after twelve to twenty-four hours.

On heating a specimen cautiously, with the tube inclined, the fluid along its upper edge sometimes became opaline, and the appearance then spread rapidly through the whole before the temperature was sufficiently high to form steam. At other times small bubbles of steam were generated and passed up, nearly reaching the surface, before an opalescence appeared, indicating a much higher temperature of the fluid. The coagulation in the former case was from albumen, in the latter from globuline. Sometimes there was a slight coagulation at the lower temperature, and a much more copious one at the higher, indicating an excess of globuline, though no free blood-globules were

seen in the urine. In common, however, the albumen so far exceeds the globuline that the latter cannot be detected in this manner; but it may be separated from the albumen by boiling alcohol, which I have done several times.

The nitric acid test was confirmatory of that by heat, and served to distinguish discoloration by blood from that by bile, as well as indicate the presence of urrhodine. Part of the specimen can be examined for chlorides, after the subsidence of the coagulum.

When acetic acid was added to a specimen containing casein, the colour became lighter, and more or less opaline, but in general subsidence did not take place to any extent for some hours. After twelve hours the precipitate had usually fallen, and constituted a fine amorphous, rather compact deposit, at the bottom of the tube. The supernatant fluid was then poured off, the precipitate washed and allowed to subside again, when the fluid was separated, and fresh water being added, a few drops of solution of carbonate of soda dissolved it at the temperature of the air (80° to 86° Fahr.); this observation has been repeated in so many instances, with the same result, as to leave no doubt concerning it.

Urine rich in urates gives a precipitate with acetic acid, if near the point of saturation, and at a low temperature, and the precipitate dissolves in carbonate of soda. This differs from casein in the precipitate forming immediately, and subsiding quickly; and, on decomposing the soda solution with an acid, by giving uric acid in a crystalline form, which can be recognised with the microscope. If a portion of the same urine be warmed, it will no longer give a precipitate on the addition of an acid, and if allowed to cool gradually the uric acid will be deposited in a crystalline form on the sides and at the bottom of the vessel. It was almost universally in the latter forms that it occurred in Jamaica.

I had seldom examined the soda solution for uric acid, but very frequently evaporated some drops of the secretion itself, acidulated with hydrochloric acid, on a slip of glass; and in the most decided instances of the presence of casein, did not find traces of uric acid, though hippuric was plentiful. The following case will illustrate this, as well as several other points noticed in this paper:

Henry Goodwin, a black soldier, aged about thirty, had a paroxysm of fever on the 10th August, 1859, but did not report himself sick. On the 12th, the third day of the disease, he went to hospital in the afternoon with a sharp attack of fever; the conjunctivæ were then deeply yellow. From this time till the morning of the fourth day he passed sixteen ounces urine, which was slightly albuminous. On the fifth day there was a remission; passed twenty-eight ounces urine. On the sixth day he continued much the same, the urine containing granular and epithelial tube casts in moderate quantity, with a little albumen and casein, very little urea, but much creatine and hippuric acid; no uric seen. The urine had not been examined microscopically before this day. On the seventh day fever ensued again; he had passed thirty ounces urine from the previous morning, of the same

character as last. About noon it became bloody, giving the colour of venous blood by transmitted light. It was then strongly acid, specific gravity 1014 at 84°, did not deposit a sediment, but had a few flocculi of granular and epithelial tube-casts, and epithelium from the bladder, but not a blood-globule could be detected. As the fluid filtered with extreme slowness, part was heated without filtration; coagulation took place partially, some time before ebullition, but increased as that occurred, and a sediment of a reddish colour fell, leaving the supernatant fluid pretty clear. Some of the latter gave a deposit with acetic acid, which dissolved in dilute carbonate of soda. A portion of the urine was treated with acetic acid; coagulation was produced almost immediately, and after some hours a deposit of one-seventh of the bulk of the fluid took place, of a reddish colour, and over it a thin loose stratum of deeper red colour, leaving the supernatant fluid clear dark amber; both deposits dissolved with carbonate of soda. As on the previous day, hippuric acid and creatine were copious, but there was little urea, and no uric acid. On the morning of the eighth day the fever continued; forty-two ounces of urine had been passed from the previous noon, of darker colour than before. Early this morning gallic acid was commenced, in three-grain doses every fourth hour. A specimen of the urine passed this forenoon was darker in colour than that of the previous day; it contained several granular tube-casts, which were tinged red, but none contained blood-globules, neither were any free globules seen. A coagulum of one-third formed by heating; but with acetic acid it was, to-day, not more than one-thirtieth of the whole, the supernatant fluid remaining of a clear deep cherry red. On the morning of the ninth day the urine collected in the previous twenty-four hours amounted to eighty ounces, of similar character; there was less fever, but a tendency to collapse; the gallic acid was increased to three grains every third hour. In the afternoon, ten ounces of a much lighter coloured secretion was passed, when the gallic acid was diminished a half. On the morning of the tenth day there was more fever; no urine had been passed since the preceding day; the gallic acid was then stopped. On the morning of the eleventh day, no urine having been passed for thirty-six hours, a catheter was introduced, and four ounces drawn off, of a dark brown muddy appearance. It contained numerous short solid pieces of granular tube-casts, of 2^{lin}·0, 1^{lin}·0, and 0^{lin}·75 in diameter; these seemed infiltrated with a clear material, which in many had accumulated pretty thickly outside the granular portion, and with it was tinged throughout of a reddish brown colour. These casts were unaffected by strong acetic acid. No blood-globule was seen in the casts, or free in the urine itself. With heat the urine gave a coagulum amounting to one-fifth of the whole, and with acetic acid one amounting to one-tenth; the former dissolved in caustic potash, but was unaffected by carbonate of soda; the latter dissolved in carbonate of soda. The man died in the evening of this day.

This case is of much interest in the following respects:—1st. As showing the existence in the urine, at the same time, of albumen, casein, globuline, and the colouring matter of the blood. 2nd. In the absence of all trace of blood-globules throughout. 3rd. In the immediate reduction of the quantity of casein on the eighth day, under the influence of gallic acid. 4th. In the formation of waxy tube-casts under these circumstances, and the rapid diminution of the urine. Gallic acid passes through the kidneys unchanged, and may be detected in the urine within a very short time of its administration. It does not coagulate albumen, but precipitates casein immediately, and if brought in contact with the latter, sufficiently concentrated, as in the tubes of the kidneys, would cause its coagulation between and around the epithelium and granular matter constituting waxy casts, as in this case. Gallic acid would thus be a remedy of very questionable advantage in cases in which the urine contained casein.

The occurrence of albumen in the urine of yellow fever was first remarked, so far as I am aware, by Staff-surgeon Collins, at Barbadoes, in 1848,* and the same gentleman met with two cases in which the albumen was replaced by a substance having the properties of casein.† Blair seems to have doubted the correctness of the latter observation,‡ and there is no indication in La Roche's work, that any other person had detected this substance in the disease.

In watching a case from day to day it is found that, sometimes in the course of the third day, or by the morning of the fourth, heat indicates a small portion of globuline or albumen in the urine; and on the morning, or in the course of the fourth day, albumen generally appears in such quantity as to obscure the indications of globuline. The fifth day the albumen is more copious, and would seem to attain its maximum on that or the following one, after which it gradually declines. Casein appears about the fourth day, and accompanies either globuline or albumen. I do not remember to have seen it alone in fever. When albumen becomes very copious, the casein frequently disappears, and, under ordinary circumstances, seems to do so before the albumen. In some cases, globuline and casein have continued during the course of the disease, without albumen having been detected.

The quantity of albumen, &c., may be estimated approximately, from day to day, by the space the sediment occupies in the test-tube relatively to the bulk of the original fluid, and may be expressed conveniently in parts of the whole, either as a decimal, or vulgar fraction. The albumen was found to vary in different cases from a mere trace to 1·0; the globuline, from a trace to 0·7, though in general not exceeding 0·1; and the casein from a trace to 0·2, but generally less than 0·1.

The albumen varies greatly. At one time most cases present it to a considerable amount, at another there is much less, though the cases may be very severe, or even fatal. When the liver was severely implicated, and there was marked tenderness over it, with an early yellowness of the surface, the urine contained less albumen than when the

* Blair on the Yellow Fever at Demerara, third edition, p. 98. † Ibid., p. 99.
‡ Blair: Report on the Recent Yellow Fever Epidemic at Demerara, 1856, p. 18.

hepatic affection was less prominent. This peculiarly existed during the greater part of 1859, and early part of 1860.

Though the urine have a high specific gravity from the third day onwards, the urea seems much diminished. I have not determined the quantity with precision, but much less was obtained on evaporating a small portion of the fluid, acidified with nitric acid, than from healthy urine. La Roche gives the result of an analysis to the same effect.*

Though urea be deficient, creatine is unusually copious in the febrile affections of Jamaica, whether pure remittent or yellow. If two or three drops of urine from such cases be evaporated on a piece of glass, numerous needle-like crystals, visible to the unassisted eye, more or less branched, appear before the fluid has quite dried, and frequently cover the surface extending from one side of the specimen to the other, among the substances deposited during the evaporation. At a certain stage in the operation small rhomboidal plates appear, or more frequently hexagons, with the obtuse angles of the rhomboid removed, and, as the concentration proceeds, these are seen to shoot out both ways from the acute angles, forming the needle-like crystals mentioned: the needles always present a swelling in the position of the original hexagon, and the prolongations seem to have a triangular section, with the base on the glass, and the apex uppermost. These crystals present the nacreous appearance peculiar to creatine; they are soluble in water, ammonia, and dilute nitric, hydrochloric, and acetic acids, from which they are deposited again, generally in the form of hexagonal plates. Alcohol does not seem to affect them. Sometimes, though the specimen under examination be rich in creatine, it remains fluid and the creatine does not crystallize; if a drop or two of alcohol be added under these circumstances, numerous rhomboidal or hexagonal crystals appear, but they generally redissolve as the alcohol evaporates.

In one case, in which these crystals were numerous, and the portion of the urine from which they were obtained was evaporated to dryness over a water-bath, the residue was exhausted by alcohol, to remove urea, &c., and the creatine was separated from the remainder by ammonia. On filtering and concentrating the respective solutions, a quantity of creatine was obtained, about equal to that of the urea.

Creatinine exists in many of these cases in considerable quantity, besides creatine, but as it requires a troublesome process to isolate, it was less easily detected, and not so often looked for. In one case in which the urine had been treated as in the last paragraph, a portion of the concentrated alcoholic extract gave very little urea, even when nitric acid was added, but the remainder displayed numerous clusters of beautiful navicular crystals of creatinine. When a drop of this secretion acidified with nitric acid is evaporated on a slip of glass, in addition to the nitrate of urea, crystals are often seen resembling the dendritic masses of creatinine figured by Robin and Verdeil,† but

* La Roche on Yellow Fever, vol. i. p. 561.

† Robin et Verdeil: Traité de Chimie Anatomique et Physiologique, Atlas, pl. xxvii. fig. 2.

these mostly extend from one side of the axis of the mass only, and are not symmetrical, as represented by those authors; at other points they present the characters delineated at Fig. 2 *a* of the same plate. The exact composition of the crystals in question I cannot say, but if digested in ether, the latter on evaporation affords the symmetrical crystallization represented by Robin and Verdeil, with more or less hippuric acid, which usually accompanies them. I have recently obtained similar results from a specimen of urine from a case of bronchitis in this country.

Rounded masses resembling leucine were occasionally seen, when a few drops of the secretion were allowed to evaporate on glass, but this was rare. I do not recollect to have met with tyrosine, as figured by Frerichs in the frontispiece of the Sydenham Society's edition of his work on 'Diseases of the Liver.'

Uric acid was frequently present, and even in considerable quantity, when the urea was much diminished, and the chlorides almost or entirely absent. This was not found in every case, however, and I am not prepared to indicate the peculiarity of those in which it was observed.

Hippuric acid is formed copiously in the urine of febrile cases in Jamaica, as indeed in every other instance in which it was looked for. Uric acid was often plentiful in the same specimens, neither seeming to take the place of the other. When present in any quantity, it is easily detected by placing two or three drops of the secretion on a slip of glass, adding a drop of nitric acid, and evaporating slowly, when the peculiarity of the crystallization is quite characteristic.*

The chlorides in the urine undergo a marked decrease in the case of yellow fever, as met with in Jamaica. The only notice I have seen on this point is that given by La Roche,† on the authority of Dr. Wragg, of Charleston, who was of opinion that hydrochloric acid was thrown out largely from the kidneys. The details of Dr. Wragg's process are not given, nor the period of the disease to which his observations refer, which are important circumstances. My observations were made in the usual manner, by acidifying with nitric acid a portion of urine with its albumen removed (when so plentiful as to mask the operation), and then adding nitrate of silver. The freedom of the nitric acid from chlorine was previously ascertained.

With these precautions, the chlorides were found perceptibly less as soon as the urine contained traces of albumen, and on the evening of the fourth day and course of the fifth, when the desquamation of the urinary passages was in active progress, there was never more than a trace, sometimes not even a trace, to be detected. These began to reappear about the seventh day, when the case progressed favourably, and increased from day to day thereafter.

* British and Foreign Medico-Chirurgical Review, vol. xxviii. p. 487. I have found hippuric acid in advanced pregnancy and in chronic bronchitis, in this country, where no benzoic acid had been administered previously, and apprehend it is more common than is generally supposed.

† La Roche on Yellow Fever, vol. i. p. 559.

Blair remarks* that albumen was not detected in the urine of cases of intermittent which occurred contemporaneously with the epidemic, and he saw the value of the distinction in diagnosis. My observations are to a similar effect, having found, concurrent with decided yellow fever, intermittents and remittents, which presented the usual characteristics of these affections, and neither displayed desquamation of the bladder or kidneys, nor albumen, globuline, or casein in the urine, while the chlorides remained undiminished throughout. I met with one case, however, exactly resembling those of yellow fever, which occurred about the same time, save that there were neither tube-casts nor albumen in the urine, nor were the chlorides much diminished. This individual had previously had frequent attacks of inflammation of the sheaths of the tendons in the wrists, hands, ankles, and feet. How far the kidneys may have been influenced by the peculiarity of constitution indicated thereby, must remain an open question at present.

Albuminuria is common in Jamaica, and it is quite possible that febrile symptoms might arise in such a case, and lead to a doubt as to its nature. It may be distinguished from yellow fever, however, by the absence of the desquamation of the bladder on the fourth day, followed by that of the kidneys, and by the urine retaining a fair proportion of chlorides, though loaded with albumen.

Alvine Evacuations.—The alvine evacuations have not received the attention they require; until they have been as closely examined as the urinary, much valuable information regarding disease will remain untouched. My own observations on the subject have neither been so numerous nor so minute as those on the urine, still they afford some hints which are not noticed elsewhere, and which seem of value in explaining the characters of yellow fever.

Blair has given a short chapter on the character of the stools, as he saw them in Demerara,† which agree in the main with what was found in Jamaica. He describes the evacuations as feculent at first, with more or less admixture of mucus, and a matter he denominates "melanotic," and as giving off a very disagreeable odour. These were succeeded by what he calls the "caddy stool," a liquid light-coloured evacuation, depositing a dirty grey sediment, containing crystals of triple phosphates, and uric acid, and numerous little amorphous masses of black opaque matter, which he regards as its constant ingredient. As the disease advanced the caddy stool was replaced by a very scanty mucous stool, consisting of clear mucus, with broken-up epithelial matter, and myriads of epithelial granules, either uncoloured, or variously tinted of yellow, or green colour, by bile, or brown or black with the elements of blood. These may present several of the crystalline forms of the caddy stool, and are contemporaneous with diminished urine and black vomit. The elements of blood were sometimes so copious as to give the evacuation the appearance of black vomit.

In Jamaica the bowels were seldom costive or difficult to move. The first evacuations were always feculent, more or less modified by medi-

* Report, 1856, p. 21. † Ibid., pp. 24–28.

cine, and generally offensive. About the fourth day, or earlier, the brown feculent character which had already been becoming less marked, often disappeared when the lighter-coloured stool Blair designates "caddy" took its place; this, though frequently liquid as he describes, was by no means always so, for I have seen it consistent, and formed, in many cases; it was never very copious. Its chief characteristic was the want of the brown colouring matter (usually thought bilious), supplied by the glands of the mucous membrane of the colon,* which is altogether different in colour from bile, and gives a different reaction with acids. These discharges may even have a yellowish or greenish tinge, from bile, however, while the proper brown is nearly or entirely absent. They seem to differ little from the clayey evacuations which accompany jaundice and other affections in this country, only less copious, and essentially depend on the colon performing its secreting function imperfectly, a circumstance which though frequently associated with retention of the biliary secretion, is not necessarily so, either in diseases of this country or the tropics.

The persistence of these light-coloured evacuations is always of serious import, as they are frequently followed by black vomit, or other forms of hæmorrhage. Their disappearance, on the other hand, on the occurrence of a more natural feculent evacuation about the fourth or fifth day, is usually the harbinger of a safe termination, and speedy convalescence. The suppression of the natural secretion of the colon would therefore seem to be intimately connected with the vicarious appearance of hæmatine in some form elsewhere. The importance of this principle in yellow fever is very great, as it directs attention to exciting the secretion of the colon, as the natural way of obviating many of the unmanageable symptoms of this disease, a point of late years too much overlooked.

The evacuations occasionally contained the elements of blood. These varied in appearance from blood little changed, through a fluid of the colour of dark venous blood with very few globules, to one exactly resembling black vomit, of a blackish brown colour, with scarcely a blood-globule to be seen. The more hæmorrhagic forms came from the lower part of the small intestine, or colon, and those without the globules from the stomach or duodenum. The mucous membrane of these organs respectively, in such cases as were examined, being found congested, softened, and easily abraded. In the intestines these fluids sometimes present a very different aspect in different parts. I have seen a fluid like very dark venous blood, with acid reaction, in the stomach and duodenum, which, in the lower part of the jejunum, had a black colour with alkaline reaction, and under the microscope a greenish tint, changes effected by an admixture of bile. In this case there had not been black vomit, but from the stomach to the cœcum the canal was filled with this bloody fluid. Some assistance may be obtained towards deciding on the part these discharges come from by the nature of the contained epithelium. The black vomit from the stomach, in addition to columnar epithelium, contains numerous small

* See British and Foreign Medico-Chirurgical Review, vol. xxviii. p. 488

granules with occasional granular cells; that from the intestine has the columnar epithelium in abundance; while the discharges from the colon alone contain casts more or less complete from the tubular glands of its mucous membrane. A discharge may contain all these, but one form or other will predominate, according to the locality where it wa produced.

A full chemical analysis of the alvine evacuations in yellow fever is very desirable. I made various attempts at qualitative examination, but as the methods were defective, and the results consequently uncertain, it would be useless to notice them further.

Discharges from Stomach.—Though the discharges from the stomach have attracted attention from the earliest period, much difference of opinion exists as to their nature and origin, and their value as characteristic of the disease.

At the commencement, if the stomach be irritable, the matters rejected, in addition to the ordinary ingesta, are mucous, more or less tinged with bile. To these succeed, in many cases, a clear fluid, with an acid reaction, which seems to have been particularized first by Blair, and which he denominated "acid elimination," or "white vomit." This, again, is followed by black vomit. All these may occur in succession, in the same individual, but one or more, or even all, may be absent in a genuine case of yellow fever.

The early vomitings are accompanied by a good deal of nausea, and much straining. With the white vomit there is extreme oppression at the precordia, often with a burning sensation; the straining during the efforts to vomit is very great, and, after a painful endeavour to relieve the stomach, the patient will often turn back in bed without having thrown off anything. When a little is rejected it is usually clear mucus, sometimes very acid, but sometimes this is less marked. The more copious the white vomit is, the less acid is it found to be, and the oppression at the epigastrium seems less.

When black vomit comes on, the discharge takes place without any very decided effort, and often without any apparent exertion of those muscles which are deeply engaged in the ordinary efforts of vomiting; and the oppression at the precordia, so remarkable with the white vomit, has often completely disappeared.

The transition from white to black vomit first manifests itself by the appearance of brown specks in the clear mucus, which have been likened to pinches of snuff. These increase in number, the mucus becomes more limpid, and tinged more or less of the same colour, and a sediment separates. The fluid in this condition often remains decidedly acid. As the brown matter increases in quantity, the acidity frequently becomes less marked, and sometimes is insufficient to redden litmus.

The nature, and place, and mode of origin, of black vomit, have given rise to much discussion. Many have thought it a morbid secretion of the liver; others have attributed it to a dissolved state of the blood, allowing it to exude through the mucous membrane; others have considered there was hæmorrhage from the capillaries, and that the blood-

globules were destroyed in the acid secretions of the stomach; others, again, have attributed the black vomit to a secretion from the mucous surfaces of the organs in which it was found.

On examining specimens of characteristic black vomit by the microscope I found much columnar and glandular epithelium, the latter granular; and many free granules which were colourless, pretty clear, spherical, and sometimes corrugated on the surface; these were half the diameter of blood-corpuscles, and of a different colour. The colouring matter was brown, amorphous, and no blood-globules were detected. Spores, torulæ, and other extraneous matters were common. These appearances agree in the main with those described by American authors; but I have not met with the masses "of modified and disintegrated blood-corpuscles," or "the granular detritus and irregular masses, apparently the results of degradation of blood-corpuscles" described by La Roche.* The discharge is sometimes much more of the colour of venous blood than the usual coffee-ground appearance, and may even contain blood-globules, little altered, from hæmorrhage, but in its most characteristic forms these may be, and most frequently are, completely absent.

When little black vomit had been ejected, or formed in the stomach, a large portion of the mucous membrane was often of a deep brown colour. When more of that had been formed, even though it remained in the organ, the lining membrane presented a less extensive discoloration, a few brown streaks only remaining, or even these were absent. It is clear, from this fact, that the discoloration of the mucous membrane does not arise from imbibition of the coloured fluids in contact with it. Yet on placing a section from the discoloured portions under the microscope, the tubular glands were found with their epithelium in a granular condition, and thoroughly impregnated with a brown colouring matter—the granules, however, remaining pretty free from it. Vessels could be detected among the tubes, in various places, distinctly, with entire blood-corpuscles in them. As has been stated by Blair and others, it is quite a mistake that the blood, generally, is in the dissolved state so often supposed by many authors.

The facts of the glandular epithelium in the tubular glands of the stomach being coloured brown and containing numerous granules, coupled with the disappearance of that colour as black vomit becomes copious, and the occurrence of similar elements constituting the characteristic portions of the vomit itself, appear to leave no doubt as to its place of origin, and as to its being a true secretion, though occurring in the course of disease. It is quite analogous in this respect to what has been described above as having taken place from the kidneys in the course of this disease, and to what I have elsewhere shown takes place in a state of health from the glands of the mucous membrane of the colon.† It is a significant fact, too, that those cases of yellow fever in which the colon ceases to perform this part of its

* On Yellow Fever, vol. i. p. 315.

† British and Foreign Medico-Chirurgical Review, vol. xxviii. p. 488.

function, are those most inimical to black vomit, or similar discharges, or hæmorrhage from other organs, while natural-coloured alvine discharges are the surest signs of amendment. The occurrence of hydrochloric acid in considerable quantity in the white and black vomits, coincident with the diminished elimination of chlorides from the kidneys, affords another indication of the stomach exercising a vicarious eliminative action in the disease.

Blair has given a table of the days of occurrence of white and black vomits, from which it appears that the former manifests itself most frequently on the third and fourth days of the disease, though frequently also (and nearly in equal numbers each day) on the second and fifth days; while in other cases it took place as late as the twelfth day. The black vomit appeared most frequently on the fourth, fifth, and sixth days, though cases were by no means uncommon on the third and seventh days, and instances were seen on the first, and as late as the thirteenth day of the disease. As these discharges may be regarded as efforts of the system at crises, it is clear they may be looked for at the various periods of the disease when critical evacuations might be expected; and though most frequent from the third to the sixth day, yet it is possible they might occur either sooner or later. Blair's table, however, may require modification; he was under the impression that the access of yellow fever was characterized by well-marked symptoms, which left no doubt as to its period of invasion; this, however, is not always the case, and the exceptions are more numerous than he contemplated. The following extract from one of the older writers on West Indian fever is more correct:

"It is worth remarking, that the fever sometimes appears in a very slight way, with languor, loss of appetite, some degree of headache, disturbed sleep, and whiteness of tongue; the patient being able all the while to go about his usual employment. In symptoms so moderate, the presence of a fever is hardly acknowledged, though the readiness with which they rise into a severe disease, on the least irregularity, or any anxiety or distress of mind, leaves no doubt of their nature."*

Cases answering this description must have occurred to every one of any experience in the tropics; and the difficulty I have had in fixing the period of accession of the disease in such, makes me doubtful as to the weight to be attached to Blair's determinations for the earlier days in his table.

Hæmorrhages from other Organs.—I have known three cases of discharge of bloody fluid from the lungs in the last stage of yellow fever; and oozing from the gums, nose, and conjunctiva are not uncommon. Copious discharges from the vagina are met with in females. As in none of these cases, however, had I examined the fluid with the microscope, I cannot give any information as to the condition of the blood it contained.

* Observations on the Diseases of the Army in Jamaica, by John Hunter, M.D., Physician to the Army, p. 95. London, 1788.

HOSPITAL STATISTICS

AND

HOSPITAL PLANS.

By FLORENCE NIGHTINGALE.

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In my paper on the Sanitary Condition of Hospitals, (read before the meeting of this Association at Liverpool, in 1858,) the defective state of hospital statistics was pointed out, as well as the necessity for all hospitals coming to a common agreement on the number and nature of the data to be tabulated for future use. It then occurred to me that the best thing to do to forward the object would be to prepare a set of forms to give effect to these suggestions, and to bring them for discussion before the International Statistical Congress in London last year, the subject being one of interest for all hospitals, foreign and British. To do this, it was necessary to adopt a common nomenclature of diseases, as the foundation. Such a nomenclature had been already adopted at a previous meeting of the Congress at Paris; and was used in substance in the forms I laid before the London meeting.

It was most important to arrive at some common agreement as to classification of diseases, in order to give the requisite facilities for reducing the statistical data and obtaining the results. This matter is confessedly beset with difficulties, not likely to be soon solved. But, as it would never do to leave hospital statistics in the unsatisfactory state they were found in, till everybody had agreed on a classification, that one in use by the Registrar-General of England (and now by a large section of the United States) was adopted.

The paper and forms which I now lay before the Association are those which, after a lengthened discussion, were adopted by the Statistical Congress. I thought it right to bring them before the Dublin meeting, because of an implied engagement to follow up improvements I had myself urged on the Liverpool meeting of the Association, as above said; and also because I have been given to understand that several eminent hospital medical authorities in Dublin (in that spirit of improvement which distinguishes medical

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science there) had wished that the subject should be thus introduced.

It is proposed that one and the same form should be used for each statistical element. Seven such elements are required to enable us to tabulate the results of hospital experience; they are as follow:—

1. *Remaining in hospital* on the first day of the year.
2. *Admitted* during the year.
3. *Recovered or relieved* during the year.
4. *Discharged* incurable, unrelieved, for irregularities, or at their own request.
5. *Died* during the year.
6. *Remaining in hospital* on the last day of the year.
7. *Mean duration of cases* in days and fractions of a day.

These seven elements printed as separate headings and attached to copies of the same form, or written in, would furnish us with the means of tabulating every fact we require. Provision can be made for different sexes in one or two ways:—the column for each age may be subdivided for males and females; or it might be more convenient to have two sets of forms, one for each sex.

Again, surgical cases and injuries may be included in the same form with medical cases; or, in large hospitals, a separate set of forms might be devoted to surgical cases.

For small hospitals, one set of seven forms might easily be made to contain the annual statistics of ages, sexes, and diseases (medical and surgical;) but for very large hospitals, possibly four sets might be required.

The primary object of these Tables is to obtain an uniform record of facts from which to deduce statistical results, among which the following may be mentioned:—

1. The total *sick population, i.e.*, the number of beds constantly occupied during the year by each disease for each age and sex.
2. The *number of cases* of each age, sex, and disease submitted to (medical or surgical) treatment during the year.
3. The *average duration* in days and parts of a day of each disease for each sex and age.
4. The *mortality* from each disease for each sex and age.
5. The annual proportion of *recoveries* to beds occupied and to cases treated for each age, sex, and disease.

In reducing the data to give the annual results, either percentages or per thousands may be used.

The number of beds constantly occupied may be obtained by taking the mean of the numbers remaining at the beginning and end of the year, if the hospital has been fully occupied; or the mean of the numbers remaining at the beginning and end of each quarter; or oftener, if the hospital be irregularly occupied; or the total number of days spent in hospital by all the cases during the year might be obtained; and by dividing the sum by 365, the mean daily sick would be arrived at. [The total daily "*diets*" issued during the year divided by 365 would give the same result.]

A.—HOSPITAL ADMISSION AND DISCHARGE BOOK.

No. of Case.	Date of Admission.	Name.	Age.	Sex, M. or F.	Residence, and Place where taken Ill or Injured.	Trade or Occupation.	Disease or Accident.	Date. Of Attack.	Of Recovery.	Of Death.	Of Discharge (Relieved) or (Unrelieved,) or otherwise.	Of Transfer to other Division of Hospital.	Duration of Case in Hospital, in Days and Quarters.	Remarks. (Previous Diseases of Patients and of Parents.
1					*Example of the Manner of filling up the Return.*									
2	May 17.	John Johnson...	35	M.	263, Strand..... Run over by a cab on London Bridge.	Shoemaker....	Compound fracture of tibia and fibula. Amputation, May 20.	May 17	Aug. 18	—	Aug. 18	—	94 days	——
3	Aug. 5.	Maria Wood...	29	F.	28, Burrage Road, Plumstead..... Attacked at her residence.	Laundress	Ague.....	Aug. 2	Aug. 28	—	Aug. 28	—	26 days	——
4	Nov. 3.	James Young...	14	M.	Workhouse..... ..... Attacked at workhouse school.	Son of a tailor	Smallpox. 12 days Pneumonia, 3 days. (Not vaccinated.)	Nov. 3	—	Nov. 18	—	—	15 days	——
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														

B.—Proposed Hospital Statistical Form.

This Sheet will serve for the Classification of Cases in Hospitals under the following headings:—"Remaining, 1st January"—"Admitted"—"Cured (or Relieved)"—"Dead"—"Discharged incurable, for Irregularities, or at their own Request"—"Remain-

[illegible]
Hydrocele.. .. .. ..
Ovarian Dropsy .. ..
OTHERS .. ..

Order VII.

Synovitis .. ..
Ostitis (including periostitis and endostitis ..
[illegible]

[illegible]

Order VIII.

roseola
urticaria
eczema
herpes
pemphigus
ecthyma
impetigo

B.—Proposed Hospital Statistical Form.

This Sheet will serve for the Classification of Cases in Hospitals under the following headings:—"Remaining, 1st January"—"Admitted"—"Cured (or Relieved)"—"Dead"—"Discharged incurable, for Irregularities, or at their own Request"—"Remaining, 31st December"—"Duration of Cases in Days."

Write the Name of Hospital, the Sex, the required Heading, and Date with the Pen.

Ages	Years. 0	1	5	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85 and upwards	Totals.
CLASS I.—Order I. (Zymotic Diseases.)																			
1. Small Pox																			
Measles																			
Whooping Cough																			
Croup																			
Scarlatina																			
Quinsy																			
Diphtheria																			
Cornea, Catarrh, Influenza																			
Ophthalmia (purulent)																			
Erysipelas																			
Scleda (puerperal Fever)																			
Pyæmia																			
Hospital gangrene																			
Carbuncle, Boil																			
Scrofula																			
Diarrhœa																			
Cholera																			
Typhoid Fever (typhus)																			
Typhus																			
Relapsing Fever (typhoid)																			
Agues																			
Intermittent Fever																			
Rheumatism																			
OTHERS																			
Order II.																			
Gonorrhœa																			
Primary Syphilis																			
Secondary Syphilis																			
Tertiary Syphilis																			
OTHERS																			
Order III.																			
Scurvy																			
Purpura																			
Alcohol { 1. Excessive Use / 2. Intemperance																			
OTHERS																			
Order IV.																			
Thrush																			
Purpura																			
Scabies																			
Worms																			
OTHERS																			
CLASS II.—Order I. (Constitutional Diseases.)																			
Gout																			
Dropsy																			
Cancer																			
Cancer (ovum)																			
Scirrhus																			
OTHERS																			
Order II.																			
Scrofula																			
Tuberculous Meningitis																			
Phthisis																			
Scrofula																			
Pneumothorax																			
Hydrocephalus (with tuberous deposit)																			
OTHERS																			
CLASS III.—Order I. (Local Diseases.) a. Brain, spinal marrow, and nerves.																			
Meningitis																			
Cerebritis (including acute hydrocephalus)																			
Paralysis																			
Chorea																			
Ataxia																			
Epilepsy																			
Hysteria																			
Tetanus (idiopathic)																			
Convulsions																			
OTHERS																			
b. Sense organs. Ophthalmia (not purulent)																			
Cataract																			
Amaurosis																			
Glaucoma and other diseases of the eye																			
Otorrhœa																			
Otitis																			
Deafness and other diseases of the ear																			
OTHERS																			
Order II.																			
Carditis																			
Pericarditis																			
Endocarditis																			
Disease of Heart, Valves																			
Heart Hypertrophy																			
a. Atrophy																			
b. Fatty Degeneration																			
Aneurism of heart																			
Aneurism of aorta, &c.																			
Angina Pectoris																			
Pleurisy																			
Pleurodynia																			
Tabes																			
OTHERS																			
Order III.																			
Epistaxis																			
Laryngitis (Disease of the glottis)																			
Bronchitis																			
Pleurisy																			
Pneumonia																			
Asthma																			
OTHERS																			
Order IV.																			
Gastritis																			
Enteritis																			
Peritonitis																			
Constipation																			
Colic																			
Ileus (Stricture of bowels)																			
Intussusception																			
Hernia																			
Stricture of œsophagus																			
Stricture of intestinal tube																			
Ulceration of intestinal tube																			
Dysentery																			
Prolapsus																			
Fistula																			
Gastralgia																			
Enteralgia																			
Ascites																			
Melæna																			
Hæmatemesis																			
Pyrosis																			
Pancreatic disease																			
Spleen disease																			
Hepatitis																			
Jaundice																			
Gall Stones																			
Cirrhosis																			
Ascites																			
OTHERS																			
Order V.																			
Nephritis																			
Lithuria																			
Nephria (Bright's disease, Albuminuria)																			
Diabetes																			
Stone (with Acid, &c.)																			
Gravel (with Acid, &c.)																			
Hæmaturia																			
Cystitis																			
Disease of Prostate Gland																			
OTHERS																			
Order VI.																			
Metrorrhœa																			
Hysteria																			
Ovarian Disease																			
OTHERS																			
Order VII.																			
Synovitis																			
Caries (including paries and anchylosis																			
Exostosis																			
Curvature of Spine																			
Luxation																			
Rickets																			
Muscular Atrophy																			
OTHERS																			
Order VIII.																			
Phlegmon																			
Wounds																			
Abscess (collapsed)																			
Ulcer (external)																			
OTHER SELF Diseases																			
CLASS IV.—Order I. (Developmental Diseases.)																			
Spina bifida																			
OTHER malformations																			
Teething																			
OTHERS																			
Order II.																			
Chlorosis																			
Cholerine { Hæmorrhage, Anæmia, &c.																			
Peritonitis (Secondary Accumulations, Lymphatic Vessels, Tract of life, Glandular																			
CLASS V.—Violent Deaths or Diseases.																			
Order I.—(Accidents.)																			
Burn																			
Scald																			
Fracture																			
Contusion																			
Concussion																			
Crushed wound																			
Cut, stab																			
Poisoning																			
OTHERS																			
Order II.—(Homicide.)																			
Order III.—Suicide.																			
Crushed wound																			
Cut, stab																			
Poisoning																			
OTHERS																			
Sudden deaths (cause not ascertained)																			
Causes not specified or ill-defined																			
Total																			

Most of the diseases in the following enumeration are of too frequent occurrence in hospitals; and all, with some exceptions, are classed as "Others" in their respective orders in the left-hand columns. They will be distinguished in ascertaining the duration by noting the ages of the persons attacked, cured, or dead, &c.; entering the particular disease in the marginal index. Thus, a person aged 35 would, if admitted for "Syphilis," be indicated in the body of this sheet by a dot against "Others" of Class I. Order I.; and his age (35) would be written against "Syphilis" in the margin. And so of other diseases. The diseases not found printed in the margin must be written in their proper compartments. A summary of the facts in this manner should be given as an appendix to the present tables.

CLASS I.

Order I.
- variolous
- morbilous
- scarlatic
- anginous
- stridulous
- Quinsy with abscess of liver (placed in dysentery)
- pulse large

Order II.
- Spasm (Greek diaphthoneia)
- pain
- jactation
- hydrophobia
- diaphragm, pectoris
- paralysis

* Arthritis by preference in diarthrosis, as by handling the parts of dead animals.

Order III.
- febrile
- hæmorrhoids
- continuous
- algidous

Order IV.
- phthiriasis

Pyrexiæ, hepatirrœa, and other diseases should be distinguished here. As the capital table they will be added to the head "Fevers."

CLASS II.

Order I.
- scrofula
- rupia
- lèpi elephantus
- tuft tree
- melanosis

The several forms of cancer comprised in the capital table, under the head "Cancer," should be distinguished as under; the sepia and pearly affixed, should also be specified—
- *Soft*
- *Colloid*
- *Osteoid*
- *Scirrhus*
- *Epithelial*

Order II.
- pulmonic
- mediastinal abscess of joints (placed in scrofula)
- tuberculous peritonitis

CLASS III.

Order I.
- apoplexy
- shaking palsy (placed in paralysis)

The parts affected, in all cases referred to "paralysis" in the capital table, should be distinguished here, and the eyes stated.
- amaurosis (placed in amaurosis)
- dysmenia (placed in dysmenia)
- hemicrania skotodina

The different parts of the ear attacked by inflammation should be distinguished here.
- acousticia (in deafness)
- anosmia

Order II.
- arthritis
- adhesions (of adhesion)

Order III.
- hydrothorax
- empyema
- pneumonorrhœa (placed in pneumonia)
- congestion of lungs (placed in pneumonia)
- emphysema (of lungs)
- spurious hæmoptysis

Order IV.
- gastralgia
- enterodynia
- pharyngitis
- œsophagitis

Dysmenorrhœa here the following synonyms of hernia, all of which are classed in the capital table under hernia—
- congenital
- femoral or crural
- inguinal
- scrotal
- umbilical
- ventral

Order V.
- stranguria
- ischuria at urethra (not a consequence of gonorrhœa)

In cases of stone and gravel, the composition of substances should be specified here.

Order VI.
- orchitis
- hydrocele
- ovarian tumour
- uterine tumour
- polypus of uterus

Order VII.
- [illegible]
- [illegible]

Order VIII.
- mania
- phrenitis
- nostalgia
- amaurosis
- myopia
- presbyopia
- asthenopia
- astigmia
- acute
- neuralgia
- tetanus
- priapism
- pantalgia
- pantodynia
- [illegible]

In abscess and ulcer the parts affected should be distinguished here.

CLASS IV.
- malformations
- sclerotic hypertrophies
- synocha
- decay of old age
- atrophy and debility

CLASS V.

Order I.
- explosion of powder, gas, &c. (placed in burn)
- electrical
- frost-bite
- hanging
- lightning (which attracts and kills?)
- sun-stroke (state circumstances)

The circumstances attending deaths by violence should be shown in detail, as, for example, how many persons, at their several ages, were burnt by their clothes taking fire, how many died by falling from scaffolds or heights, how many were poisoned by arsenic, opium, prussic acid, &c., and with what intent, whether accidental, suicidal, or murderous. All violent deaths should fall under one or other of the three orders—Accident—Homicide—Suicide.

The "*sick treated*" during the year may be obtained by taking the mean of the admissions, and of the discharges from all causes, including deaths.

With fixed data, arrived at on these principles, we can readily obtain the proportionate mortality, not only of the whole hospital, but of every ward of it, and also the proportionate mortality and duration of cases for each age, sex, and disease.

The laws which regulate diseased action would thus become better known, the results of particular methods of treatment, as well as of special operations, would be better ascertained than they are at present. As regards their sanitary condition, hospitals might be compared with hospitals and wards with wards.

The whole question of hospital economics as influenced by diets, medicines, comforts, could be brought under examination and discussion.

The liability of particular ages, sexes, occupations, and classes of the community to particular forms of disease might be ascertained; other data, such as "married" or "single," previous attacks of illness of the same or different kinds, birthplace, &c., might be added for comparison, and hospital experience might thus be made to subserve sanitary improvement.

The data for these latter comparisons would have to be kept separately, as indeed they generally are in all well-regulated hospitals.

A. is a leaf of the hospital "Admission and Discharge" book, proposed by the secretaries to the Statistical Congress, for entering those details required for filling up the annual forms proposed by me and adopted by the Congress; and also for registering the additional particulars regarding the patients, required by the Congress.

B. is one of the annual forms referred to.

Especially I wished to call attention to the additional points of hospital statistics agreed to by the Statistical Congress, and which will be found at the end of my paper. They did not come within the scope of my forms. But they are of great importance, particularly those referring to the sanitary condition of hospital wards, and to the method of recording fresh attacks of disease *in* hospital, in the "Admission and Discharge" book. These data, if properly used, will enable a check to be kept over the sanitary condition of the hospital, at least as regards hospital diseases.

But it must not be forgotten that a hospital is in a bad sanitary state before such diseases can appear. They are evidence of bad constructive arrangements or of culpable sanitary neglect having produced their results, rather than indices of the actual sanitary state of the wards. All careful hospital physicians and surgeons, as well as nurses, can generally tell to what extent a ward is healthy, or otherwise, by the manner in which cases are progressing, before actual hospital disease appears. *This* is the time to prevent the occurrence of hospital diseases, not after they have occurred.

I refer to the point because, since my papers were read, some melancholy instances have occurred of fatal hospital diseases arising

from distinctly preventable causes. In one such case, in a small provincial hospital in one of the healthiest counties in England, twenty-four poor creatures ran the gauntlet of their lives in nine months, from erysipelas, of whom eight died. And this after very trifling accidents, or operations, none of which ought to have produced erysipelas at all—much less to have ended fatally. In this case there were both local causes of disease about the hospital, and there was also defective structure.

Especially am I anxious to recur to this latter point. I have seen several misapplications of the principles of hospital construction (briefly laid down in my former paper) defended because it was said they were adaptations of those principles; also bad principles of construction defended because they had been "already adopted"!

This is not the way to hasten human progress. Defects, the result of want of knowledge, must disappear; improvements, the result of experience, must advance.

I can do no more in the matter but reiterate the appeal (at the end of my former paper) that the real practical object and intention of these principles should be very carefully considered and embodied by those on whom it falls to design, to construct, or to manage buildings for the care of the sick.

Let us look forward to the time when the necessity of providing even for the record of *hospital* diseases, so much insisted upon by the Statistical Congress, will thus cease, and when the stigma of these diseases will be wiped out from hospital records.

EXPLANATION OF THE PLANS.

At the date of my former paper (1858) there was no really good plan of hospital construction in this country to refer to. Since that date, however, several excellent hospitals have been planned, and are now in process of construction. These will, when completed, practically show forth the principles required to give pure air to the sick, and to insure economical and efficient administration.

I beg to submit plans of two of these hospitals. They are both military—I am sorry I cannot give any civil ones as models, for they do not exist. Some, however, will soon exist, and it is fairly to be hoped that in all future hospitals generally, the same principles will be substantially adopted—yes, and improved upon. It need hardly be said that the details in civil must be somewhat different from those in military hospitals.

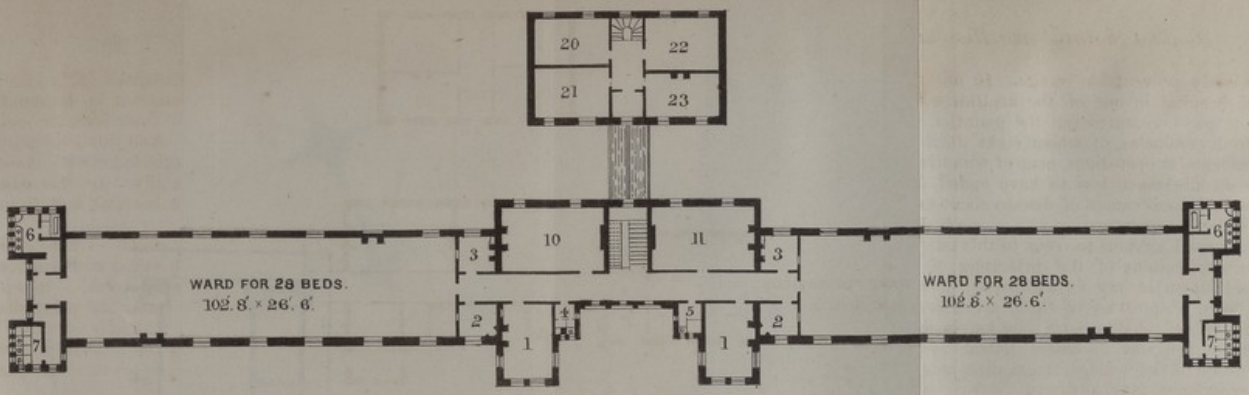
One of these plans is for an infantry regimental hospital for one hundred and twenty sick. The other is the plan of a General Hospital for the Royal Artillery Garrison, at Woolwich, (six hundred and fifty beds.)

The infantry hospital consists of one double pavilion, containing four wards, each of twenty-eight beds, and four small wards of two beds each. The larger wards are open from end to end, so that the attendant in the nurse's room can see every bed in the ward. The small wards have windows on three sides, and are so arranged as to be under constant inspection from the same nurse's room. The

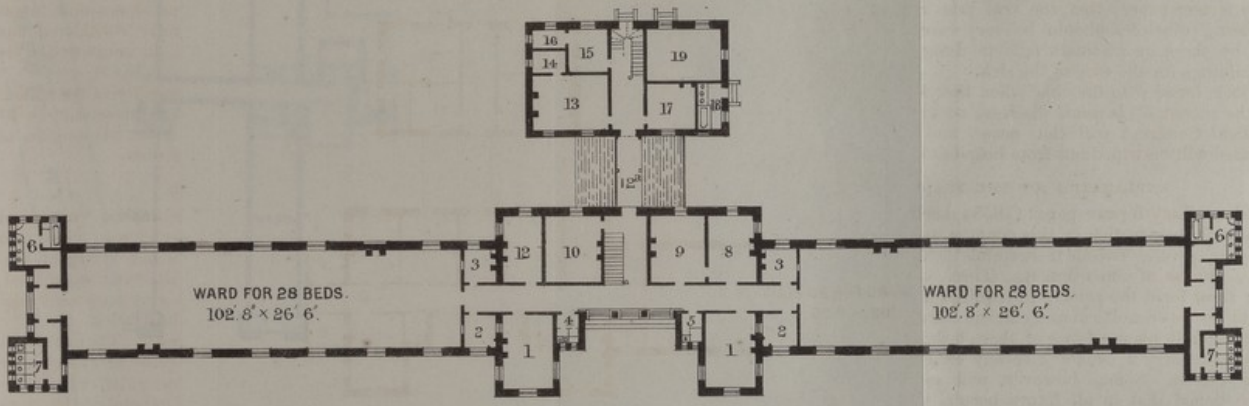
Way.

Comforts.

om.
& Bath & Lavatory.
Clerc.
inen.
Store.
y

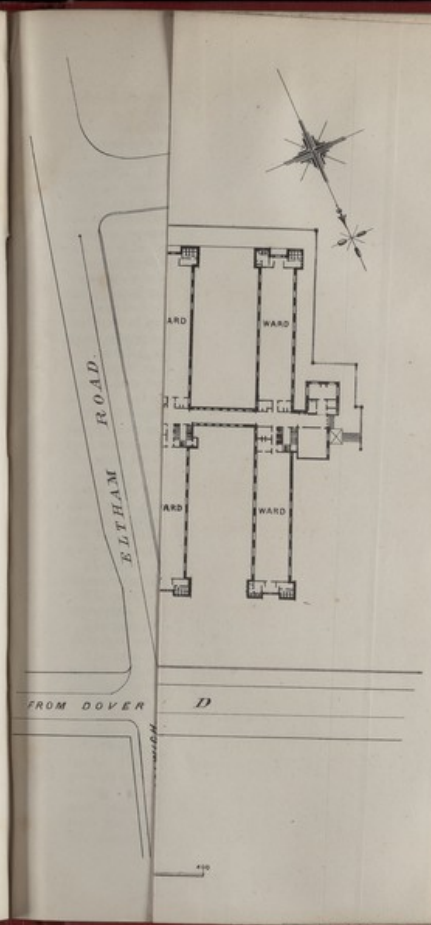


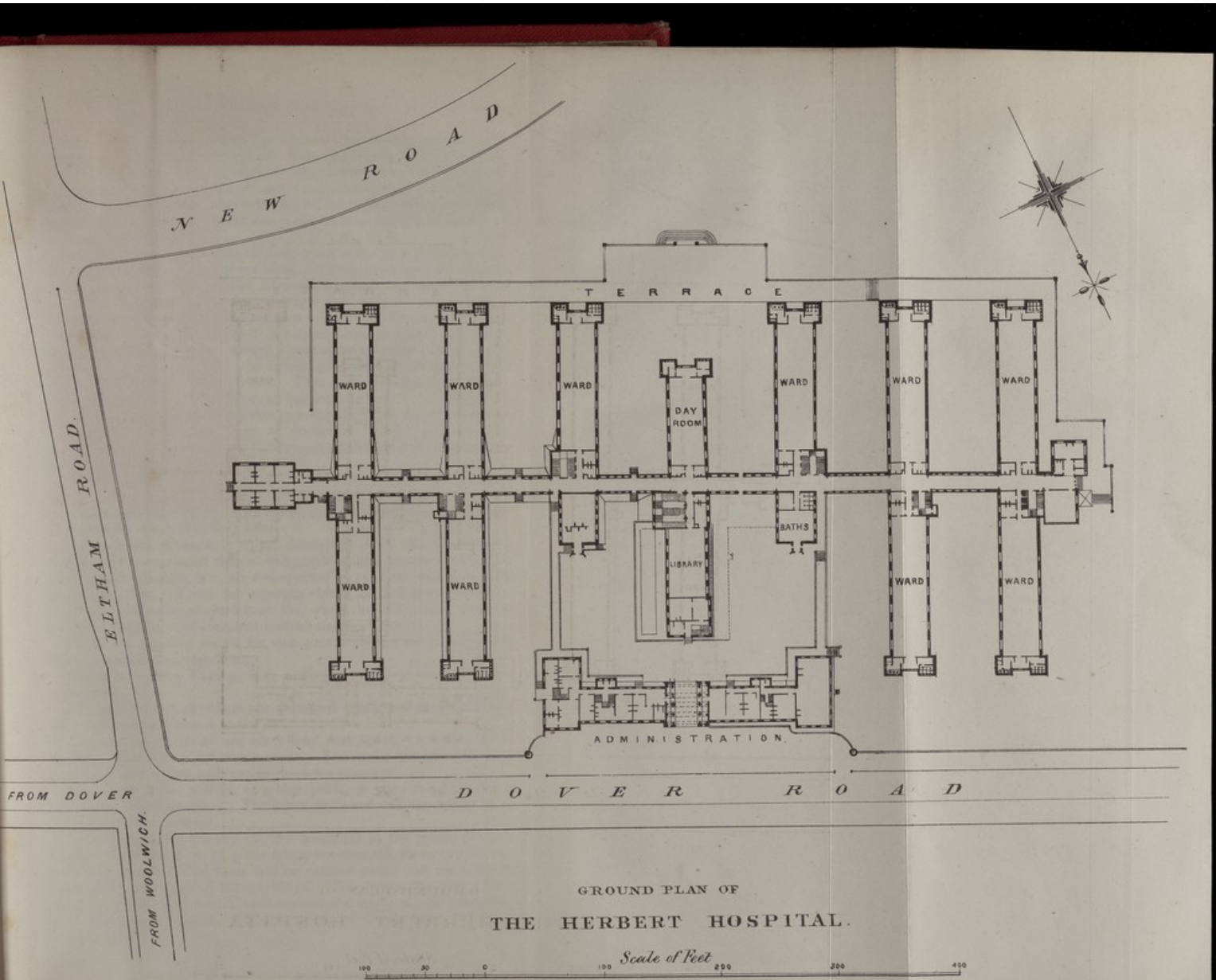
FIRST FLOOR PLAN.



GROUND PLAN.

1111. *2 Bed Wards.*
2.2.2.2. *Ward Orderlies.*
3.3.3.3. *Soulleries.*
4.4. *W.Cs, Sinks & Urinals.*
5.5. *W.Cs & Portable Baths.*
6.6.6.6. *Baths, Lavatories & Urinals.*
7.7.7.7. *W.Cs & Sinks.*
8. *Surgery.*
9 *Waiting Room.*
10.10. *Orderlies.*
11. *Day Room*
12 *Hospital Sergeant.*
12a *Covered Way.*
13. *Kitchen.*
14. *Scullery.*
15. *Medical Comforts.*
16. *Larder.*
17. *Cook's Room.*
18. *Orderlies' Bath & Lavatory.*
19. *Utensil Store.*
20. *Clean Linen.*
21. *Pack Store.*
22. *Bedding*
23. *N. C. O.*


ELTHAM ROAD
WARD
WARD
WARD
WARD
FROM DOVER
D



GROUND PLAN OF

THE HERBERT HOSPITAL.

Scale of Feet

water-closets and baths are at the angles of the wards, opposite the entrance, and are entirely cut off from the wards by a method of ventilation which insures any foul air being blown away from the ward. The large end window allows of easy ventilation during the night.

In this hospital the fireplaces are in the walls, with a window over them. Each large ward has a separate scullery ; a matter of necessity, not choice.

The two pavilions are cut off from each other by a large passage and staircase traversing the building. The kitchen and stores are under a separate roof. The hospital sergeant and orderlies are quartered in the centre of the building; and surgery and waiting-room are in the same position, as also a day room for convalescents. Thus the whole administration is concentrated in the middle, and the hospital sergeant can always know at any moment where each of his orderlies is, and where he is not, and what he is doing; and the same of each of his patients. There are no dark corners nor spare rooms, and "skulking" is all but impossible.

This plan, then, combines the greatest facilities for economy in administration, with efficiency of discipline, (which includes the utmost care for the sick and the utmost obedience from the convalescent,) and pure air for all.

The Woolwich Hospital plan is simply an arrangement of a number of these pavilions—each having two floors of wards, connected by a corridor one floor in height—under one general central administration for the whole hospital.

There is one kitchen in a half basement under the library and chapel. It is connected with all the pavilions by a basement corridor, along which all diets, &c., are transported on rails and raised by lifts to each pavilion. There are separate shoots for foul linen and dust, hot and cold water are laid over the whole building, and there is a central bathing establishment besides the ward baths.

There are separate wards for sick prisoners and for lunatics and others requiring segregation.

There is a large library, also a dining and day room for convalescents.

The axes of the pavilions are arranged north and south, so as to have both walls exposed to the sun.

The nearest pavilions are sixty-four feet apart, or double their height. The others are much more. The eight wards in the end pavilions have a free look out to the open country.

The outer walls will be of white brick, to give the building a more cheerful appearance. The inner walls and ceilings are to be of polished Parian cement.

In this hospital there will be two fireplaces in the centre of each ward. They are to be of terra cotta, constructed so as to give the greatest warmth. The flues will be carried under the ward floors, and up the side walls of the pavilions. This leaves the view of the ward open from end to end, and enables the nurse to see every bed from her room window. [There are to be female head nurses in this hospital.]

The principles embodied in this plan are sub-division of sick under a number of separate roofs; separation between the hospital proper and the administration; no more than two floors of wards, opposite windows in each large ward with the beds ranged between them, one window for every two beds; sufficient isolation and free ventilation of the water-closets and baths; one scullery and one nurse's room for each ward, and placed at the entrance end, so that the attendants, while overlooking the patients, can be themselves overlooked; large separate day room for convalescents; building to be placed on high ground in the open country; abundant external ventilation.

The wards of each of these hospitals are 14 feet high. Each bed has from 93 to 97 superficial feet, and from 1,200 to 1,400 cubic feet. The width of the wards between the opposite windows is from 26 feet 6 inches to 26 feet 9 inches.

The cubic space of military hospitals is not so large as that required for civil hospitals, because the great bulk of the patients in military hospitals are what we should call convalescents.

This building is to be called the "HERBERT HOSPITAL," after the great and good statesman whom we have lost, who was himself its founder.

Let Dublin, who knew him so well, join with us, who loved him so well, to give him worthy tears—such a tribute as he would have liked—he, who suffering under a fatal disease—he, who with every possession which God could bestow to make him idly enjoy life—yet ran like a race-horse his noble course, till he fell—and up to the very day fortnight of his death struggled on doing good, not for the love of power or place, (he did not care for it,) but for the love of mankind and of God. His glorious death would be almost too sacred to mention here, but for the sake of calling upon those who loved him—and who did not?—to carry out his purposes. It is five years since he began to carry out his chief purpose to restore the health of the British army; and how well he worked at it all know. But the soldier was not his only care. His cares were national; and one of his cherished principles was the reconstruction of all hospitals according to the latest improvements of the pavilion structure. It is not often that we find a man, born to politics and high position, who would master, for the love of his kind alone, every dry detail of this almost technical subject. Yet he did. His loss is irreparable. Time will only show more and more what we have lost in him. But at least let his purposes and principles outlive him in us.

ON THE

PHYSICAL CHARACTERISTICS

OF THE

JEWISH RACE,

BY

JOHN BEDDOE, B.A., M.D.,

FELLOW OF THE ETHNOLOGICAL SOCIETY, FOREIGN ASSOCIATE OF THE SOCIÉTÉ D'ANTHROPOLOGIE.

[*Reprinted from the* ETHNOLOGICAL TRANSACTIONS.]

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1861.

ON THE

PHYSICAL CHARACTERISTICS OF THE JEWS.

I HAVE two objects in inviting the attention of the Society to the subject of the Physical Characteristics of the Jews. In the first place, I should be glad to elicit from those who have already considered it, their views as to what peculiarities of form and feature do really constitute that type, which most of us believe to distinguish the Hebrews from every other people. In the second, I wish to lay before the Society such information as I have been able to procure, respecting the varieties of complexion among the Jews, and to make a few remarks on their probable origin.

It would be difficult, perhaps, to define what it is that makes a Jew's eye proverbially recognisable. It is generally full and prominent, though the brow is well marked. Some think its principal peculiarity is the long almond shape; but this is common to several Oriental peoples; and the expression of meditative mildness, with a degree of cunning, or sometimes of timidity, which appears almost always to accompany it in the Israelite, and which seems to speak of centuries of oppression patiently endured by a people of great intellectual powers, is not, I believe, usually observed in other people with eyes of that form. That it is not the colour may be easily shown. Nor does it consist in obliquity of the opening, for persons of thoroughly Jewish aspect may be seen to present, some one, and some the other kind of obliquity, while in most of them the opening is, I think, as strictly horizontal as in other so-called Caucasian people.

Again, can any distinctive character be traced in the lower jaw, or in the nose? The former is usually somewhat heavy though rounded, with a receding chin and full lips; while the upper maxilla is large, and the nasal bones low at the root, and salient. But individuals deficient in some of these marks are to be met with every day. In some Jews, who are at once recognized as such from the *tout ensemble* of their features, the profile of the nose is concave. In such persons, however, there is often a slight downward curve towards the point, as though the bridge had slid down a little below its proper place.

The common type of nose is not sufficiently described when it is called aquiline, though that term is etymologically very appropriate. There are usually, I think, more hollowness at the root, more depression at the point, and more tucking-up of the wings, than in high-nosed persons of Aryan race.

As to the prevailing form of skull, I will make only one observation, viz., that in Turkey the crania of the Jews appeared to me to be longer and narrower than those of the other races. Colonel Hamilton Smith* calls the Jewish skull spherical, in which I cannot agree with him.

The varieties of complexion and colour among the Jews have attracted the attention of some ethnological writers, and of many observant travellers. These differ widely among themselves in their notions on the subject.

Dr. Prichard, for example, seems to have believed that the Jews, without having sullied the purity of their blood to an extent capable of producing notable effects on their physique, had been, by the influence of climate and modes of living, almost assimilated to the nations among whom they dwelt. "Among the Jews of Northern Europe," he says,† "the xanthous variety becomes general," and he instances particularly those settled in North Germany as being conspicuous for their bushy red beards.

These views and this illustration have been frequently quoted and made much of. I suspect them to be doubly erroneous. I doubt whether red beards are more common among German than other Jews; and I doubt whether any evidence can be adduced to show that climatic influence, without crossing of blood, has produced any change in the Jewish physiognomy.

It is true that Professor Owen has lately expressed himself very positively in the same sense with the illustrious ethnologist just quoted. He professes, indeed, to derive, from the variations of the Jewish race, a proof of the unity of origin of mankind. "For 1800 years," says he, "that race has been dispersed in different latitudes and climates, and they have preserved themselves distinct from intermixture with other races of mankind. There are some Jews still lingering in the valleys of the Jordan, having been oppressed by the successive conquerors of Syria for ages, a low race of people, and described by trustworthy travellers as being as black as any of the Ethiopian races. Others of the Jewish people, participating in European civilization, and dwelling among the northern nations, show instances of the light complexion, the blue eyes and light hair of the Scandinavian families. The condition of the Hebrews, since their dispersion, has not been such as to admit of much admixture by the proselytism of household slaves. We are thus led to account for the differences in colour by the influence of climate, without having to refer them to original or specific distinctions."

* Nat. Hist. of the H. Sp., p. 393. † Researches, iv, 507.

On two of the three statements made in the above paragraph, viz., the occurrence of xanthous individuals among the northern Jews, and the supposed infrequency of proselytism, I will touch presently. The remainingone is very important, if true. I regret that I have been unable, in the course of inquiries made on the subject, to trace it to its source. I have examined many books of travels, and interrogated many travellers, but have not been able to get any confirmation of the existence of these negroid Jews.

I am informed by Mr. Hodges of Bristol, who was long a missionary among the Jews in different countries, that there are no Jews in the Ghor, or lower valley of the Jordan. There is a populous settlement, of ancient date, at Tiberias, on the low hot shore of the Lake of Gennesareth; but the Jews there present no striking peculiarities, certainly not black skins or crisp hair. Some of them are quite fair.

Is it not possible that the foundation of this statement may, after all, be found in the writings of Silk Buckingham, who noticed some flat-faced, crisp-haired people among a tribe on the Lower Hami or Hieromax? The tribe, however, was Arab, not Jewish; the complexions were not so dark as those of some other Arabs; and lastly, the presence of a black slave girl suggested the probability of negro concubinage.

In this connexion an account of the Jews of Waregla, given by Mr. Tristram in his recently published travels in the Sahara, is deserving of mention. Waregla is an oasis in the desert, about north lat. 32°, inhabited by a race believed by Mr. Tristram to be deeply stained with negro blood. The Jews have been settled there for ages. "They afford," says he, "an interesting example of the effect of climate, which, in the course of generations, seems to have produced the dark colouring pigment. They were almost as black as negroes, much darker than their brethren of the M'zab and Wed R'hir; yet there was not the slightest trace of the negro features: all the lineaments were as distinctively Jewish as in any clothes-dealer in Houndsditch. They were as dark as the black Jews of Abyssinia, whom I have seen in Jerusalem, but the hair, without being woolly, was grizzled and matted.

The Jews of Ghardaia, in the Wed M'zab, are also stated to be very dark, dark as Hindoos, but "with features intensely Jewish." On the other hand, Mr. Tristram found in and near Tuggurt a sept of Mussulmans, who never intermarry with the others, and who are very fair, with strongly marked Jewish features. They are called Mahadjeriah, and are said to be of the

earliest date of settlement, who submitted to the Koran several centuries ago. Mr. Ginsberg (*Jewish Intelligence*, No. 308), who also met with these Hebrew Moslems, says that the characteristic signs of the Jewish face are very recognizable; and that, in spite of the influence of climate, the Jew retains his white complexion, and forms a striking contrast to the native Arabs, and even Moors. Mr. Ginsberg did not visit Waregla; but his remark is probably meant to extend to the Jews of the M'zab and other oases, which he did visit. These last facts seem to neutralize that stated respecting the Jews of Waregla. At all events, one can hardly attribute the wide difference between the Mahadjeriah and the Waregla Jews, who are separated by little more than a degree of latitude, counterbalanced by a considerable difference in elevation, to the effects of climate alone, especially as no analogous difference is noted between the non-Jewish inhabitants of the two districts. It would be at least as legitimate a conjecture if we supposed the Wareglan Jews to be hybrids, deriving their colour from the negro, and their features from the Jewish parent.

Some have accepted as the Jewish type "a more or less sallow complexion, black hair and eyes, aquiline nose, and high but receding forehead";* and then, attributing all exceptional instances to admixture of alien blood, have used the supposed invariability of this type among pure-blooded Hebrews as an argument in favour of their polygenistic views. Others, again, have admitted the existence of two distinct types (at least in certain countries), of which the second is thus described by Gliddon: "It is distinguished," says he, "by lank and tall frame, clear blue eye, very white and freckled skin, and yellowish-red hair.†

Most of the writers who have taken up this opinion, have done so independently; and some of them, having made their observations in only one or two countries, have supposed the phenomenon of a xanthous type among Jews to be confined within more or less narrow geographical limits. Hamilton Smith, however, ascribed it to the whole race (p. 391).

I will now proceed to adduce what evidence I have collected as to the Jews of particular countries and families. And first let us take the Ashkenazim, the Northern or German and Polish Jews, the great bulk of whom seem to have had a common descent, and to have spread gradually eastward from the great Roman cities on the Rhine. There is much German in the colloquial dialect of the Polish Jews, though their costume is Oriental to this day.

* Gliddon, Indig. Races, p. 579. † Ibid., p. 580.

"The Polish Jew," says Henderson,* "is generally of a pale and sallow complexion; the features are small, and the hair mostly black. A fine beard covers the chin. Few of them enjoy a robust constitution, an evil resulting from a combination of physical and moral causes."

"They have," says Kohl,† tall meagre figures; their complexion is always pale, and this does not appear to be occasioned by personal cares or troubles, but to be the common colour of the race; it is at the same time very delicate. They have brilliant eyes, and black hair. How the Italian painters created so many beautiful Jewish heads, without ever having been among the Polish Jews, I am at a loss to understand."

James, a very observant traveller, wrote thus of the Jews of Volhynia: "We could not help being very much struck with the beauty of this race of people, for they seem by no means to have degenerated from limiting themselves to intermarriage with their own breed. The character of countenance is from this circumstance almost invariably the same, not in any way resembling what we call in England the Jewish turn of feature. The women were remarkably handsome, their persons large and full, their faces very regularly formed, with black eyes and hair, set off with delicate complexions of white and red. The men tall and straight, but rather of a spare habit, their features small, and fashioned very much like that meek and placid countenance which the Italian painters have invariably given to the picture of our Saviour. This peculiar style of visage, however, was gradually lost as we approached nearer to the confines of Germany, nor did it anywhere seem so prevalent as in this province."

Another traveller‡ remarked in Lithuania "swarms of people differing entirely from the other inhabitants in physical appearance and costume; and in whose sharply-drawn features, long beards, coal-black eyes, and flowing dresses, I at once recognized," says he, "the children of Israel. Here I observed what has often been remarked by other travellers, when the features were at rest, a style of face and expression resembling the pictures of the Saviour in the Italian galleries."

All the accounts I can get represent the Jews of Germany as generally dark-eyed and dark-haired.

The xanthous type does, however, occur among them, though Dr. Prichard's informants evidently much exaggerated its frequency. The same statement applies to those of Holland, who descend partly from the Portuguese stock.

Koch has given a minute description of the Karaim, who in-

* Biblical Researches. † Travels in Austria, etc. ‡ Stephens.

habit Chufut-kale, in the Crimea. "Though of short stature," he says, "they are not at all stunted. Their heads are rather round, instead of being long. Their plump and round faces, the features of which are not at all prominent, have nothing of the Jew about them. The Jews have generally a large nose; but in the Karaim this feature is small, and, as in the Greek face, forms nearly a straight line with the forehead. In their eyes, which are also round, there is a dark ring, which is scarcely separated from the pupil. The mouth appears remarkably small, and the chin projects very slightly. The hair is black, but not so harsh as that of our Jews, which it resembles in being lustreless. The beard seems to be generally weak among the Karaim."

These people, according to Haxthausen, use the Jagatay-Tatar dialect. Koch's description of them, just quoted, reminds one in most respects of the Tatar type, though the not very intelligible account of the Karaite eye does not do so. If any descendants exist of those Khazars who adopted Judaism for their religion, it is at Chufut-kale that they are most likely to be found. On the whole, I think we are entitled to regard the Karaim as Israelites in little else than their religion, and to exclude all further consideration of them from this discussion.

Let us now pass to the Sephardim—the Southern, or Mediterranean Jews. Hitherto we have found the Jews to be remarkable as a black-haired people, dwelling among races preponderantly xanthous: henceforth we shall find the relation of colour generally reversed.

"In Morocco their women are generally grey-eyed," says Hamilton Smith. "Their complexions are remarkably fair," says Lempriere, who practised as a surgeon in Morocco in the last century. In Algeria, Rozet, Bory de St. Vincent, Broca, have all noticed the frequency of blond hair among them. Mr. Wilde made a similar observation in Tunis, twenty years ago; he perceived its importance, and recorded it in his *Narrative*.*

Mr. Blakesley, in his recent work on Algeria, has given some interesting statements on the subject, which are all the more valuable, as his observations also were made quite independently. "The type of the Jewish countenance," says he, "is, at least as regards the women, very different as one gets further east. At Algiers, the expression is mean and ugly to the last degree; the nose is hooked, and the chin short and receding; and this effect is increased by their habit of tying up the lower

* See Cyprian, "De Habitu Virginum," for the antiquity in Barbary of the female practice of dyeing the hair. But Mr. Wilde was well acquainted with the use of henna.

jaw, like that of a corpse, with a handkerchief. At Constantine, the nose was straighter, and the chin longer and fuller, and I was astonished to find some with fair complexions and auburn hair, who reminded me of one of Guercino's Esthers: but the majority were dark. On arriving at Tunis, I found this the predominant type of the female Jewish physiognomy, which accident gave me an unusual facility for observing. On the 1st of May it is the practice to decorate the synagogues with flowers and wax candles. Every woman who has been married during the previous month comes to the synagogue of her district, dressed out as handsomely as she can compass, and remains till midnight. Those I saw were all much alike. Their hair varied from black to auburn, but their complexions were invariably bright and clear."

Mr. Blakesley further informs me that, according to his observations, the straight profile and full chin of the Jewish women are very rarely indeed not conjoined with the xanthous complexion. West of Algiers, he thinks, he never saw a Jewess who was not dark (although sometimes the dark hair was accompanied by very dark blue eyes), and scarcely one who had not a hooked nose and a receding chin.

Berbrugger, again, says "that great varieties of complexion, colour of eyes and of hair, occur in all the Algerian races." He adds, however, that "sous le ciel d'Afrique, de même qu'en Europe, les Juifs ont leur type spéciale; nez aquilin, barbe noire, œil magnifique quoique toujours faux, teint blanc et lisse. Il est facile de les reconnoître à cet air de fourberie et d'humilité, à cette inclinaison du corps penché en avant, à ces traits sevères, et à ces demicercles qui encadrent leurs noires prunelles, et qui sont un des signes particulières de leur race."

Gliddon,* if I rightly interpret his slovenly manner of writing, says that xanthous Jews are rare in Egypt and Syria, but frequent in Rhodes, Smyrna, and Constantinople. But Sir Gardner Wilkinson found the Syrian Jews also to be frequently xanthous, and recorded the fact, of which he appears to have supposed himself the first observer, in the abridged edition of his work on the Egyptians.† His remarks are so interesting and pertinent, that it may be well to read them at length.

"Here I may mention a remarkable circumstance, that the Jews of the East to this day often have red hair and blue eyes, with a nose of delicate form and nearly straight, and are quite unlike their brethren of Europe; and the children in modern Jerusalem have the pink and white complexions of Europeans. The Oriental Jews are at the same time unlike the other Syrians

* Indigenous Races of the Earth, p. 580. † Vol. ii, p. 197-9.

in features; and it is the Syrians who have the large nose which strikes us as a peculiarity of the Western Israelites. This prominent feature was always a characteristic of the Syrians, but not of the ancient, nor of the modern, Jews of Judæa; and the Saviour's head, though not really a portrait, is evidently a traditional representation of the Jewish face, which is still traceable at Jerusalem. No real portrait of Him was ever handed down; and Eusebius of Cæsarea pronounced the impossibility of obtaining one for the sister of Constantine, but the character of the Jewish face would necessarily be known in those early days (in the fourth century), when the first representations of Him were attempted; and we should be surprised to find any artist abandon the style of features thus agreed upon for ages, and represent the Saviour with those of our Western Jews. Yet this would be perfectly correct if the Jews of his day had those features; and such would have been, in that case, his traditional portrait.

"I had often remarked the colour and features of the Jews in the East, so unlike those known in Europe; and my wish to ascertain if they were the same in Judæa was at length gratified by a visit to Jerusalem; where I found the same type in all those really of Eastern origin, and the large nose is there an invariable proof of admixture with a Western family. It may be difficult to explain the great difference in the Eastern and Western face (and the former is said to be also found in Hungary); but the subject is worthy of investigation, as is the origin of those Jews now living in Europe, and the early migrations that took place from Judæa, long before the Christian era. These would be more satisfactory than mere speculations on the lost tribes."

Curzon, in his *Monasteries of the Levant*, has the following passage. "It is remarkable that those Jews who are born in Jerusalem are of a totally different caste from those we see in Europe. Here they are a fair race, very lightly made, and particularly effeminate in manner: the young men wear a lock of long hair on each side of the face."

This long lock, by the way, is very commonly worn among the Polish Jews also. I believe they assign as a reason for wearing it the passage in Leviticus xix, 27: "Ye shall not round the corners of your heads; neither shalt thou mar the corners of thy beard." But it may be worth while to note that the same fashion was in use among the Rebo of the Egyptian monuments, who were a xanthous Asiatic people.

In 1637, Sandys gave a quaint description of the Jews of Jerusalem, which rather leads one to suppose that no great change has taken place there in the mean time. "They are

men of indifferent statures, and the best complexions. Many of them have I seen abused, some of them beaten, yet never saw I Jew with an angry countenance. Their familiar speech is Spanish, yet few of them are ignorant in the Hebrew, Turkish, Moresco, vulgar Greek, and Italian languages. Their women are generally fat and goggle-eyed."* Some points in this curious account will be acknowledged, by those who have travelled in the Levant, to be tolerably applicable at the present day.

Mr. Hodges agrees with all other travellers whom I have interrogated, as to the good looks and fair complexions of the Sephardim of Jerusalem. Some cursory observers even bring away the impression that the majority of them are xanthous, but this is doubtless an exaggerated idea. A Jerusalem Jew who himself combined grey eyes and light brown eyebrows with black hair, was interrogated on the subject by my friend Mr. Barnard Davis. He maintained that the majority of his fellow citizens had black hair, but that many had it of other colours, such as we see in England. Probably his account would be pretty correct, if he had said "black or dark brown," instead of "black."

I am informed by Mr. Hodges that there are in Galilee at least two villages, Shefa Amar and Boukeyah, where Jews are agriculturists and proprietors of the soil. Shefa Amar, which is said to be mentioned in the Talmud, is in Lower Galilee, not far from Acco: Boukeyah is in a very retired situation, hidden in a cleft of the mountains that extend eastwards from the White Cape. Here, if anywhere, it is likely that a remnant of the ancient Galilean population may have remained undisturbed; and I commend the careful observation of the Boukeyans in particular to any ethnologist who may be travelling in their neighbourhood.

I have not been able to find any sufficient account of the physique of the Jews of Kurdistan and Persia. Layard† met with a nomadic and pastoral tribe of Jews in the mountains south of Wan, but he says nothing of their physique, except that it differed notably from that of the neighbouring Kurds.

As for the black Jews of Cochin, I believe it is now generally acknowledged that they are not Jews at all, except in religion. Among the so-called white Jews, indeed, there may be a fair proportion of true Israelite blood, and accordingly they are stated to have retained, after the lapse of so many centuries, a comparatively fair complexion. But I can obtain no

* Sandys' Travels. † Layard's Discoveries (second expedition), p. 383.

accurate information on the point, and none at all as to the colour of their hair.

Pickering speaks indefinitely of unexpected varieties of feature and complexion found among the Bombay Jews. He mentions also some Jewish boys seen at Aden,* who had flaxen hair, adding that he did not recollect having ever seen hair of that colour among Orientals, *i. e.*, apparently, among the inhabitants of the southern coast and islands of Asia. He says nothing, however, of red hair.

The results of my own observations on the subject are contained in the tables appended to this paper. They exhibit the colours of the hair and eyes in 665 persons. Of these 33 were seen at Constantinople, 54 at Brusa, 54 more at Chanak-kalesi on the Dardanelles, and 92 at Smyrna, making a total of 233 Oriental Jews. At Amsterdam I noted but 13, and at Rome only 7, one of whom had red hair; at Prague, where they have a very ancient and populous settlement, 100; and at Vienna 113, including a good many from Poland and Moravia. To these I have lately added 50 in Bristol, all or almost all, of German descent, 100 from the congregation at the Great Synagogue in Duke's Place, London, who are Ashkenazim, and 50 from that of the neighbouring Portuguese synagogue.

There is, it will be observed, a considerable resemblance between the proportions of the different colours found in the northern and southern Jews, though the latter inhabit a country enjoying an annual temperature from 10° to 15° Fahrenheit higher than that of Prague and Vienna. The most notable difference consists in the greater proportion of red-haired persons in the Levant, where it equals that found in many Saxon districts of England. It becomes conspicuous there to the most unobservant traveller, from the great rarity of the colour among all the other races of the Levant. The German and Polish Jews, on the other hand, dwell in the midst of more or less xanthous races, though red hair is not indeed nearly so common in Bohemia and Lower Austria as it is further west, where Teutonic predominates over Slavic blood. Nevertheless they exhibit here a proportion of red hair, equal indeed or superior to that of southern Europeans in general, but much less than that of their eastern brethren, while in other respects there is no very noteworthy difference. Dark brown hair is more common than black in both divisions. Light eyes are more common in the northern than in the southern division, though black and brown form the majority in both. The colour of the skin is comparatively light; and in Turkey I

* Pickering's Races of Man, p. 244.

found the Jews and Greeks, as a rule, conspicuously fairer than the Armenians and Turks.

Red and fair hair is by no means always accompanied by blue or grey eyes. Hazel eyes and chesnut or auburn hair, with a very fair complexion, form a frequent combination. A very light shade of hazel, which should rather be called yellow, and which sometimes reminds one of the cat's eye, is not uncommon: Mr. R. Stuart Poole considers this colour to be peculiarly Jewish.* The eyes in the xanthous are usually well opened, and the features altogether softer and less strongly marked. The comparatively straight profile, spoken of by Sir Gardner Wilkinson, Mr. Blakesley, and others, as pertaining usually to the xanthous Jews of Africa and the East, is not unfrequent, I think, among their northern brethren of like complexion. In both divisions I have seen faces of great beauty, which by their form and colour strongly reminded me of the traditional representations of the Saviour; but such are, I think, much less rare in the east than at Prague, or Vienna, and rarest of all in England. Mr. Heaphy, in his recent papers in the *Art Journal*,† has done much towards proving that, at least as early as the second century, Christian artists at Rome had abandoned their previous mode of representing Jesus, for the type which has since been universally accepted, and which, I have little doubt, was really derived from the East. I shall presently show that the Jews of that day were almost certainly in the main a dark-haired people. If, therefore, the Roman artists had meant merely to represent Jesus as a Jew of great beauty, they would probably have copied from the handsomest examples of the common type; and the fact that they took in preference the rarer type, which is almost always associated with a light complexion, renders it almost certain that they followed a tradition—a tradition which, having had but a short time to run, may not unlikely have been founded on a fact.

To return from this digression. Are we not entitled to say that the xanthous type has been found among the Jews wherever it has been looked for, and notably in the regions of the Mediterranean and Levant?

Let us now briefly consider the manner in which it has been sought to account for these curious facts. Dr. Prichard, to whom they were very imperfectly known, ascribed them to climatic influence. I cannot see, however, how any one, in the present state of knowledge on the subject, can adhere to

* Genesis of the Earth and Man.
† An Examination of the Antiquity of the Likeness of our Blessed Lord.

his views on this point. If we were to establish any relation at all between climate and the Jewish complexion, it would rather, probably, be the very paradoxical one, that the hotter the habitat the more rufous are the Jews. It is, however, almost equally difficult to ascribe all the phenomena to admixture of alien blood, at least to admixture subsequent to the dispersion of the nation. This is, nevertheless, the hypothesis that has been embraced by most authorities. M. Paul Broca, for example, in a recent article in Brown-Séquard's *Journal de la Physiologie*, makes use of the supposed fact, that some parts of Hungary, and still more of Poland, had to some extent embraced Judaism between the eighth and the eleventh century. And Gliddon, after enlarging on the vicissitudes of their history, their forced conversions and relapses, and so forth, observes that Poland seems to be the focus of this fusion of the Jews with the German and Sarmatian races.

All this may be very true, but is scarcely relevant. What could have been the effect of intermixture with the swarthy Modyors, among whose descendants I have indeed occasionally seen flaxen, but hardly ever, so far as I can recollect, red hair? Nor have even the Poles or Slovaks enough of rufous blood to have leavened an alien dark race to any great extent.

Besides, the real difficulty is in Barbary and the Levant, the Jews of which regions have never mingled much with those of Poland and the north, but are known to be sprung from communities fixed there for very many centuries, overlaid, and in some places probably much outnumbered, since the latter part of the fifteenth century, by the descendants of the great Spanish and Portuguese emigration. Spanish is to this day, in most places, their domestic language, instead of the Greek, Turkish, or Arabic of general intercourse.

Mr. Blakesley derives the Jews of Tunis and Constantine in part from the Vandals of Genseric and Gelimer, of whom he believes a considerable portion to have become incorporated with the independent tribes of the interior, and to have assisted in raising the power of the latter to the pitch it attained not long afterwards. And Berbrugger says, "Si l'on en croit des historiens Arabes, la plupart des Arabes et des Berberes d'Afrique professaient le judaisme dès les septième et huitième siècles, et la prédication musulmane ne fit point de prosélytes chez eux." It is the fact that fair-haired people are numerous among the Berbers, at least in particular tribes, and some of these may have been incorporated among the Jews. But at the best these views affect only the people of Tunis and Algeria, and leave those of all the East, if not of Morocco, unaccounted for.

That the Jews in Spain, while under Visigothic rule, mixed freely with their Christian countrymen, does not admit of doubt.* Their settlement was of ancient date: tradition named David and Solomon as its founders: they were largely engaged in the cultivation of the soil, as well as in trade: they were slave-holders, and appear to have been disposed to proselytise their slaves; and their belief in the unity of the godhead seems to have been a source of sympathy between them and the Arian Goths. It is noteworthy that Jews assisted vigorously in the defence of Arles against the Franks, and of Neapolis against Belisarius. The conversion of King Recared to Catholicism changed these friendly relations; and thenceforward, till the Moorish conquest, the Jews underwent most bitter persecutions; but in Narbonnese or Gothic Gaul they continued to flourish, and Basnage states facts sufficient to prove that even in the ninth century the conversion of Christians to Judaism was not infrequent. Still later, in the thirteenth century, Rabbi Moses de Cozzi attributed some persecutions to God's anger against his people for marrying strange women.

That numerous body, therefore, who, by the cruel edicts of Ferdinand and Isabella, and of Emanuel of Portugal, were finally expelled from the Peninsula, and committed as it were to the Mediterranean, to be flung here and there upon its southern and eastern shores, may—nay, must—have been of very mixed descent. But we have surely no reason to suppose that they can have carried away with them more Gothic blood than they left behind. And though red hair seems to have been not uncommon among the Gothic aristocracy of Spain, in the middle ages—Pedro the Cruel, Isabella the Catholic, the great Marquis of Cadiz, and Vasco Nuñez de Balboa, were all red-haired—the colour is certainly rare at the present day in the mass of the Spanish people. Besides, though the language, in default of countervailing evidence, renders it probable that the Spanish emigrants contributed more largely to the ancestry of the Levantine Jews than did those whom they found already settled in the maritime cities, it is likely that the latter formed not inconsiderable communities. Benjamin of Tudela, in the twelfth century, had found, or professed to have found, 2,500 of his nation in Constantinople, where they occupied, it would seem, their present quarter, on the northern shore of the Golden Horn. He mentioned also a large community, of nearly 300 persons, at Salonica, and others at Rodosto, at Gallipoli, and elsewhere.

The admixture of Visigothic, Vandal, or other Germanic

* Basnage, passim. Finn's Sephardim.

blood, seems, then, insufficient to account for the phenomenon under discussion, and it may be necessary to fall back on the ideas of Sir G. Wilkinson and Colonel Hamilton Smith. These agree in supposing the rufous type to have existed among the Jews from the earliest ages, and to have belonged to the original Israelite stock, as distinguished from the Syrian. That about the time when we begin to have evidence of the separate existence of the Hebrews, people of xanthous type occupied some of the warmer regions of Western Asia, is rendered probable by the Egyptian representations of their enemies, the Rot-n-nu and the Rebo. Some of the red-haired captives portrayed in them have even been supposed to be Canaanites, but I am not aware that there is any good authority for such a notion.

It is impossible, however, to maintain that the Jews were ever predominantly xanthous. What evidence can be gathered from the Bible, from the Mishna, and from the Talmud, all runs quite the other way; and of this I am assured by a great authority in Hebrew literature, the Rev. Aaron Green, of London. In the first place, *black* is always spoken of as the healthy colour of the hair, in the regulations of Moses respecting leprosy. In Canticles the bride is made to say, "I am black, but comely." "Look not down on me because I am black (dark), hence it might be inferred that the general colour was fair; else why the apologetic tone of the interlocutor. But in the same book the same person says of the bridegroom, "His head is as the most fine gold; his locks are curled, and black as a raven." The Mishna and Talmud furnish strong grounds for supposing that other colours than black were exceptional. In them black (shachor) is used as a synonym for hair (séor). Thus, "He who vows the *black* of the head," and in the Ethics, "Affable to the black (young)," *i. e.* to the young whose hair is black. In the Talmud, commenting on Leviticus, it is said, "He uses '*black*,' because it was a generic term for *hair*." The word frequently translated "*fair*" in the Old Testament signifies, I am informed, *beautiful*.

The only mention of hair of other colours seems to be in the case of Esau, supposing that the word "admoni," "*red*," all over *red*, like unto a hairy garment, refers to the hair, as it almost certainly does.

Let us now return to the ascertained facts discussed in the earlier parts of this paper. These seem most consistent with the supposition that the xanthous element of the Ashkenazim and Sephardim was to some extent derived from a common source, the greater part of which, however, flowed into the veins of the latter.

Three considerations occur to me with respect to this difficulty. One is, that the Jewish traditions as to the very early date of their settlement in Spain may very probably have been founded on fact; and that though the tomb and epitaph of Adoniram, Solomon's collector of tribute in Tarshish, may never have existed, yet colonies may actually have been sent by them to Tarshish, *i. e.* Spain, and even to Cornwall, to Marazion and the land of tin, long before that Babylonian captivity, which may have wrought a change on the physical as well as on the moral character of the race.

Another is, that the xanthous type may have belonged to the Phœnician rather than to the Hebrew stock, and that both in Africa and in Spain remnants of the former may have become incorporated with the latter, and thus transmitted some of their physical peculiarities to the modern Jews.

A third conjecture remains. The Idumeans were compelled by Hyrcanus to be circumcised, a rite they had apparently renounced, and they afterwards gradually amalgamated with the southern Jews. Did the name of Edom, אדום, the red, originate in the colour of the soil, or in that of its inhabitants, or, by attribution, in that of their supposed forefather Esau? If it arose in the second way, (and I believe it is consistent with Arab usage to name a tribe from any peculiarity of complexion or feature), then another possible source of the xanthous element is pointed out.

It is hardly possible to take leave of the subject, without remarking on a quality of the Jewish race, which may perhaps be in some degree connected with its double physical type, and which has been repeatedly enlarged upon by those who have written on its peculiar nosology.* I mean, that as the Jews in their own body represent the two extreme types of the Caucasian family, the pure xanthous or rufous and the melanous, so they are able, it seems, to live, thrive and multiply in all countries where any branch of that family can subsist. In Sweden they increase in numbers, and the proportion of children to married persons appears, from the census tables, to be greater than among the Christian population. In the towns of Algeria they are, according to Boudin,† the only race that is able to maintain its numbers, while Frenchmen, Spaniards, Moors and Negroes tend to die off more or less rapidly. And in Cochin and Aden, the latter one of the hottest places in the world, they succeed in rearing children, and in forming permanent communities.

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* Nott & Bondin. † Geographie Médicale.

COLOUR OF EYES AND HAIR IN SIX HUNDRED AND SIXTY-SIX JEWS, OF SEVERAL COUNTRIES.

	No. of Persons observed.	Eyes Light. Hair. Red.	Fair.	Brown.	Dark.	Black.	Eyes Neutral. Hair. Red.	Fair.	Brown.	Dark.	Black.	Eyes Dark. Hair. Red.	Fair.	Brown.	Dark.	Black.
Brussa	54	1	1·5	9·5	4·5	2·5			3	1				5·5	10·5	15
Stambol	33	2		9·5	2·5					2				·5	7·5	16
Dardanelles	54	2	·5	·5	3				1·5	4	·5		1	1·5	39·5	18
Smyrna	92	1	1	5	6·5	·5		2	4	5			1	7	29·5	28·5
Prague	100	1	1	10·5	8·5	4			4·5	6	2·5			1	38	34
Vienna	50			7	7·5	·5			1	7·5	1·5				13	12
Do. (many Polish)	63	1	4·5	11·5	9	2			2	5				3·5	11	13·5
Amsterdam	13				·5	·5								1·5	10·5	
Rome	7			1						1	1				2	1
Bristol	50			4	4	1			3·5	1	1·5			1	15	16
London	100		1	6·5	12·5	2		1	2·5	8	1·5			2·5	22	38·5
Do. (Portuguese)	50		2	2	5	2			2	4·5	1·5			1	8·5	30·5

Since this paper was in type, I have received from Dr. Wolff some valuable information respecting the Persian Jews. Red hair, he tells me, occurs among them, though they are not Sephardine. Among the Bokhara Jews black hair prevails, but not to the exclusion of red and other colours; the eyes are oblique, but the general aspect of the features Jewish. Dr. Wolff also testifies to the light complexion of the "White Jews" of Cochin, but cannot recollect having seen any among them with red hair. He describes the Jews of Yemen as of mingled Arab extraction, and as resembling their Arab neighbours in person. Dr. Stern, lately a missionary in Abyssinia, informs me that some of the Falasha, who claim to be the descendants of a Jewish colony as old as the days of Solomon and the Queen of Sheba, appeared to him to have something more Hebrew or Semitic in their aspect than the Christian Abyssinians; but his impression is that black hair is quite universal in that country.

QUARANTINE AS IT IS,

AND

AS IT OUGHT TO BE.

BY

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QUARANTINE AS IT IS,

AND

AS IT OUGHT TO BE.

QUARANTINE is the enforced detention and isolation of ships and of everything on board them, persons as well as cargo, on arrival in a harbour, in consequence of the apprehended importation thereby of a disease deemed liable to spread and to become pestilential.

There is also a Quarantine by land, which consists in trying to isolate a place where the disease already exists, by encircling it with a cordon of troops, to bar all intercourse between the infected locality and the adjacent districts, in the hope of preventing the extension of the mischief, and extinguishing it on the spot where it exists.

The duration of Quarantine is made to vary according to the believed presence or absence of the apprehended disease in the port from which the vessel sailed, or at which she last touched, the health of the crew and passengers during the voyage and on her arrival, the description of her cargo, and the circumstance of there having been any communication or not with other ships, persons, or things on the high seas or elsewhere.

If the port of departure be entirely free from the disease, the vessel receives a clean bill of health (*patente nette*); if otherwise, a foul bill (*patente brute*), the effect of which is, that a more or less lengthened Quarantine will be imposed on her in the port of arrival, although all on board may have remained in perfect health during a voyage of many days, or even weeks, and although there be no trace whatever of any sickness when she arrives. There is, moreover, what is called a 'suspected' bill of health (*patente touchée*), given to vessels coming from places which, although quite healthy themselves, continue to hold communication with countries where the apprehended disease may exist, without adopting the customary and traditional stringent measures against these countries. The quarantine required for suspected bills of health is intermediate in duration and strictness between what is imposed in the other two cases; for it is to be kept in

mind, that even a clean bill of health does not always ensure immediate 'pratique,' or free communication with the shore upon the ship's arrival.

Some articles of merchandise are considered to be susceptible, *i.e.*, capable of attracting and becoming impregnated with the morbific miasm floating in the atmosphere of an infected locality, and of conveying this poisonous matter from place to place. Other goods are supposed to possess this property only feebly and imperfectly; while a few are said not to have it at all, and to be *unsusceptible*. These distinctions are for the most part purely imaginary.

The visit of a Quarantine officer to a ship on arrival is rather for the purpose of obtaining answers to certain prescribed questions respecting the voyage, &c., than of ascertaining the actual condition of the vessel itself and of the persons and things on board, as far as sickness, or liability to cause sickness, is concerned. He merely goes alongside in a boat, puts certain queries to the captain, writes down the answers on a sheet of paper, and passes this to the captain for signature. The signed paper and the ship's bill of health, having (in the event of any suspicion) been first sprinkled with vinegar, or duly fumigated, are received back into a basket, or with a pair of metal tongs, by the health-officer, who returns on shore either to make out a warrant of release or to prescribe the necessary Quarantine.

Should any one be sick when the ship arrives, and there be no medical man on board, the Quarantine officer prescribes as he best may, without seeing the patient. If he went on board, he must remain there, and could not return on shore. The case is the same even when the sick or suspected are removed to a lazaret. The health officer can attend upon them only under certain appointed precautions; otherwise, he could not leave the lazaret himself without incurring the risk of conveying the pestiferous poison abroad!

The theory and the whole machinery of Quarantine rest on the belief, not only that certain diseases are communicable from the sick to the healthy under all circumstances and conditions, and are capable of spreading in this manner with epidemic force in a new and distant locality; but also that the miasms of these diseases, floating in the atmosphere of infected places, are liable to cling to the surface of persons and inanimate objects, and may thus be conveyed in shipping to great distances, and after long intervals of time, retaining all the while the power of infecting the atmosphere in the port of arrival.

It is also presumed that the morbific germs may be incubant or lying dormant in the systems of persons who, although perfectly well on arrival, may sicken afterwards, and then become the radiating centres of a wide-spreading infection.

That certain zymotic diseases are more or less actively infectious—*i.e.*, communicable from the sick to the well through the medium of the atmosphere—is not to be gainsaid.

In one group of these diseases, as in small-pox, scarlatina and measles, the infectious property seems to be *inherent* and *essential*. This may, indeed, at times be feeble and unenergetic; still, it is always

present, and may, from some unforeseen cause, suddenly acquire great potency.

Moreover, no ordinary sanitary precautions that we know of can prevent either the development, the extension, or the recurrence of the exanthematous or eruptive fevers, however much these precautions will very generally serve to abate their severity and fatality. Occasionally, though rarely, small-pox and scarlatina are as fatally malignant in the clean and airy abodes of the rich as in the dwellings of the poor. The temperament and constitution of the persons attacked have much to do with the severity of the seizure.

There is another group of zymotic diseases in which the infectious property is not inherent and essential, as in the former, but is only *conditional* and *contingent*, *i.e.*, depending upon, and requiring for its manifestation, the coexistence of an artificially polluted atmosphere. Typhus fever is an example of this class. No disease has a more terrible power of self-propagation and increase when the sick are crowded together in impure, ill-ventilated chambers. In clean and spacious apartments, however, where the atmosphere is being continually renewed by the due admission of fresh air and the simultaneous escape of the vitiated air, all risk of the extension of the infection ceases. The means of arresting the evil are thus in our own power, and are, moreover, always at hand.

In this respect, therefore, there is a marked difference between the infection of typhus, and that of such diseases as small-pox and scarlatina. Unlike, too, to the true exanthematous or eruptive fevers, typhus seldom or never springs up *de novo* without the concurrence of local noxious agencies which it is easy to prevent and remove, and the very existence of which is proof positive of neglected sanitary regulations.

Now, what is true of typhus is equally applicable to the oriental *plague*, as respects its mode of development and extension. The experience of the last five-and-twenty years has established this as a fact beyond any reasonable doubt. The plague is apt to spring up in the filthy towns and villages of Turkey and Egypt, under the very same conditions as typhus does in our foul lanes and alleys; and when it spreads, its spreading is due to the like influences of artificial local contamination. It was therefore no vain or unmeaning boast of the late Mehemet Ali, when, alluding to the many works of improvement he had carried out and intended to carry out in Egypt, he said, 'We must get rid of the plague.' He knew that it might be done.

In all prophylactic and preventive measures, therefore, directed against the plague, we have but to consider what experience has shown to be necessary against typhus; neither more nor less being required. The Quarantine restrictions and regulations against the former disease should be exactly those which it is found right and necessary to be adopted against the latter disease.

But what have recent occurrences in the Mediterranean shown to be the practice still pursued by almost all the European States in reference to this matter?

In the early part of the present year, a bad form of fever broke out in a filthy Arab village near the town of Bengazi, on the Barbary coast, and continued to spread slowly for weeks and months without exciting much alarm in the district. During all this time, it was not regarded or called the plague. This has always been the case with epidemics of this pestilence. No one pretends to be able to distinguish the disease at first from other bad forms of fever. And so it was at Bengazi. It was only when buboes and carbuncles were superadded to the other symptoms, that the fever was recognised and designated as the plague; and then only did quarantine measures begin to be enforced in the Mediterranean ports against the infected place. Before that, no special precautions had been taken or deemed necessary against arrivals from the Barbary coast. But no sooner was the dreaded name of plague affixed to the disease, (which, as we have seen, had been existing for months before its real nature was discovered,) than the entire machinery of quarantine, with all its strange and most extravagant complications, was set in motion by most of the European States to prevent the importation of the pestilence among their subjects.

One or two examples will suffice to show the nature of some of the precautions.

A quarantine of twenty-one days' duration was imposed in the ports of Naples, Greece, Portugal, &c., upon all vessels coming from or which had touched at Gibraltar; not that any disease existed there or that the health of the Rock was bad at the time, but merely because it continued to hold communication with Morocco, which was also at the time in a healthy state and quite free from any pestilential malady. Our Government, as well as that of France, held out for some time against such preposterous proceedings, and counselled a rational moderation in the enforcement of precautionary measures; but the attempt only brought down upon our intercourse and commerce retaliatory prohibitions of the utmost stringency, and our Mediterranean ports were compelled to yield.

One of the Peninsular and Oriental steamers on her voyage out from this country to Alexandria had to land some passengers at Gibraltar. Before leaving the harbour there, it was necessary to have a bill of health of the place. The document was duly sent on board, enclosed in a tarred box carefully fastened down. The captain of the steamer, not aware of the risk he and his ship incurred, inadvertently opened the box to look at the paper. On arrival at Malta, it was declared by the authorities there that, in consequence of this act, the steamer must be regarded as having had communication with a suspected port, and must undergo a quarantine of ten days. The passengers who landed were detained in the lazaret for that period, before they received pratique!

At Alexandria, a curious event occurred. A vessel with 250 pilgrims crowded on board arrived in that port from Tunis. During the voyage, one of the pilgrims—who, it is scarcely necessary to say, are always abominably filthy in their persons and habits—sickened

of a fever and died. After some controversy as to the true nature of the case among the health officers of Alexandria, it was decided that it should be regarded as one of plague, and the most stringent precautionary measures were accordingly enforced against the ship and all on board, to prevent the spreading of the disease to the town. The pilgrims were crowded together into the lazaret, and kept under strict guard. While thus confined, another man fell sick of fever and died. Again was there difference of opinion among the medical attendants as to whether it was a case of genuine plague, or not; but the majority decided in the affirmative. One of these gentlemen, in examining the case, had touched the patient's body, and had returned home without having undergone the prescribed purification. When this came to be known to the foreign consuls, they at once communicated the intelligence to their governments, and the result was that Alexandria was forthwith declared to be infected or suspected of having the plague, and treated accordingly.

Comment upon such proceedings as the above is unnecessary; they outrage common sense, and disgrace the medical profession at whose door lies all the folly of 'quarantine as it is.'

The subsidence and all but cessation of the plague during the last twenty years in the Turkish dominions has been attributed by many to the institution of quarantine, or rather a system of sanitary police, by the Porte in 1838-39. And doubtless the measures which have been carried out in Turkey, Syria, and Egypt since that period, must have been productive of no small amount of good in arresting and extinguishing the disease, and preventing its unchecked propagation. Wherever a real or suspected case of the disease occurred, the infected house was immediately emptied of all its inmates, and underwent a thorough cleansing and purification. Infected or suspected shipping was likewise subjected to quarantine detention, and not permitted, as had previously been the case, to enter harbours at once and communicate immediately with the shore without let or hindrance.

After the great fire of London in 1666, which swept away so much of the worst-conditioned parts of the city, and resulted in a general improvement in the dwellings, streets, &c., the plague, which was then seldom absent in its sporadic form, and had three or four times raged with epidemic violence since the beginning of the century, became greatly less frequent, and ere long ceased to be ever met with in the metropolis; and this, too, before any system of quarantine had been established in our country.

I shall now briefly notice another pestilence against which quarantine is in the present day specially directed—viz., *yellow fever*.

The experience of the last nine or ten years has afforded an unusually wide field for the observation of this disease, and it has been studied with much greater exactitude than before. Its appearance for the first time (as far as accurate records go) as a great epidemic in the Brazils in 1849-50, and its gradual extension northwards and southwards to the latitude of New York on the one hand and that of Buenos Ayres on the other, and from east to west right across the

South American Continent, as well as its persistence from that date down to the present time in some part or other of this wide extent, are events full of instruction and warning.

Now, no one fact has been more indisputably made out than that yellow fever never manifests any tendency to spread from the sick to the well in pure and airy chambers, more especially when the patient has been removed from the place where he caught the disease. The medical and other attendants run no risk whatever under such circumstances.

To deny the communicability of yellow fever absolutely and unqualifiedly is unwise, because it is against evidence. In the ill-ventilated between-decks of a ship, and in like conditioned abodes on shore, it has unquestionably spread by infection. The potency or activity of the infectiousness of yellow fever is, however, never so great as that of the plague or of typhus; it is more easily dissipated and annulled.

As in the case of the plague, mild cases of yellow fever are not distinguishable from the ordinary endemic fevers of the country, which are not regarded as at all infectious, and against which there is no quarantine. Such cases usually usher in an epidemic. It is only when its malignancy is fairly established that quarantine comes into force. The gates of the citadel are closed after the foe has got in

Certain it is that quarantine, as hitherto practised, has signally failed in keeping out yellow fever from countries exposed to its invasion. Instances upon instances might be quoted: I shall mention but one, the most recent and one of the most striking of all; viz., that of Lisbon last year. Notwithstanding the unceasing maintenance of a most vigilant and stringent quarantine at every point of her coast, and against every part of the world which was or could be suspected—to the immense inconvenience of all intercourse and serious detriment to commerce—the enemy found its way into that notoriously foul and unwholesome city, and caused such a panic by its destructive ravages, that for a time all business was suspended, the law courts were closed, and the legislature refused to hold its sittings.

Portugal was the only country in Europe visited by the pestilence, although others, our own among the number, had much ampler and more frequent intercourse with Brazil, from which the Lisbon Board of Health contended that the disease had been imported.

The mild precautionary measures adopted of late years at Southampton, towards vessels arriving there with cases of yellow fever recently or actually on board, have been found quite sufficient in protecting the public health.

Epidemic Cholera is another disease for which quarantine continues to be imposed in many countries.

It was expected by the medical profession and the educated public in this country, as well as in France and the United States, that after the experience of the two visitations in 1831-2 and in 1848-9, the universally ascertained inefficacy of ordinary quarantine to keep

out the pestilence—for not a country or land escaped—would have been everywhere acknowledged and acted upon in the future. Not so, however; for on no former occasion was the system more rigorously followed out than it was in the last visitation in 1853-4 by Spain, Portugal, Naples, Greece, and Sweden.

For example, on the earliest intimation of cholera having appeared in this country, Spain immediately required that Gibraltar should at once impose a strict quarantine upon all arrivals from our shores, whether the ships were healthy or not. The governor of the garrison hesitated to accede to the demand; and straightway an embargo was placed by the Spanish authorities on all direct communication between their country and the Rock, to the great inconvenience and distress of the inhabitants of both, more especially of the latter, which derived its chief supplies of food from the surrounding district. Smuggling of course went on, however, actively all the while. After lengthened remonstrances and counter-remonstrances, Gibraltar was compelled by force of circumstances to yield. Ere long, the exigencies of war broke through all quarantine restraints both there and in other ports in the Mediterranean; and during the greater part of 1854, when the cholera was at its height both in our own country and in France, an unobstructed intercourse was continually going on with Gibraltar and Malta, and between those places and every part of the Mediterranean, the Bosphorus, and the Black Sea. Now, it is a very notable fact that during the whole of the Russian war, cholera never spread either at Gibraltar or Malta, nor yet at Balaklava or at Kamiesch, although vessels were continually arriving and landing the sick at all those places, and the only precautions that were adopted were the prompt removal from shipboard of every person that could be sent on shore, and the locating them in healthy situations. No experiment could be more conclusive or ought to be more instructive.

While such was the course pursued, and such were the results, in English and French ports, the most rigorous quarantine continued to be exercised by other countries. The steamer, in which I was a passenger in the summer of 1855 from Marseilles to Constantinople, took on board at Malta a French soldier who, while affected with diarrhœa, had most imprudently bathed in the sea just before coming off to the vessel. The symptoms rapidly became worse, and he died collapsed next morning. The body was immediately committed to the deep. On reaching the Greek island of Syra, the steamer was declared to be infected, although there was not the slightest trace of sickness among any on board, and kept during her stay in strict quarantine, and the passengers, who had to be landed, were sent off for ten days to a lone island seven or eight miles distant!

Notwithstanding the utmost vigilance of the Spanish and Portuguese authorities at the same time, the pestilence found its way into both of these countries, and spread from town to town and from district to district, committing terrible ravages everywhere, and especially in seaport towns, which are always the most unwholesome and worst conditioned. No city has of late fared worse than Lisbon has done. In

1856, the cholera, and in 1857-8 the yellow fever, swept away thousands of her people. Nowhere is quarantine more vigilant and more strict.

I have thus briefly noticed the three diseases—plague, yellow fever, and cholera, against which quarantine is at present chiefly directed. Admitting that infection, or communicability from the sick to the well, is an element or factor in the propagation of each and all of them—although in the case of cholera the property is comparatively very feeble—I have sought to show that it requires for its active manifestation the co-existence and co-operation of a polluted atmosphere, and that all that is needed for its effectual dissipation is the correction or removal of this artificial adjunct. The ready means of extinguishing the mischief are thus always in our own hands. Let not, therefore, in considering the subject of quarantine, the mere abstract technical question, 'Does this or that disease ever manifest an infectious property?' be uppermost in the mind and guide our decision; but rather such practical questions as these,—'What part does infection play in their general dissemination?'—'Is the part a principal or merely a subordinate one?' and 'Is the infection constant and inherent, or is it only conditional and, therefore, avoidable?' This simple rule will save the inquirer from many errors, and lead him into the right way.

'Quarantine as it ought to be,' should, in my opinion, be as follows:—

1. The enforced detention and isolation of shipping are necessary only when disease actually exists on board, and when the vessel is in a foul and infected condition upon arrival.

The health-officer should go at once on board, and personally inspect the state both of the ship and of all on board, before determining the restrictions to be imposed.

An accurate registry of every inspection should be kept.

2. The sick, and all persons in whom the early or precursory symptoms of sickness are present, should be removed as promptly as possible, from the ship to clean and airy rooms on shore, or to a floating hospital moored in a healthy situation. The detention of such persons in an infected ship is obviously most objectionable.

3. There being no reliable evidence that any pestilence was ever introduced into a community by persons who had been quite healthy during a voyage, and were so upon arrival, it is unnecessary to detain such persons in a lazaret upon the mere speculative apprehension that the disease may be dormant in their systems.

Emigrants and pilgrims, being often extremely filthy in their persons and clothing, should be subjected to special examination and purification before they are permitted to go free upon landing. A supervision of the dwellings to which such passengers usually resort should also be maintained.

4. The experience of all lazarets having shown that the fears of a pestilential disease being introduced by the ordinary cargoes of dry and imperishable goods are groundless, the tedious and expensive restrictions often imposed upon such cargoes may be discontinued without any risk.

Such articles as foul rags, putrid hides, rotten meat and vegetables, guano, &c., should be landed under special regulations, and apart from ordinary wharves and from dwellings.

Foul bed and body linen and other baggage of the sort should not be landed when there has been sickness on board, or where any epidemic exists on shore, without previous thorough cleansing and disinfection.

5. Vessels in a filthy, unwholesome state from foul bilges or otherwise should not be allowed, whether there has been sickness on board or not, at once to enter a crowded port, or to lie alongside a wharf or other ships; nor should they be permitted to land their cargoes until they have been duly cleansed out and ventilated.

A foul ship is much more to be dreaded as a vehicle of introducing disease than anything she has on board; and no small risk is often incurred by pilots, custom-house officers, and other persons who go and remain on board. The atmosphere in the hold and the between-decks of such a vessel will often poison a stranger fresh from the shore, when the crew have escaped.

If disease has been on board during the voyage or on arrival, the ship should be limewashed and fumigated, as well as cleaned out and aired, before free entrance is granted.

6. One of the most important duties of a quarantine health-officer should be to maintain a vigilant supervision over the sanitary state of ships in port and on arrival.

If bills of health were made to certify the condition of a ship, and of her accommodation for the crew and passengers, as well as the mere existence or non-existence of disease in the port of departure, a far more effectual protection against the introduction of disease into the port of arrival would be afforded than now exists.

A *clean bill of health* would then have a significant meaning, and the services of the health-officer would be of great value to the community.

The machinery of quarantine might thus be made instrumental in the general sanitary improvement of mercantile shipping, a subject which calls for much more public attention in every country than it has yet received. There is a large amount of impaired and damaged health, as well as of actual disabling sickness and of death, among the crews of our merchantmen, arising from causes on board ship which might be easily prevented.

7. As to the quarantine measure on land of encircling an infected spot with a cordon of troops or police in the hope of preventing the extension of any pestilence, humanity as well as experience denounce it as utterly unjustifiable. It is alike barbarous and homicidal.

Such is the system of quarantine which I should propose. If asked what hope is there of so simple a system being ever adopted generally, and in foreign countries as well as in our own country and colonies, I must admit that the attempts hitherto made to reform the existing quarantine have been anything but encouraging. Missions and commissions, and international conferences have been tried and failed, and diplomatic remonstrances have not been more successful.

No one nation can well act in the matter quite independently and without the concurrence of other countries. England and France and the United States would willingly adopt a more rational procedure, but they are checked (as recently in the plague on the Barbary coast) by other governments refusing to go along with them, and threatening their intercourse with oppressive restrictions.

One way only is left, and probably it is the best, after all—viz., to enlighten general opinion everywhere, by keeping before the public eye the fallacies and evils of the existing system, and at the same time the simple and effectual means of reform.

A good mode of doing this would be by the annual publication of a digested report of all proceedings touching quarantine, not only in our own ports at home, but also in our different colonies, as well as in all foreign countries, in as far as they have affected in the course of the year our commerce and intercourse. A large amount of information on the subject is continually being sent to the Foreign and Colonial Offices, and also to the Board of Trade and Privy Council. Hitherto, this information has been only occasionally and at uncertain and often distant intervals made public, and then generally in a bulky blue-book. Let but an annual digest of each year's proceedings be prepared in the Privy Council Office, and, as with the reports of other governmental departments, be regularly laid before Parliament; and ere long public attention will be drawn to the subject, first in our own country, next in our colonies, (in many of which the utmost ignorance and error prevail,) and eventually even in those continental nations that have hitherto resisted every attempt at change, and cleave to a system which, in most of its details, outrages common sense and is a scandal to medical science.

The appointment of a Special Committee by the Association to examine into the whole subject of quarantine, and to report the results of their inquiries at the next annual meeting, might, I think, be also productive of much good to the cause of enlightenment and truth.*

* A resolution to this effect was adopted by the Public Health Section, and afterwards confirmed by the Council of the Association.

The Committee appointed consists of the Superintendent-General of Quarantine, the Directors-General of the Army and of the Navy Medical Departments,—Sir James Clark, Bart., Professor Owen, Drs. Southwood Smith, J. Davy, Babington, Farr, M'William, Bryson, and Milroy; and Messrs. Ronald Martin, Spencer Wells, and Wiblin.—London, March, 1859.

Among the mountain ranges of the western ghats of India, the Neilgherries, and elevated spurs of the lofty Himalayan chain, districts and climates, suitable for the healthy residence and vigorous existence of the European race, have of late years been eagerly explored, and as rapidly made the settlements of English invalid officials. The best known and most frequented of these hill stations are Aboo and Mahabaleshwar on the west, for the Bombay presidency; Ootakamund and the other Neilgherry stations for Madras; Darjeeling for Calcutta and Bengal; Simla, Nynee Tal, Landour, and Mussoorie, for Bengal and the north-west provinces; and Murree and Dalhousie for the Punjaub. The experience of thirty years has established that the climate of these stations is congenial to the feelings and health of Englishmen, and that, as permanent residences, they are suitable for our population, in so far as their limited extent of territory permits; and that the out-door labours of settlers would not, for eight months of the year at least, be interrupted by the excessive rain-fall, which, for successive days of the four months of the Indian rainy season, is found amounting to 10 or 24 inches of rain daily. Along with the introduction, therefore, of the railway system into India, flattering schemes for the colonization of these hill stations, and the cantonment there of a large English force, have been perseveringly and glowingly set before the Government and the public, as encouragement for both to liberally subscribe their money for the practical completion of such schemes. Some of these recommendations, however, more particularly their military occupation as acclimating stations for troops, have been made without due knowledge and consideration of the physiological changes effected in the human body, under change of climate and locality; or of the hygienic conditions under which such changes, and the acclimation of Europeans, with the results of their efficiency for service in hot climates, can be most effectually obtained. In fact, the elevated table-lands, or plateaux, above which several of the hill stations rise, such as Dapoorie, on the same high plain as Poona, or 1,900 feet above the sea-level, have been somewhat incongruously spoken of as hill stations, and recommended, in the same breath with the last, for extended military occupation. But the conditions of climate peculiar to the former, and the organic physiological changes effected by residence there, which form individual constitutions suitable for hot climates, are altogether different from those experienced at higher elevations of from 4,000 to 7,000 feet; where elevation is accompanied by the same diminution of temperature as met with in temperate latitudes, or in this country, but from which European soldiers, after years

of healthy residence, would, on descending to the lower plains for military service, suffer nearly as much as if under direct and immediate transference from temperate to equatorial latitudes; where, as already recommended in my former lectures, the best means of assimilating the raw soldier's constitution to new employment and climate will be to remove, as far as possible, all local and topographical causes of unhealthiness; and to neutralise, at the same time, the hurtful agencies of extreme and variable temperature, or excessive dryness and humidity, by well-regulated systems of diet, clothing, exercise, and amusement, along with the healthy sites of the soldiers' tents, barracks, huts, and hospitals.

Certain increased ratios of sickness and mortality among masses seem inseparably associated with certain degrees of latitude; the average of human life, under equal circumstances, being shorter in proportion as we are near the equator, and lengthening gradually as we approach the pole. Such higher or lower averages seem mainly dependent, as a whole, on higher or lesser degrees of temperature and moisture connected with particular latitudes, and are inversely as the degrees of latitude. They are also relatively greater or less, in the inverse ratio of elevation of site and locality, when the diet, clothing, and social and moral habits of individuals are alike and placed under equally sanitary conditions of a dry soil, good drainage, and an open country, more exposed to sea than land breezes. The conservative influence of insular maritime climates is greater than continental sites in the same degrees of latitude, and is probably one reason why the per-centage of mortality for age in England is less than that of France. In the southern provinces of the latter country, where the climate is warmer, the average mortality of the population is a tenth greater than in the northern provinces, or 1 in 33 to 1 in 44; and yet it is not from the last, but from the former, that troops for service in Algeria are taken, as their constitutions, after a few years' residence there, are found better able to resist the morbific influences of a hot climate, and the disturbed physiological actions of constitution incident to all cases of transference from different climates and localities. To avoid, therefore, the probability of any great increase of the ratio of sickness and mortality, among troops under transference from cold to hot climates and localities, it is desirable that the transference should be effected at that season of the year when the conditions of climate and country to which troops will be exposed are found to vary least from those conditions characteristic of the climate and locality they have just left. In selecting, then, particular elevated sites and localities for military occupation in hot climates, the question is not one merely of the highest elevation, possessing climatic conditions of the temperate zone, and the consequently diminished chance of engendered malarious influence and sickness; but at what altitudes and in what localities of India, and other hot climates, can large bodies of troops be best cantoned and habituated to varied and elevated temperature; and to the moisture of these climates, so as to keep down high ratios of sickness and mortality among soldiers, and render them most efficient for service in the field. If the question was only one of colonization or permanent occupation, without chances of removal to service and fatigue in a warmer atmosphere, the choice, without any risk of failure or disappointment in result, might be given to the greatly elevated and colder hill climates of

India, met with at the height of between 6,000 to 8,000 feet. But, on the subject of military occupation and the cantonment of troops, it plainly resolves itself into conclusions from facts, as to the final results for armies best prepared for field service; or, in other words, what climates and localities of India are most calculated to effect that sanitary condition of European military masses, so as to render them least susceptible of morbid impressions, during exposure to heat and other causes of disease incident to field-service in that country: where, out of any given number of men, entering on such service, and accustomed to a hot climate, there will be the greatest amount of efficiency in the field, under a decreasing ratio of sickness and mortality. The answer to these queries, and their solution, mainly depends on a right appreciation of what essentially constitutes for strangers in a new climate, and under its modifying climatic agencies, that altered constitutional condition which ends in health for the new comer, with the possibility of living in and resisting the diseases of the country nearly as well as those who are indigenous to it. These modifying atmospheric agencies are temperature, density, moisture, and electricity; the nature and composition of the soil and locality, with its extent of easting, and proportion of continent or otherwise; which, continually acting on the body, effect in due time a special modification and interchange of organic functions, which adapt individuals and masses to the new conditions of their existence.

Some, from having confounded together two orders of agencies, the atmospheric and endemic or miasmatic causes of disease, absolutely deny the possibility of acclimating Europeans in hot climates. Mons. Baudin in France, Sir Alexander Tulloch and Mr. Martin in this country, incline to this view:—which is, however, opposed by the enlarged experience and well-considered opinions of Dr. M. Levy, MM. Celle, Perier, and Aubert Roche in France, and of many other experienced army medical officers in this country. Dr. Levy says, "According to the investigations of Sir Alexander Tulloch, it has been advanced that prolonged sojourn, far from promoting acclimation, increases the chances of mortality; and statistics, always pliant and flexible for every kind of paradox, have crowded their group of figures around this opinion. Soundly-observed facts refute it however. From 1,220 military who died in Algeria, and taken at random, three-fourths had not exceeded a residence of 17 months. We have also noticed the progressively numerical decrease of men discharged: for, out of 1,575 dysenteric cases that came under observation during 10 years in Africa, 338 belong to the first year, 235 the second, 150 the third, 86 the fifth, 35 the seventh, 17 the eighth, and 2 the last two years."*

These preliminary observations on the subject of localizing and acclimating European troops on hill stations in India bring me to the consideration of the three following heads of this lecture:—

1st. If acclimation be possible, what is the nature of that physiological adaptation of European constitutions for hot climates that assimilates them to the same standard of organic action incident to the organism of the indigenous inhabitants, and confers on them a nearly like immunity from certain diseases?

* Traité d'Hygiène Publique et Privée; par Michel Levy, Medicin principal d'Armée, &c. tome i. p. 568.

2nd. The elevation and condition of the stations and climates of India most desirable for placing European soldiers beyond the range of aggravated attacks of fever and bowel complaint, and most suitable for producing that kind of constitutional adaptation by which they may be rendered most efficient for field-service.

3rd. What practical lessons may be drawn from the consideration of these questions, and what organisation of European troops in India would secure most efficiency on service, and with greatest good to the State?

I shall endeavour to treat these points in a comprehensive but brief manner, still sufficient, I hope, to convey to my hearers definite ideas of a difficult subject; obscured as it has been, in some measure, by incongruous elements of morbific causation, such as yearly decrement of constitutional power by age, augmented by miasmatic influences of locality, not having been separated from atmospheric causes by those who obtained statistical figures and results, to prove that in hot climates there is no acclimation. But, if acclimation be possible, what are the proofs of it? I have already quoted the opinion of the well-known French army physician Dr. Levy, that according to his experience the contrary opinion of this is a paradox. Indeed, it is true only in this way, that the law of yearly increasing mortality from five years of age onwards, and which, for Europeans, prevails with the smallest ratio of mortality in temperate latitudes, when exaggerated by transference to equatorial latitudes, and other elements of increased morbid causation, not ameliorated by suitable sanitary arrangements for climate and locality, gives a large and continuously-increasing ratio of physical degradation and mortality. The operation of this law, among masses of men, gives the least statistical ratio per 1000 for the civil population of England, or a mean of 8·45; while in Prussia, France, and other continental states, it increases to 10· and 11·25 respectively. But the relatively mean ratio of mortality under this law, when sought for among the soldiers and officers of the English army at home, is 14·52,* and among those of the French army 15·10;† showing that the soldiers' separation from the influences of his natal place, climate, and association, increases on the whole his physical degeneration—even under home residence and climate. The mean ratios of mortality among the French military at home, and of English troops in Ireland, under this law, compared with the respective means for the troops of both nations under hot climates, are to be seen in Table III. The home ratios, having been calculated for years when the sanitary condition of soldiers was little attended to, are higher than those obtained from later years. What wonder, then, that under transference to equatorial latitudes, and augmented sources of unhealthiness unremoved, and not ameliorated by suitable sanitary provisions and arrangement, statistical figures and results should

* In the tables handed in by Sir Alexander Tulloch, in support of his evidence before the commissioners appointed to inquire into the organisation of the Indian army, the mean of cavalry and infantry is given at 15·52. The other table there, corresponding with No. VI. I have taken from Mr. Marshall.

† The mortality of Europeans under military life, and in increasing ratio according to residence and proximity to the 1st degree of equatorial latitude, is increased by advance of age, transition from native climates, transference to tropical latitudes, unremoved sources of endemic disease, and bad sanitary arrangements for soldiers in respect of their diet, barracks, clothing, and exercises.

have been obtained to speak so loudly against the possibility of constitutional acclimation, or adaptation of the nervous, circulating, and excretory functions necessary to contend against the changed conditions of life in a new climate. We may at once learn, by a reference to Table VII., how this law of yearly-increasing mortality for age, per 1000 of the civil population, operates in this country; and by Table VI. we may see how, by the same law, an exaggerated ratio of mortality takes place among the military on transference to our colonies. In latitudes north of the equator it is least in the Ionian Islands, being 19·8;* but in southern latitudes, under the rather hot climate of the Cape of Good Hope, and where but few sources of miasmata exist, it falls to 17·6, being only 3·8 above the mean ratio for this country.

"Change of climate," says Dr. Levy, "is to be born to a new life. Some changes become necessary in the vicarious or alternate functional action of the principal organs, in the regimen, and habits moral and social; but so complete ought these changes to be that they may be effected without necessarily producing either disease or death. The gift of elasticity of our fibres, the gift of extent of our functional oscillations, is conferred on us for accommodating ourselves to new influences collectively, in order to plant ourselves in every place where humanity is represented by some one of its numerous tribes. But this is under the condition of conforming to things necessary for the transition, and of combating, by attention to hygienic modifiers, the assaults of climate and irregularities of organic action. That the statistical mortality of Europeans in hot climates need not be a subject of exaggerated fears, we repeat that it proves less the radical unhealthiness of certain climates than the deleterious conditions, but correctible, of their topography, such as the existence of marshes, and vast masses of organic matter. It proves above all the baneful consequences of neglecting the laws of hygiene."

The operation of age, in diminishing constitutional vigour, and thereby increasing the yearly ratio of mortality among bodies of men, is sensibly felt and appreciable, under all conditions and in every quarter of the globe. The statistical results, therefore, of this operative law necessarily increase, in proportion as those subject to it are exposed to additional causes of morbid causation in hot climates, and such as have been mentioned; but, though we cannot altogether bring down the mean ratios of mortality of hot climates to the standard average of temperate ones, we have still within our power the removal of certain endemic sources of disease in localities, and to so train the changing organic functions of the body into a healthy state, under altered conditions of elevated temperature, for purposes of assimilating a majority of European constitutions to hot climates, and with results of having mean ratios of sickness and mortality among troops, not greatly in excess of those incident to our own country and like temperate zones. If this were not the case young soldiers in India, under exposure to elevated temperature and fatigue, would be quite as healthy as the old or seasoned ones; while the very reverse of such result is found to be the experienced opinion of old military and medical officers. The acclimation so acquired, and by which old soldiers

* In the second of Sir Alexander Tulloch's tables before quoted this is given at 16·4.

can outwork the younger ones on a campaign, is not mere experience gained by residence; but partially a physiological adaptation of constitution to new conditions of life, with improved physical qualities, for accommodating itself, under fatigue, to those conditions.

The adaptation to the changed conditions of hot climates, independent of miasmatic sources of disease, must be gradual and progressive for unacclimated masses of strangers, and imposes on them the necessity of shorter or longer sojourn in intermediate regions, with proper attention to moderate eating and drinking, selection of season for landing in the new climate most akin to that which they had just left, and, after arrival, fixing on habitations and localities free from miasmata, protected from land winds, and under the salutary influence of those from the sea; together with the resolute adoption of suitable diet, clothing, and exercise. Such care and attention become necessary, in order that certain organic functional actions, in more elevated temperature, may be reduced in force, and so regulated as to be brought into vicarious healthy action in place of others, and to aid some, lessened in power and activity.

At page 31 of the Appendix to Minutes of Evidence taken before the Commissioners appointed to inquire into the Organization of the Indian Army, Returns 34 and 35 are given, in illustration of the comparative beneficial results of transference of regiments to India, after sojourn in the intermediate climates of Australia or the Cape, and of direct transference from England. While the result of these Returns makes questionable the propriety of transferring troops from our Australian colonies, they bring out the benefit of doing so after a sojourn at the Cape. The mortality of five regiments sent from the Cape to India, after the first year of service, was 4·8 to 11·0 among eight regiments sent direct from England; and if the ratio of mortality for three additional regiments at the Cape be added to the former ratio, we obtain the comparative beneficial results of transference from the Cape and from England as 7·21 per cent. to 11 per cent. of their strength. Nothing can be more conclusive than this of the possibility and benefits of graduated acclimation to elevated temperature, apart from the miasmatic influence of locality. The superiority of residence at the Cape over the graduated influence of a sea voyage, is thus brought out. Acclimation too of troops in India, under suitable sanitary arrangements, as not only practicable, but an obvious result among old soldiers, when they have become seasoned, is further substantiated by many valuable facts brought forward in Mr. Willoughby's able and consistent evidence, given at p. 267 of the Commissioners' Report, as well as by much that is admitted in the evidence of the medical witnesses; for at page 171 of the Report, and in reply to Major-General Hancock's question, "Does not a greater mortality prevail among young officers and soldiers than among those who have been eight, ten, or twelve years in India?" Mr. Martin answers, "Yes, always; the mortality is greater among the young, the improvident, and, if I may so call it, the unseasoned. I am afraid to say anything which should lead to the conclusion that there is such a thing as acclimation; but that kind of accommodation of the habit and constitution occurs in every country in the world, not in India alone. The army of Napoleon broke ground from Boulogne in 1805, he marched 400 French leagues to the battle of

Austerlitz, they were all old soldiers, they were exercised, no room was left for idleness, and there were hardly any sick on the roads. When he went again, in 1809, to the battle of Wagram, the roads were lined with youths who perished." Is not this corroborative of the opinion I hold, in common with many celebrated physicians and physiologists, "that there is virtually a physiological adaptation of constitution to new conditions of life, with improved physical qualities?" This, too, is an adaptation which not only prepares them for greater fatigues during a campaign, but exempts them from attacks of many severe diseases incident to marching in hot climates, particularly cholera and sun-stroke. Regarding the exemption from the latter enjoyed by old soldiers, Sir Robert Vivian, in his evidence (p. 137 of the Report), adduces, in support of his opinion that Europeans can be seasoned, the superintending surgeon, Dr. Arnott's, medical experience, "that it was a somewhat remarkable fact of two European regiments engaged in the affair before Koomeh, on the 7th May, 1858, the right wing of H.M. 71st Regt., about 425 strong, had twenty men attacked with sun-stroke, of whom seven died, while the portion of the 3d Bombay Europeans, about 330 strong, had not only no casualty from, but no man attacked by, this disease, though both corps were equally exposed to the same causes of disease, and under circumstances apparently precisely similar. The 3d Europeans had an average service of three years in India, the 71st arrived in Bombay the preceding February, 1858.

Acclimation, then, in hot climates being admitted as a physiological and practical result, I come to the second part of the inquiry, "What should be the elevation and condition of stations and climates in India most suitable for producing that kind of constitutional adaptation, by which men may be made most efficient for field service?" Not certainly in the more elevated mountain climates of India, within the range of 4,000 to 7,000 feet, where diminution of temperature produces climates akin to those of the temperate zone, and associated with kindred organic functional actions of the body as are met with in those; except that calorification and respiration are less energetic from the diminished density and oxygenation of the air, while the processes of sanguification and nutrition are more venous and incomplete, with a greater concentration of blood in both the lungs and digestive apparatus. Their limited extent, too, may scarcely admit of large bodies of soldiers being acclimated there, and it would be found on experience that, like the indigenous inhabitants of these mountain ranges, Europeans so localised, when brought down from the hills for service in the plains, during the rains and hot weather, would be quite as sickly under the transference, and die in as great relative proportions as men brought direct from England. Elevation of site in equatorial latitudes is accompanied by nearly like climatic conditions as are met with in the temperate zone, and with the same preponderance of certain functional actions of the organism as distinguish its inhabitants and vegetable productions. Special modifications and interchange of these functions would be as necessary, under transference to the elevated temperature and other altered climatic conditions of the plain, as when required for improving the health of Europeans, recently arrived in India.

On this subject Sir George Clerk, in his evidence, page 195 of the Commissioners' Report, says, that locating European troops on the

mountains of India is a false measure; and that with good barracks placed at certain commanding points on the plains of India, they would be more healthy than they are in the West Indies, or in many other colonies. If by commanding points he means, such dry sandy plains as Deesa, or the high plateaus of Poonah, Belgaum, Dharwar, Bangalore, and such like elevated places in the Bombay and Madras presidencies, I entirely concur with this opinion, that with good barracks, and under suitable sanitary arrangements for diet, clothing, and exercise, the ratios of mortality per 1,000 would be so reduced as not to exceed those of temperate climates. In all of these places, much of their healthy character is evidently due to the dryness of the site. At Deesa, in the northern military division of the Bombay presidency, where the elevated temperature sometimes exceeds 110° of Fahrenheit, the ratio of mortality, for 10 years, 1847-57, was 21·9 per 1,000; at Poona, 10·7; at Belgaum, in the southern division, 19·; at Bombay, 55·5; and at Bangalore, in the Madras Southern division, 23·8. At Aden, in Arabia, a very dry locality, but hot climate, the ratio per 1,000 is only 25·2. Soldiers cantoned at elevated sites, ranging from 2,000 to 2,500 feet, would be more efficient in the field, and more able to bear up against hardships and exposure on actual service, than those stationed at higher elevations and under conditions of climate more nearly akin to those existing in the temperate zone.

Stations of this kind, where large bodies of troops may be cantoned and acclimatised for Indian service, are everywhere available through the wide extent of the Bombay and Madras presidencies. Selection of moderately elevated sites for Bengal proper, that may be rendered healthy for troops, by means of good drainage and well-constructed barracks, is a matter of more difficulty, from the general flatness of the country: but for the north-west provinces, many eligible and elevated sites may be chosen for locating European troops. Dryness of site, gravelly character of soil, and freedom from masses of organic matter, should be always of the greatest importance in determining a preference of selection for such stations.

Mere elevation of site, without other essential conditions of endemic health, will not necessarily secure low ratios of mortality for troops. Reference to Tables IV and V. for the ratios of mortality according to elevation of site in the tropical latitudes of the east and west, indicates that at elevations much higher than that of Poona, and other like healthy localities, where, from the nature of the soil and site, endemic sources of malarious disease are allowed to exist, the ratios of mortality per 1,000 will be still found very great, and little or at all below those attainable for troops localised on the plains—facts sufficiently instructive in guiding us to the most necessary sanitary arrangement for soldiers in hot climates, namely, to select, for their barracks or encampment, eligible sites and localities, where there is no accumulation of surface-drainage, and no relative sources of miasmata in the vicinity.

In the Madras presidency, the average ratios of mortality for five years will be found least in the presidency and Mysore divisions of the army, including Bangalore, being respectively 25·5 and 23·5. Within the ten military divisions of that presidency, though there are some very elevated sites, still they are most unhealthy from those endemic sources of disease we have mentioned, and there are many others that

might be yet selected with great advantage for the localisation of troops. Among the elevated but unhealthy sites within this presidency, it will be instructive, on this subject, to notice that in the Mysore division the sites of Seevasamoodrum and Seringapatam, elevated about 2,000 feet, have been found very destructive of European health, while many other localities of the same division, peculiarly productive of fever in former times, have since become perfectly healthy; and in others the very reverse has taken place, shewing the main sources of European unhealthiness are endemic miasmata, and not mere elevated temperature, to which the human organisation adapts itself. Seevasamoodrum is surrounded by water and jungle, and near one of the falls of the Cavary. In other districts of this presidency the ravages of fever and other miasmatic diseases are not stayed, even at an elevation of nearly 5,000 feet, where their endemic sources are allowed to exist. In the Travancore province of the southern division a considerable plateau of table-land, 4,740 feet high, and in the vicinity of Trevandrum, but not yet thoroughly explored, is said to be healthy. Again, in the Salem district of the same division, the table-land of the Shivaroy hills, at a general elevation of 4,600, and but scantily clothed with vegetation, is not beyond fever range after falls of rain. During the dry months they have been found perfectly healthy; but the breaking out of a fatal remittent form of fever among the European residents there, during June, 1824, caused them to be deserted. It is not mere elevation then that we have to look to for European health in India, but to an eligible and perfectly well drained and dry site for European soldiers.

I come now to the third and last point—What practical lessons may be drawn from the consideration of these questions, and what organisation of troops would secure most efficiency on service, and with greatest good to the State? The previous observations made, and the statistical facts adduced in proof, that old and seasoned soldiers are superior in endurance and physical qualities to young unseasoned ones in India, have partly anticipated the solution of these problems. Lord Ellenborough in his evidence, p. 293 of the Commissioners' Report, fully bears out this opinion in the statement that he saw 100 men of the 9th Lancers, who had never seen an enemy, die within the first year of their residence in India. At the utmost strength of cavalry regiments this would be fully a sixth of their strength. The possibility of acclimating troops to mere elevated temperature being possible, and the adaptation of their constitutions being followed on service by lessened ratios of sickness and mortality, form one of the strongest grounds for a considerable organisation of European troops for local service in India; independent of those financial and political considerations, which, for the ultimate safety of our Indian empire, strongly urge on us the necessity of this measure. It is not within the province of this lecture to discuss the financial and political bearings of the question, that there should be a large permanent European force maintained in India, and proportioned to the moveable force of the British Army, always subject to the periodical reliefs from home. The permanent force should be at least two-fifths of the moveable force—say 32,000 to 48,000 men of the regular Army, from among whom, on being relieved to return home, European colonists for hill stations, and recruits for the permanent local force, might be obtained.

In concluding the exposition of the medical questions that have been mooted, we may draw the following inference:—

1st. That the law of constitutional deterioration—greater mortality for age in hot climates, beyond the ratios of like age in temperate ones—can be greatly reduced in operation by removing endemic sources of disease, and by selecting suitable dry localities.

2nd. That in the most insalubrious tropical countries, the selection of good positions, on dry elevated table-lands, suffices often to secure for European troops a perfect sanitary state, nearly equal to the more salubrious regions of the temperate zone: this salubrity varying, however, in a remarkable manner with the geographical latitudes and longitudes of places.

3rd. That the increasing ratios of mortality for hot countries mainly depend on unremoved surface drainage, and the generation of miasmata in places occupied.

4th. That the morbific influence of seasons and climates in producing disease is in direct relation to and dependence on the quality of the soil, the latitude, the longitude, the elevation of the place, its northern or southern exposure, and the national temperaments and races of soldiers who may be there located.

TABLE I.—GENERAL MORTALITY of the ENGLISH ARMY at HOME and ABROAD, from 1819 to 1828.

Years.	Effective Strength in the United Kingdom.	Deaths.	Ratio of Deaths per 1,000.	Effective Strength beyond the United Kingdom.	Deaths.	Ratio of Deaths per 1,000.
1819	53,330	493	9	54,992	3,755	63
1820	54,527	740	11	50,557	2,584	57
1821	37,988	620	16	51,277	2,220	42
1822	41,530	560	13	46,709	2,692	57
1823	40,786	566	13	48,995	1,981	40
1824	42,585	651	15	49,888	2,257	45
1825	57,048	854	16	53,755	3,849	71
1826	48,826	1,082	22	58,339	4,513	77
1827	47,747	824	17	58,440	3,713	63
1828	46,193	828	18	58,592	2,844	47
Total . .	470,610			531,534		

TABLE II.—MORTALITY of ENGLISH TROOPS from WAR, and under TRANSITION to OTHER COLONIES.

Places.	Authorities.	Period of Observation.	Annual Mortality per 1,000.
Cape of Good Hope . . .	Official Reports, 1818 to 1836	1818 to 1836	15·5
New Scotia and New Brunswick .	Ditto	1817 to 1836	18·
Malta	Ditto	1817 to 1836	18·7
Canada	Ditto	1817 to 1836	20·
Gibraltar	Ditto	1818 to 1836	22·1
Ionian Islands	Ditto	1817 to 1836	28·3
Mauritius	Ditto	1818 to 1836	30·5
Bermudas	Ditto	1817 to 1836	32·3
St. Helena, 1816 to 1822, and from 1836 to 1837	Ditto	.. ..	35·
Tenasserim Provinces	Ditto	1827 to 1836	50·
Madras Presidency	Quetelet	1826 to 1830	52·
Bombay ditto	Ditto	1826 to 1830	55·
Bengal ditto	Ditto	1826 to 1830	63·
Ceylon	Official Reports	1824 to 1836	57·2
Antilles and Guiana.	Ditto	1817 to 1836	85·
Jamaica	Ditto	1817 to 1836	143·
Bahama	Ditto	1817 to 1836	200·
Sierra Leone	Ditto	1819 to 1836	483·

TABLE III.—COMPARISON of the MAXIMA and MINIMA of MORTALITY of FRENCH and ENGLISH TROOPS in TEMPERATE and HOT CLIMATES.

TEMPERATE CLIMATES.				HOT CLIMATES.			
Periods and Departments of Service.	Mortality per 1,000.			Periods and Departments of Service.	Mortality per 1,000.		
	Maximum.	Minimum.	Mean.		Maximum.	Minimum.	Mean.
FRENCH.				FRENCH.			
Infantry for 6 years in France, 1820 to 1826	23	15	19·4	In Algeria 5 years, 1838 to 1843	104·	49·	76·5
ENGLISH.				ENGLISH.			
Troops in Ireland 32 years, 1797 to 1828	20	10	15·	In the Antilles and Guiana 19 years, 1817 to 1836	152·8	40·6	96·7

TABLE IV.—INFLUENCE of ELEVATION and LATITUDE in DIMINISHING the RATIO of MORTALITY among EUROPEANS in HOT CLIMATES.

Countries and Latitudes.	Stations.	Elevation in feet from the Sea.	Mortality per 1,000.	Remarks.
Saint Lucia, 13° 50′ north	Mount Fortunate	850	122·	
Jamaica, 17° to 18° 30′	Up Park Camp	200	152·8	
	Stony Hill	1,360	96·	
	Maroon Town	2,000	32·	Deducting deaths of sick brought there, only 22
Ceylon, 6° only of north lat.	Kandy	1,670	69·7	
	Badula	2,100	97·1	
	Nieur-Ellia	6,200	24·	
Mysore	Bangalore	2,400	22·	In 1849 only 16 per 1,000·
Neilgherry Hills, in lat. north 11° 10′ to 11° 32′	Ootakamund	7,116	20·	

TABLE V.—INFLUENCE of PROLONGED SOJOURN in INCREASING the MORTALITY of HOT CLIMATES.

Places.	Length of Sojourn.	Periods of Age.	Mortality per 1,000.	
Ceylon	Below 1 year	—	44·	
	1 to 2 years	—	48·7	
	Beyond 2 years	—	49·2	
Jamaica	Below 1 year	—	77·	
	1 to 2 years	—	87·	
	Below 2 years	—	81·	
	Beyond 2 years	—	93·	
Cape of Good Hope	3 years	—	8·	The mortality here given is only of one Regiment, the 72nd, of which the effective strength is unknown; but still progressively increasing in a country where malarious influences on mortality is scarcely appreciable.
	4 ditto	—	13·	
	5 ditto	—	12·	
	6 ditto	—	16·	
	7 ditto	—	13·	

TABLE VI.: from Mr. MARSHALL.—INFLUENCE of AGE on the ANNUAL MORTALITY of every 1,000 EFFECTIVE MEN among ENGLISH TROOPS at HOME and ABROAD.

Places of Residence.	Mortality per 1,000 from Age.				Mean Mortality per 1,000 at all Ages.
	From 18 to 25 Years.	From 25 to 33 Years.	From 33 to 40 Years.	From 40 to 50 Years.	
United Kingdom — Cavalry of the Line	13·9	14·	17·8	26·7	15·3
United Kingdom — Horse Guards	14·7	11·4	16·3	22·8	14·5
United Kingdom — Foot Guards	22·3	22·5	17·7	27·5	21·6
Gibraltar	18·7	28·6	29·5	24·4	22·3
Malta	13·	22·3	34·	56·7	22·3
Ionian Islands	12·2	20·1	24·4	24·2	19·8
Antilles	50·	74·	97·	123·	67·
Jamaica	70·	107·	131·	128·	91·
Bermudas	16·5	42·	42·	76·	28·9
Canada—Upper and Lower	19·7	27·7	37·7	35·7	25·7
New Scotia and New Brunswick	14·	22·5	30·8	41·5	20·3
Cape of Good Hope	9·	20·6	29·7	82·	17·6
Mauritius	20·6	38·	52·7	86·7	34·7
Ceylon	24·	55·	86·4	126·6	48·3
Bombay	18·2	34·6	46·8	71·1	33·1
Madras	26·	59·3	70·7	86·5	52·2
Bengal	23·8	50·3	50·6	83·3	44·5

TABLE VII.—MEAN ANNUAL PROPORTION of MORTALITY among every 1,000 LIVING INDIVIDUALS of the ENGLISH CIVIL POPULATION above 4 YEARS of AGE, 1838 to 1841.

Age.	Ratio of Mortality per 1,000 Living Males of every Age.	Age.	Ratio of Mortality per 1,000 Living Males of every Age.
Under 5 years	70·97	From 60 to 70 years	43·60
From 5 to 10 „	9·48	„ 70 „ 80 „	91·98
„ 10 „ 15 „	5·24	„ 80 „ 90 „	201·73
„ 15 „ 20 „	7·39	„ 90 „ 100 „	461·93
„ 20 „ 30 „	9·91	„ 100 and above	454·79
„ 30 „ 40 „	11·39		
„ 40 „ 50 „	15·00		
„ 50 „ 60 „	23·01	General Mean	23·16

Dr Parkes
with Dr Mis compts

REMARKS

ON THE

CLASSIFICATION AND NOMENCLATURE

OF

CONTINUED FEVERS.

BY

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MDCCCLVIII.

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REMARKS

ON THE

CLASSIFICATION AND NOMENCLATURE

OF

CONTINUED FEVERS.

All the divisions of Continued Fever, as well as the numerous designations which have been applied to these, have, for the most part, been founded upon their symptoms, or upon their supposed anatomical origin. But the more one studies the subject, the more he will be convinced, that in the case of such diseases as idiopathic fevers, the most philosophic classification must be one which is based on their etiology. Fevers dependent upon the most different causes may occasionally resemble each other closely in their symptoms, so as to render their diagnosis difficult. Take, for example, the so-called Relapsing Fever; when the relapse and other characteristic symptoms are absent, it may be difficult to distinguish between it and a case of Simple Fever or Febricula. Surely, however, we are not to conclude, that the former, which is a contagious disease, prevailing in widely spread epidemics, and dependent upon a specific poison, is one and the same affection with the latter, which is constantly occurring in the sporadic form, and arises from non-specific causes, such as exposure to the sun's rays and fatigue. In like manner, with regard to typhus and typhoid fever, in their symptoms, they may sometimes be closely assimilated; in their causes they are widely different. Now we know, that very similar symptoms may be produced in the animal body by two very different vegetable or mineral poisons; so much so, that it may be impossible to determine from the symptoms alone what the poison is. No one would be presumptuous enough to conclude, that the poisons, under such circumstances, were identical, without subjecting them to analysis; and the same principles should guide us in the study of fevers, which only differ in the nature of the poisons being more obscure.

Even those febrile conditions of the system which are the result of some local inflammation, may approximate idiopathic fevers very closely in their general characters; and, indeed, the resemblance between typhus and typhoid fever is never so great, as what we not unfrequently observe between the general symptoms of typhus fever and asthenic pneumonia. If there be no cutaneous eruption,

I know of no symptoms by which we can distinguish a case of primary asthenic pneumonia from one of typhus, in which the pneumonia is a secondary complication; and yet there is this important practical difference, that the one is contagious, the other not so. If typhus was not prevalent, or the patient had not been exposed to its contagion, we should no doubt set down such a case as one of primary pneumonia; but we should be led to such a conclusion, solely from the certainty with which we can detect the presence of the local lesion. But in reference to typhus and typhoid fever, we must recollect that *both* are idiopathic fevers, independent of any local lesion; and that, although a specific lesion is developed in the course of the latter, the symptoms which indicate its existence, even when it is most extensive, may be very obscure. It is not to be wondered at, then, that they who have not had much experience in both fevers should have some difficulty in distinguishing them; but it is scarcely legitimate to infer, that the two fevers are identical.

One reason why many still refuse to admit the plurality of species of Continued Fever, is their neglect of the circumstances under which fevers originate. In an essay, which I lately had the honour of submitting to the Royal Medical and Chirurgical Society,[1] I endeavoured to prove that the class of Continued Fevers comprises three, or in all probability four, distinct species, originating from widely different causes.

First, there is *Typhus*, the grand predisposing cause to which is destitution; while the exciting cause, or specific poison, is generated by overcrowding of human beings, with deficient ventilation, and afterwards is propagated by contagion. Hence it is, that epidemics of typhus occur during seasons of famine, and in besieged cities; and hence it is, that we find it limited to the most overcrowded localities of large towns, and seldom meet with it in country districts, or in the upper classes of society.

Secondly, there is the "*Relapsing Fever*," about which there may still be some doubts as to its specific distinction from typhus. There can be no question that it differs widely from that disease, both in its symptoms and mortality; and also, that a previous attack of the one confers no immunity from a subsequent one of the other. On the other hand, relapsing fever is found to prevail, as epidemics, at the same times, and under the same circumstances, as typhus. Researches are still wanting as to the distinctive etiology of these two fevers; but I have grounds for believing, that it will yet be shown that relapsing fever is produced by famine alone; typhus, by destitution and overcrowding combined: in other words, that destitution and starvation are the predisposing causes of typhus, the exciting causes of relapsing fever.

Thirdly, there is *Typhoid* or *Enteric Fever*, which is less contagious than either typhus or relapsing fever, and which is quite independent of the causes which give rise to these, being generated by the putrid emanations from decaying organic (animal) matter. The grounds for this opinion may be briefly summed up as follows:—

1. Previous attacks of either typhus or relapsing fever confer no immunity from subsequent attacks of typhoid fever (and *vice versâ*.)
2. There is no authenticated proof that the poison of typhus has ever generated typhoid fever (nor *vice versâ*.)
3. Typhoid fever does not prevail in wide-spread epidemics. It is essentially an endemic disease; or when it does become epidemic, such epidemics are always of the most limited and circumscribed character.
4. Typhoid fever is always most prevalent in autumn, or after a long continuance of hot weather. A hot autumn after a wet summer appears to afford the most favourable conditions for its development.
5. Typhoid fever is not, like typhus and relapsing, limited to the poor, but is met with among poor and rich alike.
6. Typhoid fever is not confined to overcrowded localities, but appears alike in the most dense, and in the least populous districts of large towns, and even in isolated houses in the country.
7. There is evidence, of the most conclusive nature, that typhoid fever may result from the emanations from (animal) organic matter, in a peculiar state of decomposition.[1] In every instance where "Fever" has been described as originating from such a cause, the fever has been typhoid. The reason why this cause is not more generally recognised, is the want of attention to the distinctions between the different fevers. Those who deny that "Fever" can be the result of putrid emanations, adduce thousands of cases of typhus and relapsing fever as negative evidence, in the same way as there are not wanting a few who bring forward typhoid cases to prove that fever cannot be the result of destitution and overcrowding.

Fourthly, there is *Simple Fever*, or *Febricula*, which is non-contagious, and arises from such non-specific causes as exposure to the sun's rays, fatigue, surfeit, etc. In its simplest form, this fever may terminate in 24 or 30 hours, as in the Ephemeral or Diary Fever of systematic writers; or it may be prolonged to eight or ten days, as in the Ardent or Sun Fever of tropical climates.

A faulty nomenclature must be assigned as another reason, why the various fevers are not more generally recognised as distinct diseases. The term Typhus, though derived from a single symptom, and so far objectionable, is one which is sanctioned by great antiquity and

[1] This Essay will appear in the 41st volume of the "Transactions."

[1] In addition to the evidence upon this point which will be found in my essay in the Medico-Chirurgical Transactions, I may allude to the circumstance, that Dr Barker of Bedford has recently succeeded in producing in animals symptoms very similar to those of Typhoid fever, by making them inhale the noxious principles arising from cess-pools.—*The Influence of Sewer Emanations*, by T. Herbert Barker, M.D. Lond., 1850.

a Hippocratic origin. The designation, Relapsing Fever, is no doubt inappropriate; for, in the first place, in a large proportion of the cases there is no relapse; and, secondly, it is hardly accurate to call that a relapse, which is a constituent part of the ordinary course of the disease; yet the name is distinctive enough, and, in the present state of our knowledge, it might be imprudent to alter it. The same remark, however, does not apply to the appellation Typhoid, to which I beg more particularly to draw attention. It is one which is not only faulty, but tends to create confusion. It is faulty; for, first, it literally means "like Typhus," and, consequently, it is at variance with all precedent in the scientific nomenclature of natural objects, whenever it is desired to confer designations on distinct genera or species; secondly, because the same word is constantly employed, in an adjective sense, to indicate a group of symptoms, which may come on in the course of any disease; and, thirdly, a large proportion of the cases to which it is applied exhibit no symptoms of a typhoid character, or resembling typhus. For the same reasons, it greatly tends to create confusion; and, indeed, I have good reasons for believing, that this name has done as much as anything else to make the public and the great body of the profession consider, that the affection is merely a variety of typhus. At the same time, none of the numerous synonyms is, in my opinion, more appropriate. For example, it would not be desirable to have a name derived from the abdominal lesion, tending, as such would do, to revive in the minds of many the exploded doctrines of Broussais. A suitable distinctive name for the disease remains a *desideratum*; and after having devoted much thought and attention to the question, I ventured, in a foot-note to my essay, already referred to, to propose one, derived from what I believe to be the cause of the fever. In that essay, I collected what, in my opinion, is conclusive evidence that typhoid fever is produced by the putrid emanations from decaying (animal) organic matter; and I therefore suggested for it the appellation of *Pythogenic Fever*,—πύθογενής, from πύθων (πύθομαι, putresco) and γενάω. In repeating this suggestion in a more prominent manner, I do so with considerable diffidence, and am actuated solely by the crying necessity there exists for adopting a more appropriate designation for the disease in question. Should a better one be proposed, I shall gladly accept it; but, in the meantime, I would recommend the subject to the earnest consideration of the profession.

The whole class of Continued Fevers may be said to occupy an intermediate position, between the Eruptive Fevers (Variola, Scarlatina, and Rubeola) on the one hand, and the Malarious Fevers (Remittent and Intermittent) on the other. As to the causes which originate the eminently contagious poisons of the eruptive fevers, we as yet know little or nothing; and if we have almost succeeded in eradicating one of these, our preventive measures have no reference whatever to the causes which generate it. The malarious fevers are non-contagious; and although we know little of the intrinsic nature of malaria, we have long known the causes and circumstances which give rise to these, and the prophylactic measures by which they may be in a great measure averted. Hence it is that agues, which in former times were so prevalent and so fatal in many parts of Britain, are now rarely met with. The continued fevers resemble the eruptive in being contagious, though to a less degree, while they are also assimilated to the malarious fevers, inasmuch as we know the circumstances under which they are developed, and the means by which they may, to a great extent, be prevented. I am fully aware, that the doctrines here enunciated are at variance with the deeply-rooted convictions of a large body of the profession, who, while they admit that the various conditions specified in this paper may favour the propagation of the specific poison of fever already existing, yet deny that the poison of a contagious disease can be by any such means generated *de novo*. But if this view be correct, how comes it that the same conditions only give rise to one form of disease? If, for example, overcrowding only acts by favouring the propagation of typhus (that it does thus act I am far from denying), how is it that, in temperate climates, it is always typhus which appears as an epidemic in a besieged city, or in an overcrowded prison, and not diseases which are notoriously more contagious, such as variola and scarlatina? In fact, with regard to typhus and pythogenic fever, the matter resolves itself into this: if certain conditions are present, we can, with almost certainty, predict the result.

Pythogenic fever may be said to form the connecting link between the continued and the remittent fevers. It is but sparingly contagious. There is also much that is remittent in the history of the course of the disease,—so much so, that many of the designations which have been bestowed upon it have reference to this character. There can be little doubt, I think, that the *Hemitritæus* or *Febris Semitertiana* of old writers, which was considered a composite disease made up of a tertian and quotidian intermittent fever, was pythogenic fever;[1] while it is now generally admitted, that the so-called "Infantile Remittent Fever" is of the same nature. Again, there are not a few well-authenticated instances of pythogenic and malarious fevers prevailing together, and apparently generated under similar circumstances. Such is the case, Dr Mercer Adam tells us, every summer in the foul-smelling city of Amsterdam. A most remarkable instance of this intimate relation between the two fevers will be found in an account of the diseases observed in the commune of Guermange, in the Duchy of Lorraine, and presented by M. Ancelon to the French Academy of Sciences in 1845.[2] There are also good grounds for believing, that careful dissections will show that many of the so-called remittent fevers of tropical

[1] See description of the *Febris Semitertiana* given by Hoffmann, *Op. Om.* 1740, lib. ii., cap. 5, p. 40.
[2] *Compt. Rend.*, vol. xxi., p. 158.

climates are typhoid or pythogenic. Already Drs Scriven[1] and Ewart,[2] of the Bengal Medical Service, have proved, by *post-mortem* examinations, the existence of pythogenic fever in India and in Burmah. Dr Scriven, who studied the characters of the disease under Dr Jenner at University College, has given figures of the intestinal lesion, and has written me that he has met with several other cases of the same fever since the date of his papers. It will be important to ascertain what are the precise circumstances under which such cases are observed in India, and whether they are not different from what are known to develop the more prevalent malarious fevers. With regard to these last, the common opinion at present is, that, although the putrefaction of vegetable matter is a frequent concomitant, it is not an essential part of the process of the development of malaria. This opinion is founded on the facts recorded by Chisholm[3] and Fergusson;[4] but both the facts and the opinion require reconsideration.[5] Without entering into this question at present, I would merely record my opinion, that it is highly probable that vegetable putrefaction is the source of malarious fevers, while the putrefaction of animal matter begets pythogenic fever.

All the continued fevers which have been described by authors under so many different names, may be referred to one or other of the four species already spoken of. The following synonyms I have arranged under each of the fevers to which I believe they belong, after having referred myself to the works of most of the authors quoted. I have likewise given briefly the leading distinctive characters of each fever.

I.—Typhus Fever.

Characters.—A disease generated by contagion, or by overcrowding of human beings, with deficient ventilation, and prevailing in an epidemic form in periods, or under circumstances, of famine and destitution. Its symptoms are: more or less sudden invasion marked by rigors or chilliness; a small, weak, usually frequent pulse; dry, brown tongue; in most cases, constipation; skin warm and dry; a morbilliform rash, appearing between the fifth and eighth days, frequently accompanied by true petechiæ, and lasting until death or recovery; great and early prostration; delirium coming on early, and for the most part low and wandering; contracted pupils; duration of the fever usually about 14 days, seldom or never more than 21. In the dead body, no specific lesion, but great congestion of all the internal organs.

Synonyms.

Τυφος † (Hippoc.);[6] Febris typhodes? (*Prosp. Alpin.*, 1611; *Recalchus*, 1638;

[1] *Med. Times and Gaz.*, Jan. 28, 1854, p. 79; and *Ind. Ann. of Med. Science*, No. viii., 1857.
[2] *Ind. Ann. of Med. Sc.*, No vii., 1856.
[3] *Edinburgh Medical and Surgical Journal*, vol. vi.
[4] On Marsh Poison. *Edinburgh Philosophical Transactions*, vol. ix.
[5] See my remarks on the Origin of Marsh Poison, in my paper on "The Diseases of Burmah," *Edinburgh Medical and Surgical Journal*, vol. lxxxii., p. 79.
[6] Probably a different disease.

Juncker, 1718); Typhus (*Cullen*, 1769); Enecia Typhus (*Mason Good*, 1817); Typhus and True Typhus (*modern English writers*).

Febris pestilens (*Galen*? *Fracastorius*, 1546; *Forestus*, 1591; *Riverius*, 1623; *Willis*, 1659; *Sydenham*, 1668); Febris epidemica (*J. Bursserius*, 1625); Pestilential Fever (*Grant*, 1775; *Stoker*, 1826); La constitution epidémique (*Beaulac*, 1810); Epidemic Fever *pro parte* (*recent writers*).

One of the morbi contagiosi (of *Fracastor.*, 1546); Febris contagiosa (*Coytterus*, 1578); Infectious Fever (*Lind*, 1763); Der ansteckende Typhus (*J. V. Hildenbrand*, 1810); Typhus contagieux (*J. C. Gasc*, 1811); Das ansteckende Nervenfieber (*Horn*, 1814); Contagious Fever (*Bateman*, 1818); Tifo contagioso (*Rossi*, 1819); Contagious Typhus (*English writers*).

Febris putrida et maligna, Synochus putris and S. cum putredine (*old authors*);[1] Febris maligna pestilens (*Riverius*, 1623; *Sennertus*, 1641; *Willis*, 1659); Malignant Fever (*Langrish*, 1735; *Fordyce*, 1791); Febris continua putrida (*Boerhave*, 1738; *Wintringham*, 1752); Putrid Malignant Fever (*Huxham*, 1739); Febris exanthematica, maligna et venenosa, et perniciosa (*J. F. Bianchini*, 1750); Febris maligna (*Le Roy*, 1771); Putrid Fever (*Macbride*, 1772); Febris continens putrida (*Selle*, 1770); Das Faulfieber (*Hecker*, 1due); Febbre putrida (*Ital.*); Fièvres putrides et malignes, *pro parte* (*Fr.*); Typhoid Fever, with putro-adynamic character (*Copland*, 1844).

Febris contagiosa in carceribus genita (*Huxham*, 1742); Jail Fever (*Pringle*, 1750; *Heysham*, 1782; *John Howard*, 1784); Typhus Carcerum (*Sauvages*, 1764); Febris carceraria (*Bursserius*, 1785); Jail Distemper (*J. C. Smyth*, 1795); Maladie des Prisons (*French*).

Malignant Fever of the Hospital (*Pringle*, 1752); Febris nosocomialis (*Bursserius*, 1785); Fièvre des Hôpitaux (*French*).

Pestis bellica and Typhus bellicus (*var.*); Morbus Castrensis vel Morbus Hungaricus, *pro parte* (*many old authors*); Morbus qui ex castris in Bavariam penetravit? (*Rhumelius*, 1624); Febris Castrensis (*Willis*, 1659; *Haller*, 1742); Febris militaris (*Petri*, 1665); Typhus Castrensis (*Sauvages*, 1768); Camp Fever (*Grant*, 1775); Die Kriegspest (*Hufeland*, 1814); Typhus des camps et des armées (*Louis*, 1829).

Febris pestilentialis nautica (*Huxham*, 1752); Ship Fever (*Lind*, 1763; *Grant*, 1775); Febris nautica (*Bursserius*, 1785).

Febris pestilens quam Cuticulas vel Puncticula vocant (*Fracast.*, 1546; *Forest.*, 1591); Tabardillo et Puntos? (*De Torres*, 1574); Febris purpurea epidemica? (*Thevenus*, 1576); Febris petechialis (*Salius Diverens*, 1584; *Sennert.*, 1641; *Selle*, 1770; *Bursserius*, 1785); Febris petticularis (*Roboretus*, 1591); Febris purpurata? (*Riverius*, 1623); Febris pulicaris seu puncticularis (*Pet. A. Castro*, 1650); Morbus puncticularis (*Donkers*, 1686); Febris petechialis vera (*Hoffmann*, 1700); Das Fleckenfieber (*Ettmuller*, 1726; *Reuss*, 1814); Spotted Fever (*Strother*, 1728); Morbus cum petechiis (*Strack*, 1786); Febbre petecchiale (*Rossi*, 1802; *Razori*, 1812); Morbo petecchiale (*Acerbi*, 1811; *Palloni*, 1817); Typhus exanthematicus and Das exanthematische Nervenfieber (*of German writers*); Petechial Fever (*Peebles*, 1835); Petechial Typhus (*auct. var.*).

Febris asthenica † (*var.*); Febris atacta *pro parte* (Selle, 1770); Fièvre ataxique *pro parte* (*Pinel*, 1798); Fièvre adynamique (*Pinel*, 1798; *Roux*, 1813); Adynamic Fever (*Stoker*, 1826; *Burne*, 1829); Brain Fever † (*auct. var.*)

II.—Relapsing Fever.

Characters.—A contagious disease, which is apparently generated by destitution, and which is only met with in the epidemic form during seasons of

[1] Previous to the time of Huxham and Pringle, the terms putrid and malignant were frequently applied to all fevers, except the Simple or Febricula.

scarcity and famine. Its symptoms are: a very abrupt invasion marked by rigors or chilliness; quick, full, and often incompressible pulse; white tongue; tenderness at the epigastrium; vomiting, and often jaundice; enlarged liver and spleen; constipation; skin very hot and dry; no characteristic eruption; high-coloured urine; severe headache, and pains in the back and limbs; restlessness, and rarely subacute delirium; an abrupt cessation of all these symptoms about the fifth or seventh day;—after a complete apyretic interval (during which the patient may get up and walk about), an abrupt relapse on the fourteenth day from the first commencement, running a similar course to the first attack, and terminating on or about the third day of the relapse;—mortality small, but occasionally death from sudden syncope;—after death, no specific lesion, but usually enlargement of liver and spleen.

Synonyms.

A five days' Fever with Relapses (*Rutty*, 1770); Short Fever, Five days' Fever, Seven days' Fever (*var.*, 1843); Relapsing Fever (*Paterson, Steele*, etc., 1847; *Jenner*, 1849).

Fever of the New Constitution (*O'Brien*, 1828).

The Epidemic Fever (*auct. var.*); Epidemic Fever of Edinr., 1817 (*Welsh*, 1819); Epid. Fev. of Ireland *pro parte* (*Barker and Cheyne*, 1821); Scotch Epidemic of 1843 (*Wardell, R. Cormack, Alison, Jackson, Henderson, Craigie, etc.*); the Silesian Fever of 1847 (*Brit. and For. Med. Ch. Rev., July* 1851).

Epidemic Remittent Fever (*Mackenzie*, 1843); Gastric Fever with Remittent type (*Craigie*, 1843); Gastro-hepatic Fever (*Ritchie*, 1855); has also been designated—Mild Yellow Fever, Bilious Relapsing Fever, Bilious Remittent Fever, Remitting Icteric Fever.

Irish Famine Fever (*Stoker*, 1826; and *Dublin Journal*, 1849); Die Hungerpest (*Gracvell's Notizen*, 1848).

Dynamic or Inflammatory Fever (*Stoker*, 1826); Synocha (*Christison*, 1840 *and* 1853).

Relapsing Fever in all probability constituted one of the varieties of the Inflammatory Fever or Synocha, of the writers of last century; in more recent times, on the other hand, it has not unfrequently been considered a variety of Typhus.

III.—Pythogenic Fever.

Characters.—An endemic, slightly contagious disease, generated by putrefying organic (animal) matter. Its symptoms are: a commencement often insidious, or marked by slight rigors, a sensation of chilliness, or profuse diarrhœa; pulse usually frequent and soft, but variable in the same patient; tongue red and fissured, in a few days becoming dry and brownish; in most cases, but not invariably, increased splenic dulness, tympanites, abdominal tenderness, gurgling in the iliac fossæ, and diarrhœa, with or without melena; urine copious and pale; skin warm, often with irregular sweats; an eruption of rose-coloured papules, first appearing between the seventh and fourteenth days, and coming out in successive crops, each of which lasts two or three days; very rarely petechiæ; frequently epistaxis; prostration coming on late, and often slight; delirium active or often absent; dilated pupils; the disease often protracted to the thirtieth day, and occasionally, though rarely, followed by a relapse of all the symptoms, including the eruption; after death, ulceration of the solitary and aggregated glands of the ileum, and enlargement of mesenteric glands.

Synonyms.

Typhus mitior and Synochus *pro parte* (*Cullen*, 1769); Abdominal Typhus (*Autenrieth*, 1822, and *German writers generally*); Fever with affection of the abdomen (*Alison*, 1827); Fever with ulceration of the intestines (*Bright*, 1829); Synochus and Typhus with abdominal affection (*Southwood Smith*, 1830); Fièvre Typhoïde (*Louis*, 1829; *Chomel*, 1834); Typhoid Fever (*Stewart*, 1840; *Bartlett*, 1847; *Jenner*, 1849); Mild Typhoid Fever (*Copland*, 1844); Enteric Typhus (*Christison*, 1850).[1]

Πυρετὸς ἡμιτριταῖος? (*Hippoc.*); Hemitritæus? Tritœophyas? and Triphodes? (*auctor. antiq. var.*); Febris semitertiana seu composita (*Galen? Forestus*, 1591; *Spigelius*, 1624); Tritœophya typhodes (*Mangetus*, 1695); Frigeraria? (*Sagar*, 1776).

Infantile Remittent Fever (*var.*); Febris hectica verminosa (*Vander Bosch*, 1769); Febris verminosa (*Selle*, 1770); Infantile Gastric Remittent Fever (*Locock*, 1840); Infantile Hectic Fever and Worm Fever (*auct. var.*).

Febris non-pestilens? (*Forestus*, 1591); Morbus Hungaricus and Febris Hungarica *pro parte* (*Auct. var. et Sennertus*, 1641); Endemic Fever (*var.*); Autumnal or Fall Fever (*Austin, Flint*, 1852; *and in America generally*).

Febris putrida (*Riverius*, 1623); Febris putrida quæ vulgo *lenta* appellatur (*Willis*, 1659); Febris putrida nervosa? (*Wintringham*, 1752); Febris putrida aut biliosa (*Tissot*, 1758); Febris a putredine orta (*A. Tralliani, quoted by Burserius as Syn. for his Feb. gastric. ac.* 1785).

Febris lenta (*Forestus*, 1591; *Willis*, 1659; *Linnæus*, 1763; *Vogel*, 1764); Febris hectica sive lues nenrodes (*Willis*, 1667); Slow Fever (*Strother*, 1716; *Langrish*, 1735); Nervous Fever (*Gilchrist*, 1734); Slow Nervous Fever (*Huxham*, 1739); Febris chronica? (*Juncker*, 1736); Febricula, or Little Fever, commonly called the Nervous or Hysteric Fever, the Fever on the Spirits, Vapours, etc. (*Manningham*, 1746); Febris atacta *pro parte* (*Selle*, 1770); Febris lenta nervosa maligna (*Burserius*, 1785); Irregular low nervous Fever (*Fordyce*, 1791); Fièvre ataxique *pro parte*, and F. adéno-méningée (*Pinel*, 1798); Nervenfieber? (*Bischoff*, 1814); Fièvre nerveuse (*Fr.*); Common Continued Fever (*Armstrong*, 1816); Low Fever (*auct. var.*).

Febris petechizans vel Spuria (*Hoffmann*, 1699).

Febris biliosa (*Galen? River.* 1623; *Stahl*, 1700; *Juncker*, 1736); Bilious Fever (*Pringle*, 1750; *Rutty*, 1770); Febris biliosa putrida (*Selle*, 1770); Febbre biliosa (*Benelli*, 1775); Synochus biliosus (*Sauvages*, 1763); Febris cholerica? (*Vogel*, 1764); Bilio-gastric Fever (*Copland*, 1844); Gastro-bilious, and Bilious Continued Fever (*modern writers*).

Febris catarrhalis? (*Bockel*, 1580; *Crause*, 1676); Febris colliquativa? (*J. R. Fortis*, 1668); Febris Stercoralis? (*Quesnay*, 1753); Morbus mucosus (*Roderer and Wagler*, 1762); Febbre glutinosa gastrica (*Sarcone*, 1765); Febris mucosa (*Selle*, 1770); Febris pituitosa (*Stoll*, 1785; *Strack*, 1789); Febris colliquativa primaria seu essentialis (*Burserius*, 1785); Morbus biliosus mucosus (*Knaus*, 1786); Febris pituitosa nervosa (*Jacobi*, 1793); Schleimfieber? (*Canz*, 1795); Fièvre muqueuse (*Fr.*); Mucous or Pituitous Fever (*Copland*, 1844).

Febris gastrica (*Ballonius*, 1734); Febris acuta stomachica aut intestinalis (*Heister*, 1736); Febris gastrica acuta (*Burser.* 1785); Fièvre méningo-gastrique (*Pinel*, 1798); Gastrisches Fieber (*Richter*, 1813); Fièvre gastrique (*Dict. des Sc. Méd.*, 1816); Epidemic Gastric Fever (*Cheyne*, 1833); Gastric Fever (*Craigie*, 1837).

Febris mesenterica maligna (*Baglivi*, 1696; *Hoffmann*, 1728); Febris intestinalis et mesenterica (*Riedlin*, 1705); Febris mesenterica acuta (*Burchard, quoted by Burserius*, 1785); Fièvre entero-mesenterique (*Petit* and *Serres*, 1813); Enteritic Fever (*Mills*, 1813); Gastro-enterite (*Broussais*, 1816); Entero-mesenteric Fever (*Abercrombie*, 1820); Dothienenterite (*Bretonneau*, 1825; *Christison*, 1840); Enterite Folliculeuse (*Forget*, 1841); Muco-enteritis and Gastro-enteric Fever (*var.*). Enteric Fever (*Wood*, 1848; *Aitken*, 1858).

Night-soil Fever (*Brown*, 1855).

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[1] Clinical Lectures, not published.

Many of the cases described by Cullen and his successors, under the designation Enteritis erysipelatosa, were probably examples of this fever.—(See description of it in Alison's Path. and Pract. of Med., p. 323.)

IV.—Simple Fever or Febricula.

Characters.—A sporadic, non-contagious disease, arising from exposure to the sun, fatigue, surfeit, inebriety, etc. Its symptoms are: frequent, full, and firm pulse; white tongue; great thirst; constipation; high-coloured urine; very hot and dry skin; no eruption; severe headache, and sometimes acute delirium; the fever subsiding in from one to ten days, with copious perspirations, herpetic eruptions, etc.; in the dead body, congestion of all the internal organs.

Synonyms.

Καῦσος (*Hippoc.*); Causus sive Febris ardens (*Galen, Willis*, 1659; *Boerhave*, 1738); Synochus causonides (*Forestus*, 1591; *Mangetus*, 1695); La Calentura? (*Piquer*, 1751); Causos (*Vogel*, 1764); Endemical Causus (*Moseley*, 1789); Enecia Cauma (*Mason Good*, 1817); Ardent Fever (*Burnett*, 1812; *Ronald Martin*, 1841; *Copland*, 1844); Ardent Continued Fever (*Morehead*, 1856).

Σύνοχος? (*Greeks*); Synocha vel Synochus Simplex (*Riverius*, 1623; *Hoffmann*, 1700; *Juncker*, 1736; *Burserius*, 1785); Synocha (*Linnæus*, 1763; *Sauvages*, 1768; *Cullen*, 1769); La Fièvre Synoque (*Davasse*, 1847); Synoshische (*Germ.*)

Synochus imputris? (*Galen*); Febris continua non putrida (*Lemnius*, 1563; *Boerhave*, 1738); Synocha sine putredine (*Sennertus*, 1641); Synocha non putris (*Bellini*, 1732); Febris non putrida (*Quarin*, 1781).

Συνοχὴ φλεγμωδὴς? (Gr.); Febris Sanguinea? (*Avicenna*); Synocha sanguinea? (*Sennertus*, 1641); Feb. acuta sanguinea (*Hoffmann*, 1700); Febris venosa (*Ballonius*, 1734); Acute Continual Fever (*Langrish*, 1735); Simple Inflammatory Fever (*Huxham*, 1739; *Fordyce*, 1791); Febris acuta simplex (*Storck*, 1741); Synocha plethorica and Ephemera plethorica (*Sauvages*, 1763); Febris continens inflammatoria simplex (*Selle*, 1779); Febris acuta (*Plouequet*, 1791); Entzundungsfieber and Entzundliche Fieber (*Reil*, 1794, etc.); La Fièvre angioténique (*Pinel*, 1798); La Fièvre angioténique pure et simple (*Bouillaud*, 1826); Fièvre inflammatoire (*French*); Febbre infiammatoria (*Ital.*).

Febris depuratoria? (*Quesnay*, 1753); Judicatoria? (*Sagar*, 1776).

Febris septenaria (*Platerius*, 1656; *Sprengel*, 1814); Ephemera plurium dierum (*Sennertus*, 1641; *Juncker*, 1736); Synocha septimo die soluta (*Hoffmann*, 1700); Febris continens? (*Stahl*, 1700); Febris continua simplex (*Lieutaud*, 1776); Simple Continued Fever (*modern writers*).

Febris ephemera (*Riverius*, 1623; *Sennertus*, 1641; *Sauvages*, 1768); Diary Fever (*Strother*, 1728); Ephemera simplex (*Boerhave*, 1738); Febris diaria, (*Juncker*, 1736; *Linnæus*, 1763); Fièvre ephemère (*Davasse*, 1847); Febricula (*var.*, and *Jenner*, 1849, not the Febricula of *Manningham*); Das entägige Fieber (*Germ.*); Effimero (*Ital.*); Efemera (*Span.*).

Ephemera a frigore and E. a calore (*Sauvages*, 1768); Sun Fever (*Scriven*, 1857).

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REMARKS

ON THE

CHANGES WHICH ARE SUPPOSED TO HAVE TAKEN PLACE

IN THE

TYPE OF CONTINUED FEVER.

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[REPRINTED FROM THE EDINBURGH MEDICAL JOURNAL, AUGUST 1858.]

It is not my object, in this paper, to enter into any discussion concerning the general question of changes of type in disease. I merely wish to call attention to one or two circumstances, which, in my opinion, must modify in a very great degree the conclusions which have been drawn by Dr Christison, in a very valuable paper read by him before the Medico-Chirurgical Society of Edinburgh, and published in the *Edinburgh Medical Journal* for January of the present year.

One of the main arguments, if not the principal one, urged by Dr Christison in favour of a change in the type of fever is, that in the epidemic of 1817–19, the practice of bleeding largely, so far from being injurious, as it would undoubtedly be in the fever which of late years has been most prevalent, was followed by the most favourable results. Thus he remarks, after speaking of drawing "a legitimate allowance of thirty ounces (of blood) in all;" "And let it be remembered that we did by no means slay our patients by such blood-thirstiness. On the contrary, the mortality from the whole forms of fever collectively in that epidemic, did not exceed 1 in 22 at any period, and was reduced to 1 in 30 as the epidemic spread, and the remedy became more and more familiar."[1] It is well known, however, and acknowledged by Dr Christison himself, that the fever which characterised this epidemic was that which is now familiar to many members of the profession under the designation of Relapsing Fever, and which was probably included in the *synocha*

[1] *Edinburgh Medical Journal*, January 1858, p. 587.

of Cullen.[1] I am aware that Dr Christison, and many other distinguished authorities, still regard this fever as a mere variety of typhus; but whether this be the case or not, whether the poisons of the two diseases be identical or different, whether, in short, the diseases themselves be different species or different varieties of the same affection, are questions quite unnecessary to the present inquiry. What I maintain is, that this relapsing fever, which seems only to occur in the epidemic form at lengthened intervals, has been at all times remarkable for its small mortality, as compared with that of the ordinary typhus, and that when no bleeding has been resorted to, the mortality has been even smaller than under the heroic practice, which was resorted to in Edinburgh during the epidemic of 1817–20.

Dr Christison tells us that the mortality from this epidemic, under the bleeding system, was from 1 in 22 to 1 in 30, or, in other words, from 4½ to 3⅓ per cent.; and out of 743 cases which came under the notice of Dr Welsh, who wrote a history of the epidemic, and who was the great advocate for copious bleeding, 34, or 4½ per cent., died. Now, this relapsing fever was no new disease in 1817. Frequent mention is made of it by that accurate observer Rutty, in his *History of the Weather and Seasons, and of the Prevailing Diseases in Dublin*, as having occurred in Ireland during the last century. The following extract from Rutty's work shows that an epidemic of relapsing fever occurred in Ireland in the autumn of 1739, while it also indicates that, even at that remote period, particular attention was attracted by the small mortality which it occasioned, this small mortality, moreover, being a concomitant, if not the consequence of a non-recourse to medical interference of any sort. "The latter part of July, and the months of August, September, and October (1739) were infested with a fever, which was very frequent during this period, not unlike that of the autumn of the preceding year, with which compare also the years 1741, 1745, and 1748. It was attended with an intense pain in the head. It terminated sometimes in four, for the most part in five or six days, sometimes in nine, and commonly in a critical sweat. It was far from being mortal. I was assured of seventy of the poorer sort at the same

[1] Relapsing Fever may be defined as follows:—A disease commencing very abruptly with a sensation of coldness and rigors, and attended by quick and often incompressible pulse, white tongue, tenderness at the epigastrium, vomiting, enlarged liver and spleen; occasionally jaundice; constipation; high coloured urine; great heat of skin, but no eruption; severe headache, and pains in the back and limbs; restlessness; and rarely slight delirium;—an abrupt cessation of all these symptoms, with free sweating between the fourth and seventh days, usually on the fifth;—after a complete apyretic interval (during which the patient may get up and walk about), an abrupt relapse on the fourteenth day from the first commencement, running a similar course to the first attack, and terminating on or about the third day of the relapse;—rarely sudden syncope and death;—after death, no specific lesion, but in most cases enlargement of liver and spleen.

time in this fever, abandoned to the use of whey and God's good providence, who all recovered. The crisis, however, was very imperfect, for they were subject to relapses, even sometimes to the third time; nor did their urine come to a complete separation. Divers of them, as their fever declined, had a paroxysm in the evening, and in some there succeeded pains in the limbs."[1] Several epidemics of relapsing fever have occurred subsequently to that of 1817–20; and although venesection has constituted little or no part of the treatment, the mortality has not exceeded, or has been considerably less, than that observed during the period just alluded to. Thus, in 1843, relapsing fever was again epidemic in Edinburgh, and was made the subject of a monograph by Dr Rose Cormack,[2] and of a lengthened series of papers in the *Medical Gazette* by Dr Wardell.[3] Among the cases observed by Dr Wardell, the mortality was only 1 in 20; and among Dr Cormack's cases it was 1 in 16½. Again, out of 7804 cases of relapsing fever (classified as distinct from typhus), which were admitted into the Glasgow Royal Infirmary between the years 1843 and 1853 inclusive, only 405 or 5·2 per cent. died;[4] and of 203 cases admitted into the Edinburgh Infirmary in the year 1848–49, only 8 cases, or 3·94 per cent. died.[5] The following table gives the mortality from all the cases of relapsing fever admitted into the London Fever Hospital, during the last ten years:—

TABLE I.

Cases of Relapsing Fever admitted into the London Fever Hospital.

Years.	No. of Cases.	Deaths.
1848	13	1
1849	29	0
1850	32	2
1851	256	7
1852	88	1
1853	16	0
1854	5	0
1855	1	0
1856	0	0
1857	1?	0
Total,	441	11

[1] *A Chronological History of the Weather and Seasons, and of the Prevailing Diseases in Dublin.* By John Rutty, M.D. Lond. 1770. Pp. 75 and 76.

[2] *Natural History, Pathology, and Treatment of the Epidemic Fever at present Prevailing in Edinburgh and other Towns.* By John Rose Cormack, M.D. Edinburgh, 1843.

[3] *London Medical Gazette.* Vols. xxxvii. to xl.

[4] *Glasgow Medical Journal.* Vol. ii., p. 161.

[5] *Statistical Tables, Royal Infirmary.* Ninth Series, p. 15.

From this table it would appear, that out of 441 cases of relapsing fever treated in the London Fever Hospital, during the last ten years, only 2½ per cent. have died, or about 1 in 40.

Typhus and enteric fever (typhoid fever or dothinenteritis) present a striking contrast in this respect to the relapsing fever, as will be apparent from Table II., which shows the rate of mortality from each of these fevers in the London Fever Hospital, during the last ten years.

TABLE II.

Mortality from Typhus and Enteric Fever in the London Fever Hospital in Ten Years.

Years.	Typhus.			Enteric Fever.		
	No. of Cases.	Deaths.	Mortality Per Cent.	No. of Cases.	Deaths.	Mortality Per Cent.
1848	526	106	20·15	152	41	26·97
1849	155	39	25·16	138	26	18·84
1850	130	24	18·46	137	24	17·51
1851	68	6	8·82	234	30	12·82
1852	204	24	11·76	140	25	17·85
1853	408	90	22·06	211	59	27·96
1854	337	68	20·18	228	44	19·3
1855	342	82	24·	217	31	14·28
1856	1062	207	19·49	149	23	15·43
1857	274	69	25·18	214	30	14·02
Total, .	3506	715	20·39	1820	333	18·29
Deducting cases fatal within 24 hours after admission,	3457	668	19·32	1806	319	17·66
Deducting cases fatal within 48 hours,	391	600	17·69	1791	304	16·97

Moreover, any one who will take the trouble of studying the historical records of fever, will find that the true typhus, with a measly eruption, has invariably been productive of a far greater mortality than relapsing fever, and that at no period has it derived benefit from copious depletion.

Among other arguments in favour of blood-letting in the epidemic of 1817–20, it was urged that, in many cases, its practice was followed by the most sudden and marked improvement in the general symptoms. Dr Welsh speaks of it as having "cut short" the disease

in many cases. Against this, however, it must be borne in mind that a very sudden improvement in the symptoms constitutes a peculiarity of relapsing fever, totally independent of venesection. Dr Cormack, speaking of the effects of bleeding in the relapsing fever of 1843, remarks, "These beneficial changes were often not effects, though sequences of the bleeding, as was satisfactorily proved by the very same changes frequently occurring as suddenly and unequivocally in patients in the same wards, and affected in the same way, who were subjected to no treatment whatever."[1] This observation has frequently been confirmed in the London Fever Hospital. Dr Jenner, after mentioning a case of relapsing fever, which had been bled in this institution with no marked benefit, observes:—"Nature, unaided by the loss of blood, in many cases effected a much larger improvement in a much shorter space of time."[2]

When we recollect the small mortality from relapsing fever, as compared with that of the more ordinary forms, typhus and enteric fever, it is obvious that the greater the ratio which the relapsing cases bears to that of the other forms, the less will be the aggregate rate of mortality from all the cases of continued fever taken together; or, in other words, the rate of mortality will be smallest at those places, and in those years, in which there has been the largest number of relapsing cases. This is well shown in Table III., which gives the number of deaths and the rate of mortality from all the cases of continued fever (including those entered as "febricula") which have been admitted into the London Fever Hospital during ten years. When this Table is compared with Table I., it will be seen that the mortality was very much smaller in the two years, in which there was the greatest number of relapsing cases; although it is also to be observed, that the mortality from typhus only, in the same two years, was much below the average.

I would only add three remarks in conclusion, which I think may be regarded as legitimate inferences from the foregoing statement of facts:—

1. In comparing the mortality from continued fever at different times and places, or for the purpose of judging of the merits of different plans of treatment, it is essential to take into account the form of fever which has prevailed.

2. The small mortality, and the frequency of sudden improvement in the symptoms, which were observed to follow venesection in the epidemic of 1817–20, and which have been attributed to that practice, were characteristics of the relapsing form of fever which then prevailed, and have been equally characteristics of it at all times, even when blood-letting has never been resorted to.

3. Consequently, it is not a legitimate argument in favour of a change in the constitutional type of fever, to contrast the mortality

[1] *Op. cit.*, p. 151.
[2] *Medical Times and Gazette.* New Series. Vol. ii., p. 31.

after blood-letting in the *relapsing* epidemic of 1817–20, with what would be the effects of bleeding in the *typhus* of the present day.

TABLE III.

Mortality from the Cases of Continued Fever, taken collectively, admitted into the London Fever Hospital in Ten Years.[1]

Years.	No. of Cases.	Deaths.	Mortality Per Cent.
1848	707	148	20·93
1849	401	65	16·21
1850	361	50	13·85
1851	614	43	7·00
1852	561	50	8·91
1853	787	149	18·93
1854	714	112	15·68
1855	622	113	18·16
1856	1300	230	17·69
1857	561	99	17·64
Total, .	6628	1059	15·98
Deducting cases fatal within 24 hours after admission,	6567	998	15·19
Deducting cases fatal within 48 hours,	6482	913	14·07

[1] During ten years the different forms of Continued Fever, admitted into the London Fever Hospital, have been carefully distinguished, and records have been preserved of every case. From these records I have prepared the tables contained in this paper.

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From Dr. Beale's Archives of Medicine, No. XII, 1862.

ON OPHTHALMIA.

By Jeffery A. Marston, M.D., Assistant-Surgeon, Royal Artillery.

(*Supplement to former Paper.*)

Learning that ophthalmia was prevailing in an epidemic form at the Central London District Schools, I applied for permission to inspect the affected children. Through the great courtesy and kindness of the medical officers I was permitted to do so.

It was with much interest that I witnessed for the first time in England an ophthalmia, prevailing in an epidemic form, under circumstances perfectly parallel with what is found in military life, and with symptoms so essentially similar to those I described in my last paper, as to leave no doubt of its identity with the military form.

I gather the following facts from the published report of the Committee, appointed in September, 1861, to inquire into the state of health of the children of the school:—

The Central London District comprises—

City of London Union,
East London Union,
West London Union,
St. Saviour's Union, Southwark,
St. Martin's-in-the-Fields Parish.

The then present number of children was 1,148.

The Committee was assisted in their inquiries by Mr. H. Haynes Walton.

The physical characters of the children at the different London Institutions were alike, inasmuch as they were gathered from a very low class, from crowded habitations, and presented the same general features, physically and morally, on their admission into the different schools.

It would appear that the health of the children at the Central London contrasted with that of the schools of other districts, principally, though by no means entirely, in the prevalence of ophthalmia. This disease had prevailed at the date of a similar commission in 1858.

The Committee advert to the disproportionate number of children at the Central London School affected with itch, and other cutaneous diseases, compared with other schools.

They remark upon the defective (excessive) ventilation and heating at the Central London Schools, and quote Mr. Haynes Walton to the effect that the disease was catarrhal ophthalmia, and not depending upon contagion or infection, nor excited by the mechanical irritation of dust, but that the *existing* cause of the disease was excessive ventilation.

Mr. Bowman, in 1858, had pointed out that the fresh air was admitted into the dormitories, directly from without, through a grating in the wall near the head of the beds. The corridors at Hanwell run the whole length of the building, from east to west, giving rise to strong currents of air. No distinct building existed as an infirmary. Under the head "*bathing*," the Committee remarked that the troughs in the boys' washing room were in an unclean condition. At Sutton School the Committee state that each child had a separate towel, which was not the case at the Central District Schools. (One towel to ten was the average.) At the Forest Gate School every child had fresh water for ordinary washing, and large plunge baths were supplied also with water constantly running in and out. No large day-rooms appeared to be set apart for the children during inclement weather, as at three of the other schools.

The Committee after regretting the existing state of bad health among the children of their school, as compared with the others, express their opinion that, "had the recommendations contained in Mr. Bowman's report in 1858 been rigorously enforced, much, if not all, the ophthalmic disease would have disappeared, certainly would have been much diminished in extent and danger."

Mr. Haynes Walton in his report October 1st, 1861, denominates the disease "catarrhal ophthalmia," existing in the mild and definite form, and not having passed into the purulent Egyptian, or military ophthalmia; that it was uncomplicated, that it was caused by atmospheric influences; that, though it prevails every year, it is occasionally epidemic, and had been very prevalent that year in London. Respecting its contagious or infectious nature he says "I am not aware that the matter conveyed from the eye of one person to another will produce it, such evidence as I can gather is against it; of its infectiousness I have no faith, and therefore I think that no advantage is to be got from isolation."

He appeared to consider the ventilation as the existing cause, and that the washing department was efficient, although he recommended, to be upon the safe side, that no one who had the disease should be allowed to wash with any healthy person, until he was quite well.

Mr. Walton did not consider that the prevalence of dust from the yard, had the least influence in causing the disease, as he says "irritation of the eye, arising from the intrusion of extraneous bodies, however minutely subdivided, is attended with very different symptoms."

Mr. Bowman in his report, in June 1858, appears to have recognised and spoken of the occasional epidemic character of the disease, and its spread by contagious influences, and to have pointed out the indications such a view would entail.

Owing to the continuance of ophthalmia, Mr. Bowman revisited the school upon 21st and 27th March, 1862.

Whatever might have been the disease hitherto, it was then no longer a simple malady, as regards its extent or consequences.

From Mr. Bowman's report of the latter date I gather, that ophthalmia was extensively prevalent, affecting about 686 of 1,162 children; 92 cases were separated and about 594 remained unseparated. Of these about 396 were cases relapsing after apparent cure, and 193 were slight commencing cases, not yet brought under treatment.

Mr. Bowman, writing for the perusal of non-professional men, says, "The Ophthalmia presents itself under four conditions, which I will enumerate as A, B, C, and D.

"*Condition A.*—Slight redness of inner corner of eyes. The inside of lids red. The eyes itch, look weak, and are often rubbed with the fingers. This, which is the common early stage, may vary in intensity, and may last for some time without attracting attention. To be detected early *it must be looked for*.

"It differs from ordinary catarrhal ophthalmia, on which I reported to you in 1858, by its persistency, and by its not tending to a speedy natural cure; by its liability to pass into the next condition (B), and also, as might be hence inferred, it differs in my opinion most essentially in its *cause*. I believe it to be propagated from one affected person to another.

"*Condition B.*—Worse stage of condition A. The eyes would be called *badly inflamed*, the edges and corners of the lids are more red, somewhat swollen and wetted with a good deal of discharge. There is itching, smarting, and intolerance of light. The inside of lids is of a lake colour, the membrane thickened and rough with small granulations. It is the same as condition A, but *with more inflammation*.

"*Condition C.*—is the most terrible form. The inflammation is so intense as to swell the lids rapidly with much pain and profuse suppuration"—purulent ophthalmia in short. "This

severe variety presented itself in January, and has occurred only among the younger boys. There have been about 30 cases in all, and of these 7 eyes appear to have been lost.

"*Condition D.*—This I particularly specify in the present report, because of its importance in reference to the arrest of the disease, and its eradication from the school. It is the *convalescent* and at the same time the *relapsing condition*, in which an apparent cure having been effected, the treatment ceases, and the child is sent back among his fellows, until the symptoms again become urgent enough to call for his re-separation. I was informed by your medical officers that since June the children have been in many instances sent back from the ophthalmic ward into school, apparently cured, and then have had to be separated again within a few days, in consequence of a fresh attack.

"'Frequently in going round the school,' says Mr. Goodchild, 'we have seen cases among those who had been apparently cured, and who had consequently been allowed to return into school, and we have had to isolate them again. We have also at the same time seen *other new cases*, which had to be sent into the ophthalmic ward. Relapses have been frequent.'

"In this condition (D) of *convalescence* or *apparent cure*, but where relapses are so apt to occur if treatment is intermitted, the eyes have *nearly* lost their redness, but it quickly returns on slight excitement. There is very little discharge, but a little increase of redness is followed by a more abundant secretion, and the inner surface of the lid is found to be still too thick, and more or less granulated.

"By the mere intermission of treatment the discharge accumulates, the eyes get dirty, and the disease relapses.

"Of the 594 children whom I estimated as having ophthalmia, yet as mingling with the healthy children and not under any special treatment, a part were under condition A, and a part were under condition D, *i.e.*, they were either slight commencing cases, or nearly cured, or relapsing cases, in about the proportions already specified."

Numerous recommendations then follow upon the view, which he most strongly urges, of its infectious or contagious nature. "Under circumstances not easy to explain or to specify, but usually connected with over-crowding and want of cleanliness, the milder forms may pass with more or less suddenness into the more severe. In the present instance all the children seized with the more virulent form were already suffering from the less virulent, and several had been long under treatment. It would appear that in January and February the

type of the disease changed in many instances; or else that a *single severe case having occurred in the boys' ophthalmic ward, others were contaminated by it*, for *the severest purulent cases were* not *at first isolated from the less severe ones.*

"It is noticeable that *all* the *worst* cases (form C) have been among the *boys*, none among the *girls*, although at the period of my visit girls were affected in greater number."

Extract from Mr. Bowman's Report, April 11th.

"For the single object of eradicating the ophthalmia a removal of the children who are now *healthy* for a time to some other suburban locality, or even to their own several workhouses, would seem to be a wise course, if only on their own account, and it would enable the officers to spread the suffering ones over a much wider area, afford them better ventilation, and give them a bed each."

Prevalence of the disease.—I made my first visit towards the latter end of April, and, examining individual children taken at random from those outwardly healthy, it was the exception to meet with a perfectly healthy condition of the conjunctiva.

Abstract from Three of Mr. Bowman's Weekly Reports.

Date.	Class A.	B.	C.	D.	Total cases.	Total children in School.
April 19	277 ..	88 ..	26 ..	59 ..	450	1,132
May 21	320 ..	65 ..	7 ..	92 ..	482	1,040
June 21	273 ..	34 ..	11 ..	98 ..	416	992

Its origin.—This is doubtful, but it may be remarked that Mr. Goodchild noticed that after the introduction from St. Pancras in 1858 of some children, affected with ophthalmia, the disease became more frequent and troublesome at the Central District Schools. Whether it took its origin from this source, or whether ordinary catarrhal ophthalmia, when protracted and widely prevalent among human beings living together under a defective hygiene, can assume the specific characters described, cannot be accurately determined. My own impression is so strong as to amount to a conviction that either of these conditions is adequate.

Its nature.—That form of ophthalmia which prevails in armies, and other bodies of human beings similarly circumstanced, and, whatever be its exact pathology, possessing the

characters I have already described. The earliest and perfectly latent stages were comparatively absent, owing to the widely spread operation of exciting causes, and the epidemic influence. There were, however, large numbers of children affected with the sparsely shed "vesicular" or "sago grain" bodies, in different stages, as regards vascularity, limited to the retrotarsal fold of conjunctiva at the outer canthi, and offering no symptoms indicative of their presence, without a careful scrutiny of the lids. Entering the school-rooms, no one would have imagined from the appearance of the children the widely spread prevalence of the disease, such an absence was there of any appearance about the children's features, or the exposed surface of the conjuctiva to indicate it.

Mr. Bowman, recognising the presence of these "sago grain" granules, in many of the cases, holds strongly to the opinion, from their definite seat and character, that they must have their origin in a distinct physiological structure.

The causes.—Those of constitution, as congenital or acquired debility of constitution, such as must widely prevail among the children of the poorer population. That these are insufficient to account for all the cases, or the spread of the disease, will be apparent from the fact, that children of every constitution, physique, &c., have suffered in different degrees, just as was observed among the military, and in the Gibraltar convict establishment, where the disease attacked individuals of every type and conformation of body.

Contagion.—Into this I need not enter further than to remark that such an agency is generally allowed, and that Dr. Piringer, Van Roosbröeck, and others, have produced ophthalmia by inoculation of purulent discharges obtained from various sources. The latter, indeed, goes so far as to classify the Egyptian, military, and gonorrhœal forms under the same head, declaring that the diseases resulting from pus-inoculation are essentially the same, the different degrees of intensity resulting from the different sources (*quoad* intensity of inflammation), from which such discharge has been produced and obtained. The experience obtained from cases of artificial conjunctivitis by pus-inoculation is highly corroborative of the truth of Van Roosbröeck's statement, inasmuch as it has been found that the more intense the inflammation producing the pus used, the more intense the inflammation resulting from its use. Assuming that the disease *only* spreads in the *direct* way (which has not been yet proved), and that the contact of discharge from a diseased eye is essential to its production, it is still impossible to say in what stage *no* discharge whatever is

present, for in the earliest, a little blinking in the sun, and slight gumming of the lids can be made out upon close enquiry; while in others, further advanced, we may often discover threads of muco-pus by eversion of the lids, although the symptoms appear very trivial. Granting the disease to be contagious, we have, it appears to me, not far to go to seek the causes for its epidemic prevalence at the school in question.

We have seen from Mr. Bowman's report that affected children had been allowed to mingle with the healthy. Fresh towels had been supplied daily, in the proportion of one to ten children. The children washed in wooden troughs (not a running stream)—by relays.

The bath is capable of holding about twenty; the dirty surface water drains off by one opening and fresh water flows in by another, so that the water is replenished without being *thoroughly renewed*. Up to the date that Mr. Bowman undertook the investigation into the causes of the epidemic, it does not appear that any means for the prevention of the spread of the disease were vigorously pursued. The first efforts were directed to the discovery, classification, and isolation of all cases of the disease, however slight.

Very many of the children slept two in a bed, and they occupied the same rooms by day, during wet weather, as at night.

The school rooms were divided by curtains (retentive of dust) for the purpose of facilitating class teaching.

The rest may be summed up in the expression, that the children are subject to those evils to which persons living in a gregarious manner must, in different degrees, be always exposed.

Of the *exciting* causes we have two of a well defined character present, and to which I have particularly alluded in my preceding paper, viz.:—1. *Catarrhal Causes*, as pointed out by Mr. Bowman and Mr. Haynes Walton.

2. *Dust.*—A large quadrangular yard exists, covered with an impalpable dust, particles of which penetrate everywhere. That such dust, *per se*, gives rise to a different and easily distinguished disease is true enough, but this is not by any means the case where other and more widely prevailing causes are present; then it takes its place as an irritant. Among the exciting causes Mr. Bowman speedily recognised the presence of dust as one urgently requiring removal.

RESULTS OF SOME ADDITIONAL OBSERVATIONS.

I. The reaction of the conjunctival secretion was tested in a great many instances. With one exception, the re-action

was always weakly alkaline. The effect upon test paper was permanent also, indicating the presence of a fixed alkali. The lotions used were perfectly neutral to the same test paper.

II. With the view of corroborating the statement that pus was present in the air of ophthalmic wards, the bodies floating in the atmosphere of the wards were collected and examined, with negative results however, as regards pus cells. Dissatisfied with the very limited observations made in the wards, I have since used the aeroscope in a room, wherein some fluid pus was exposed. The bodies collected were examined microscopically. Beside dust, fibre, cotton, &c., there were organic bodies of various kinds and forms, (in very great part vegetable germs far smaller than pus cells).

Numerous minute germs (often as small as $\frac{1}{1000}$th inch in diameter) were found. That these were in great part vegetable, I think conclusive from the fact that sporules of fungus, and cellular bodies arranged in a linear series forming filaments, or mycelium, subsequently appeared upon the slides.

I found that if portions of cotton, wool, or lint, soaked with pus, be first desiccated, and the current of air passing over these be received by the aeroscope, some pus cells can be discovered with detached and isolated fibres of cotton; but no pus cells were found so long as the lint remained moist.

III. The worst cases and those in which the cornea sloughed or ulcerated, and sight was more or less destroyed were either compound in nature, the contagious ophthalmia engrafted upon the strumous form, or the purulent form of the disease in children of very delicate conformation of body and deficient powers of circulation.

As far as these unfortunate children were concerned they had all the advantages derivable from subsequent operative interference at the Moorfield's Ophthalmic Hospital, and with very gratifying results.

The sago-grain state of lid, advanced to the vascular or congestive stage, formed by far the larger proportion of the whole number affected.

Subsidence of the vascular phenomena was easily procured by mild treatment. Depletion and all lowering remedies were quite out of the question, owing to the tender age and defective nutrition of the patients.

IV. Mr. Bowman holds (of the truth of which I have no doubt) that it is well to *watch*, but not interfere with the quiescent stage, as astringent applications would probably only *induce* vascular phenomena.

In conclusion, I must thank Mr. Bowman for his kindness in giving me the benefit of the perusal of his reports. I may remark (with all modesty be it said) that I could not expect any thing in these papers to be new to a man of Mr. Bowman's observation and experience. He has most minutely pointed out the causes of its epidemic prevalence, and, by a series of most lucidly written recommendations, he has endeavoured to grapple with the disorder with a large measure of success. But the subsidence of such a disease must necessarily be gradual, not only on account of its obstinate nature, but because the necessary sanitary measures cannot always be carried out as efficiently and as early as would be desirable, owing to the conditions incident to a large pauper establishment. The Board of Management have shown the most praiseworthy desire to improve the hygienic state of the buildings by taking the steps recommended, regardless of cost. It may be hoped that a repetition of such an epidemic in future will be thus in a great degree guarded against.

Conceiving that it would be adding to the practical character of this paper, I have appended a series of sanitary suggestions.

Practical Recommendations to be put in force in a Regiment afflicted with Ophthalmia.

1. That all the men of an affected regiment be inspected by a medical officer at least once daily, with the view of removing at any rate all cases affording any discharge from the eyes.*

2. To make the men, as far as practicable, wash at a pump, having placed a sentry upon the spot with orders to see that every man brings his towel with him.

3. To place a sentry upon the lavatory to see that every man brings and removes his own towel, fills a basin with water from the tap, empties the same after washing, and refills the basin for his successor, who shall empty the water so left and refill the basin before using it.

4. To institute (if season permit) frequent bathing parades—four times weekly. It is better to make the men bathe in the evening in warm climates, both because it sends them to bed perfectly clean and refreshed after the duties of the day, and,

* If a man affected with ophthalmia joins a regiment, it is better to billet him upon a company in which ophthalmia has been present than upon a company free from granular disease.

by encroaching upon their spare time, prevents it being spent in public houses, &c.

5. To avoid, as far as possible, the exposure of the men to the direct rays of the sun, dusty localities for parades, and the massing men together on parade.

6. Frequent exercise in the air in small parties of four to six men, whether affected or not with the disease,—provided that direct sunshine and easterly winds be avoided.

7. To have separate wards for ophthalmic cases, and it is recommended that the worst (purulent) cases be separated from the less acute and less advanced forms of the disorder.

8. Convalescent wards in hospitals, and convalescent rooms in the barracks, for men who have been treated, so that every affected case can be made to pass through a period of probation and observation before joining his regiment in the ordinary way. By this means the danger of contagion from relapsing cases will be avoided.

9. If the men of one room be affected, it is obviously well to clear out that room for a time, and to whitewash it.

10. To see that all bedding, &c., be daily exposed for some hours to the sun and air, and the barrack-rooms thoroughly ventilated. To ensure this being done efficiently day-rooms for the men are essential.

11. To increase as much as possible the cubic space for the inmates of the barracks.

12. The strictest attention to the latrines, urinals, &c.; closing those which are placed too near the barrack-rooms; directing that the tubs be placed outside the rooms during the night, and filled with water and some disinfectant during the day.

13. To discover, correct, and remove any such exciting causes as may be prevalent—*e.g.*, draughts in the rooms; dust in the barrack yards, and by selecting a cool part of the day and the shade for all necessary parades.

14. Cautioning men against the indiscriminate use of pocket handkerchiefs, &c.

15. The use of tow, cotton wool, or lint in hospital—the destruction of the same after use, with a strict prohibition against all sponges.

16. If the barracks be badly constructed, low in site, or otherwise defective, obviously a change is necessary, and encamping is far preferable, during even hot weather, to inhabiting such buildings. Splitting up the regiment into small bodies is to be strongly recommended also.

17. It is recommended when one eye only is affected, and affording discharge, that it be kept closed by means of

cotton wool, to prevent the discharge coming into contact with the sound organ, which is apt to occur during the night from the patient's fingers. The only objection to this plan is, that it tends to heat the eye and confine the discharge; this can only be guarded against by frequent inspection and syringing.

18. To ensure a prompt and efficient execution of any sanitary measures, it is necessary to obtain from the commanding officer one or more steady and vigilant non-commissioned officers with some soldiers to act as sanitary police. Great care should be exercised also in obtaining trustworthy, cleanly and attentive nurses for the sick, particularly in the purulent ophthalmic wards.

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OBSERVATIONS

Dr Parkes

ON

Inst. Sanitary

YELLOW FEVER.

By ROBERT LAWSON,
DEPUTY INSPECTOR-GENERAL OF HOSPITALS.

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OBSERVATIONS ON YELLOW FEVER.

Division II.—Morbid Appearances.

Kidneys.—The prominence given to the urinary secretion in the preceding part of this paper naturally suggests that the condition of the kidneys after death should come under consideration first. These, with the liver and intestinal canal, are the organs most implicated in yellow fever, and it will be as advantageous to treat them in this order as in any other.

After death the kidneys are always found congested, and almost always somewhat larger than usual; those that were weighed having been from 5½ to 8 oz., though the subjects from which they were taken were none of them above medium size. In the cortical substance, though the bloodvessels were full, the intermediate portions were light greyish yellow, more prominent when cut into, and the thickness from the surface to the base of the pyramids rather greater than usual. The substance was rather more friable than natural, the capsules not more adherent than common. The pyramids showed the congestion better than the cortical part; they were not enlarged; on pressure, a little milky-looking matter exuded from the papillæ, and traces of the same were found in the calices; this has been noticed by Blair and others, and consists of tube-casts. The pelvis, or course of the ureters, seldom exhibited much congestion. In one case the whole organ seemed quite œdematous from interstitial effusion.

The bladder was always contracted, sometimes quite empty, at others containing urine, varying from two drachms up to five or six ounces. When death occurred before the eighth day this was always albuminous, and contained tube-casts. The lining membrane of the bladder itself was pale in every case which came under my notice, and nothing anomalous was detected in it.

On placing a thin section of the kidney under the microscope, the convoluted tubes were found with their epithelium very granular, the outlines of the cells being for the most part indistinct, and the nuclei difficult to detect among the multitude of granules, or if they were apparent, their contents were granular as well. In most instances the convoluted tubes were filled with this granular epithelium, and

frequently distended by it to a considerable diameter; I have met with them as large as $\frac{1}{40}$; their canal of course was quite obstructed, and in such cases there was little or no urine in the bladder. In others, though the epithelium was equally granular, it did not close the canal altogether in any situation, so that some fluid could pass; and in these the substance of the epithelium was generally tinged brownish, and some urine found in the bladder. In the case of Goodwin, detailed above, the epithelium almost entirely filled the convoluted tubes whenever examined; in many places it was deeply tinged with hæmatin, which gave a brownish-red colour to the whole thickness of the cells, as in the casts that were obtained from the bladder. In another case there was a deposition of pigment at intervals along the convoluted tubes, covering the contained epithelium thickly in the form of minute granules for a distance equal to from one to two diameters of the tube, the intermediate portions of the canal being quite clear of it; this peculiarity was found not only in the convoluted tubes, but in the capsules of the kidneys and in the tubes of the cell-containing network of the liver.

The capillary vessels ramifying among the convoluted tubes always had their surfaces covered with nuclei. These, which in the usual condition of the vessels are scattered and not very prominent, in the congested kidneys of this disease were so numerous as to cover the whole surface continuously. Under the action of acetic acid they seemed to contract somewhat, so as to expose the parietes of the vessel between them and the whole to become clear; but the nuclei still remained distinct, studding the surface at much less intervals than in healthy vessels, or in those in other parts of the same subject. Under a power of 450 these nuclei appeared granular. The loops of the Malpighian bodies were similarly affected, and the appearance was quite distinct on the larger vessels in their interior. In this condition the capillaries appear tumid and opaline or dark grey, as they are just within or beyond the focus of the object-glass. The connective tissue around them generally seems swelled, and contains a little clear or opaline exudation, and often granular matter. In the case alluded to above, in which the kidneys seemed œdematous, which had passed the ordinary period of the disease, and proved fatal on the twenty-third day with suppression of urine, there was a large amount of opaline exudation found among the straight and convoluted tubes, with numerous granules, oil, and some pus globules, in addition to the condition of the capillaries just described, and the tubes had lost their sharpness of outline, so that the whole was clouded and indistinct.

These conditions of the kidneys were well marked in cases which proved fatal from the fourth to the seventh or eighth day of the disease. They indicate an active exudation into the parenchyma of the organ, and a catarrhal affection of its mucous surfaces. It can be easily understood that the latter, at least, though salutary in itself, may prove excessive; and by closing the tubes prevent the passage of urine, and so become one of the most fatal complications of the disease.

This seems to be the reason of the frequent suppression of urine in yellow fever about the fifth day, and one of the causes of its so often terminating in death after the urgency of the febrile symptoms had passed away. The case particularly alluded to above, however, shows that there may be a suppression at a subsequent period, after the flow had become copious, and danger from that source had apparently ceased, by interstitial exudation destroying the secreting power of the gland. This might occur earlier in the disease, but the choking of the tubes by the enlarged epithelium seems the more common cause at that period, though the congested state of the kidneys, and the active exudation into them even then, requires the closest attention.

Liver.—This viscus was generally somewhat enlarged, its weight, when ascertained, was from three pounds twelve ounces to a little above four pounds, the subjects being small, or not above medium size. There was generally a flaccidity about it, giving the impression that the firmness and cohesion of the parenchyma was diminished. On cutting into it, the colour was found very different in different cases. In several it was of a uniform light yellow, with tinges of grey or brown in different individuals; in others this uniformity of colour was varied by congestion of the portal or hepatic capillaries, or of both, producing varieties of the rhubarb or nutmeg liver; in others, little or no yellowness was visible, and to the naked eye the parenchyma did not differ in appearance from that of health. There were other cases, again, in which the colour was olive or greenish; in one such the outlines of the lobules could be perceived on the surface of a section quite distinctly from the interlobular tissue, as if that formed a separate capsule; the latter was congested, while the lobule itself was comparatively bloodless. These varieties of colour were mainly owing to the varying quantities of oil, bile, and blood in the organ. When there was a large quantity of oil, as in a young, robust, healthy white man, the colour was most uniform, and there were fewest traces of blood in the capillaries, or the redness of that was so covered by the bile and fat, that there was merely a brownish tinge throughout the yellow. When the oil was less copious, the capillary congestion came out better, and was more intense; but, on the other hand, more or less of the nutmeg appearance was often visible in livers in which no oil was detected by the microscope. The olive or green colour was found only when there had been an early and more decided affection of the liver, and deeper bilious impregnation of all the white tissues in the body, than in ordinary cases, and in which there was more interstitial exudation in the liver itself than was common, with little or no oil.

In the class of cases last mentioned, there was tenderness over the liver, and yellowness as early as the third day of the disease; the peritoneal covering in these was opaline in places, thickened, and with a quantity of exudation containing numerous granules under it, and on tearing it off, more or less of the parenchyma adhered to it. In one

case, about two drachms of pus was found between the surface of the liver and the diaphragm, inside the coronary ligament, where the liver was not covered by peritoneum.

The gall-bladder was often distended by bile, and never was quite empty. The contained fluid varied from a mucus tinged yellow, to a dark-green or almost black bile, which in a thin stratum was of a yellowish-brown colour; and the quantity of fluid in it did not seem to depend on the ducts being unobstructed, for it was occasionally found quite full, though these were pervious. Late in the disease, stools were occasionally seen quite black to the unassisted eye, but which with the microscope were found to consist of mucus coloured with a deep-green bile, and similar matter has been detected in the small intestine in some of the fatal cases, though the whole of the white tissues in the body were deeply tinged with bile, so that even when there is sufficient retention of bile to produce jaundice, still a notable quantity may find its way into the intestine.

On putting a thin section of liver from a case of yellow-fever under the microscope, the following appearances could generally be made out at some part or other. The smaller branches of the portal vein were found to be imbedded in a layer of connective tissue, more or less abundant in different cases, of an opaline appearance, separating the vein from the lobules on either side, interposing between the vein and accompanying artery and duct, and separating these from each other to a greater extent than in a sound liver. When this connective tissue was neither very abundant nor very opaline, the condition of the artery and duct could be perceived distinctly, and smaller branches proceeding from the vein or artery, or to join the duct, could often be distinguished. The condition of the smaller vessels, whether arterial or venous, resembled that already described in connexion with the kidneys,—viz., they were covered with closely-set nuclei and granules, and the connective tissue in their neighbourhood contained more or less exudation and granular matter. The bile-ducts in the smallest portal canals sometimes had their epithelium distinct and tinged brown, at other times this was less distinct, of an opaline appearance, without the least trace of brown; in the former case bile seemed to have been passing through them to the last, and in the latter its passage seemed to have ceased; the former was found when there had been no jaundice during life, the latter in the more frequent cases where it was well-marked.

These appearances were continued from the lesser portal canals through the interlobular spaces, and into the lobules themselves, the smallest vessels in all cases being covered with nuclei, and surrounded with more or less connective tissue, which seemed to contain exudative material, clear in some instances and opaline in others. The connective tissue was very copious in the lobules occasionally, lying between the tubes of the cell-containing network, and towards the margin of the lobules occupying as much space as the tubes themselves, and the connexion between the two was so slight, that in

making a thin section, the one was torn from the other, and the tubes of the cell-containing network left bare at various points.

In every case in which death occurred about the usual period in the disease, the hepatic cells were found of a pretty deep brown colour from biliary matter. The formation of bile, therefore, had gone on, though, owing to the condition of the smaller ducts already described, it may have been detained in the lobule. The cells were usually somewhat granular, the nuclei not always distinct. In one case only have I seen the cells dissolving away, leaving a little granular matter in the tubes in their place; this was confined to the immediate vicinity of the smaller portal canals, and was in a liver with much interstitial effusion. The case was that alluded to above as having proved fatal on the twenty-third day. The cells were frequently altogether without oil-globules, or displayed a few very small ones only; at other times the liver was decidedly fatty, and large clear globules were seen, equal in diameter with the tubes, or even swelling them out to twice that of the portion occupied by the cells without oil near them. On examining a very thin section of a portion of fatty liver, the large oil-globules appeared as if between the tubes of the cell-containing network, but on separating these as much as possible, the oil-globules were always found attached to and partially imbedded in the hepatic cells, the smaller oil-globules were often quite imbedded in them, while none could be seen outside the tubes among the capillaries, unless at a later period, when considerable interstitial exudation had taken place. The deposition of oil in the liver corresponded with that in the subcutaneous connective tissue in amount, and must be regarded rather as a physiological phenomenon than as a pathological one, and seems quite unconnected with the disease, all the characters of which were found equally well developed when no oil was detected in the liver at all.

Some of the smaller branches of the portal vein, and more frequently those of the hepatic vein, contained quantities of clear granular matter without distinctly-formed fibres or cells; at other places, or frequently close to the former, there were distinct fibrillæ, and granular cells of the size and appearance of the white globules of the blood, the two presenting exactly the character of the fibrinous concretions generally found in such cases in the heart.

There is thus an active exudation into the parenchyma of the liver in yellow fever, and the symptom from which it has derived its name depends on the exudation process having embraced the minute bile-ducts, and closed them against the passage of the bile, of which there are abundant indications in the lobules. The affection of the liver, as indicated by the occurrence of jaundice and uneasiness in the hepatic region, does not always appear at the same period of yellow fever; sometimes there is no yellowness until after the urine has become albuminous and tube-casts have appeared in it; at others, there may be tenderness over the liver, and bilious vomiting, with yellowness, as early as the third day, and with the kidneys as yet not affected per-

ceptibly, though in the next two days the urinary symptoms follow the usual course. In such cases the yellowness of the conjunctivæ and surface becomes much deeper than in those in which the liver is implicated at a later period, the urine contains more bile, and blistered surfaces give out a deep yellow serum profusely; if there be a pulmonary complication (and it is not infrequent), the expectoration is green. So far as I have seen, there was much less urrhodine in the urine when the liver was thus early affected than when it became so later in the disease; the cases were more prolonged, too, and the convalescence much more tedious, than when this organ was less seriously involved.

Spleen and Pancreas.—These viscera have not received as much attention as the liver or kidneys. The spleen varied in size from what was natural to one weighing above a pound; its texture was normal in some, and friable or even pulpy in others. It had a greenish tint occasionally, when there had been much bilious impregnation of the other tissues in the body. The pancreas was examined in a general way only; nothing anormal was detected in it.

Stomach and Intestinal Canal.—The stomach was occasionally much contracted, so as not to exceed the ordinary size of the duodenum, but more commonly it did not present anything remarkable in this respect. The intestines, so far as I have seen, were much as usual after death. When the patient had taken little food for some days, or had had great irritability of stomach, it was most likely to be greatly contracted, and its mucous membrane was then found in longitudinal folds, with their free edges congested, and most probably with some acid mucus more or less tinged with blood in it. When the organ contained black vomit, its size was seldom diminished.

The contents of the stomach and intestines varied considerably in different parts of their course, and in different cases. The stomach sometimes contained nothing but a little mucus, or fluid the patient had taken shortly before death; at others, a little clear acid mucus—the white vomit of Blair; this was seen tinged reddish-brown by blood, or contained brown specks, the transition to black vomit, or it had gone on to black vomit, and a variable quantity of this was found. The duodenum and intestines presented mucus more or less opaque from the quantity of epithelium it contained, and variously tinted with blood or bile, or occasionally both together. In the colon the mucus had sometimes become consistent, and occasionally presented a yellow tint from bile; here, as higher up in the intestine, the other appearances were occasionally obscured by bloody matter.

The mucous membrane of the stomach was somewhat thickened and tender, giving way readily; it was sometimes much congested, and this was generally confined to either the cardiac or pyloric half. When the organ contained black vomit there might be patches of congestion here and there. When little black vomit had been formed, a large portion of the mucous membrane was often of a deep brown colour; when the quantity was greater, there was merely a number of

streaks or patches of a brown colour; when that was copious, the whole inner surface of the organ was free from colour. This appearance is owing to the impregnation of the epithelium of the tubular glands of the mucous membrane with the matter of black vomit, as already explained.* The congestion sometimes extended to the duodenum, and I have seen it there to a greater extent than in the stomach of the same body. There was seldom much fulness of the vessels of the jejunum met with, but in the lower part of the ilium and colon it was occasionally seen, though there were at the same time congestion or black vomit in the upper part of the canal.

One feature of the disease—the desquamation of the mucous membrane of the duodenum and jejunum—was very remarkable in several instances, the columnar epithelium not only being found copiously among the mucus in the tube, in a separate form, but large flakes of it were numerous in which the cells still adhered to each other side by side, and such flakes could be seen also still loosely attached to the membrane. This condition seemed most developed when there had been little black vomit or hæmorrhage, but a good deal of irritation of the mucous membranes.

In the former part of this paper it has been shown that black vomit is a secretion from the tubular glands of the stomach, and a case was given in which a similar one had taken place from the kidneys. I have met with some instances in which there was black vomit in the stomach without any having passed down the intestine, yet in the ileum the mucus, though clear at other parts, was of a dark-brown or reddish hue opposite the patches of Peyer's glands, and these were impregnated with a similar colour. The colon, too, occasionally throws off a bloody-looking fluid, and after death it is found confined to it, not extending beyond the ilio-cæcal valve. From this we may conclude that in yellow fever many other glandular organs beside the stomach may give origin to a matter resembling black vomit.

Small ulcers were occasionally seen in the ileum, cæcum, and descending part of the colon. These had raised surfaces, appearing as if covered with a patch of adherent feculent matter. Their position and size rendered it probable that they were connected with the solitary glands, which were more prominent elsewhere than usual. Cases of typhoid fever were by no means uncommon at one time, with the enlarged tumid patches of Peyer well developed, and leading to ulceration, hæmorrhage from the bowels, and in some to perforation of the intestine; these were quite different from the others as regards the enteric lesion, but most of them occurred in the same locality. At the same

* British and Foreign Medico-Chirurgical Review, vol. xxix. p. 483 (April, 1862). In two cases of typhoid fever in which there had been frequent vomiting of mucus tinged green, the lining membrane of the stomach presented large patches of a greenish colour. The analogy of the black vomit suggests that in these cases the mucus, tinged apparently with bile, came from the stomach itself, and was not a regurgitation from the duodenum. This will apply to the vomitings in malarial fevers pretty generally, I expect.

place an intermediate kind of case was not infrequent, in which the enteric lesion of typhoid fever was quite distinct, whole patches of Peyer's glands being tumid, and many of them ulcerated; while death was preceded by more or less bloody discharge from the bowels, albuminous urine with granular tube-casts, going on to suppression, yellowness of the conjunctivæ (most of these cases were in black men), and after death congestion of the mucous membrane of the stomach or duodenum, and a condition of the liver and kidneys closely resembling that described above. There was thus a gradual transition from uncomplicated yellow fever through one with small ulcers in the ilium, cæcum, and colon, to another with well-marked typhoid ulceration in the ilium presenting many symptoms and post-mortem appearances of yellow fever, and finishing the series by one characterized by the fully-developed enteric lesion of typhoid fever, terminating in perforation and death. Though the appearances peculiar to each form of the disease were distinct enough in the extreme cases, yet in the intermediate ones their development and combination were such that it was impossible to decide to which the case should be referred.

Brain and Membranes.—The frequency of head symptoms in the course of yellow fever renders an acquaintance with the condition of the nervous centres of much importance; but hitherto comparatively little has been done, with the improved means for investigation of the present day, to increase the amount of information which has long been available regarding them in this disease.

When there had been much heaviness, stupor, or coma before death, the membranes of the brain were always found with their vessels full, and the pia mater looked opaline from interstitial effusion, and there was a variable quantity of yellow serum at the base of the brain and in the ventricles. On removing the substance of the hemispheres slice by slice, red points seemed more numerous than in a healthy brain, and the consistence was in some cases less firm than usual, but in others there was scarcely a perceptible difference, though the head symptoms had been well marked. On subjecting portions of the brain to microscopic examination in these cases, more precise information was obtained, those which to the unassisted eye presented nothing unusual, then manifesting unequivocal indications of disease. In every case I examined in which there had been a well-marked affection of the head before death, the large exudation corpuscles were numerous in the white matter near the surface of the hemispheres; and the smaller bloodvessels and capillaries, which are difficult to detect in a healthy brain, were often seen extending beyond a cut surface, or even ramifying in the substance of the section when it was compressed, with their sides covered with closely-set nuclei, the same as already described in connexion with the kidneys and liver; it was more difficult to determine whether there was exudation surrounding these to any extent, but their appearance rendered this probable, while the exudation corpuscles showed that active exudation had been going on. Amyloid bodies were seen in some instances, but the exudation corpuscles just noticed had neither the firmness nor fracture of these, but under pressure merely became flattened. Softening of the upper surface of the cerebellum was found in the case of Goodwin, which was detailed in the first part of this paper (vol. xxix. p. 475), and a soft state of its whole surface in another case.

Head symptoms are always a source of anxiety in yellow fever, and they will sometimes take even experienced practitioners unawares by the suddenness of their onset, and their unmanageable nature, when it was thought all danger from them had passed. The following case will illustrate this point: Corporal Brownlow, a white artilleryman, aged thirty-seven, had been four years in Jamaica, and had given way to intemperate habits latterly. He was stationed at Fort Augusta, two miles across the harbour from Port Royal. On the 7th August, 1859, he had a paroxysm of intermittent, which came on in the forenoon, and went off in the afternoon. On the 8th, the second day of his complaint, he walked about ten miles in the sun, returning to the fort in the evening much fatigued, and with severe headache. On the third day fever came on about seven A.M., with severe frontal headache, and he went to Port Royal, which he reached at four P.M., and was taken into hospital, where the fever went off at six P.M., with profuse perspiration, and he then expressed himself quite free from pain. Ten grains of calomel, with as much quinine, were given, and he had a good night and slept well. On the fourth day he was quite apyrectic; the bowels were moved thrice during the night. Quinine in doses of five grains was given every six hours. I saw him about noon, when he expressed himself quite free from pain; there was a complete absence of fever; pulse 86; surface cool and soft; and he seemed in a favourable condition, save only a slight want of animation about the eyes, scarcely amounting to heaviness. Half an hour afterwards fever came on, with great heat of surface and severe headache; pulse 120. Notwithstanding the application of ice to the head, and a blister to the back of the neck, delirium ensued quickly; at three P.M. he was comatose, with slow respiration, and he died at a quarter to six P.M. There was no yellowness in this case. Three ounces of urine were found in the bladder, which was highly albuminous, and contained granular casts; the mucous membrane of the stomach and duodenum was much congested. The inner surface of the dura mater and pia mater were much congested; the substance of the cerebrum soft, but not otherwise changed in appearance; the cerebellum apparently healthy. Under the microscope the cerebrum showed numerous large exudation globules; the small arteries and capillaries were covered in every direction with closely-set nuclei, and a quantity of granular matter.

It is scarcely to be supposed that the morbid appearances in the brain in this case were produced during the last six hours of life, the history of the case is altogether opposed to it; yet if it be admitted that considerable active exudation had taken place into this organ previously, the complete subsidence of fever and the freedom from

pain from the evening of the third day until the accession of fever on the fourth, though there was active disease in the brain, is a remarkable circumstance, and the rapidity with which this led to coma and death on the fourth day no less so; not that they are rarely met with, but because the force of the local affection was so much governed by the phases of the fever. It is possible that on the evening of the third day the head symptoms might have run on to a fatal termination but for the profuse critical evacuation by the skin; but on the fourth day, ere this could afford relief the brain was so deeply implicated that death was inevitable. Every one who has had experience in the malarial fevers of warm climates must have encountered cases of this description now and then, and those best acquainted with their character will be most desirous of getting even the smallest information as to their nature, or the slightest hint for averting their danger.

There is another form in which a cerebral complication is found in fevers, but the accompanying fever is pure remittent or intermittent, and the urine remains copious to the last, and presents neither albumen nor tube casts. In this there is not more uneasiness about the head than usual in remittent fever, and there is neither increased fulness of the vessels about the head, nor any alteration in the senses, or mental manifestations to indicate that the brain is particularly implicated. The only peculiarity is the persistence of the regular accessions of fever, often slight in themselves, long after they should have given way in ordinary cases to the remedies employed. The patient, perhaps, cannot be persuaded there is anything serious the matter with him, and the medical attendant, though uneasy, cannot satisfy himself as to the cause of the fever going on in spite of his treatment, until at last, at the regular period of exacerbation, the patient experiences some unusual or unpleasant sensation about the head, congestion takes place rapidly, and within an hour or two he is comatose, and in a few more dead; or, the first indication of the implication of the head may be a convulsion, from which the patient never recovers, but which leads to a fatal termination even more quickly. Such cases are always a source of great anxiety to the medical attendant, even when fully alive to their nature; if he do not stop the fever, every paroxysm increases the mischief in the brain; and if he be not cautious in the measures he adopts to overcome the fever, he is very likely to increase the cerebral affection by his remedies, and so accelerate the result he is so desirous of averting. Every practitioner who has been long in the tropics, who will look back inquiringly on his past experience, cannot fail to recognise instances illustrative of both these difficulties.

Heart and Blood.—On opening the pericardium, serum, varying in quantity from half an ounce to ten times as much, and generally yellow, was found; the heart itself was rather pale, soft, and its cavities frequently distended. The cause of distension was found to be blood, or coagula of lymph, in variable quantities in different cases. Sometimes there was little lymph, the cavities being filled with dark

fluid blood; sometimes there were large coagula extending continuously from the hepatic veins through the auricle and ventricle into the pulmonary artery, and sometimes even into the ramifications of this vessel; in one case, a coagulum was withdrawn from it, which showed many distinct branches corresponding to the fifth subdivisions of the artery. These coagula were mostly met with in the right cavities, but sometimes smaller ones were found in the left, and there was a quantity of blood with them varying inversely as the size of the lymphy concretion. They were always lying free in the cavities of the heart and vessels, and nothing unusual was detected in the lining membrane of either, unless in one case, in which a portion of firm lymphy exudation was found adherent to the surface of one of the mitral valves, and the valve itself thickened. These coagula appeared to be larger and firmer in cases in which the liver was more severely affected than common; when the kidneys, intestinal canal, or brain were more implicated, they were less, or even absent. Their presence was perceptible during life by the distinct murmur over the origin of the pulmonary artery with the first sound of the heart.

Some of the American writers have stated that the heart in yellow fever was fatty; it is quite possible an individual with this organ so degenerated might contract fever, but fatty degeneration of it is neither a common nor necessary condition of the disease. I have never seen an instance of it. The soft undulating pulse of the latter stages of yellow fever, it is true, suggests an alteration in the condition of the muscular fibres, and on examination that proved to be the case, for on submitting a portion to the microscope they were found pale, rather opaline in appearance, not well defined, their transverse striæ indistinct, and with a very remarkable disposition to separate longitudinally into their component fibrillæ. The vessels among the fibres were all covered with closely set nuclei, and had a hazy outline, from exudation into and around them, and here and there a communicating capillary could be seen running across a fibre from one longitudinal capillary to another, in the same state. Portions of voluntary muscle from the same bodies presented none of those appearances, but had the fibres sharply defined, the transverse striæ well marked, and there was no disposition in the fibrillæ to separate from each other longitudinally; the capillaries were found at various points with clear membranous sides, with scattered nuclei, and without any trace of exudation around them. The heart thus appears to be subject to acute exudation in yellow fever, as well as the kidneys, liver, or brain, and the state of its actions in the latter days of the disease is obviously connected with this condition.

It seems still a common belief that the blood in yellow fever is in a dissolved state, and that exudation of this from the vessels into the surrounding tissues is the cause of the yellowness. The blood, however, is not dissolved, but the globules remain distinct and well formed, and the yellowness of the serum depends on the colouring matter of bile, as indicated by its changing to green on the addition of nitric acid.

I have examined portions of serum from the brain, pericardium, or from the blood itself, for urea, and have always obtained indications of it. For this purpose the albumen was coagulated by heat, and removed by filtration, the filtrate evaporated to dryness over a water-bath, and the residue exhausted by alcohol. On concentrating the latter, and adding solution of oxalic acid, crystals of oxalate of urea were obtained. In several instances the process was continued by adding an excess of solution of oxalic acid to the residue of the alcoholic solution, filtering, and agitating the filtrate with ether; on removing this, and allowing it to evaporate spontaneously, there were traces of hippuric acid; the fluid remaining after the removal of the ether being neutralized by carbonate of lime, evaporated to dryness, and extracted with alcohol, gave unequivocal indications of urea.

In several instances, a few drops of nitric acid were added to serum, and the whole boiled to remove the albumen. After separating the latter, the fluid remaining gelatinized on cooling. If treated with acetic acid the serum did not give this result.

Lungs.—The condition of the lungs varied much. Sometimes they were remarkably free from anormal appearances, even from the hypostatic congestion of fatal cases, and contained very little blood, though both sides of the heart were distended by it. At other times there were the traces of acute active disease in them. This was occasionally in the form of congestion of the mucous membrane of the trachea and bronchi, with bloody mucus in the tubes, and accompanied by more or less pneumonic condensation. Occasionally there was pneumonic condensation alone of a portion of the lung, and in one there were numerous small portions throughout the lungs, in front when there was no general congestion, as well as behind when there was much, from the size of a millet-seed to that of a filbert, which were firm, of greyish-yellow colour, and surrounded by a narrow line of congestion. Under the microscope these showed the air-cells filled with epithelial cells in a granular condition. Exudation into the pleura was not met with in any decided case of yellow fever.

Division III.—Form and Causes.

There is still much difference of opinion among authors on yellow fever, whether it be a disease of one paroxysm followed by a lull, in which the hæmorrhages or other fatal symptoms occur, or of a remittent character. Many authors whose opportunities of observing it were great, claim for yellow fever a distinctly remittent, or in certain cases an intermittent form; while others maintain that the remissions, if these occur at all, are nothing more than slight diminutions of the symptoms or abatements in the morbid feelings, and not remissions in the true medical acceptation of the term. Some of this divergence may be attributed to the varieties in the form of the disease in different climates or localities; but at the same place, and even in the same case, some medical practitioners will designate that a remission, which others regard a mere diurnal oscillation of symptoms quite unworthy of the name.

It may be asked, then, what constitutes *a remission?* The answer, I apprehend, can only be, that diminution in the febrile symptoms observed in cases of remittent fever, in localities where that disease is common. I have had considerable experience of remittent fever, personally, during rather a prolonged service on the coast of Africa, and when no other form than remittent was prevailing. In numerous attacks I found my pulse, during the exacerbation, was very rarely above 96, and in the remission not lower than 92. The exacerbations came on in the afternoon, and continued until about four the following morning, after which the headache, heat of skin, and feverish restlessness gave way, and there was a slight moisture inside the wrists and across the forehead. On the accession in the afternoon, these were replaced by the original symptoms, and much to the same extent. The comfort and relief during this abatement of the symptoms was very marked as compared with the feelings during the preceding or following paroxysm; and it would have been difficult to convince me that the one was not a decided remission, in fact, whatever it might have been according to theory, while the other was an exacerbation, not attended with great acceleration of pulse perhaps, but still with such an accession of fever, restlessness, wakefulness, and other disagreeable symptoms, as to leave no doubt of its nature, and create a strong desire for the return of the remission. I have had numerous opportunities of observing the same in others. The pulse, it is true, will generally alter a little more than in my own case, but very often does not differ above eight beats between the exacerbation and remission, though I have met with some in whom the change was only four. The amelioration is perceptible in such cases rather in the diminution of the restlessness and feverish oppression, than in the pulse or heat of surface. Many expect a remission to present an abatement of fever almost equal to a complete intermission, and will not apply the term to anything less marked. I can only say that in my experience this was not very common, and in far the greater number of cases it was as described above.

Authors seem pretty well agreed that the following peculiarities are characteristic of yellow fever:

1st. A febrile disease, usually terminating in convalescence or death from the fourth to the seventh day; but it may be as early as the second, or as late as the tenth or twelfth, or even later.

2nd. There is generally yellowness of the surface, and, in case of death, the same of all the white tissues in the body, commencing at various periods in different individuals or epidemics.

3rd. In the course of the disease the urine becomes much diminished in quantity, and often is nearly or altogether suppressed. These are more particularly seen from the third day onwards.

4th. The alvine discharges are devoid of the natural feculent appearance, especially from the third day onwards, until the disease gives way.

5th. As the alvine and urinary secretions assume these peculiarities, there is a great tendency to black vomit, or discharges of similar

matter from the bowels, or to hæmorrhages from the various mucous passages, or even the skin; and on death such may often be found in the intestinal canal when not manifested during life.

Though a case present most of these characters, those who attribute contagious properties to yellow fever declare, when remissions are mentioned in connexion with it, that he who mentions them must have mistaken an endemic remittent for true yellow fever. The remittent, they allow, may occasionally present yellowness, and even something approaching the appearance of black vomit, but state that it rarely proves fatal before the eighth, ninth, or tenth day, or causes suppression of urine, or the peculiarity of the alvine evacuations noticed in yellow fever. Instances are not rare, however, in which a fever distinctly remittent proves fatal by the fifth day with these characteristic symptoms, and black vomit as well. Nevertheless, as there may be a doubt as to the form of the disease when all these are not fully developed, it is of importance to obtain some symptom, or combination of them, diagnostic of yellow fever, and which will serve to distinguish it, whether fatal or not, from the other forms resembling it that may occur at the same time and place.

The diminution or suppression of urine is a constant feature in yellow fever, which the investigations of Collins, Blair, and others have shown to be accompanied by albumen and tube-casts, and farther conditions connected with which have been more fully developed in the previous part of this paper. Blair, at an early period, found that in ordinary intermittents the urine did not contain albumen, and immediately saw the value of the distinction in diagnosis. In Jamaica I found the same peculiarity: there were certain cases with all the appearance of ordinary remittents and intermittents, in which, though watched from day to day, there was no trace of albumen, or the other albuminous substances particularized above, found at any time; and there were neither desquamation of the bladder or uriniferous tubes of the kidneys, nor material diminution of the chlorides in the urine. There were other cases of fever, again, sometimes under treatment at the same moment in contiguous beds, in which the urine contained albumen, &c., presented the desquamation of the bladder and kidneys, and the absence of the chlorides, occurring in the order and at the period of the disease described above. These cases all presented other characters of yellow fever, and some terminated fatally, with black vomit or hæmorrhages, from the fifth to the seventh day. Therefore, without asserting dogmatically that the urine must present these in every case of this disease wherever it may arise, it seems quite justifiable to designate any in which they do occur, at the period, and in the succession previously detailed, as undoubtedly yellow fever. With the means of distinguishing them admitting of such precision, and so easily put in practice, the diagnosis between the yellow and other forms of fever will acquire much more certainty, and the relations between them be made out in a clearer manner than has hitherto been done.

With the advantage of this means of diagnosis, I have no hesitation

in confirming the observations of many of the older observers, that yellow fever, in Jamaica, is frequently remittent, or sometimes even an open intermittent; and that, in cases of this nature that prove fatal, death takes place for the most part on the fifth, sixth, or seventh days of the disease, usually with yellowness of the surface, black vomit, or other hæmorrhages. The disease, therefore, answers the character of true yellow fever, and is not merely a yellow bilious remittent, which many who endeavour to prove the contagiousness of yellow fever assert.

The following case shows the disease in its remittent form, and illustrates many of the other points dwelt on in the previous part of this paper. Sergeant P. Sheehan, a European, aged twenty-nine, had been eight months in Jamaica—five at the mountain station, Newcastle, and the last three in Kingston, as a clerk in a public office, but had not had fever. After some days' indisposition he had a paroxysm of fever on the afternoon of the 31st August, 1859; but the following morning, feeling better, returned to his office. On the 1st September, or the second day of the disease, fever ensued again about one P.M., with severe frontal headache, suffusion of the eyes, and slight vomiting. Happening to be at his office at this time, I sent him to hospital. On the third day there was a remission in the morning; at two P.M., the exacerbation took place, with irritability of stomach and bilious vomiting, but the headache was less than the previous day. The cutaneous capillaries were injected, giving a dusky-reddish colour to the surface; and when any part was pressed, the marks of the fingers were left bloodless for a little, while the intermediate spaces retained their colour. Stools consisted of a fetid dirty mucous-looking matter, tinged with bile. Urine scanty; on acidulating some passed in the afternoon with nitric acid, it displayed a little albumen, and with nitrate of silver very little chlorides. On the morning of the fourth day there was a remission again, which at two P.M. was followed by the exacerbation. At five P.M., there was moderate fever, the capillaries of the surface much injected, and a copious eruption, resembling lichen tropicus. The marks of the fingers remained after pressure, as on the previous day. The tongue was furred in the centre, red at tip and edges; the stomach much less irritable. Stools more feculent in appearance, and less fetid than the previous day. There was a sense of weight across the loins, but no tenderness on pressure or percussion. A portion of urine passed this morning, after standing a little, presented a sediment of one-fourth its bulk. This consisted almost entirely of scaly epithelium from the bladder, with a few slightly granular tube-casts from the kidneys. The urine, after being filtered, was of the colour No. 6 by Vogel's scale;* specific gravity, 1023 (at 60°), and strongly acid. It contained a moderate quantity of albumen, also of casein, very little urea, scarce a trace of chlorides, but a good deal of hippuric acid, creatin, and apparently creatinine. On the fifth day there was the usual remission in the morning, only

* Thudichum's Pathology of the Urine, Plate 8.

more complete, the skin cool and moist; pulse 80; and there was no exacerbation in the afternoon. A portion of urine passed this morning presented a sediment nearly as copious as that of the previous day, but which consisted of tube-casts, mostly very granular, with traces only of epithelium from the bladder. The contents of some of the casts were tinged brown. The colour and constituents of the urine, otherwise, were the same as on the fourth day of the disease. From the fifth day there was no return of fever, the skin acted well, the papular eruption disappeared, the urine became copious, and the convalescence was uninterrupted. On the eighth day the tube-casts were much less numerous, and the chlorides decidedly increased in quantity. On the ninth there was no indication of albumen with nitric acid, and the chlorides were more plentiful. He returned to duty quite well on the thirteenth day.

This case, though slight, is interesting in many respects; it was the first attack in an unacclimated European; it presented the frontal headache, the injection of the conjunctivæ and skin, alteration in the alvine discharge, diminution of urine, and the duration of cases of yellow fever; the appearance of albumen in the urine on the third day, of scaly epithelium from the bladder on the fourth, and of tube-casts from the kidneys on the fifth, with great diminution of the chlorides and increase of the albumen from the third to the fifth days, are all well marked, and leave no doubt as to its having been true yellow fever. The form was distinctly remittent throughout, the patient himself remarking on his freedom from fever in the forenoon. The appearance of the eruption on the fourth day, together with the desquamation of the bladder and more feculent character of the stools, accompanied as they were by less irritability of stomach and a more moderate exacerbation in the afternoon, show these to have been critical efforts, insufficient to prevent the febrile paroxysm at a later hour that day, but enough to moderate it, and to obviate its renewal the next. Had the improvement in the stools not taken place, secretion of hæmatin from the kidneys would likely have occurred, of which some of the casts on the fifth day gave indications by their brown colour; and had the kidneys also ceased to act, black vomit might have been looked for. The rapid improvement of the case under the opposite conditions is well marked, and is of value in suggesting the plan of treatment.

In the following case, as well as that of Brownlow, given above, the fever seems to have been intermittent in form, though the account is not quite so precise on that point as desirable. Thomas Coker, aged twenty-five, a black soldier, employed as policeman in barracks at Up Park Camp, in Jamaica, had a paroxysm of fever on the afternoon of Monday, the 17th May, 1858, which induced him to go to hospital the following morning, where he received some medicine, and was excused duty for the day. On Wednesday, the third day, he felt better, and went to his duty in the morning; it could not be ascertained subsequently whether he had had fever that afternoon. On the fourth day he was pretty well in the morning, but a paroxysm of fever

came on in the afternoon, with vomiting. Next morning, the fifth day, he walked to the hospital at 7 A.M., being then feverish, inclined to drowsiness, with soreness in pharynx, and pain in swallowing. Conjunctivæ yellow; tongue red at tip and edges, white in centre; pulse small and quick; condition of the stomach, bowels, and urinary organs not noted. After admission he vomited once, and passed some urine, which were thrown out without having been examined. At half-past one P.M. he brought up a small quantity of black vomit, and died immediately. On examining the body three hours after, the white tissues were all of a pretty deep yellow colour. The stomach contained a pint of acid black vomit, its mucous membrane was somewhat congested in parts; that of the duodenum and jejunum was thickened, as if about to desquamate, and the solitary glands were enlarged like those in cholera cases. The mucous membrane in the lower part of the ileum was somewhat congested. The liver was rather large, flaccid, and presented congestion of the hepatic and portal vessels, with a circle of yellowish-grey colour between. Gall-bladder distended with dark fluid bile. Spleen rather large and pulpy. Kidneys enlarged and congested; bladder contained a quarter of an ounce of urine only. This case was well marked yellow fever appearing in a black man, a circumstance I have found of more frequent occurrence than many authors lead us to suppose. The congestion of the lower part of the ileum accompanying that of the stomach and duodenum, and the enlargement of the solitary glands, deserve attention in connexion with what has been already stated regarding typhoid complications.

These cases are corroborative of the opinion entertained by the older writers throughout the West Indies and Southern States of America, that yellow fever is often a remittent, or intermittent, and consequently, that whatever may be the form it presents in other localities where the ordinary causes of periodic fevers may be less common, yet when they are rife, the yellow fever so closely resembles their more common products in many of its features, and so coincides as to time of appearance and locality with ordinary remittents, as to suggest a community of origin, the resulting disease taking the guise of yellow, or pure remittent fever, for reasons all of which we are not yet well acquainted with. The following table of the mortality among the troops at the chief military stations in Jamaica, between 1804 and 1820, will show its regularity according to season. The deaths from all diseases are included, but as about five-sixths of them were from fever, and when numerous generally of the yellow form, the table will give a pretty fair idea of the periods of activity of the causes of fever. To facilitate comparison, the numbers in the table have been calculated on the assumption that 1000 men died at each station, but the actual number of deaths is given also.

Mortality in each month in 1000 deaths from disease, among the white troops at the undermentioned stations in Jamaica, between 1804 and 1820:—

Month ending	Port Royal, 1807 to 1820 (14 years).	Spanish Town, 1804 to 1820 (17 years).	Up Park Camp, 1804 to 1820, excluding 1819 (16 years).	Up Park Camp, 1804 to 1820, including 1819 (17 years).	Stoney Hill, 1804 to 1820 (17 years).
January 20th .	65	94	75	64	110
February ,, .	37	45	37	30	79
March ,, .	75	43	28	22	42
April ,, .	101	45	26	21	21
May ,, .	91	33	32	28	17
June ,, .	90	40	34	30	25
July ,, .	50	71	43	52	32
August ,, .	65	83	80	125	66
September,, .	120	66	95	127*	91
October ,, .	89	106	156	145	231
November,, .	112	152	263	227	183
December ,, .	105	222	131	129	103
Year . . .	1000	1000	1000	1000	1000
Total deaths recorded in period	536	995	1929	2398	967

These stations are all on the south side of Jamaica, and within sight of each other; the distance from Port Royal to Spanish Town being about nine miles in a direct line, to Up Park Camp five miles, and to Stoney Hill ten miles. They differ in the time of occurrence of the least and greatest mortality, and, while Spanish Town, Up Park Camp, and Stoney Hill have each a single minimum and maximum in the course of the year, Port Royal has an earlier minimum than either, and a maximum in April, when the others are about their minimum; and maxima occur again in September and November as well. The table has been brought down to 1820 only, as up to that time the troops seem to have been retained at the different stations whether they were healthy or not; the severe fever epidemic of 1819 induced a deviation from this system, and the remains of the 50th and 92nd Regiments, which had suffered so terribly from it at Up Park Camp, were removed in August and September. Similar movements took place in subsequent epidemics, so that the records for the periods embracing these give a less correct view of the activity of the morbific influences at each than those previous to 1820.

These facts show that fever in Jamaica is a disease of season, the period for which is well-defined at each station, and that these periods differ materially at different stations, though in the immediate neighbourhood of each other. Each retains its distinctive features to this day, though now they are never permitted to develope their powers to any extent, the troops being removed as soon as fever threatens to be serious. The experience of other countries is to the same effect, the yellow fever in all observing regular periods of increase, culmination, and decline, which are partly dependent on the climate, partly on circumstances more immediately connected with particular localities, as at Port Royal.

* In consequence of the severe epidemic of 1819, most of the troops were removed from Up Park Camp in August and September, and did not return until December, which gives a considerably different result if 1819 be included. Previous to this year the troops do not seem to have been removed, however sickly the season.

Many illustrations of the power of local causes to generate yellow fever, can be obtained from the countries where the disease is common; but some, taken from a place where fever of this form is rarely met with, and when there was no question of importation to complicate it, may be more convincing. The subjoined cases are particularly interesting in this respect; the subjects of them were men of the 36th Regiment, stationed with their company at Vido, a small island in the harbour at Corfu, where they were employed removing a considerable depth of moist alluvial clay for the foundation of a water-tank; both seem to have been drinking freely before their attack. It is to be remarked, that at Vido there is some peculiarity leading to fever, as it is stated in the 'Statistical Report on the Sickness and Mortality among the Troops in the Mediterranean' (p. 41), that between 1817 and 1836 the majority of the cases of remittent fever in the returns for Corfu were derived from Vido.

Private J. Culleton, aged twenty-six, while employed as abovementioned, was attacked with fever on the 22nd of August, 1850. The following day, the second of the disease, he was admitted into the Regimental Hospital at Corfu, in a state of considerable prostration; the heat of surface but slightly increased; pulse small and frequent; tongue coated, with a brown, dry streak in centre, but moist and clean at edge. On the third day the prostration continued, and there was oppression at the præcordia, nausea, and vomiting. Lemon colour of the surface, with little elevation of its temperature; pulse 136, small and unsteady. On the fourth day the surface was moist; pulse 110; tongue moist and cleaner; yellowness increased; stomach irritable. During the night he had passed three ounces only of a high coloured, turbid urine. On the fifth, the yellowness was deeper, temperature of surface natural; pulse ninety-four; the nausea and vomiting rather less; alvine evacuations offensive, and wanting in bile; passed six ounces of urine only since previous morning; an eruption of bullæ filled with a yellowish serum, with some purple discoloration about their bases, had appeared on the arms and chest. On the sixth day, the yellowness was deeper; pulse continued the same; no urine had been passed; and there was a fixed pain in the region of the right kidney, for which he was cupped to six ounces. On the seventh day, the suppression of urine continued. In the evening, a purgative enema brought away an offensive motion without bile. The eruption did not present an increased number of bullæ, but they were larger, and their contents had become a dirty, sanious pus, or were mixed with dark-coloured blood. On the eighth day, after having been wandering all night, there was epistaxis; the functions of the liver and kidneys were still suspended; the stomach irritable, the matters ejected of a dark, grumous character from admixture of blood. Death occurred at midnight.

On examining the body, the mucous membrane of the stomach was found softer than natural, and congested in parts, more especially

about the cardiac orifice. There was fulness of the vessels, with effusion of blood beneath the mucous membrane in the ileum and rectum, but no trace of ulceration anywhere. The liver weighed five pounds two ounces, its colour was between olive green and dark brown; structure friable, and capillaries congested. Gall-bladder full of dark-coloured bile. Spleen soft, easily broken up. Kidneys almost double their usual weight; much congested, with some muco-puriform matter* on the lining membrane of the calyces and uriniferous tubes. Bladder quite empty, but healthy. The low fever, its abatement from the third day, the diminished secretion of urine on the fourth, and want of bile in, or ordinary feculent appearance of, the stools from the fifth, are all characteristic of yellow fever, and serve to distinguish the case from any of the other forms of fever. But for the eruption on the fifth day, black vomit, or hæmorrhage from some mucous surface, would probably have appeared on that day, and even this did not obviate the epistaxis and black vomit on the eighth day.

The other case was that of Private G. Hargrave, who was attacked on the 17th September, at Vido; but I have no detail of symptoms before the 19th, the third day of the disease, when he was admitted into the General Hospital at Corfu. There was then much debility present, with headache, soreness of chest (part not specified) and abdomen, and pains in limbs; heat of surface slightly above natural; pulse small, weak, and frequent; bowels acting freely from medicine given at Vido; tongue thickly coated with a brown fur. On the fourth day the headache and uneasiness in chest and abdomen continued; the skin and conjunctivæ were yellowish; pulse less frequent, rather firmer; was purged during the night; urine rather scanty, high coloured, depositing lithates freely; tongue as yesterday. In the evening the fever was less, but was much troubled with flatus. On the fifth day the surface was cool, the yellowness increased; stomach irritable, and vomited after taking anything; tongue coated, but moist and clammy at the edges; bowels freely moved during the night, when he passed a few drops of urine; pulse 96. On the sixth day the fulness at the epigastrium and irritability of stomach had increased, and become distressing; the yellowness was deeper; no alvine evacuation or secretion of urine; pulse 100. In the evening an enema brought away some hardened lumps of offensive slate-coloured fæces. On the seventh day there was considerable drowsiness, stomach rather less irritable; pulse 100, smaller; no urine secreted. In the evening there was one liquid stool, containing some clots of blood, and only one ounce of turbid, high-coloured urine passed during the day. On the eighth day there was again increased irritability of stomach, and he was passing dark-coloured offensive liquid evacuations from the bowels, containing much dark liquid blood; tongue brown and dry; pulse thready; temperature of surface failing. These symptoms increased, and he died at eight P.M.

On examination after death, the surface of the lungs was found

* Most likely tube-casts, but the matter does not seem to have been examined with the microscope.

mottled with dark red spots of active congestion; they contained much fluid, with considerable hypostatic congestion. The mucous membrane of the stomach, towards the pyloric orifice, and the upper part of the duodenum were intensely congested. The intestinal glands were free from ulceration, but throughout the jejunum, ileum, and colon there was exfoliation of the mucous membrane, the epithelium lying in ragged patches on the subjacent membrane, beneath which there was extravasated blood. The liver weighed four pounds; its texture was softened and portal capillaries congested; gall-bladder full of dark-coloured bile, ducts pervious; spleen of usual size, very friable. The kidneys weighed seven ounces each, and were much congested; bladder contracted, and did not contain a drop of urine. This case, like the former, presented a commencing diminution of the pulse and fever on the third day. The yellowness was first perceived the following one, when also the scantiness of urine attracted attention, which subsequently was almost completely suppressed. The irritability of the stomach on the fifth day, the light-coloured alvine evacuations noted the following one, and hæmorrhage from the bowels at last, are all characteristic; and the congestion of the pyloric portion of the mucous membrane of the stomach and of the duodenum, the desquamation of the intestinal mucous membrane, congested state of liver and kidneys, and empty bladder, leave no doubt whatever that the case was yellow fever of a malignant description. The supposed deposit of lithates on the fourth day, from its immediately preceding suppression, was most likely a sediment of epithelium from the bladder or tube-casts, or both. It does not seem to have been examined by the microscope, nor with the view of seeing whether it really were composed of lithates. The treatment in both cases was judicious; it consisted of quinine, with cupping over the loins and epigastrium, and external warmth. Mild saline diuretics and diaphoretics also were given, to promote the flow of urine and determine to the surface, and wine and nourishment as required.

These cases were the only ones presenting the characters of yellow fever seen at Corfu in 1850, and there was no question of importation to suggest a doubt as to their origin. The men were stationed on a small island which had previously produced much remittent; they were engaged excavating the soil, an operation which has often proved hazardous to those engaged in it; and their susceptibility was heightened by free indulgence. Under these circumstances they contracted fever, which proved to be the yellow fever; and it can be attributed to no other cause than the emanations from the soil to which they were exposed in the island, if not actually in the work on which they were engaged. The cases are particularly valuable. They were recorded by officers who had no theory to support. The notes, of which the above is an abstract, were communicated by Dr. Jopp, surgeon of the regiment.

I have encountered yellow fever in Barbadoes, Sierra Leone, and Jamaica; and after the best consideration I could give the facts which presented themselves, am firmly impressed with the belief that the

evidence they afford was quite in accordance with the origin of the disease from local causes, and irreconcileable with the opinion that it either arose from, or was propagated by, contagion. General statements were often submitted to me which would have borne a different construction, but on a full examination of the circumstances they were said to embrace, their insufficiency became apparent, and the deductions from them fell to the ground. It would occupy too much space to give details for all these, but I may here refer to the outbreak at Newcastle, in Jamaica, in 1856, an account of which appeared in the number of this Review for October, 1859, p. 445.

Newcastle is placed on the crest of a sharp ridge, so narrow that in several places there is space for a single barrack-room only. The cantonment occupies something under 800 yards of the ridge, within which distance it falls from 4120 feet to about 3500 feet above the sea. Here, in August and September, 1856, cases of yellow fever showed themselves in persons recently from the low ground, and on the 17th and 18th September, two men in the same ward of the hospital with the last case, and who had not been away from Newcastle for months, were attacked. After this the disease appeared in two houses near the hospital, and subsequently in other parts of the cantonment, and before the end of December had proved fatal to forty-five persons. This general statement is correct in every particular mentioned, and would be received by many as incontestable evidence of the contagiousness of yellow fever. Most of those advanced for this purpose are of the same description. Its insufficiency for this purpose will be obvious, however, and these facts appear in a very different light, when it is explained that, on tracing every person to his place of residence at the time of attack, it was found that there were four zones in the cantonment, embracing all the rooms and tents across the ridge, which enjoyed immunity almost complete from the disease. These included, and alternated with, three others, in which the disease appeared; and the hospital and rooms where the first cases occurred were in one of these unhealthy zones. But the proofs in favour of local causes did not end here. Other patients and attendants on the sick having been attacked in the hospital, it was cleared, and another opened on one of the healthy zones; and though the unhealthy situations continued to afford fresh cases, which were removed to this as they occurred, the disease could not extend itself from them to the attendants or others at a point not 200 yards from where they originated.

In every instance I have met with yellow fever among the troops, the limits within which it appeared were well defined, though the positions of danger and immunity did not alternate so remarkably as at Newcastle. Facts of this description, of which there are many, show the unsoundness of the evidence in favour of contagion sought to be derived from the spread of yellow fever among persons in an unhealthy locality, or from its non-appearance among others in quarantine who may happen to be placed in a healthy one; they prove, also, that sickly spots may be very limited in extent, and may adjoin

others that are healthy, and that these may even be mixed up together in a manner wholly irreconcileable with the notion of the extension of the disease by personal communication. It would be well, in any attempt to prove that crowding or other personal influences were instrumental in extending yellow fever, to admit these facts, as unless this be done, no sound advance can be made in our information on the subject.

If yellow fever arise from the same local causes which at other times produce remittents or intermittents, it may be asked whether the emanations from these are merely more concentrated, as some suppose, or are somewhat changed—whether, in short, there be merely a more concentrated poison, or another with somewhat different properties produced. The latter view represents the facts better than the former, for were the poison more concentrated only, all cases of yellow fever should be more severe than remittents, whereas there are many cases of the former well-marked, even in unacclimated Europeans, which are as slight as the slightest remittent, and sometimes scarcely sufficient to detain the patient in bed. On the other hand, pure remittents may be so severe as to prove fatal in four or five days. Again, yellow fever is sometimes produced by the emanations from the holds of ships,* which are not known to give origin to intermittents or remittents. It has been observed, too, that heavy rains either suspend the production of the poison causing yellow fever, as seemed to be the case at Newcastle, in November, 1856,† or alter its nature so far that most of the fevers which appear during their continuance are mild remittents only, as occurred at Sierra Leone in the epidemic years 1823, 1829, 1837–8, and 1847, though when the rain was succeeded by fair weather, whether at the end of the rainy season or during a break in its middle, yellow fever presented itself, in the latter case to be supplanted again by the remittent on the recurrence of heavy rain.

A further proof that the emanations causing yellow fever are in some respect different from those giving rise to remittents, is derived from the symptoms of the former itself. Its peculiarity, as compared with remittents, consists in the desquamation of the bladder and uriniferous tubes of the kidneys about the fourth day, the cessation of the secretion of colouring matter by the colon about the same time or earlier, and the early active exudation into the substance of the liver and kidneys, leading respectively to jaundice and suppression of urine; the black vomit and haemorrhages, and irritation and exfoliation of the mucous membrane of the small intestine, when they occur, seem to be consequent on the suppressed function of the colon, kidneys,

* This does not refer to the odour of "bilge water," as it is called, which is well known from the sulphuretted hydrogen it contains, but to an emanation arising from a foul hold in a sailing vessel, and more frequently met with of late years in steamers and vessels which have carried coals to the tropics. Of the first, Bancroft gives many instances in his essay and sequel; many also are mentioned by La Roche. Others are noticed in the Reports on the Health of the Navy; and a very striking one in the Address of the President of the Epidemiological Society, Transactions, vol. i. p. 139.

† British and Foreign Medico-Chirurgical Review, Oct. 1859, p. 479.

and liver. In ordinary remittent, the functions of these organs are less frequently suspended, and very rarely so early as in yellow fever; the system can, therefore, go on relieving itself from time to time by partial critical evacuations, and, provided the brain do not become seriously affected, the patient has a fair chance of recovery. The occurrence of desquamation of the uriniferous tubes, and the other symptoms connected with them, on the fourth and fifth days in the yellow form of the disease, coincide in time with the natural remissions of the second tertian period, and are therefore to be regarded as critical efforts, and their appearance is undoubtedly connected with some peculiarity in the poison from which the disease originally sprang. Being of a critical nature, it is quite possible they might appear during the first tertian period in some cases, or not before the third or fourth in others, but for the most part they are met with in the second period, or between the third and fifth days of the disease.

Can a fever originally of a continued form present, at an early period, an affection of the kidneys and other organs such as those which have been shown to characterize the remittent forms of yellow fever, and, on their appearance, remit and assume the other characters of the latter disease? The reply, it seems to me, must be in the affirmative, as most who have seen yellow fever must have met with cases in which there was no apparent remission until the fourth day, or later, when the urinary secretion became diminished, and albumen was found in it. There is nothing extraordinary in this, if the affection of the kidneys be regarded as a critical effort, for a sufficient crisis will at all times resolve a fever, of whatever form it be, and though in our experience in this country such seldom occur, and the continued fevers are usually extended over a long period, yet in warm climates, where pure synocha is met with, it is otherwise, for a sharp attack of that is frequently terminated by a profuse sweat on the fourth or fifth day, and the patient may be able to move about within a week. It must be admitted, therefore, that yellow fever may present a continued as well as a remittent or intermittent form, the course of all these being assimilated only after the lesions peculiar to the disease come to be developed.

Fevers in tropical climates are by no means so simple or well-defined in their forms on all occasions as many suppose; on the contrary, they are often very complicated. I have known cases commence as remittent, and continue as such to from the sixth to the tenth day, having an intermission on the morning of these days, yet the same afternoon fever recurred, which soon took on the character of yellow fever, and proved fatal on the fourth or fifth day of that form, with black vomit and other unmistakeable symptoms of this disease. I have seen in other cases which commenced as intermittent, diarrhœa ensue, and after three or more tertian periods, the fever became continued, and assumed the character of typhoid fever, and ultimately presented the affection of the kidneys and urine seen in yellow fever, and then terminated in death. On examining the

bodies, the intermixture of the morbid appearances peculiar to yellow and typhoid fevers were detected in variable proportions, as already detailed. The cause of the typhoid complication in these cases was a privy immediately in rear of the building from which they came, but to windward of it at night; this had a deep cesspit, which had been emptied, and thus exposed the additional surface of the sides, as well as the bottom, to give off emanations. On clearing the building of its inmates, the typhoid complication disappeared. These facts show that yellow fever is not a complaint separate and distinct from all others, but that it becomes mixed up with them in various ways, according to circumstances.

Division IV.—Treatment.

There are cases of yellow fever so slight that they get well with little or no treatment; there are others, again, and unfortunately they are much more numerous, that seem doomed from the first, and in which treatment is of no avail. The number of the latter varies much in different epidemics, but under all circumstances they may be expected to cause a high mortality, quite beyond the power of medicine to prevent. There are many, however, between these extremes, in which the disease endangers life, and in which an enlightened and discriminating treatment may avert a fatal result: such a plan of treatment is still a desideratum in this disease.

Treatment is naturally divided into means for resolving the disease during its course, and those for meeting the various morbid actions which arise when that is unchecked, and the evil consequences resulting from them. A few remarks on each in connexion with what has gone before, though they have no pretension to be considered as more than an outline, may serve to clear away some of the obscurity in which thewhole subject is involved.

Blair, at Demerara, employed large doses of calomel and quinine as early as possible in the disease, with the view of checking it; the quantities he employed were twenty grains of the former and twenty-four of the latter, which he repeated every six hours, for several times, if necessary. This medicine acted freely on the bowels and skin, and, according to his experience, was often sufficient to cut it short. The same practice has frequently proved successful in Jamaica; but, according to Dr. Davy, it was not attended with beneficial results at Barbadoes; and the American practitioners at New Orleans have not found it answer their expectations in stopping the fever, while the large and frequently repeated doses of quinine were often highly injurious. This discrepancy may be explained in part by the fact, that fever at Demerara generally, and in Jamaica very often, is of the periodic form, and yellow fever when it arises will retain more or less of the same peculiarity; in such, if the fever can be checked, and the system brought under the influence of quinine, that medicine may prevent another paroxysm, and thus obviate the affection of the liver or kidneys when these have not actually commenced. At Barbadoes,

on the contrary, though periodic fevers are not unknown, they are not common, and when yellow fever arises, it is apt to have a continued form, and not be amenable to the anti-periodic influence of quinine; hence its exhibition there was not likely to be equally beneficial. This explanation, I apprehend, will apply to a considerable extent to New Orleans; for although there were abundant sources of remittent fever around that place, still in the city itself, when many of the cases of yellow fever originate, the causes will be rather those peculiar to large towns, with the surface more or less covered in, than to the more exposed places where remittents are common. The calomel is a very essential part of the treatment; it acts powerfully on the colon, causing a profuse dark pultaceous stool, and seems to anticipate that condition of the intestine when its secretion ceases. I saw a case of yellow fever at Barbadoes cut short by an emetic, followed by strong purging with calomel and sulphate of magnesia, but without quinine, while another, attacked at the same time, and in the contiguous bed, in which these measures were not adopted, went on to black vomit and death. These were men in hospital, and were brought under treatment within a few hours after the fever had declared itself. The practice deserves notice, though I have not many cases to adduce in support of its efficacy.

Blair, who recommended these large and frequently repeated doses of quinine in yellow fever, at first thought he had never seen them act injuriously; subsequently, however, he altered this opinion; but many still believe they do no harm. In 1847, at Sierra Leone, I saw coma induced in a robust adult female labouring under remittent fever by a dose of quinine of fifteen grains only, at a time when much larger were commonly exhibited; and though she had no more fever there was for a considerable period afterwards so much fulness and uneasiness in the head as to induce caution in the employment of this medicine with others. I have seen or heard of several other cases of coma from over-doses of quinine, and have known a good many men in whom even moderate quantities, not exceeding twenty grains in twenty-four hours, have brought on at least congestion of the membranes of the brain, which could not be distinguished from meningitis, unless perhaps by the readiness with which it gave way to a large blister on the back of the neck. The experience of the physicians at New Orleans is to the same effect; the frequency of deafness, blindness, partial paralysis, and other consequences of injury to the nervous centres, by the too free exhibition of quinine, has rendered them more cautious in their use of it. The fact seems to be, that many persons can take large quantities of this medicine without further inconvenience than a temporary singing in the ears, while others are much more sensitive to it, and smaller quantities are sufficient to induce serious disease of the brain. So far as I have seen, there is no certain means of distinguishing these. It is satisfactory, however, to know that most of the beneficial effects of quinine can be obtained with smaller doses, if not so quickly on all occasions, at least with less risk. During the latter years of my service at Sierra Leone and

the Gambia, I never gave more than fifteen grains of this medicine in the day, and though living in the midst of severe remittents, found the results not less satisfactory that when large doses were employed, while the bad effects were rarely encountered.

Should the effort to cut the disease short have failed, or should the patient not have been seen until it was too late to attempt it, the object of the medical attendant will be to moderate excessive action in any organ, and endeavour to bring about as complete a crisis as he can about the fifth day, the natural period of resolution in the disease. For this purpose nothing is of more importance than to re-establish the secreting function of the colon and to obtain feculent evacuations, not mere bilious discharges—for a patient may have these and yet die—but proper dark-brown feculent stools. But how to bring about this desirable result is the difficulty. Violent measures of any kind are not likely to be successful at this period of the complaint; and the best devised will but too often prove ineffectual. Gentle excitement of an extensive portion of the lining membrane of the colon, with frequent copious enemata of tepid water, or any bland fluid, or these rendered more stimulating with any of the ordinary substances employed for this purpose, deserve a full trial; powerfully stimulating enemata of any description, or drastic purgatives, will only serve to increase the mischief. Should the case present violent purging, with or without blood, which is sometimes the case, this of course would be inapplicable.

Should a natural alvine secretion be obtained, it is not likely there will be much further trouble with the case; but if, as will too often happen, it is not, the next condition demanding attention will be the state of the kidneys. The congestion of these on the fourth and fifth days will require watching, so as to diminish the chances of suppression of urine, and to bring about a more natural secretion, so far as that can be done by reducing the congestion, and preventing the closure of the uriniferous tubes by accumulated epithelium. This point has not received that attention it deserves, though it is obvious that serious diminution of the urinary secretion will inevitably aggravate the other symptoms, if it do not induce a fatal result. Cupping, either dry or with the abstraction of blood, and frictions with stimulating liniments over the loins, have proved useful; these, with warm baths, or still better, hot-air baths, deserve a full trial; not that they will cure every case, or even a large portion of those in which they may be required, but they afford the best chance of relieving the kidneys, and may save life under circumstances otherwise all but hopeless. Small doses of acetate of ammonia with potash or soda, or their salts in common use, with diaphoretics, so as to act gently on both kidneys and skin, may prove beneficial, in addition to the other measures.

Local abstraction of blood, counter-irritation, and a variety of medicines calculated to relieve urgent symptoms, or check excessive discharges, can be had recourse to as the judgment of the practitioner may suggest. The patient will often derive much comfort, or troublesome complications be kept in check for a little, by a discriminating

employment of these; but inasmuch as all the conditions calling for them seem to be but efforts of the system, whether by secretion from a mucous surface, or exudation into the parenchyma of an organ, to rid itself of what under ordinary circumstances should have passed by the bowels, kidneys, or skin, unless the functions of those parts be restored, remedies directed specially to other organs are but palliatives, useful in their way, no doubt, but still not striking at the root of the evil.

The administration of alcoholic stimulants in yellow fever requires notice, as they are often pushed at a time when, to say the least, their use is very questionable. When a patient is very low, and the heart's action weak and languid, it is necessary to employ wine or brandy to maintain life; and provided the kidneys be unaffected, large quantities of either can be given, it may be with benefit, at all events without serious injury; but when the kidneys are congested, and still more if secretion has ceased, the alcohol will accumulate in the system if given freely, until it either cause irritation of the bowels and diarrhœa, or pass off through the lungs. I have known the air in a large room in which there was a window and door always open, to be so impregnated with the vapour of brandy given off with the breath of a patient in yellow fever, that it was disagreeable; and I have seen the lungs of another who had suppression of urine, and died of the disease, so impregnated with brandy that they gave off the odour of it from every part as strongly as if they had been steeped in it for some time. A patient whose life is already endangered by the embarrassment of the kidneys and intestinal canal, is not likely to have his chances of surviving increased by so drenching him with alcohol; the congestion of the kidneys will be most certainly increased, if it have not as yet gone beyond what is compatible with a restoration of function, and the irritation of the bowels will only present a further obstacle to a healthier action on their part.

These remarks are necessarily very incomplete. All practice in yellow fever must at present be more or less empiric, and we can expect to substitute more rational plans only as our knowledge of the diseased actions and their results becomes extended. It is much to be desired that the alvine evacuation should be as fully investigated both in health and disease, as the urinary has been; but even then, until the transformations of matter in the system during the secondary assimilation are more fully understood, we shall not be in a position to develop a really scientific practice in this disease.

I was indebted to the various medical officers who served with me in Jamaica for their assistance in carrying out the investigations on which the above remarks are based. The details of cases were obtained from their records, though I saw many of them frequently myself, and was present at nearly every post-mortem examination. All the remarks on the urine and morbid appearances of the various organs are from my own observations.

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NUMERICAL ANALYSIS

OF THE

PATIENTS TREATED IN GUY'S HOSPITAL

FOR THE LAST SEVEN YEARS,

FROM

1854 TO 1861.

From the Journal of the Statistical Society of London, September, 1861.

Numerical Analysis *of the* Patients *treated in* Guy's Hospital *for the last Seven Years, from* 1854 *to* 1861.

By John Charles Steele, M.D., *Superintendent of Guy's Hospital.*

[Read before the Statistical Society of London, 18th June, 1861.]

The accompanying series of Tables have been drawn up with the view of illustrating the annual amount of relief afforded to the community through the agency of a large Public Hospital, and are submitted to the Society in the hope that they may prove serviceable for purposes of reference and comparison with similar sources of information. Their scope embraces all the persons that have passed through Guy's Hospital for the last Seven Years, and the analysis of each year has been separately made from the records, of which they present a faithful abstract. In originating the registration, my desire was to combine a convenient register of the patients admitted and discharged, for the ordinary business purposes of the hospital, with some facts of more vital interest relating to the nature of Disease and results of Treatment, and so arranged, as to obtain with facility at the end of each annual period a general *resumé* of results. In order to accomplish this, it was found necessary to furnish each patient on admission with a card, containing his name, age, and date of admission, similar information having been already entered in the Hospital Register; and on the occasion of the patient's discharge, this bed card has been completed by the filling up of three remaining entries — representing the date of discharge, the result of residence, and the nature of the disease or diseases and injuries, as far as it is possible to obtain accurate knowledge. These details are subsequently re-entered on the dismission side of the register, on a line corresponding with the entries on the admission side; which, in addition to the facts furnished by the card, takes note also of the previous residence, employment, social condition, and other matters tending to identify the patient. In cases of Accident, the cause of accident is entered on a separate column; and where operative interference has been judged requisite, the nature of operation, and other details bearing on the history of the patient are registered in a separate record. After much experience of the vital statistics of hospitals, I cannot help regarding a system of registration organized in this way as perhaps the only one that will admit of uniformity, and although its meagre character may be objected to on medical grounds, it is sufficiently comprehensive for reference and comparison, while it sedulously avoids all matters that admit of colouring or fallacy. To attempt more would require much additional machinery, and is far better left to the many diligent cultivators of clinical details, who abound in every London hospital, and whose labours are weekly analyzed and reflected from the pages of our medical journals. The plan proposed by Miss Nightingale at the last meeting of the International Statistical Congress, was in most respects similar to the arrangement adopted in the accompanying tables, differing only in the manner of registration by substituting sheets for cards, and by a more rigid adherence to the nomenclature founded on the death register of the Registrar-General. The mode of registration is merely a matter of choice, and may be dealt with accordingly; but while fully admitting the desirability of adhering to one uniform system of nosology, I apprehend that in practice much difficulty will be experienced in attempting to systematize individual diseases; while every hospital establishment, especially if allied with a medical school, will be disposed to employ those terms of nomenclature which use and wont have made familiar to its rule.

Guy's Hospital, founded in 1722 for the reception of 400 patients, contained at the commencement of the septennium under consideration accommodation for 520 individuals. Since that time its benefits have been still further increased by the addition of nearly fifty beds, while its internal organization has undergone much alteration and change, mainly with the view of meeting modern requirements with respect to the successful treatment of the sick. To facilitate this, as well as to utilise the practice of the hospital for scholastic purposes, wards have been exclusively allotted for accidents, clinical, ophthalmic, uterine, and venereal affections, while the great bulk of the accommodation, amounting to 376 beds, is subdivided among what are ordinarily termed medical and surgical patients, in proportion to the relative claims for admission and the influence of disease on the sexes. One noticeable result of this classification, is the great similarity which obtains on a comparison of the returns of the practice of one year with another, an analogy rendered more obvious, by the fact that no limits are assigned to admission, save those necessary to meet the ordinary requirements of the hospital. The presence or absence of epidemic disease in the metropolis does not materially influence the induction, as contagious diseases are inadmissible, and the epidemics of childhood are, for the most part, treated at home. The first year of the septennium, however, presents features which renders it an exception to the rule laid down. On referring to the table, it will be seen that the deaths in 1854 exceeded by 25 per cent. the same results in the six subsequent years; a fact that is to be explained by the prevalence of cholera during the period, and the unusual facilities which the patients had, for a time at least, of obtaining admission. In other

respects the diseases and mortality of one year are but a reflex of another, and the combined results indicated in the tables may be accepted as having occurred in pretty equal proportions annually during the entire period under consideration.

The first Table of the series gives a collective return of the Total number of patients who have passed through the hospital from 1854 to 1860 inclusive, indicating also the results attending their residence, while the second takes note of the same numbers subdivided among the respective years, and includes also an enumeration of the class registered as out-patients. In estimating the amount of relief afforded, the division adopted into cured, relieved, unrelieved, and died, will be found, on experience, best adapted for questions of this nature, as it distinguishes a tangible result in every case. It is the plan now usually employed by hospital statists, and for the sake of uniformity it is desirable that it should be universally adhered to. It is no less desirable, however, that the exact meaning of the terms employed and the latitude which each embraces, should be fully understood, as fallacious inferences are not inapt to be drawn from a misinterpretation of the terms. The two first divisions, "well" and "relieved," represent two great measures of relief—the maximum and minimum, the relative proportions being 66 per cent. of the former to 25 per cent. of the latter. With reference to the class designated "cured" or "well," it is well known to those accustomed to hospital practice, that the meaning intended to be conveyed is not an absolute and permanent recovery from disease in all cases, but that it includes a very large number of cases where a restoration to temporary health is the utmost that can be expected. In fevers and in the greater number of surgical diseases, especially external injuries and patients subjected to operative interference, no doubt can exist as to the credibility of the return; while in a large mass of cases represented by the return "well," the amount of relief afforded must be accepted within circumscribed limits. The same remark is equally applicable to the division "relieved," which embraces 25 per cent. of the entire cases. Under this latter heading are included a large, perhaps the greater portion of the patients whose classification might, with equal propriety, have been inserted in the category of incurable cases, were it not the fact that they had received benefit from their temporary residence, and were discharged much better in health than they were at the date of their admission. The heading indicated by "unrelieved," is shown to average 8 per cent. of the total numbers discharged, and is interesting in consequence of its affording illustration of a fact that is often called in question, namely, that a considerable portion of cases deemed incurable are annually admitted to the benefits of the hospital. This average would of course be much increased in amount by the addition of the many cases of hopeless

disease that have died in the hospital; and it will be obvious, on reflection that in proportion to the facilities for admission given to patients at large, more than to any sanitary defects in hospital organization, are we to attribute the large mortality which obtains in the more liberally conducted hospitals, when compared with others where it is customary to reject persons suffering from chronic disease. Another circumstance not to be lost sight of in estimating comparative mortality, is the length of residence of the patients. It will be noticed, on referring to the table, that the average stay of each person has varied in respective years from thirty-two to thirty-five days; and on examination of details, it will be discovered that, in proportion to the length of residence, the chances of recovery become smaller. This fact is more marked in cases of chest disease than in any other class of affections, and as the class in question far outstrips in fatal results any of the others mentioned, the influence of the prolonged residence will become still more apparent.

The third and fourth Tables represent the annual changes that have occurred in the two great departments of the hospital, medical and surgical, distinguishing the sexes and noting the relative mortality. It will be observed that the results of treatment are in each department more favourable in the case of females than males, in consequence of the less liability of the former to attacks of acute disease. The great disproportion in the mortality between the two subdivisions is not less significant, for while in the surgical wards it averages less than 6 per cent., in the medical department it is rarely less than 14 per cent. of the numbers treated.

In Table V an attempt has been made to solve the question whether death occurs more frequently at one period of the day than another. An idea prevails extensively that some law of periodicity influences the period of dissolution, and favours the supposition that the death-struggle terminates an hour or two after midnight; but the data recorded do not support this assumption. They rather lead to the inference that the death term is pretty equally distributed over the whole diurnal period, although it is interesting to note the fact that the hours of midnight and noon are less marked with fatal results than the others, the proportion of deaths during these two hours not amounting to more than 115, or the 21·3 part of the entire cases.

Table VI comprises, under fifteen distinct headings, the various forms of disease treated in the hospital during the period named, along with the estimated results in each class. The plan adopted will be considered defective by many, in consequence of its collective character precluding the possibility of comparison with such tables as those of the Registrar-General; but, on the other hand, it is to a great extent free from errors of diagnosis and the fallacies which are

so apt to arise in an individual disease list, from the association and complication of diseases in the same person. On reviewing the different classes in the table, it may be noticed that diseases of the *organs of respiration* occupy, as might be anticipated, the most unfavourable position as respects mortality, the deaths amounting to more than one-fourth part of the total number affected with diseases of this class, and to no less than 27 per cent. of the total deaths from all cases. Consumption, in its numerous varieties and complications, numbers 537 of the 813 deaths, or 18 per cent. of the total mortality. This item in our accounts, after all that has been said about unhealthy site and overcrowding, is in reality the cause of the chief discrepancy in results when we compare the mortality of one hospital with another, for in proportion to the cases of consumption received, to the exclusion of diseases of a less grave character, so must the mortality of all hospitals be influenced. It would be as unfair, for instance, to compare the total results of treatment of such hospitals as Guy's or Bartholomew's with similar annual results of the practice of the London Hospital, where the accommodation is almost exclusively of a surgical character, as it would be to draw a similar comparison with the periodic reports of such establishments as that for consumptive cases at Brompton or the hospital for incurables. In the report of the Statistical Society on Hospital Statistics, it was ascertained that the deaths from consumption alone in the practice of the London hospitals amounted to rather more than 16 per cent. of the total mortality. It has already been noticed that the number of deaths from this cause at Guy's, has averaged 18 per cent.; and it would not be difficult to show that a similar large estimate of mortality has attended the course of other affections usually regarded as incurable. But independent of the mortality register, there is abundant evidence in these tables to show that so-called incurables partake largely of the benefits afforded by a general hospital, and that no form of physical suffering is excluded from the wards. The large class of sufferers, classified *as unrelieved* or worse on their dismission, bears witness to this assertion, and testifies to the occurrence of a period when hospital treatment exhausts itself, indicating, at the same time, the want of an asylum suitable for their reception. It is frivolous to believe that the small modicum of accommodation supplied by one or two establishments, instituted with the avowed object of meeting this want, can relieve more than an inappreciable number. The natural consequence is, that a majority of these cases find a final refuge in the workhouse, while the remainder continue a burden on their friends or relations, who, in many instances that have come under our notice, have exerted themselves in their behalf at the expense of other, and sometimes more urgent, claims on their resources. The most feasible

attempts that have yet been made towards diminishing the evil, consist in the efforts of a benevolent society, recently instituted, for the object of introducing into the incurable wards of workhouses, many of those home comforts and conveniences that are found in general hospitals, and in other ways of promoting the comforts of the inmates. If in addition to those laudable efforts this society could prevail on the Poor Law Board to double the amount of its present minimum cubic space for each hopeless case of disease, it would confer an incalculable boon on the sufferers, and render the success of its own mission more hopeful and assuring.

Next in mortality to diseases of the respiratory organs, and still more significant of future fatal results, as shown by the larger percentage of cases unrelieved, are diseases of the *heart and blood-vessels, and dropsies*. From the former have been excluded numerous instances of cardiac disease, associated with affections of the respiratory organs, as well as rheumatism; while the latter heading, perhaps more open to objection in a strictly pathological sense than any other in the series, has been arranged solely to meet a want arising from the complicated nature of those affections, and can only be accepted as exhibiting an approximation to the number in which the dropsy formed the most distressing symptom.

Diseases of the *organs of digestion* number 2,222 of the cases analysed, and were followed with 431 deaths. In this number are included the cases of cholera already referred to, and which were attended with 65 deaths, as well as all the cases of hernia, which contributed 71 deaths to the total mortality. If these two diseases are excluded from the list, the fatal consequences will not appear so formidable, the percentage mortality being thus reduced to 16.

The numbers entered in the class of *venereal diseases* show a maximum of numbers and a minimum of mortality when compared with the others. Two wards, male and female, in the upper floor of the hospital have been set apart for their reception, the former accommodating twenty-four and the latter thirty beds, and generally speaking there is little difficulty experienced in keeping both fully occupied. On the female side, cases are continually applying for readmission, so that the table, of necessity, includes a considerable number who have passed through the hospital more than once, but who are there represented as separate individuals. On the male side the reverse is the rule, for readmissions in this department are less frequent than in any other portion of the hospital.

The four sections of the disease table, from the eighth to the eleventh inclusive, represent nearly 10,000 *surgical cases* properly so-called, and include in the category all injuries and diseases arising from external violence, the result of accident or intention. The two classes embracing diseases and injuries of bones and joints are

remarkable for the small fatality attendant on their sojourn in hospital; but it is proper to notice, that in addition to ordinary diseased joints, the ninth section comprises all the cases of rheumatism that have occurred in the hospital during the period mentioned. These usually average from 190 to 200 cases annually, and as the mortality pertaining to them is almost *nil*, certainly not more than 1 per cent., it would be nearer the mark to fix the rate of death among the purely surgical affections at 6 instead of 3·3 per cent. The greatly increased mean residence of persons suffering from diseased joints, is a feature in connection with the class worthy of note; and as is the case with other groups of disease characterized by long stay in hospitals, the amount of benefit conferred becomes reversed in proportion as the columns headed "relieved" and "unrelieved" abundantly testify. In this respect, scrofula, which is the primary source of these affections, bears a similar relation in surgical ward practice to that held by consumption in the medical wards, and is even more chronic in its career, although at the same time it is not usually attended with fatal results.

Under the class, *fevers*, are enumerated besides the ordinary continued fevers, the various exanthems, as well as cases of ague and also the milder forms of febrile disease, the whole combining to reduce the total mortality from these affections to 8 per cent. Excluding the latter from the calculation, the mortality in the severer forms of fever usually known as typhus and typhoid, is increased to 12½ per cent., or about 1 in 8 of those attacked, a death-rate that will be found to mark a fair average of results in all establishments where proper hygienic precautions are used to promote a successful issue. With this view it has been customary to place patients suffering from fever in those positions most likely to be favoured with a constant renewal of the atmosphere, and in as isolated places as possible, consistent with the general requirements of a medical ward. Notwithstanding the proximity of these cases to the general patients, little harm has been found to ensue from the practice, although at the same time precautions are taken to restrict as much as possible the admissions of persons suffering from febrile diseases to the same apartment. In the event of the disease proving epidemic in the locality, such an arrangement could not be carried out with impunity, as it is a fact fully established by observation, that the concentration of the poison appears to develop its inherent contagious influence.

The last or fifteenth section of the disease table, comprises a motley group of affections, the most prominent of which are intemperance, destitution, gangrene, uncertain or unascertained diseases, malingering, and patients admitted without any disease. It is obvious that these will form a considerable proportion of the patients

admitted annually to all hospitals, and that no system of classification can be arranged to place them in a scientific nomenclature. The utmost that can be done is to reduce the section to the smallest possible limits consistent with truth by distributing diseases of uncertain seat—such as rheumatism and scrofula, under some other subdivision allied to them through a prominent system. With this object, the former complaint has been placed under diseased joints, while the latter, with more justice perhaps has been chiefly distributed over the eighth, ninth, and eleventh sections according to the prominent manner in which it manifested itself. Notwithstanding the curtailment, the total cases amount to 876 of the entire number classified in the table.

Table VII, representing the *ages of the patients*, possesses some features worthy of notice. It will be observed that a considerable proportion of cases entered are children, of which 1,135 are under 5 years, and 2,703 are under 10 years. These patients are usually distributed among female adults, and have cots assigned them in the relative proportion of about one cot to every five beds. It is understood that this arrangement answers better than one adopted in former years of having separate wards allotted for the purpose, as by the present plan the little sufferers are, as a rule, better looked after and from their diminished number they can be more readily quieted. They are admitted with all forms of disease, with the exception of those contagious maladies which debar them even from the benefit of institutions set apart for the exclusive reception of children, and which a wise experience has demonstrated are much better treated at home. The mortality at different ages is well illustrated by the table. Under 5 years we have the uniformly large proportion of deaths associated with the most critical period of life; the major portion of the deaths, however, are not those that we find swelling the death-roll of the Registrar-General at this early age, but are chiefly attributable to external injuries from burns, while a smaller proportion are assigned to croup and tracheotomy. The class in the table, including these injuries, presents by far the largest proportion of deaths under 5 years, the numbers quadrupling at the same age those entered under the section of respiratory diseases, usually the most prolific cause of the casualties of childhood. From 5 to 10 years the deaths diminish from 16 to 6½ per cent., and are still mainly attributable to burns and scalds. After this, the mortality diminishes, the quinquennium between 10 and 15, presenting a death-rate of only 4½ per cent.—the smallest in the series. It now increases gradually, and in pretty equal proportion through each quinquennial period till it reaches 80 years, the decennium preceding this term being marked with a death-rate of 18½ per cent. After 80 the debt due to nature is repaid with compound interest,

the mortality being 33 per cent., or twelve out of the total number of thirty-six patients who were admitted to the hospital over 80 years of age. The intervening years, betwixt 15 and 30, will be observed to furnish by far the largest proportion of patients to this, as they do to all hospitals for the sick, not less than 14,000 of the total number being entered under the above ages.

One of the columns of the hospital register distinguishes the *countries* in which patients have been born, and an analysis of this column has been made in Table VIII appended to the series. Foreigners are usually afforded every facility of admission to the endowed hospitals, and the data in the table prove that they are in the habit of fully availing themselves of the privilege.

Another column, exemplified by Table IX, refers to the localities in town or country, from which patients are brought. A partial analysis only of this table has been made, comprising 5,000 of the patients, chiefly under treatment during the year 1859, 3,000 of which were admitted into the surgical division, and 2,000 into the medical wards. Though limited to one year, the numbers are sufficiently comprehensive to indicate, under a general estimate, the proportion of inmates furnished by town and country. The subdivision under three headings represents the patients admitted from the districts situated within and without the parliamentary boundaries of the metropolis, the terms Middlesex and Surrey being used to indicate those districts on each bank of the river within the boundary. It is not unusual to hear stated as a matter of regret that two of the largest metropolitan hospitals should have been placed in such close proximity to each other as Guy's and St. Thomas's; and there can be no doubt, locally speaking, that it would be a great convenience to the sick poor of the densely populated localities south of the river, if they were placed further apart; at the same time it must be borne in mind that no difficulty is experienced in filling the wards of each hospital, nor are they limited to the districts of the boroughs of Southwark and Lambeth, for their supply of inmates. It will be noticed that more than one-fourth part of the number who have received benefit from the Charity, is furnished by the districts lying north of the river, chiefly St. George's in the East and Whitechapel, localities that are generally supposed to be succoured by the London hospital. There is another fact brought to light by the table that ought not to be lost sight of. In calculating the respective numbers, a marked disproportion is observed to exist between the medical and surgical patients received from the Middlesex side, when compared with the analogous admissions from our own localities, a circumstance that can only be explained by the want of accommodation for medical patients in the north-eastern districts of the metropolis. These facts are fully borne

out by the experience of St. Thomas's Hospital, which in other matters closely resembles the data afforded by these tables. Of patients received from the country, by far the larger number arrive from the three neighbouring counties, south of the River Thames, and as a rule preference for a particular hospital is to be judged of, from its convenient position more than to any supposed superiority in its interior administration. Notwithstanding this, a certain proportion of cases are annually received from the provinces, from localities already furnished with asylums for the sick poor, and not a few show a partiality for this, as they do for other hospitals, in consequence of recommendations made by medical gentlemen formerly associated as pupils with the hospital.

Table X presents us with a summary of the more important *surgical operations* performed during the period in question, and gives a fair estimate of the palpable benefit arising from this interesting and important field of observation. There is perhaps no department of hospital statistics that has been more diligently cultivated by individual inquirers than that of operative inteference in surgical disease, and there are none so liable to be trammelled with the influence of personal bias in favour of, or in condemnation of, particular operations. This evil, chiefly attributable to the miscellaneous nature of the information from which a deduction is made, is perhaps less felt in the field of hospital experience than in any other, for here it is not difficult to discover and to make due allowance for those unities of time and place which possess such a vital influence on the results of practice. On this account also, the experience of one hospital, when the returns are sufficiently comprehensive, is more to be relied on than that obtained in mass from several similar sources, where in all probability the data have been collected under widely different circumstances. It is absolutely essential in judging of results that antecedent distinctions should be carefully made, and at the outset of all inquiries similar to those we are at present engaged in, there arises no greater fallacy than that which springs from a desire to incorporate large numbers, with the view of arriving at foregone conclusions. In the table of operations are arrayed in the category of simple operations as well as under more complex headings, a large proportion of individuals, whose physical condition is by no means adequately expressed by the classification adopted nor indeed is it possible under any classification to take note of the numerous casualties which complicate operative success in particular hospitals. It is well known to all conversant with our public institutions, that prior to a patient's seeking an asylum there, especially if he is labouring under any unusual form of surgical disease, he has generally had the advice of the regular, and not unfrequently has submitted to the treatment of the spurious practitioner. The conse-

quence of this state of things, by no means improves the ultimate results, and if we deduct, as we are in fact necessitated to do, no inconsiderable proportion of cases whose favourable character for operation has already induced the medical practitioner to interfere on their behalf, our means of judging of average success and fatality become still more doubtful and unsatisfactory. The important question with reference to amputation is one that has frequently been attempted to be solved by the statistical method, but however, useful and instructive a collection of data from authentic sources bearing on the subject may be, it is far from probable that it would influence the surgeon in his attempts to save life or limb. An inherent persuasion acquiring strength from personal experience and observation, and untrammelled with dogmas, unless of an individual kind, is doubtless the incitement to action in the majority of instances in question. The natural tendency of the mind to become conservative is also nowhere better shown than in the field of operative surgery, and without venturing on an assumption that would appear arrogant we cannot withold an impression that in proportion to the experience obtained, the repugnance to amputation renders itself more manifest, and thus the results of operation are in consequence more fatal, and to appearance unsatisfactory. It is from the class of patients registered as secondary amputations from injury, that we have to ascribe an unusually high rate of mortality in hospital practice, and at the same time we are bound to draw an inference from this source, that the laudable attempts to save limbs have not been unattended with success, notwithstanding the fact that their existence is ignored in the operation list and consequently they cannot appear to the credit of the surgeon. These remarks are not made in any apologetic tone, but are simply intended as facts to guide us in forming an estimate of the results contained in the tables, and without which it is impossible to arrive at any correct conclusions. In the list of operations submitted, there are no fewer than 383 cases wherein amputation has been performed. These numbers include, however, many minor operations, and to facilitate reference the following reduced classification of what are usually called capital operations, will be found better suited than that employed in the larger table.

The proportion of males to females who underwent amputation is in the ratio of 4 to 1, and the deaths will be noticed in the extended list to be somewhat greater in the former than in the latter; the numbers, however, are not sufficiently comprehensive to draw conclusions from. The next section in the table refers to the excision of tumours, of which operation there are no fewer than 446 instances registered, by much the largest subdivision in the operation list. The pathological characters of the tumours, as far as they could be determined, as well as the sexes of the patients, are entered on the

table. It is noticeable that the female sex suffers in a much greater degree than the male from this class of disease, the proportion being rather more than two of the former to one of the latter, and that

Amputation of	Total.	Primary.			Secondary.			For Diseases.		
		Cured.	Died.	Mortality pr. Cnt.	Cured.	Died.	Mortality pr. Cnt.	Cured.	Died.	Mortality pr. Cnt.
Thigh	106	6	11	64·7	2	8	80	66	13	16·4
Leg and foot	58	8	9	52·9	3	6	66·6	25	7	21·8
Shoulder and arm	28	10	9	47·3	4	2	33·3	3	—	—
Forearm and hand	32	14	1	6·6	3	—	—	13	1	7·1
	224	38	30	44·1	12	16	57·1	107	21	16·4

tumours of the female breast average nearly 33 per cent. of the total cases. Of mammary tumours by far the largest number are classified as cases of cancerous disease, the proportion being about 2½ to 1 of a miscellaneous character; but it is proper to notice that many of the cases entered on the list have been the repeated subjects of operation, although only registered afresh after being discharged and readmitted to the wards. The next section in the table comprises excisions of diseased bones, a most fertile source of surgical interference in all hospitals. Under this head have been analysed 265 cases, of which 57 are referable to the bones of the the upper, and 161 to those of the lower extremity. The numbers indicate a class of operations in which perhaps the minimum amount of amelioration is obtained in proportion to the length of residence of the patients, those marked unrelieved, being for the most part subjected to subsequent amputation of the diseased limb, and they consequently reappear in the previous part of the table. Males outnumbered females in the proportions of 201 to 64, and the mortality as usual was also greater in the former than in the latter.

The section indicated by the heading of *reparatory operations* represents a most interesting class of cases where attempts have been made to remedy natural and accidental deformities, through the plastic influence of the tissues in the immediate neighbourhood of the parts involved. The results obtained are highly suggestive of the benefits to be hoped for, in what are often assumed as a most hopeless class of cases, and although the numbers unrelieved, are higher in this than in any other department of operative aid, the inference is not less favourable to judicious attempts at reparation.

The important operation of *lithotomy* is entered as having been performed 93 times during the period and as having been accompanied with 16 fatal results. A glance at the ages of the patients

operated on, for stone is appended to the table, and shows how the operation may be classed as one of the most hopeful as well as one of the most formidable and fatal in the whole category. Under the age of 18 years the mortality rises no higher than 8 per cent., while from 18 to 50 years it averages as much as 24 per cent., and after the term of life last noted five out of six cases proved fatal. The returns of lithotrity are even less favourable in the aggregate than the other, but it is of importance to notice that the ages of the subjects of this operation were mostly of an advanced character, and that the greater number were operated on several times, a circumstance that is sometimes lost sight of in the preparation of similar returns, where each separate crushing is instanced as an individual operation.

It was noticed at the outset of these observations to be the misfortune of sick hospitals to receive into their wards a very numerous class of patients after the ordinary surgical appliances have failed to ameliorate their condition. In no section of the long list of operations does this fact obtain with more force than those comprised under the term herniotomy. The records of hospitals in relation to this particular operation are certainly very unfavourable, and there are few Hospital Surgeons who have not had reason to condemn and to deplore the practice of receiving patients suffering from the disease in question, days, and sometimes weeks, after all manual attempts at reduction have proved hopeless, necessitating the alternative of an operation, which under the circumstances is little better than death itself. Of the entire number registered, it will be noticed that 51 persons underwent the operation for inguinal hernia; the form of disease usually affecting the male sex, of whom 26 recovered and 25 died. The results of operations in femoral hernia, to which females are more peculiarly liable, has been considerably more successful, 68 having been cured while 39 died.

Of operations on the eye, the last subdivision of the list, little need be said. These refer specially to the more important class for improving and giving sight, and have been performed under the most favourable circumstances, as the success attending them abundantly testifies. The two casualties which are entered as having occurred after the operation of extraction, are due one to cholera, and the other to chest disease occurring in an old man who died in another department of the hospital. Similar extraneous results have determined the fatality of a certain proportion of the cases entered in the operation list, and which appear of a trivial character to be attended with fatal consequences. The operations having proved successful it would have been perfectly justifiable to have entered them on the first column of the table, but as supervening complications will always, even under the most favourable circumstances, be associated in some degree with general results, it has been deemed

advisable to transcribe the issue of each case from the termination of the patient's residence in hospital.

Table XI of the series presents under twenty-two separate sections the several cases of accident that have been admitted to the hospital during the period in question. The division adopted gives an excellent illustration of the causes leading to injury of the person to which a great city population is continually liable, as well as the danger to life involved by each separate class. The relative numbers from individual causes of accident are very similar in a comparison of one year with another, and it is presumed that a similar, if not a larger, proportion of cases presenting like features of cause and effect are annually taken into St. Thomas's Hospital which is even more conveniently situated than Guy's for the reception of the casualties which will always complicate the traffic at London Bridge. The first section, relating to accidents occuring on the river gives perhaps a less favourable estimate of comparative frequency of cause than any other in the series, inasmuch as the bulk of these accidents occur in the neighbourhood of the Docks, and as a rule are received into the London hospital. Cases of accidental poisoning and attempts at suicide number 124 of the total accidents, not a few of the latter were attempted by poisons but it is a noteworthy fact that during the last two years this means of suicide has matierially diminished in frequency, not more than five cases having been received during the period named. It will be observed that attempts at suicide are not as a rule very successful; in females less so than in males the proportion of deaths being in the former about 1 in 8 cases, and in the latter in about 1 in 4. In truth, it is very questionable whether all these cases can be classified under the heading adopted in the table, as it is generally understood by those accustomed to hospital experience in these matters that a large proportion of so-called suicides do not really meditate self-destruction, and that the vicious impulse involved in the simulated attempt is nothing more than a morbid desire to procure sympathy, or to produce remorse, and, in fact, is only in a less degree the offspring of that moral cowardice which is the mainspring of action in the perpetrators of the more heinous crime.

Burns and scalds occupy a large place in the category of accidents. The total number of injuries from these causes amount to 425, of which not less than 213 are observed to have arisen from the clothes of the patients taking fire. This cause is also noticeable as being by far the most deadly of the several ways in which a person may be burned, the deaths outnumbering by 25 the numbers of patients who recovered. As might have been expected, the number of females injured in this manner is very much larger than males, the numbers being respectively 142 and 71, or exactly double. In only one other

instance, in which the causes are of sufficient frequency to draw deductions, do females appear more susceptible of injury than males, namely, in the section designated as "falls down stairs," but in this division the numbers partake much more of an equality than the other. A glance at the totals of the accidents shows the comparative liabilities of the sexes to causes of injury, as being in the proportion of 5 males to 1 female admitted. Collisions between opposing forces, with street vehicles and simple falls on the ground, accidents incidental to a crowded throughfare, comprise 1,077, or more than one-fourth part of the total number in the table. The relative mortality is observed to be small, not averaging more than 7 per cent.

A larger source of supply arises from falls from heights, such as from scaffoldings erected for building and other purposes, and falls of heavy weights on patients, such as loads of bricks, stones, earth and rubbish. The two causes combining to produce injuries of a similar character, comprise 35 per cent. of the total accidents, and the mortality attendant thereon may be estimated at 8½ per cent. It may be noticed as a distinctive feature of the accidents generally, that they do not contribute as a rule to augment the average mortality. The reverse effect has frequently been ascribed to them, but the data furnished by these returns do not justify the inference, for with exception of two or three of the causes enumerated, the great bulk of the sections exhibit a comparatively low range of deaths when compared with other departments of hospital practice. Of the remaining causes of injury the only two claiming special reference are those arising from machinery and accidents occurring on the railway. These do not present very alarming totals for the period, when compared with other causes in continual operation. Accidents from machinery have been almost entirely confined to males, there being only two females entered under this head, while the mortality from the same cause has been comparatively small, being little over 6 per cent. Next to burns produced from clothes catching fire the railway *injuries* furnish us with the most fatal class, one out of every three persons injured *from this cause* dying, and females will be observed to have suffered in a much less degree than males, the proportionate numbers being 1 female to 16 males injured from the cause in question. No enumeration of the causes of accidents can be considered complete without allusion being made to the most prolific and at the same time the most preventible source of all accidents, namely drunkenness. We have no satisfactory statistics to guide us in estimating the proportion who have suffered from this vice, but from personal observation and experience alone we can safely confirm what has been frequently stated by others, that of all the causes in operation leading to temporary or fatal injury to the person, there

are none to be dreaded so much as those arising from the vice in question.

In fact, the public-house is no less the greater tributary to the sick hospital than to the union workhouse, and there are few moral lessons which possess greater opportunities of practical application than those illustrated by the everyday experience of an hospital ward.

Out-Patient Department.

An important feature in connection with every London hospital is its out-patient department. It is here that its benefits if not usefully bestowed are at all events numerically lavished, and although the operation of the department may be attended with many serious objections, of a character best known to those to whose care it is entrusted, it does not admit of a doubt that a large amount of relief is annually furnished to the population by the efforts made to treat disease after this somewhat summary fashion. As the Dispensary system of house-to-house visitation is denied in all London hospitals the out-patient department is based on the assumption, that applicants for relief are capable of attending at the hospital at given intervals of time, irrespective of their maladies or of the symptomatic changes accompanying them. The necessary result of this state of things is, that a numerous class of persons suffering from all species of disease especially incidental to life in a crowded city, and not of sufficient severity to detain them at home, daily flock to those establishments especially where free charity is administered, and where no limit is assigned to their number, unless perhaps it may be regulated by the exhausted energies of the Medical Officer. From the miscellaneous crowd are selected no inconsiderable portion of persons whose complaints being of a graver character than the others are drafted into the hospital as fit objects for in-door relief, while a fair proportion of the remainder are largely benefited by their occasional attendance. Notwithstanding this admission, we believe that the privileges obtained in this way are greatly abused, not only by the poor themselves but also by many whose position in life scarcely warrants their accepting charitable aid.

The *hospital-going people* of the metropolis, as a class, are remarkable for many features in common which distinguish them from the industrious and deserving poor. They are not as a rule composed of "those whose lot it is to labour," but are rather recruited from the grades who follow sedentary occupations, or of those who have no avocation at all, and while females form the great bulk of the applicants, their numbers comprise no inconsiderable proportion of the weak members of the other sex as well. Their appeals are not restricted to any particular hospital or to medical

authorities attached to it, as they migrate at intervals from one hospital to another, to test their comparative benefits, and it may be frequently noticed that their confidence in an establishment increases in proportion to the difficulties to be overcome in obtaining access to its charity. It is scarcely to be wondered at, that under such a system, a morbid confidence is engendered in the miraculous agency of physic, and that the unfortunate votary should become developed into the regular medicine voluptuary whose critical and acquisitive tastes would have found no soil for cultivation if attention in the first instance had been paid to the few natural laws which govern the functions of the organism. It has been suggested as a means of remedying the abuse complained of, that a small fee should be exacted from each recipient, and if it were possible to separate the industrious and deserving from the habitual medicine taker, there can be no doubt of the efficacy and benefit to the community at large which such a practice would induce.

But to return to the Tables. In the enumeration of patients relieved at the out-patient department it has been found impossible to furnish any detailed data of importance, for, with the exception of the midwifery division, we have no records to supply us with more than a simple numerical registration. The first table is comparatively of more importance than the others, as it refers to the patients examined and prescribed for at weekly intervals by the regular medical staff, and as they happen to be selected from the general crowd of applicants as eligible for special relief, it is assumed that their diseases are of a graver character than those alluded to in the sequel. The division adopted into surgical, medical, eye, and female diseases corresponds with that followed in the administration of the business of the out-patient department, which is under the superintendence of eight medical officers, who attend at stated intervals. Each special applicant is furnished with a card which entitles its holder to eight separate attendances, and if at the end of eight weeks it is desirable to continue the attendance, the card is renewed with this object.

The next class on the roll represents a total of 160,524 persons, whose diseases, generally speaking, are not sufficiently severe to require their continuous attendance, their visits to the hospitals being restricted to one or two occasions. The number is by far the largest on the list as well as the least satisfactory, inasmuch as the majority have not come under the cognizance of the regular staff, but have been examined and prescribed for by advanced pupils, selected for the purpose by the officers in charge. The enumeration has also been chiefly made from prescriptions retained in the dispensary, a source of doubtful accuracy, as it is possible that in some instances the patients have been prescribed for at separate intervals; nevertheless if

allowance be made for a proportion who receive advice without medicines, the discrepancies in the general total will not appear so great.

The list of minor accidents and operation cases treated in the surgery of the hospital numbers 13,387, nearly 2,000 persons annually, or two-thirds more than those treated inside the hospital. The list comprises such injuries as fractures of arm, dislocations, and in fact all such injuries which do not require the persons affected to remain in bed. As casualties of this kind are occurring at every hour of the day and night, the main work of the department falls to the care of the resident dressers, who are thus afforded a fruitful field of experience, independent of the general practice of the wards. The only remaining table, exclusively connected with the out-patients, refers to the lying-in charity associated with the hospital, and the statistics of which are more ample and detailed than the others. It appears from the analysis made, that nearly 12,000 mothers have been attended during confinement with results of a very satisfactory and encouraging kind. These persons are attended at their own homes by the pupils of the hospital, under the immediate superintendence of the physicians accoucheur, and two of the senior students are in constant residence at the hospital to keep the records and to attend to cases of urgency as well as to assist the junior pupils in cases of doubt or difficulty. The charity is of course entirely confined to the Surrey side of the river, and for many years it embraced within a radius of two miles from the hospital a considerable portion of the most densely populated districts of Southwark and Lambeth; but from the annually increasing applications for relief, and the demand made on the time of the students, it has been found necessary to curtail the area of its operations to the extent of one-half, or a mile's radius from the hospital. This circumstance will account for the diminution in the numbers attended during the last few years, or since 1856, at which period it appears to have reached its maximum.

Appended to the series of tables there is a record of the total numbers who have annually passed through the hospital from the *date of its foundation to the present time*, compiled from the admission, discharge, and death registers. An examination of this return proves that *the rate of mortality* has materially diminished since the commencement of the period, or at all events since the decennium 1740 to 1750, at which time it reached its maximum, namely 14·7 per cent., and although it may have fluctuated slightly during decennial intervals since the period mentioned, as a general rule it has continued gradually to decrease, the last decennium exhibiting the lowest average, namely 9·1, which would have been still further reduced if the exceptional year, 1854, had been excluded from the

analysis. An examination of the last century records explains in some measure the causes contributing to the excessive mortality during that epoch. The deaths registered are not dissimilar in character to those which of late years have constituted the highest class, but in addition to the ordinary large proportion of consumptions and dropsies we meet with an unusual number of cases of fever, small-pox, and syphilis, diseases now either of rarer prevalence or of less severity, or, as in the case of small-pox, inadmissible by reason of its virulently contagious character, which circumstance has necessitated the segragation of the patients in a suburban hospital set apart for the special purpose. We are also justified in inferring, from the great preponderance of hopeless cases of disease freely admitted during the greater part of last century, that the governing body was anxious to comply with a desire somewhat ambiguously expressed in the testamentary dispositions of the Founder, to the effect, that they should provide accommodation for a large number of persons whose diseases were deemed incurable; a practice which a more enlightened policy has long since thought fit to abandon.

But while mainly attributing the favourable indications to the causes above specified, it would be manifestly unjust to under-estimate the value of the greatly improved methods of medical treatment which modern science has originated for the cure of the sick, as well as the greater attention now being paid to hospital hygiene. For many years past this branch of science has been developed in a variety of ways in nearly all establishments of a similar kind. Its advance is best promoted by the improvement of the dietary of the inmates, by enlarging the individual allowance of space allotted for beds, by obtaining, at all hazards, open grounds for airing purposes, and of altering and modifying internal structural arrangements when they are found to be opposed to sanitary requirements. These measures are not effected without great difficulty and expense; in all hospitals they have vastly increased the average cost of the patients, and in many they have been attended with a considerable diminution of numbers, while they have brought others to the verge of bankruptcy. Still it cannot be doubted that in a matter of such vital importance the gain is well worthy of the sacrifice, and it is fortunate for a community that the successful management of its sick poor should have been left in a great measure to its own unaided benevolence, influenced and directed by the liberal and progressive tendencies which have characterized the present age.

TABLE I.—*Statistical Record of Guy's Hospital for Seven Years, from 1854 to 1860 inclusive.*

Patients in hospital, 1st January, 1854	....	453
Admitted during the period	....	32,360
Total	....	32,813
Discharged as cured, well, or convalescent	18,591	
Relieved or improved	8,038	
Unrelieved or worse	2,713	
Died	2,978	
Remaining in hospital, 1st January, 1861	493	
		32,813

TABLE II.—*Showing the Comparative Numbers during the Period.*

	1854.	1855.	1856.	1857.	1858.	1859.	1860.
IN-PATIENTS.							
Remaining at end of each preceding year	453	454	458	452	497	481	479
Subsequently admitted	4,636	4,306	4,615	4,774	4,712	4,668	4,649
Total annually under treatment	5,089	4,760	5,073	5,226	5,209	5,149	5,128
Cured, or discharged as well, or convalescent	2,619	2,499	2,626	2,686	2,711	2,823	2,627
Relieved or improved	1,190	1,067	1,201	1,232	1,174	1,000	1,174
Unrelieved	300	332	390	433	413	431	414
Died	526	404	404	378	430	416	420
Remaining at end of each year	454	458	452	497	481	479	493
Average number daily resident	458	452	466	456	477	462	489
Mean residence of each person in days	33·2	34	33·3	31·8	33·8	32·7	34·8
Number of accidents registered	548	529	610	458	568	624	583
Number of surgical operations registered	330	340	349	349	352	299	394
OUT-PATIENTS.							
Number of surgical patients	2,750	2,753	4,303	3,837	3,700	3,265	2,875
,, medical cases	2,845	3,025	3,057	3,141	3,549	3,855	3,943
,, uterine cases	1,298	1,376	1,454	1,438	2,126	1,836	1,822
Patients with eye diseases	1,457	1,450	1,511	1,473	1,762	1,570	1,480
Casual cases	17,638	21,285	21,036	25,886	22,057	24,764	27,858
Minor accidents	2,334	2,268	2,262	1,549	1,570	1,735	1,669
Lying-in charity patients	1,738	1,753	2,011	1,731	1,651	1,640	1,404

TABLE III.—*Annual Table of Admissions, Dismissions, and Deaths, distinguishing the Sexes.*

	Surgical Patients.						Medical Patients.					
	Admitted.		Discharged.		Died.		Admitted.		Discharged.		Died.	
	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.
1854	1,619	853	1,491	809	118	39	1,221	943	1,007	802	221	148
'55	1,542	913	1,430	860	99	57	1,004	847	841	767	164	84
'56	1,591	998	1,525	952	93	40	1,149	877	953	787	184	87
'57	1,552	1,048	1,458	1,003	65	35	1,222	952	1,050	840	166	112
'58	1,583	1,023	1,482	997	110	32	1,204	902	1,041	778	168	120
'59	1,637	1,062	1,560	1,014	80	48	1,114	855	923	757	187	101
'60	1,585	1,053	1,475	1,012	106	42	1,101	910	914	814	178	94
Total	11,109	6,950	10,421	6,647	671	293	8,015	6,286	6,729	5,545	1,268	746

TABLE IV.—*Annual Rate of Mortality, distinguishing the Sexes and the Two Main Classes of Disease.*

Years.	Total, over all the Cases.	Medical Cases, Mortality per Cent.			Surgical Cases, Mortality per Cent.		
		Male.	Female.	Both.	Male.	Female.	Both.
1854	11·3	17·9	15·5	16·9	7·3	4·6	7·8
'55	9·3	16·3	9·8	13·3	6·5	6·2	6·3
'56	8·7	16·1	9·9	13·4	5·7	4·	5·
'57	8·	13·6	11·7	12·8	4·3	3·3	3·9
'58	9·9	13·8	13·3	13·6	6·9	3·1	5·4
'59	8·9	16·8	11·7	14·6	4·9	4·5	4·7
'60	9·	16·2	10·4	13·6	6·7	4·	5·6
Total	9·2	15·8	11·8	14·	6·	4·2	5·6

TABLE V.—*Table of the Hours at which Death occurred.*

Years.	Deaths.	Hours, A.M.											
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1855	202	27	17	16	17	18	16	16	18	13	22	12	10
'56	188	14	19	10	17	19	18	12	14	24	20	15	6
'57	185	17	18	12	21	23	11	12	10	20	17	15	9
'58	217	17	22	22	20	20	22	16	12	22	18	22	4
'59	207	14	23	21	27	14	19	13	19	17	11	17	12
'60	206	18	15	15	15	23	21	14	18	25	13	12	17
Total	1,205	107	114	96	117	117	107	83	91	121	101	93	58

Years.	Deaths.	Hours, P.M.											
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1855	202	13	20	19	17	22	19	20	14	13	9	20	16
'56	216	19	30	27	15	21	16	15	20	11	16	20	6
'57	193	20	22	17	17	12	19	17	16	16	12	19	6
'58	223	16	19	32	21	17	27	11	14	20	12	16	8
'59	209	27	16	18	17	13	22	20	15	12	20	18	11
'60	204	16	19	14	22	12	26	21	15	23	21	15	10
Total	1,247	111	126	127	109	97	129	104	94	95	90	108	57

Note.—Table must be read from half hours to half hours, thus, 1 o'clock = 12·30 to 1·30 and so on.

TABLE VI.—*Summary of the Cases arranged according to Classes of Disease and the Results of Treatment.*

Diseases of	Total Cases.	Cured	Relieved.	Unrelieved.	Died.	Mortality, per Cent.
1. Nervous system	2,520	869	1,028	441	182	7·2
2. Respiratory organs	3,202	875	1,239	275	813	25·3
3. Organs of circulation	1,343	416	459	157	311	23·1
4. Digestive organs	2,222	1,058	518	215	431	19·3
5. Genito-urinary organs	3,025	1,532	903	363	227	7·5
6. Venereal diseases	3,608	2,862	610	121	15	·4
7. Dropsies	949	279	371	108	191	20·1
8. Diseases and injuries of bones	2,904	2,092	449	157	215	7·4
9. ,, ,, joints	3,055	1,853	868	231	103	3·3
10. External injuries of soft parts	1,736	1,321	167	40	208	11·9
11. Abscesses, tumours, ulcers	3,037	2,067	578	261	131	4·3
12. Diseases of the eye	1,853	1,283	375	194	1	—
13. ,, skin	872	598	198	50	26	2·9
14. Fevers	1,118	959	50	18	91	8·1
15. Miscellaneous affections	876	527	234	82	33	3·7
Total	32,320	18,591	8,038	2,713	2,978	9·2

TABLE VII.—*Table of the Ages of the Patients, arranged according to the Classification of Disease.*

Diseases of	I. DISCHARGED.												
	Total.	Under 5.	5 to 10.	10 to 15.	15 to 20.	20 to 25.	25 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	80 upds.
1. Nervous system	2,338	46	145	257	286	294	280	448	325	191	55	8	3
2. Respiratory organs	2,389	27	65	100	278	368	366	525	394	179	75	9	3
3. Organs of circulation	1,032	51	23	79	183	141	116	158	148	90	38	5	—
4. Digestive organs	1,791	63	66	68	137	205	240	409	306	204	83	9	1
5. Genito-urinary organs	2,798	86	104	78	282	375	435	652	454	297	107	24	4
6. Venereal diseases	3,393	10	13	42	1,470	1,111	450	311	124	42	17	3	1
7. Dropsies	758	15	28	40	51	63	115	175	152	91	25	3	—
8. Diseases and injuries of bones	2,689	140	226	237	273	216	286	527	392	226	119	31	6
9. Diseases and injuries of joints	2,953	99	222	338	486	474	564	479	317	197	66	10	1
10. External injuries of soft parts	1,538	111	139	167	171	157	177	226	184	86	56	14	—
11. Abscesses, ulcers, and tumours	2,906	70	108	149	356	457	374	559	453	260	100	36	4
12. Eye diseases	1,852	70	142	256	318	256	177	230	164	149	88	22	—
13. Skin „	846	55	44	58	117	111	93	136	119	72	34	6	1
14. Fevers	1,027	22	75	145	235	193	133	118	68	28	9	1	—
15. Miscellaneous diseases	843	45	66	82	104	122	110	132	105	52	18	7	—
Total	29,342	910	1,466	1,926	4,746	4,543	3,706	5,085	3,655	2,114	890	187	24

Diseases of	II. DIED.												
	Total.	Under 5.	5 to 10.	10 to 15.	15 to 20.	20 to 25.	25 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	80 upds.
1. Nervous system	182	12	11	9	15	13	31	36	33	15	5	2	—
2. Respiratory organs	813	24	10	14	73	106	102	202	166	91	23	2	—
3. Organs of circulation	211	2	5	17	23	29	28	64	64	57	18	3	1
4. Digestive organs	431	12	6	9	24	38	46	88	80	71	44	9	4
5. Genito-urinary organs	237	8	6	4	9	21	27	49	46	34	16	6	1
6. Venereal diseases	15	—	—	—	3	2	5	3	1	1	—	—	—
7. Dropsies	191	4	7	6	13	15	15	41	49	25	14	2	—
8. Diseases and injuries of bones	215	8	10	12	21	16	19	47	38	25	11	7	1
9. Diseases and injuries of joints	103	1	4	6	16	13	17	17	9	11	6	2	1
10. External injuries of soft parts	208	96	30	14	9	5	5	15	13	5	10	4	4
11. Abscesses, ulcers, and tumours	131	7	3	5	12	7	15	24	22	13	12	1	—
12. Eye diseases	1	—	—	—	—	—	—	—	—	—	—	1	—
13. Skin „	26	3	1	—	1	2	—	9	4	3	3	—	—
14. Fevers	91	7	5	1	25	15	22	8	5	2	—	1	—
15. Miscellaneous diseases	33	1	4	—	3	2	3	7	2	5	3	3	—
Total	2,978	185	102	97	247	284	335	610	552	366	165	43	12

TABLE VIII.—*Countries in which Patients were Born.*

	No.		No.
England	29,212	Italy	29
Ireland	2,436	Spain	3
Scotland	234	Portugal	2
Wales	144	Turkey	1
Channel Islands	17	Greece	1
Malta	2	India	7
Sweden and Norway	10	Ceylon	3
Denmark	3	China	1
Russia	2	Africa	1
France	37	America	39
Belgium	5	West Indies	21
Holland	14	Australia	2
Germany	74	New Zealand	1
Poland	4	Born at sea	7
Hungary	2		
Switzerland	6		32,320

TABLE IX.—*Localities from which Patients have been brought.*

	Total.	Country.	Middlesex.	Surrey.
Medical cases	2,000	274	548	1,178
Surgical cases	3,000	510	576	1,914
	5,000	784	1,124	3,092

Table X.—*Summary of Surgical Operations Performed during the Period.*

Nature of Operation.	Total Cases.	Disease or Injury requiring Operation.	Cured or Relieved.		Unrelieved.		Died.	
			M.	F.	M.	F.	M.	F.
Amputations, Primary, of—								
Shoulder Joint	3	Compound Fracture, Laceration, Smash	—	—	—	—	3	—
Arm	16	" " "	10	—	—	—	6	—
Forearm	11	" " "	10	—	—	—	1	—
Hand	4	" " "	4	—	—	—	—	—
Fingers (one or more)	64	" " "	54	8	—	—	2	—
Thigh	17	" " "	4	2	—	—	11	—
Leg	15	" " "	8	—	—	—	7	—
Foot	2	" " "	—	—	—	—	2	—
Toes	5	" " "	3	1	—	—	1	—
Amputations, Secondary, for injury—								
Arm	6	3 Com. Fract., 1 Com. Disloca. Elbow, 2 Gangrene	4	—	—	—	2	—
Forearm	2	Compound Fracture	2	—	—	—	—	—
Hand	1	"	1	—	—	—	—	—
Fingers (one or more)	25	Compound Fracture, Laceration, Gangrene	18	6	—	—	1	—
Thigh	10	" " "	3	—	—	—	8	—
Leg	9	" " "	2	1	—	—	6	—
Toes	3	" " "	2	—	—	—	1	—
Amputations for Disease—								
Arm	3		2	1	—	—	—	—
Forearm	12		6	5	—	—	1	—
Hand	2		2	—	—	—	—	—
Fingers (one or more)	44		32	11	—	—	1	—
Thigh	80		45	21	—	1	11	2
Leg	30		16	7	—	—	4	3
Ankle Joint	2		2	—	—	—	—	—
Chopart's Operation	2		—	1	—	—	—	1
Partial, of Foot	3		2	1	—	—	—	—
Toes	12		6	6	—	—	—	—
Carried forward	383		237	71	—	1	68	6

Table X.—*Summary of Surgical Operations, &c.—Contd.*

Nature of Operation.	Total Cases.	Disease or Injury requiring Operation.	Cured or Relieved.		Unrelieved.		Died.	
			M.	F.	M.	F.	M.	F.
Brought forward	383		237	71	—	1	68	6
Excision of Tumours—								
Mammary, Cancerous	101		—	92	—	—	—	9
" various	45		—	44	—	—	—	1
Cancerous Tumours of other parts	62	Chiefly of Lip	48	9	3	—	1	1
Tumours of various characters	102	64 Encysted, 15 Fibroplastic, 9 Enchondroma, 14 Bursal	42	60	—	—	—	—
" "	48	12 Gland., 26 Steatom., 2 Vascular, 8 Fibrous	17	28	2	1	—	—
" "	35	22 Fatty, 6 Follicular, 7 Cartilaginous	14	20	—	—	—	1
" "	31	13 Keloid, 7 Melanotic, 2 Fungus, 8 Epithelium, 1 Horny	9	20	—	—	1	1
" "	15	Hypertrophied Labia and Vaginal Cysts	—	14	—	—	—	1
" "	7	Characters undetermined	1	4	1	—	1	—
Excision of Diseased Bones—								
Of Upper Extremity	49	1 Clavicle, 1 Head of Humerus, 20 Humerus, 1 Scapula, 6 Ulna, 7 Rad., 3 Carpus, 3 Metacarp., 6 Fingers	35	13	1	—	—	—
Lower "	159	4 Ilium, 27 Femur, 59 Tibia, 3 Fibula, 32 Tarsus, 24 Meta-tarsus, 10 Toes	119	28	4	4	4	—
Elbow Joint	8		5	2	—	—	—	1
Knee "	2	Both afterwards amputated	—	—	2	—	—	—
Portions of Bones of Cranium	14	Depressed and Diseased, from Compound Fracture	7	2	—	—	5	—
" Jaw	18	Necrosis and Caries	10	8	—	—	—	—
" Rib	1	Necrosis	1	—	—	—	—	—
Part of a Vertebra	1		—	1	—	—	—	—
Exostosis	13	2 Humerus, 1 Scapula, 5 Femur, 2 Tibia, 3 Great Toe	8	5	—	—	—	—
Excision of Epulis	7		2	4	1	—	—	—
" partial, of Tongue	3	2 Cancer, 1 Fibroplastic Growth	2	1	—	—	—	—
" of Tonsils	7	Hypertrophy	4	3	—	—	—	—
" Prepuce	6	Phymosis	6	—	—	—	—	—
" Penis	11	Cancer and Phagedena	10	—	—	—	1	—
" Testicle	23		23	—	—	—	1	—
Carried forward	1,151		599	429	14	6	82	21

TABLE X.—*Summary of Surgical Operations, &c.—Contd.*

Nature of Operation.	Total Cases.	Disease or Injury requiring Operation.	Cured or Relieved. M.	Cured or Relieved. F.	Unrelieved. M.	Unrelieved. F.	Died. M.	Died. F.
Brought forward	1,151	. . . . .	599	429	14	6	82	21
Excision of Loose Cartilages	4	In Knee Joint	4	—	—	—	—	—
,, Hæmorrhoids	12	. . . . .	8	4	—	—	—	—
,, Rudimentary Ears	1	. . . . .	—	1	—	—	—	—
,, Foreign Bodies	5	1 piece of Metal in Jaw, 3 Needles under Skin, 1 piece of Bone in Deltoid Muscle	3	1	—	—	1	—
Reparatory Operations—								
Deformities from Burns of Neck and Face	13	Cicatrices and Contractions	5	5	1	2	—	—
Deformities from Burns, other parts	18	8 Arm, 10 Fingers	7	9	1	1	—	—
,, other Injuries	18	2 Hip, 1 Testicle, 9 Rup. Perineum, 1 Nasal, 3 Vesico Vaginal, 2 Urethral Fistulæ	4	9	2	3	—	—
,, Disease	11	3 Lupus, 8 Disease of Stump	4	5	1	1	—	—
Congenital Deformities	44	32 Harelip, 4 Web Fingers, 2 Lower Lip, 4 Fis. Palate, 2 Penis	27	13	2	2	—	—
Operations for Nævus	25	. . . . .	11	12	1	—	1	—
Exploratory Operations	35	Evacuation of Cysts and Tumours	17	12	3	1	2	—
Operations for Aneurism—								
Compression of Artery	11	2 Femoral and 9 Popliteal Aneurism	4	1	6	—	—	—
Ligature of Artery	10	8 ,, 2 Ext. Iliac Artery	8	—	1	—	1	—
,, for Hæmorrhage	14	5 ,, 3 Radial, 1 Com. Carotid, 5 Vascular Tumours	8	2	1	—	3	—
Sections of Anal Fistulæ	47	Death from Cholera	26	20	—	—	—	1
Perinæal Section	69	Fistula, Stricture, Rupt. Urethra	45	—	1	—	13	1
Urethrotomy	7	Calculus in Urethra	5	1	—	—	1	—
Puncture of Bladder per Rectum	16	Stricture and Rupt. Urethra	14	—	—	—	2	—
Extraction from Bladder	3	2 pieces of Bougie, 1 Hair Pin	2	1	—	—	—	—
Lithotomy	93	Under 18 years, 57 cured, 5 died; From 18 to 50, 19 ,, 6 ,,; Above 50 1 ,, 5 ,,	76	1	—	—	16	—
Lithotrity	15	. . . . .	7	1	2	—	5	—
Ovariotomy	3	Ovarian Cysts	—	—	—	—	—	3
Gastrotomy	2	1 Malig. Dis. of Pharynx, 1 Stricture	—	—	—	—	2	—
Carried forward	1,618	. . . . .	884	527	36	16	129	26

TABLE X.—*Summary of Surgical Operations, &c.—Contd.*

Nature of Operation.	Total Cases.	Disease or Injury requiring Operation.	Cured or Relieved. M.	Cured or Relieved. F.	Unrelieved. M.	Unrelieved. F.	Died. M.	Died. F.
Brought forward	1,618	. . . . .	884	527	36	16	129	26
Œsophagotomy	1	Foreign Body Impacted	1	—	—	—	—	—
Laryngotomy	1	Scald	1	—	—	—	—	—
Tracheotomy	46	Tumours, Scalds, Croup, &c.	10	6	1	—	17	12
Transfusion	1	Uterine hæmorrhage	—	—	—	—	—	1
Trephining	7	2 Tibia, 1 Femur, 4 Skull	4	—	—	—	3	—
Dislocations, Reduced, of—								
Upper Extremity	51	1 Clavicle, 32 Humerus, 14 Elbow Joint, 4 Thumb	38	5	5	2	1	—
Lower ,,	26	23 Femur, 1 Knee Joint, 2 Ankle	22	2	1	—	1	—
Lower Jaw	5	. . . . .	4	1	—	—	—	—
Tenotomy	55	31 Talipes, 9 Contracted Knee, 8 Contracted and Malformed Feet, 7 Compound Fracture	32	19	2	1	—	1
Operations for Varicocele	5	. . . . .	5	—	—	—	—	—
,, Imperforate Anus	1	Rectum, terminating in Urethra	—	—	—	—	—	1
Operations for Hernia—								
,, Radical Cure	2	. . . . .	2	—	—	—	—	—
,, Umbilical Hernia	17	. . . . .	5	7	—	2	1	2
,, Inguinal ,,	121	Reduced by Taxis, 68 cured, 2 died; Herniotomy, opening Sac, 18 cured, 20 died; ,, without opening Sac, 8 cured, 5 died	90	6	—	—	24	1
,, Femoral ,,	147	Reduced by Taxis, 36 cured, 4 died; Herniotomy, opening Sac, 41 cured, 28 died; ,, without opening Sac, 27 cured, 11 died	13	88	1	2	6	37
Operations on the Eye—								
Extraction of Lens	99	Hard Cataract	41	42	11	3	1	1
Dislocation ,,	2	Into Anterior Chamber	—	2	—	—	—	—
Karatonyxis	103	Soft and Capsular Cataract	67	35	1	—	—	—
Artificial Pupil	47	Closure of Pupil from Iritis	26	20	—	1	—	—
Strabismus	59	. . . . .	24	26	—	—	—	—
Excision of Globe	8	Bonnet's Operation	4	4	—	—	—	—
	2,413	. . . . .	1,273	790	58	27	183	82

TABLE XI.—*The following Table gives the Causes of the Accidents, with the Sexes and Mortality.*

Causes of Accidents.	Total Cases.	Cured or Relieved.		Died.	
		Male.	Female.	Male.	Female.
1. Accidents on the river, in barges, and shipboard	90	78	3	9	—
2. Assaults	173	102	56	14	1
3. Accidental poisoning	37	15	14	5	3
4. Attempts at suicide	87	36	35	11	5
5. Burns from clothes taking fire	213	34	60	37	82
6. ,, heated fluids	177	90	46	26	15
7. ,, explosion of gas	12	11	1	—	—
8. ,, gunpowder	23	16	2	3	2
9. Collisions between opposing forces	108	90	14	4	—
10. ,, with street vehicles	416	299	55	54	8
11. Cuts and blows from sharp instruments	175	138	28	8	1
12. Falls down stairs	155	69	78	4	4
13. ,, from a height, scaffolding, &c.	832	679	83	62	8
14. ,, from curb stones and on the ground	553	417	116	18	2
15. Fall of heavy weights on patients	427	364	17	45	1
16. Gunshot wounds	16	14	—	2	—
17. Machinery accidents	233	216	2	15	—
18. Railway ,,	84	51	4	28	1
19. Sudden torsions of the body	64	60	4	—	—
20. Foreign bodies lodged in natural passages	22	15	3	1	3
21. Bites of animals, 7 dogs, 2 adders, monkey, horse, rat, elephant, and a woman	14	13	1	—	—
22. Causes of accident not ascertained	9	3	5	—	1
Total	3,929	2,810	627	346	137

Out-Patient Department.

	Total Cases.	Men.	Women.	Children.
Surgical patients	23,483	8,768	10,636	4,079
Medical cases	23,415	8,696	10,554	4,165
Eye ,,	10,703	3,942	4,576	2,185
Diseases of women	11,350	—	11,350	—
Total	68,951	21,406	37,116	10,429

The numbers of persons prescribed for without being supplied with the ordinary letters for attendance as out-patients, 160,524.

The number of minor accident and operation cases treated in the hospital surgery, 13,387.

The following table gives a summary of the cases attended in connection with the Maternity Department during the last seven years.

Number of women confined, 11,928.

Number of single births, 11,800; twin births, 128; total children, 12,056; of the 12,056 children, 6,069 were living males, and 5,446 were living females; and 326 males and 215 females were still-born.

Of the total number 11,668 presented naturally, while 388 were abnormal presentations. Of the latter, 162 were breech, 101 were footling, 51 were arm, 34 were face, 6 were transverse, and 12 were placental presentations.

Of the 11,928 mothers confined, there were in their—

	No.		No.		No.
1st confinement	1,762	9th confinement	443	17th confinement	4
2nd ,,	1,910	10th ,,	280	18th ,,	4
3rd ,,	1,806	11th ,,	186	19th ,,	2
4th ,,	1,508	12th ,,	107	20th ,,	1
5th ,,	1,308	13th ,,	48	21st ,,	–
6th ,,	1,055	14th ,,	30	22nd ,,	1
7th ,,	850	15th ,,	14		11,928
8th ,,	597	16th ,,	12		

Among the mothers there were 36 deaths from the following causes:—14 from peritonitis, 7 from uterine hæmorrhage, 3 from rupture of womb, 1 metritis, 1 phthisis, 1 cholera, 2 pneumonia, 1 fever, 2 Bright's disease, 2 pyæmia, and 2 puerperal convulsions.

Retrospective Summary of the Patients Treated for the last Seven Years, with the Totals of each Year.

	Total.	1854.	1855.	1856.	1857.	1858.	1859.	1860.
Residents in hospital	35,634	5,089	4,760	5,073	5,226	5,209	5,149	5,128
Dispensary patients	68,951	8,350	8,604	10,325	9,889	11,137	10,526	10,120
Casual cases	160,524	17,638	21,285	21,036	25,886	22,057	24,764	27,858
Minor accidents	13,387	2,334	2,268	2,262	1,549	1,570	1,735	1,669
Women confined	11,928	1,738	1,753	2,011	1,731	1,651	1,640	1,404
Total	290,424	35,149	38,670	40,707	44,281	41,624	43,814	46,179

Number of Patients Annually Discharged and Dead in Guy's Hospital since the commencement of the Institution in 1725.

Year.	Total.	Discharged.	Died.	Mortality per Cent.	Year.	Total.	Discharged.	Died.	Mortality pr. Cent.
1725*	—	—	83	—	1772	2,230	1,997	233	—
'26	—	—	139	—	'73	2,156	1,923	233	—
'27	1,080	923	157	—	'74	2,194	2,010	184	—
'28	1,480	1,276	204	—	'75	2,247	2,013	234	—
'29	1,846	1,572	274	—	'76	2,239	2,030	209	—
					'77	2,350	2,128	222	—
1730	1,728	1,514	214	13·8	'78	2,412	2,187	225	—
'31	1,716	1,506	210	—	'79	2,064	1,814	250	—
'32	1,737	1,468	269	—					
'33	1,939	1,683	256	—	1780	2,405	2,129	276	10·3
'34	1,781	1,524	257	—	'81	2,320	2,077	243	—
'35	1,889	1,631	258	—	'82	2,226	1,994	232	—
'36	2,007	1,743	264	—	'83	2,141	1,901	240	—
'37	1,760	1,502	258	—	'84	2,158	1,938	220	—
'38	1,798	1,548	250	—	'85	2,339	2,335	204	—
'39	1,745	1,468	277	—	'86	2,152	1,919	233	—
					'87	1,965	1,717	248	—
1740	1,895	1,587	308	14·2	'88	2,090	1,854	236	—
'41	2,203	1,881	322	—	'89	2,469	2,256	213	—
'42	2,194	1,839	355	—					
'43	2,114	1,808	306	—	1790	2,243	2,021	222	10·2
'44	2,002	1,714	288	—	'91	2,037	1,815	222	—
'45	1,892	1,603	289	—	'92	2,166	1,891	275	—
'46	1,923	1,633	290	—	'93	2,345	2,047	298	—
'47	2,135	1,820	315	—	'94	2,184	1,915	269	—
'48	2,081	1,802	279	—	'95	2,376	2,114	262	—
'49	2,057	1,766	291	—	'96	2,466	2,209	257	—
					'97	2,574	2,321	253	—
1750	1,980	1,685	295	14·7	'98	2,702	2,398	304	—
'51	1,890	1,659	231	—	'99	2,642	2,328	314	—
'52	1,847	1,607	240	—					
'53	1,948	1,693	255	—	1800	2,770	2,410	360	11·6
'54	1,951	1,693	258	—	'01	2,653	2,369	284	—
'55	1,873	1,607	266	—	'02	2,774	2,433	341	—
'56	1,936	1,706	230	—	'03	2,680	2,371	309	—
'57	1,823	1,603	220	—	'04	2,482	2,157	325	—
'58	1,749	1,588	161	—	'05	2,666	2,372	294	—
'59	1,841	1,637	204	—	'06	2,505	2,235	270	—
					'07	2,856	2,553	303	—
1760	1,845	1,672	173	12·	'08	2,646	2,356	290	—
'61	1,875	1,669	206	—	'09	2,635	2,313	322	—
'62	1,907	1,673	234	—					
'63	1,911	1,698	213	—	1810	2,669	2,384	285	11·3
'64	1,667	1,469	198	—	'11	2,802	2,508	294	—
'65	1,881	1,657	224	—	'12	2,636	2,361	275	—
'66	1,900	1,692	208	—	'13	2,658	2,368	290	—
'67	1,847	1,641	206	—	'14	2,637	2,407	230	—
'68	1,858	1,648	210	—	'15	2,630	2,358	272	—
'69	1,985	1,771	214	—	'16	2,654	2,409	245	—
					'17	2,733	2,489	244	—
1770	2,076	1,853	223	11·3	'18	2,555	2,303	252	—
'71	2,155	1,908	247	—	'19	2,685	2,430	255	—

* From the decayed condition of the first registration book, it has been found impossible to calculate the numbers during the first two years of the series.

Number of Patients Annually Discharged, &c.—Contd.

Year.	Total.	Discharged.	Died.	Mortality per Cent.	Year.	Total.	Discharged.	Died.	Mortality pr. Cent.
1820	2,639	2,384	255	9·7	1840	3,646	3,329	317	9·6
'21	2,772	2,523	249	—	'41	3,402	3,067	335	—
'22	2,843	2,585	258	—	'42	3,694	3,353	341	—
'23	2,734	2,474	260	—	'43	3,757	3,427	330	—
'24	2,508	2,261	247	—	'44	3,911	3,519	392	—
'25	2,544	2,280	264	—	'45	3,807	3,413	394	—
'26	2,668	2,371	297	—	'46	3,789	3,380	409	—
'27	2,774	2,492	282	—	'47	4,049	3,660	389	—
'28	2,516	2,270	246	—	'48	3,772	3,397	375	—
'29	2,585	2,288	297	—	'49	3,824	3,449	375	—
					1850	4,221	3,872	349	9·9
1830	2,603	2,297	306	10·1	'51	4,526	4,109	417	—
'31	3,279	2,934	345	—	'52	3,876	3,580	342	—
'32	3,043	2,756	287	—	'53	3,265	2,961	304	—
'33	3,095	2,825	270	—	'54	4,635	4,109	526	—
'34	3,395	3,095	300	—	'55	4,302	3,898	404	—
'35	3,306	2,985	321	—	'56	4,621	4,217	404	—
'36	3,470	3,161	309	—	'57	4,729	4,351	378	—
'37	3,443	3,057	386	—	'58	4,728	4,298	430	—
'38	3,375	3,066	309	—	'59	4,670	4,254	416	—
'39	3,019	2,688	331	—					
					1860	4,635	4,215	420	9·1

Lecture given on the 28th March 1862 at the United Service Institution.

ON THE CAUSES OF SICKNESS IN THE ENGLISH WARS, AND ON THE MEANS OF PREVENTION.

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It is quite a truism to say that the great losses in war are not owing to shot or steel, but, like many other truisms, it is more often repeated than comprehended. Even to the mind of the soldier, the strife and peril of the battle-field throw into shade the more secret yet deadlier foes by which oftentimes campaigns are really decided and victories are really won. And yet, if there be anything a soldier ought to study out of his immediate profession, it should be those conditions which, in so many wars, have caused such losses by disease, that plans the best considered have been abandoned, courage the most heroic has been baffled, and causes the most sacred have been lost.

Our own army does not, perhaps, offer so many examples of these disasters as the armies of other states, but even with us there is a long and sad catalogue of unfortunate and unhappy enterprises, and a terrible list of soldiers' lives which have not been taken on the battle-field. As it is manifestly a matter of greater interest to review our own history than to turn to the larger and darker experience of other nations, I shall venture to attempt the enumeration of the chief causes which have led to great losses by disease in some of our wars. The subject is, however, too vast to be treated in a single lecture, and all I can venture to do is to give a rapid summary, and to illustrate it by a few examples.

As far as diseases are concerned, the history of almost all our wars presents a remarkable sameness. The same results on a larger or smaller scale repeat themselves. We are taught with what a terrible precision the same causes have stamped their marks on successive generations of soldiers, and how the pitiable history of one campaign might almost be stereotyped for nearly all the rest. Nor are these causes in any way peculiar, recondite, or mysterious. We are astonished to find how simple they are, how obvious, how apparently inadequate to produce such large results.

A writer, in giving an account of the great loss on one occasion among British troops, when, out of 7,000 men, 5,000 men were sick at one time, after enumerating the very simple conditions which had led to this end, says,—

"And yet when anxiously asked by the officers in command, what extraordinary cause could be assigned for an amount of sickness and

mortality truly alarming, something of incredulity has stolen over the countenances of my hearers while the natural causes above described were detailed, so little are we disposed to believe that great effects can be produced by the action of common causes."

But so it has always been. That the causes are common is the secret of their strength: they are ever at hand; even waiting, so to speak, for opportunities; apparently weak, they are in reality all-powerful; they are like the geni, who, in the story in the "Arabian Nights," the fisherman let out of the vase. At first there was a little cloud, which he could enclose with his hand, but presently there appeared a gigantic shape, clothed with power and irresistible in strength.

Of the early English wars the record is so imperfect that it would be waste of time to refer to them. Even of the wars of Marlborough we have but scanty medical accounts. We know that Marlborough had the reputation of being very careful of his wounded men, and it is said that he made a point of paying frequent visits to his hospitals. Doubtless he brought his extraordinary administrative powers to bear upon the medical, as on all other parts of his army. But of the exact losses by disease in his campaigns I believe little or nothing is known. They are supposed to have been small, as he was always able to bring a large number of men into the field, and England, at that time so comparatively thinly peopled, seems to have easily supported the drain both of men and money.*

Of the wars in Flanders and Germany in 1742, and of all subsequent wars, we possess tolerably good accounts, although the exact statistical reports and tables of our own day were quite unknown, and it is only from chance passages that we can form a rude numerical idea of the amount of sickness and mortality. The description of the diseases however, and of their causes, is for the most part both full and accurate.

1. Of the earlier expeditions after the wars of Marlborough, perhaps none was attended with greater losses, or excited more strongly the public feeling, than the unfortunate attack on Carthagena in 1741, under Vernon and Wentworth. It was not the first of the western tropical expeditions in which enormous losses had occurred, but the failure was so sudden and so overwhelming that it created an unprecedented sensation. To the military features of the campaign I need not refer; the dissensions between the commanders of the land and sea forces; the feeble movements of the general, and the vain courage of the troops, are sufficiently known.

Scarcely had the troops disembarked than sickness commenced. The diseases were malignant malarious fevers, scurvy, and bloody flux. The Spaniards looked down from their walls which they were scarcely called on to defend, watching curiously the dwindling away of their besiegers, till the rainy season of 1741 set in. The diseases then increased at a rate so fearful, that, to avoid complete annihilation, the force was hastily re-embarked. It is said that no less than 3,425 men perished in two days. In a few weeks, in fact, the army had been almost destroyed, and we are told that "its poor remains were afterwards almost totally cut up in the sickly season in the island of Cuba."

* The greatest losses appear to have occurred during the sieges, especially those of Tournay in 1709, and of Aire in 1710. In this latter siege the killed and wounded of the allies were said to be 7,000, and the sick double that number.

The causes of this tremendous catastrophe were matters of common talk and tradition among army surgeons for many years afterwards. Two grand errors were committed; errors which we must put in the first rank among those conditions from which British forces have largely suffered in war.

The first of these was that old error, a most imperfect commissariat. We are not acquainted with the exact rations issued at Carthagena, but the presence of scurvy, which prevailed both in the army and navy, but most in the former, proves at once that fresh meat and vegetables were entirely wanting. The scorbutic dysentery, which soon succeeded, shows us, as certainly as if the diet lists were before us, that hard salt beef and pork and biscuit formed the miserable allowance, scarcely deserving the name of food, which was issued to these men.

The effect of insufficient food of this kind is to cause some diseases; to predispose to many more. It is in this last circumstance that its great strength lies; malarious fevers are intensified by it; slight atmospheric vicissitudes, and other common agencies which fall harmless on the well-nourished body, tell with fatal effects on the enfeebled frame.

In a great number of the English wars an inefficient commissariat has been the bane of the army: I will select two or three other instances of the same fact. Perhaps the expeditions to Burmah, in 1824, and to China, in 1840, offer the best examples. In both cases the scene of operation was to some extent malarious, and in Burmah the worst time of the year, at the commencement of the south-west monsoon, was unfortunately chosen for the commencement of operations. But in both cases the cause of the immense mortality which ensued, or at least by far the most potent cause, was the food which was issued to the men. In both cases it was thought that men could be maintained not only in health, but in fighting condition, upon a diet so bad that no slave-owner in any part of the world or in any age of the world would have given it to his slaves. Wretched cattle hastily purchased and driven to Calcutta were there as hastily salted, and on this wretched meat and on almost as wretched biscuit the troops were kept, when within a few days' sail there was a land of wheat, of rice, and of fresh vegetables without end. To the immense mortality in the Burmese war I need scarcely refer. In three or four months some of the regiments lost half their strength; in eleven months 1,311 men died out of 2,716. The 13th Foot lost by disease 341 out of 608 men, or 56 per cent. So general was scurvy that the surgeons were in the habit of examining the gums of the men before a skirmish, to prevent any men having symptoms of the disease from advancing, as wounds received in that condition of body are most intractable. Malignant malarious fever, intensified by the state of the body, and scorbutic dysentery were the great agents of destruction.

Twenty-six years later, in the expedition to China, the same tragedy was repeated almost without variation. The history of the Cameronians may be taken perhaps as a type of the fate of the whole force, although the amount of sickness was greater than that which prevailed in some other regiments. The Cameronians landed at Chusan, a splendid body of men, 900 strong, on the 5th of July, 1840; in the first week in August 500 were in hospital; towards the end of August less than 100 mustered

on parade; later in the season the *débris* of the regiment, under 200 men, were sent to Manilla to recruit, and of these but a fraction ever saw their colours again. The bloodiest battle would have been mockery to this. Doubtless they were to a certain extent in a malarious country, but the malaria was not sufficiently intense to cause so great a loss. Again the simple cause is to be found in the diet. Nothing lives so long as a departmental tradition, and the errors of the last naval expedition from India were repeated in this case without variation. I have selected these two campaigns as the strongest examples of the paramount influence of diet, but many other instances also exist in our wars of the effect of an insufficient commissariat. Even in such comparatively slight operations as the first two Caffre wars a large proportion of the men became scorbutic; and in the first year of the Crimean war a diet so insufficient that any one accustomed to the subject would have been able at once, on being informed of the amount, to foresee the inevitable result, was deemed sufficient to support the strength of the men in the most trying and exhausting of wars.

In the wars of Marlborough, and in Flanders and Germany in 1742 and in 1760, the men were better fed than in many later campaigns; salt meat seems happily to have been little used. The colonels of the regiments appear to have been the chief purveyors: each colonel contracted with butchers, who drove with the army herds both of sheep and oxen for slaughter. Fresh meat, at any rate, was thus procured, and we know from the writings of Donald Munro that in 1760 the army surgeons strongly insisted on the issue of bread and fresh vegetables; fruits also were largely used, and in this way the ravages of scurvy appear to have been almost prevented.

In the wars towards the end of the century and up to the long peace the commissariat arrangements appear to have been inferior to those of eighty or sixty years before. Some of the mortality in the Peninsular war may be certainly ascribed to an inefficiency in this respect. It would seem unnecessary to allude to a point so self-evident as this of insufficiency of food, did not the repetition of the error prove that it is one which must be expected to recur. The first rule in war must be to provide a diet in the highest degree strengthening and nutritious; the diet of peace is quite unequal to maintain the forces of the body when exhausted by the mental and physical exertions of war. It may seem an expensive matter to provide a diet which is sufficiently varied and sufficiently strengthening, but it is not so really. A great army surgeon has said "Economy of lives is the truest economy of the state," and no saving can be more like waste than the saving which sacrifices men's lives.

2. The second great error committed at Carthagena was undertaking operations in an unhealthy site and with an unhealthy season impending. Of course one can understand that a military officer, for the purpose of accomplishing some military end, may deliberately occupy an unhealthy site and knowingly sacrifice a certain number of men. There are examples of this in our wars; for example, in the attack on Java in 1811, when a marshy site was occupied at the outset; but even here the military arrangements were obliged to be somewhat modified and hastened in consequence of the rapidly increasing diseases among the

troops. But unfortunately there are many instances in which unhealthy sites have been chosen without any forethought, without any deliberation, and apparently either in the belief that men were made of iron and could not be injured, or that the stories of diseases being produced by locality were mere foolish inventions and old wives' tales. Although Vegetius tells us that the Romans, the great masters of the art of war, took the extremest care to choose good encamping grounds, and even appear to have made the plans of their campaigns subsidiary to this prime necessity, the point has been too much neglected in all modern wars, and even in the English army. Of the many examples of this I will select one or two only. In 1796 a body of troops about 9,000 strong were ordered to San Domingo; some of the regiments were collected from the West Indies and others from Ireland. The Irish regiments had been rather hastily recruited and typhus prevailed among the men, but it was thought that if time were allowed this disease would be got rid of; time, however, could not be given, and the expedition was launched against San Domingo. Now in 1780 Donald Munro, an army surgeon of reputation, had described with some care the unhealthy and the healthy places of San Domingo, and in 1793 portions of the island had been occupied by our troops. It can therefore be scarcely credited that the most unhealthy spot in the whole island, Port-au-Prince, was chosen for the encamping ground. There were not wanting those who supposed that the general had been deceived by persons interested in the choice of the site: be this as it may, the troops were crowded together on a low marshy alluvial plain, where good water could not be procured, which was shut out from the sea breezes by hills, and was completely exposed to the land-winds. As if this was not sufficient, the diet was bad, and salt meat without bread and fresh vegetables formed the staple of the food. With a view of increasing the strength of the body, an old custom of the English army was in full force, and the men received large rations of rum. Of all the errors committed in our service this seems to be the most persistent and the most ineradicable. Although the best army surgeons had at that time protested against the use of rum in hot climates, although in the American War of Independence the uselessness of rum had been proved almost immediately before, although at San Domingo the immense amount of sickness showed that it was producing no good result, the fatal practice was persevered in. That army had everything against it, and the result was certain; it was almost literally annihilated by yellow fever and dysentery. A writer who saw the sad catastrophe calls San Domingo "the grave of the British army," and says "The army languished and dwindled away without the least service to the cause it was meant to support." It is impossible to know the exact amount of the mortality. Many regiments 800 and 900 strong had only fifty or one hundred men left. All lost largely, and it is probable that few of that gallant force ever did the State more service.

The expedition to Walcheren gives perhaps a still better example of the effect of a marshy and malarious locality. In 1747 Sir John Pringle, one of the most celebrated in the long list of illustrious army surgeons, described the great unhealthiness of South Beveland and of Walcheren. So great was the sickness that in many corps 6-7ths of the men were in hospital at that time.

This low tract of ground, won in almost modern times from the sea, which is everywhere swampy, and where good water cannot be procured, had not lost its ancient and well-known reputation, when in 1809 the finest expedition that ever left the British shores landed in the highest health and vigour. They found there a Dutch regiment which in three years had lost 715 men out of 800: this was the type of their own fate. This great force, nearly 40,000 men in all, was destined to attack Antwerp; it never even approached that fortress. It sailed on the 28th of July from England, invested Flushing with 17,000 men on the 7th of August and took it on the 15th: twelve days later, the men were falling sick so rapidly that the guards had to be relieved twice daily. On the 14th of September, seven weeks after leaving England, out of the 15,000 men in Walcheren 10,000 were in hospital. The deaths at last reached sixty daily, at which rate the whole force would have been destroyed in 250 days. Four months after landing, the army, utterly disorganised, was hastily re-embarked. "The expedition"—to use the words of an eye-witness—"had been productive of nothing but mortification, misery, and disgrace." The diseases were malarious fever and dysentery.

Let me take another example on a smaller scale. In the American War of Independence, two battalions of the 71st Regiment were encamped, contrary to the advice of Robert Jackson, the prince of army surgeons, and of the inhabitants of the country, on the marshy banks of the Pedee river. The men fell sick so rapidly, that the post was ordered to be abandoned. It was then found that it was almost equally difficult either to keep or leave the post. At length, after a great deal of trouble, boats were collected, the sick men were placed in them and were sent down the river, and it is said that few of them were ever seen again. The rest of the force retired from the banks of the river, and, to show the deadly nature of the encamping ground, it was said that the men improved vastly in health even on the march.

The same mistake of a malarious locality being taken as an encampment, was seen in the second American War in 1814, at the siege of Fort Erie. And there are other instances too numerous to bring before you. Even the great Duke himself was said to have crippled his forces by a prolonged sojourn in the marshy plains of Estremadura.

As in the case of food, it may be said to be impossible that errors of this kind can occur again—that, with the present organisation of the service, before any campaign is undertaken the country will be investigated, its features known, and its influences estimated, and that the campaign will be entered upon with a full knowledge of all the circumstances which can affect the men. But we have unfortunately evidence that the immense influence of a malarious locality is not even now sufficiently appreciated by our soldiers. Under some circumstances indeed it is impossible but that campaigns must be undertaken in unhealthy localities and in marshy countries. In that case certain precautions must be adopted; these precautions have relation chiefly to the arrangements of the camps and bivouacs so as to shelter the men as much as possible from unhealthy emanations; to arrangements of guards, so as to expose the men, especially at certain hours of the night, as little as possible; to the use of an extremely nutritious diet, for that has been

found to have a great effect in lessening the susceptibility of the body to malaria; to the supply of good water, and to the employment of various drugs which have been proved to produce, more or less, immunity from attacks of malaria. If malarious countries are entered, and these and similar precautions are taken, the troops will escape with as little harm as can happen under the circumstances.

3. I must now pass on to another condition. The wars in Flanders in 1742 and in Germany in 1760 have been very carefully recorded; perhaps more so than any other war, with the exception of the Russian war of 1854-5. In both these wars, at certain periods, the men were exposed greatly to inclemencies of weather. It was then seen that if men are well fed and can be kept dry they can bear great cold. The winter of 1742 was extremely severe, and in April, when the troops commenced their march, there were extraordinary snows for seventeen days. The troops marched through these storms, but were every night received into warm houses. Out of the 16,000 men not twenty were lost. Again, in the German war in 1760, some regiments made a winter campaign on the borders of the Lower Rhine; they were exposed to great inclemencies of weather, to great hardships, and to extreme cold, yet they were very healthy, much more so than the troops left in the fixed camp at Warburg, who, it may be supposed, must have been in the possession of much greater comforts. This was owing to their good food and good clothing. At that time, 1760, every soldier wore a flannel waistcoat, a custom which has now unfortunately disappeared. This custom was commenced by gifts from the Quakers to the army in 1745-6, and it was found to be attended with the greatest possible benefit. In 1760 the Government issued warm clothing of this description, and in addition there was a very large private subscription in England, and blankets, great coats, underclothing, shoes, stockings, &c., were given to the men. The men's blankets were carried on horses, and were wrapped in waterproof clothing. Each company had its own horses, which kept up with the men on the march.

The same fact, that men can bear great exposure to cold if properly fed and clothed, was also established in the American War of Independence. Some of the Rangers were out during the winter, and escaped almost entirely the diseases produced by cold. They attributed their immunity in a great measure to the use of hot ginger tea. Every man carried a piece of ginger in his pocket, and would on no account be without it. With this they made hot tea, and they found this much more comforting than spirits, which appear to have been in a great measure disused among them. Hot infusions of garlic and infusions of horseradish were also used for this purpose, until the more common employment of hot tea and coffee supplied us with means which may perhaps be considered even better adapted to protect the body against exposure to weather.

The same fact was again seen in the American War of 1814; in the partial winter campaign, the men bore the cold without great difficulty, being very carefully protected from the weather.

The same fact was again shown in the celebrated marches in Canada in the rebellion of 1837, and similar marches appear to have been repeated with as much success during the last few months.

Although, however, it appears to be quite certain that if men are well

fed, and if the surface of the body be kept thoroughly dry, they can bear great exposure, yet few armies have been so well cared for; and exposures to inclemencies of weather must be put down as the third cause which has been productive of disease in our campaigns. Even the campaigns of Flanders and Germany to which I have referred give many examples of this; one of the best, perhaps, is the often-quoted case of what occurred after the battle of Dettingen. Previously the men had been extremely healthy, after the battle they were exposed to wet and cold for two or three days; the consequence was that an attack of dysentery occurred, and was so general that half the army were affected; had this occurred a few days previously it is by no means improbable that the strenuous exertions which alone won the battle of Dettingen would have been impossible. So also in 1760 there was at times a considerable amount of sickness from exposure to weather, in spite of the great care which was taken of the men. In 1799 another campaign in Flanders owed its chief disasters to the inclemency of the weather, and the gallant force of the Duke of York was, in fact, beaten by the elements.

It is impossible that a general in command can ever protect his men perfectly from inclemency of weather; armies must be expected to suffer from this to a considerable extent; the diseases it produces are of course catarrhs, inflammation, rheumatism, and dysentery. But it is satisfactory to know what great effect the measures to which I have referred can have: if men are well fed and are well clothed and covered with water-proof clothing (which will probably be found the greatest boon which has ever been given to the soldier, but which is not yet sufficiently appreciated in our army), if hot liquids are provided for them, and spirits kept from them, or at any rate issued in the greatest moderation, there is no reason to think but that troops will bear a great deal of exposure to inclemencies of weather. Even the winter in the trenches before Sebastopol, had these means been available, might certainly have been met with comparatively little loss. But if from poverty or from defect of transport the warring nation cannot clothe and feed its troops, its plan of campaign must be adjusted to its circumstances, or it must be prepared to encounter a great mortality.

4. But catarrhs, slight dysentery, rheumatism, and inflammations are not the only diseases which affected the troops in the wars in 1742 and 1760; in both cases they suffered, though to a comparatively slight extent, from the spotted typhus and the putrid dysentery—diseases which have been the grand scourges of armies in temperate climates, in the same way as cholera and yellow fever have been the destructive agents in the tropical wars. The spotted typhus, the great typhus of armies, is, perhaps, the most terrible disease of all; wherever men are closely crowded together in ill-ventilated, unwholesome dwellings it is sure to appear. If scurvy be also present, it then attains its greatest intensity, and commits ravages which are truly astonishing. It has often passed from the army to the civil population, and has half dispeopled towns and even districts. Its ravages in the English army have never been comparable to those which have occurred in foreign forces, and, to give an idea of its powers, permit me to allude to a few examples of the effect of this disease among some continental troops.

In 1620 the Bavarian army in a few months lost in Bohemia not less than twenty thousand men from spotted typhus, and the disease being carried into other parts of Germany, obtained the name of "the Bohemian disease," just as, in the same way, on a later occasion, the typhus carried back from Hungary received the name of "the Hungarian disease." In 1628 and 1632 the Swedish army under Gustavus Adolphus carried typhus into Northern Germany, and the population was so destroyed that fifty or sixty years later villages remained without inhabitants. The wars of Louis XIV. were always followed by this disease, and the losses of the French army were enormous. But it was in the wars of 1812 and 1813 that its greatest ravages were seen. In May, 1812, the Bavarian army serving among the French numbered 28,000 men; in February, 1813, there were only 2,250 under arms. The great destroyer was typhus. In August, 1813, the first Prussian army consisted of 37,728 fighting men, in November of the same year it reached the Rhine with 11,515 men, having lost 16,000 men by the sword, and 10,000 men by disease, almost entirely typhus. Even this was trifling compared with the enormous losses among the French army. Not only the army but the civil population suffered fearfully. It is impossible to enumerate the hecatombs of victims; in Mayence alone the French lost in six months 17,000 men from typhus. It is impossible to overlook the effect which this must have had upon the fortunes of the campaign.

In later wars the same fact has occurred. I need scarcely refer to the great losses, even yet not perfectly known, of the Russian army in the Crimean War, and to the losses of the French army in the spring of 1856, when more than 17,000 men perished in less than three months, and when the highest authority stated that the safety of the whole French army was endangered by the outbreak. In the war in Flanders in 1742, and again in 1760, the great cause of the spread of typhus appeared to be the state of the hospitals. If typhus once enters a hospital, unless that hospital be extremely well adapted for the treatment of this disease, and if it once attains any proportions, it spreads among the patients with astonishing rapidity, and the hospital becomes a veritable pest-house. The only plan to adopt under these circumstances is that which was carried into effect by Sir James M'Grigor in the Peninsular War. Typhus had broken out in some of the hospitals; Sir James M'Grigor broke them up and distributed the sick among the villages, and in this way, in spite of bad food, in spite of bad attendance, and in spite of exposure, the disease was arrested. Anything indeed is better than a deficiency in the supply of air. There is no doubt that with proper sanitary precautions, the spotted typhus, terrible as it is, may be almost entirely put a stop to. It must, however, be considered as taking the fourth place in the causes which have produced disease in the British army.*

* Whether or not the circumstances to which I have referred, viz. great overcrowding and vitiation of air from organic impurities derived from respiration, will absolutely generate typhus *de novo*, is yet uncertain. In all the English wars, there has always been plenty of typhus-poison, waiting for favourable conditions to assume activity. This arose from the peculiar system of recruiting. Even in the Crimean War, we saw the relics of a system constantly resorted to in the last century to raise men. Commissions and command in regiments used to be given to those who collected a certain number of men. Every low

It has never been absent from any considerable European war till the wise sanitary measures adopted in the Crimea showed us an army with scarcely a case, while two other armies under the same circumstances lost numbers of men.

5. The other disease to which I have referred, the putrid dysentery, is one which has prevailed to a still less extent, in the English army, than the spotted typhus. It prevailed to a certain amount in the wars of 1742 and 1760, and in the Peninsular War during a short time. Arising from various causes, from exposure to cold, from bad weather and bad food, it is also propagated by contagion, and appears, indeed, to give us an example of a disease acquiring contagious properties. This fact appears to have been first indicated clearly by Sir John Pringle, but it has been subsequently confirmed by a great number of observations in the French wars, and in other cases. As in the case of typhus, there is no reason to doubt that proper sanitary measures will lessen the spread of putrid dysentery. It must, however, I believe, take the fifth place among the diseases which have caused losses in the English wars.

6. I must now pass on to another condition, which possibly might have come before one or two of the others. In 1760 the head-quarters of the troops in the German war were at Paderborn in Westphalia. There was much sickness, and great dissatisfaction was expressed in England much in the same way as in the winter of 1854–5. The diseases were putrid dysentery to a slight extent, spotted typhus to a considerable extent, and other forms of fever, among which doubtless was the disease now known by the name of typhoid fever. These malignant fevers arose at the standing camp at Warburg, and were carried to Paderborn. They were produced by the condition of the camp, which had been inhabited for a very considerable time. Both it and the whole country around were covered with putrid remains. We are told that dead men and horses lay around in "infinite numbers," and that the bodies were only thinly covered by earth.

The unhealthiness of standing camps—unless the greatest care be taken to cleanse them—is one of the best known facts of army hygiene. The frequent shifting of encamping grounds is almost the only rule which has come down to us by means of which Alexander the Great so marvellously preserved the health of his men. The Romans also took the most special care for the cleanliness of their camping grounds, as indeed in all other matters connected with the health of their men.

Unfortunately, in modern armies the grand rule of paying the greatest attention to this duty has been too little regarded. In the English army it has perhaps been more attended to than in other armies, but even with us it is impossible to read the accounts (unfortunately too short) of the

purlieu, every infamous haunt, every jail even, used to be ransacked for recruits. Wherever these men went, they carried typhus, at that time the constant scourge of our towns and our jails. It gives one a strange idea of the making of a soldier, to read in Donald Monro's essay, published in 1764, a caution "that particular regard be paid to those soldiers picked up in the streets, or who have been taken out of the Savoy or other jails. All dirty rags from such people should be thrown away or burnt." Complaints of the introduction of typhus from this source are frequently found in the writings of army surgeons of the last century. Typhus was several times carried to the West Indies, and even prevailed there apparently to some extent.

camps even in the Peninsular War without perceiving what prolific sources of disease they were.

Let me take another instance of the effect of bad encamping grounds, as it illustrates one or two other points. In 1801 a force of 4,000 Europeans and 4,000 natives landed in Egypt from India. In June they commenced their march across the desert; they underwent hardships which Sir James M'Grigor thinks were never exceeded by any army. The heat was intense, the thermometer in the tents marked 118°, and at nine o'clock in the morning at three feet depth in the ground the thermometer marked no less than 69° Fahrenheit. Owing to the difficulty of carriage, no spirits were issued. In spite of all this the men were remarkably healthy, proving, what our Indian campaigns have also shown, that with proper precaution, and if spirits are avoided, great heat can be borne without risk.. Having reached the Nile, the army descended that river for 400 miles, and landed at Ghiza. There they found the 89th Regiment very sickly; scarcely fifty men mustered on parade. This ought to have attracted attention, inasmuch as the 89th should have been considered to be the touchstone by which the sanitary condition of Ghiza was to be judged. However, the army was there disembarked, being then, to use the words of Sir James M'Grigor, "uncommonly healthy." In less than a week they sent into the hospital ten per cent. of their force; in three weeks there were a thousand sick out of the eight thousand men; in four weeks there were twelve hundred sick: then the army moved to Rosetta. We must therefore consider that no less than fifteen per cent. of that force had in that short space of time been in the hospital, and one-fourth of the duty-men in all probability must have passed through the hospital. The diseases produced in this short time were attended with very slight mortality; they were chiefly fevers which appear not to have been of malarious origin, but chiefly of that kind, yet little investigated or understood, which are known by the name of the bilious remittent, or the bilious typhoid, and the bilious relapsing fevers of the Mediterranean and Egypt. There were also slight dysenteries, and some ophthalmia, but no plague till afterwards, when the army got to Rosetta.

It was supposed at one time that the diseases produced at Ghiza were owing to the marshes in the neighbourhood, but this is rendered improbable; first from the fact that, as far as can be known from the accounts of the diseases, which are very short and imperfect, the malarious taint did not form any grand element in these diseases, and secondly from the following fact—Ghiza for months had been an encamping ground of a succession of bodies of troops—Turks, Mamelukes, French, and then English. The whole country was covered with putrid effluvia. At a subsequent period, when time had been given for the perfect dissipation and complete decomposition and elimination of all these putrid remains, Ghiza was again occupied and was found to be healthy; therefore it would appear certain that the condition of the camp was the cause which led to the great amount of sickness in the expeditionary force.

Filthy standing camps, then, giving rise to various forms of fever, typhoid being among the chief, and to other forms little understood, also to dysentery, and to cholera in some regions, must be put down as the next cause which has given rise to mortality in English wars. It is probable that this

cause will never again produce any great amount of sickness in our forces, inasmuch as not only is the necessity of the most perfect cleanliness in camps well understood, but in the present organization of the medical department, sanitary officers are appointed, whose special duty it is to insure the perfect and continued cleanliness of the camps.

7. I will now pass on to another head. The fatigues in war are excessive, and can only be borne by men whose frames are matured by age and constant physical exertion. Boys and immature young men are speedily destroyed, or only throng the hospitals. In campaigns every soldier ought at least to be twenty-one years old, and should have been accustomed to the most constant physical exertion and open-air exercise. Before a regiment goes on a campaign, it should be weeded of its immature men, who should form a corps of reserve, and be subjected to a thorough course of training, and be then sent on to join their regiment, when deemed fit to encounter the hardships of the campaign. The effect of exposing immature troops to the hardships of campaigns has been frequently illustrated. Some of the heaviest mortality in the Peninsular War was among regiments thus hastily recruited. In the Crimean War, during the second winter the troops were fortunately not called upon to undergo great exertion. Had they been so, in spite of all sanitary precautions, that young and untried army must necessarily have suffered very considerable mortality. Perhaps the best example in our annals of the effect of this cause is to be found in the history of the British Legion in Spain, in 1837, as given by Mr Alcock. This body of men consisted of about 7,000 persons, hastily recruited, comprising Englishmen and Scotchmen, chiefly drawn from towns, and Irishmen who were more largely drawn from the open country. Almost all the force were either too young or too old. They landed in Spain during the winter. In the first few months after landing, one-third of the English, one-fifth of the Scotch, and one-eighth of the Irish were "rapidly swept into the hospitals." During the six months which succeeded their landing, they lost the "lives and services of 2,000 men," and the whole force was enfeebled and crippled for six months; no doubt they underwent very great hardships, were exposed to the weather, had bad food at some part of the time, and bad shelter; but they were not exposed to greater hardships than have often been met with little loss by seasoned troops. The great cause of their losses is to be found in the quality of the men, and it is worth observation how comparatively easily the Irishmen, drawn from the country and accustomed to open-air life and to the physical exertion of agriculture, bore the hardships which prostrated so rapidly the town recruits drawn from Scotland and England.

The often-quoted marches of Napoleon may be just alluded to here in reference to this point. In 1805 the so-called "Army of England" marched across France, a distance of 450 or 500 miles, with scarcely a straggler, and with scarcely any sick. In 1812 and 1813 the French army was an army of recruits, "boys who died by hundreds on the roadside." The Emperor bitterly complained, but his complaint met with no response. He had exhausted France by fifteen years of glory, and seasoned, hardened veterans were not procurable.

But even seasoned and veteran troops may be too highly taxed. Of this

there are not many examples in the history of English warfare. There are a considerable number in the history of continental armies, as in the army of Prussia in the time of Frederick the Great, and later.

Properly to train his men, to train them so that they shall be ready for great emergencies, to save them when saving is practicable, so that when necessary their whole strength may be called upon, must be one of the most striking powers of a great commander. The exposure, then, of immature young men to the hardships of war, hardships which must be undergone, must form the next series of causes which have given rise to disease in the English wars.

8. But now, supposing that the provident care of the Government and the skill of the general have succeeded in meeting all these conditions—have succeeded in providing well trained and seasoned men, in properly feeding them, in properly clothing them, and protecting them as far as can be done against inclemencies of the weather, in looking out for, anticipating, and providing for the causes which produce typhus, the causes which produce putrid dysentery, the causes which produce typhoid and other forms of fever—supposing that all this could be done, would an army be healthy?

In answer to this it may be said that it would be, that it must be, in a great measure, healthy. But there are still some causes which the soldier himself calls into action, and from which his officers can only in a very slight degree protect him. The agencies which the soldier himself thus calls into action are, especially, the want of cleanliness, which is so difficult to be enforced in war, the excessive use of spirits, and debauchery.

During any exertion it is an important matter to keep the skin perfectly clean. There are those who underrate the importance of this point, but they are mistaken. It is a point of prime necessity. Now in war such cleanliness is hardly possible to be enforced. Water cannot be procured, time perhaps cannot be given, and the soldier necessarily becomes extremely dirty. Hence there is a certain amount—no great amount, but a certain amount—of ill-health proceeding from this cause alone.

Whenever an army has been kept from spirits, although it has been placed otherwise under unfavourable conditions, its health has been good. Some striking examples of this may be taken from the American War of Independence, among the American troops. At first the American troops in the revolutionary war were unhealthy. After a time they ceased to be paid—funds were not forthcoming to pay them. They then became very much healthier—in fact extremely healthy. The same thing occurred in 1814. In that war the American troops were also unhealthy at first. They ceased to be paid, they ceased to purchase spirits, which previously they had indulged in, and again they became healthy. A surgeon who witnessed both these campaigns states, and very truly states, that "when the soldier is poor in money he abounds in health." The same effect of abstinence from spirits being attended with an improved state of health of the troops has been witnessed often in the English army. The case of the "illustrious" garrison of Jellahabad is a striking instance. Another most striking instance is given by Sir John Hall in the last Caffre war. The troops were exposed to great hardships and inclemency of weather, and yet remained extremely healthy, in consequence, mani-

festly, as appears from all the circumstances of the case, of the fact that spirits could not be issued to, or procured by them. But perhaps the most interesting example of this fact is to be found in the celebrated Cornwallis campaign of 1781, in which a body of men made a long and fatiguing march of more than 2,000 miles, were exposed fully to inclemencies of weather, were supplied by a commissariat which was rather indifferent, and yet remained extremely healthy. Dr. Chisholm, the surgeon of the 71st Highlanders, shall however narrate this case. I will read an extract from his book giving an account of this celebrated march. He calls it "the most remarkable campaign of the American Revolutionary War, owing to the dangers, fatigues, and privations sustained by the army in the course of it:"—

"They effected a march of nearly 2,000 miles through a poor country, inhabited by inveterate enemies, always more than 200 miles from their resources; forded many large, deep, and rapid rivers at the hazard of their lives; fought one pitched battle against thrice their number; were almost constantly engaged in skirmishes; were deprived of rum or any strong liquors; were for weeks successively reduced to the scanty support which a few heads of Indian corn, and a precarious very limited allowance of lean fresh beef afforded them; had no shelter from the inclemency of the weather, or the damps of the earth and night, but a single blanket and a few boughs of trees hastily put together in the form of wigwams. These hardships, fatigues, and privations they were enabled to support by the example shown them by their excellent and amiable commander; by the exercise of marching being alternated by rest every third day, when practicable; by parading in clean linen once every marching day and twice every halting day, being obliged to clean and bathe themselves every day; by the men being obliged to wash their shirts and waistcoats and pantaloons themselves; by a necessary abstinence from strong liquors; and, finally, by what may be considered as not the least cause, their pursuing, not flying from, an enemy. The regiment I was surgeon to, the 71st Highlanders, composed a part of this truly gallant army; they consisted of about 600 men, and the average number of their sick during this arduous service was about twenty-five, exclusive of wounded, and they were all trifling cases."

Now here the great immunity from sickness may be considered to be dependent,

1. Upon abstinence from liquors.
2. Upon the enforced cleanliness.
3. Upon the rest every third day.

The commissariat, though indifferent, was not extremely bad; the men had fresh meat, at any rate, and appear also to have had corn, and possibly other vegetables. Of these causes the abstinence from strong liquors must be put down as the most important. In the long catalogue of wars I have not been able to find a single instance in which the use of spirits has been proved to be useful, and there is a very large number in which it has been proved to be detrimental. There are only three ways of keeping men from the excessive use of spirits. The first is to supply them with good malt liquor, and with red wines which contain a small per-centage of alcohol. The supply of red wines of this kind was

formerly strongly urged by Sir Gilbert Blane, the celebrated naval surgeon. The use of these wines is not merely negative as a substitute for spirits, but also positive, for by their use a large number of salts, neutral and acid vegetable salts, are supplied to the body, which are of the highest importance to the nutrition of the system, and are themselves no mean antiscorbutics. The second mode of preventing men from getting spirits is of course by camp regulations. We have seen this attempted in the present American War, for a special Act has been passed by Congress for the purpose of hindering the men from purchasing spirits—a plan, however, which is always liable to considerable evasion. A third means by which men might be kept from the excessive use of spirits, would be to teach them how really ineffective and inoperative their use is in preventing them from suffering from diseases, and how many diseases the excessive, or indeed the even moderate, use of spirits may itself give rise to.

The third cause, which the soldier brings upon himself, and which has caused a great deal of sickness in some campaigns, has been debauchery. This, of course, is a point which can only be prevented, as far as it can be prevented, by camp and police regulations.

Such are the eight different and principal causes of mortality in our wars. I have arranged them in the order in which, looking over the history of English campaigns, I find they have produced the greatest amount of sickness. I have considered them separately or enumerated them separately for the sake of convenience, but in almost all campaigns two, or three, or four, or perhaps all of them, have been acting together.

There is no doubt that to a great extent these causes are preventible, but to prevent them would require that those in authority should fully recognise their existence and meet them with continued energy. To prevent them requires no special science, no peculiar appliances, but only the exercise of common sense and of knowledge which every soldier ought to have. The Romans certainly applied and acted upon rules which we must also apply, and acting upon them they appear to have escaped, at any rate to a considerable extent, those immense losses and tremendous catastrophes which have so often befallen modern armies. Their forces penetrated many countries and underwent many difficulties; the forest, the marsh, the desert, the cold mountain pass, the torrid plain, were traversed by them with impunity. Shall we, who boast a dominion as extensive and a knowledge more subtle and profound, fall short of the results obtained by those old masters of the world? If so, it will not be because our difficulties are greater, nor because our knowledge is less, but because we refuse to hearken to the lessons proclaimed to us from the camps and battle-fields of those thousands of British soldiers who in times gone by have fallen victims to the preventible diseases of campaigns. We must not suppose, because those lessons are so obvious, that they can be suffered to be forgotten. A writer whose name will assuredly be hereafter placed by the side of those of Robert Jackson and of Henry Marshall, says, "All errors should be treasured up in our memories. Although the past cannot be redeemed, it ought to suggest lessons for the future."

And Ranald Martin goes on to cite those memorable words of Samuel

Johnson, which, written in 1771, are still full of meaning, and have lost nothing of their truth and force.

"The life of a British soldier," wrote Johnson, "is ill represented by heroic fiction. War has means of destruction more formidable than the cannon and the sword. Of the thousands and tens of thousands that perished in our late contests with France and Spain, a very small part ever felt the stroke of an enemy. The rest languished in tents and ships, amidst damp and putrefactions, pale, torpid, spiritless, and helpless; gasping and groaning, unpitied among men, made obdurate by long continuance of helpless misery, and were at last whelmed in pits, or heaved into the ocean without notice, and without remembrance. By incommodious encampments and unwholesome stations, where courage is useless and enterprise impracticable, fleets are silently dispeopled and armies sluggishly melted away. Thus is a people gradually exhausted, for the most part with little effect. In this last war Havannah was taken, and at what expense is too well remembered. May my country be never cursed with such another conquest."

It is now ninety-three years since these memorable words were written, and it is only now that we may venture to hope that this country will not again be cursed with conquests that are scarcely less disastrous than defeats. Now at last an enlightened policy has been initiated, and the health of the soldier is, as Robert Jackson said it ought to be, "a primary consideration of the State." I venture to prophecy that in after times few reforms will be thought more important than that with which the names of Lord Herbert and Miss Nightingale, and others scarcely less distinguished, are now for ever connected; a reform in which the State both recognises a duty, and, as a reward, reaps an untold advantage. But it must be for the army at large and for the general public to support exertions which, without their aid, would languish and disappear. It must be for us, in fact, not to forget the teachings of the past, but to make them ever-living, that their warnings shall not be forgotten, and that their lessons shall not be unfruitful.

THE CHAIRMAN: I hope you will allow me to convey to Dr. Parkes your best thanks for his eloquent and most instructive lecture.

Dr. Edmund Parkes with the authors regards.

On the Application of Sanitary Science to Public Works of Irrigation and Works for the Relief of Towns. By EDWIN CHADWICK, ESQ., C.B.

I SUBMITTED to the Public Health Department, at the meeting of the Association held at Liverpool, a paper on the application of sanitary science to the protection of our army in India—a subject of imperial importance. One object of that paper was to show the necessity of the cultivation of the special engineering required for the practical application of that science, without which special engineering enormous expense, as well as failure in the production of the sanitary effect, is too commonly incurred.

I have received a communication on the subject of the irrigation works of India, which have recently occupied public attention, showing on a large scale the evil consequences of the prosecution of such works in ignorance or in disregard of sanitary science. This communication appears to me to be so highly important as to render it incumbent on me to solicit the particular attention of the Association to it.

Where a clear money profit from any works is in prospect, any evidence as to evil effects produced on others, we find, meets only with inattention or hostility on the part of those by whom the profit is derived. In my own experience and investigations I have, however, found no case of works, attended with evil to the public health, which are not of a low state of structural or engineering art, and at the same time excessively expensive, and in various ways wasteful of money. Thus, the poison pit—the cesspool—in its original cost of construction, in the cost of repair and maintenance, and in the cost of constant cleansing, apart from all foulness and offensiveness, and all noxious influences, I have proved to be more expensive than a properly constructed, self-cleansing watercloset, the expense of the water included.* Thus, too, the old brick house-drains, which accumulate noxious deposit, are more than double the expense

* *Vide* "Minutes of Information on the Drainage of Dwellings and of Towns," published by the General Board of Health, 1852, pp. 12, 155, 166; also paper on "The Drainage of Towns," by Robert Rawlinson, Sanitary Engineer, published in the *Transactions* for 1857.

to construct, and are still more expensive to cleanse, than properly-adjusted tubular drains, which are self-cleansing and do not decay. So of large, flat-bottomed brick sewers which accumulate refuse, and are, in fact, only extended cesspools. Three houses or three towns may now be drained well at the expense of old works to drain one ill.* Water, good at its source, when stored in close habitations, in houses and towns, absorbs the mephitic gases, and becomes unwholesome in proportion. When we have examined the expenses of waterbutts and cisterns for separate houses, of the space they occupy, and of the walls to bear them, and the cost of maintenance and repairs, the cost of this injurious arrangement exceeded that of a constant supply of water delivered direct and fresh into every room.†

The first application of the sewerage of towns to agricultural production was by the old agricultural method of irrigation, by submerging the grass or other produce grown on panes or tables of ground levelled to receive it. To this method strong sanitary objections were raised at Edinburgh and other places, where the irrigation was by sewage water, holding considerable portions of foul matter in suspension and in solution. On examination, I found that these sanitary objections were well-founded, not only as against irrigations with sewerage, but as against the common irrigations with plain water, containing only such earthy or animal matters as may be found in the rainfall upon grazing and tillage lands.

In the first place, it was proved that the excess of moisture on the wide irrigated surfaces produced damp, and was attended with the effects of damp and cold in reducing temperature. They produced rheumatism and ague in men; and as more or less of the decomposition of animal and vegetable matter takes place in the process of drying up stagnant pools which are found in all but the most expensive constructions, the rot or typhus is produced in sheep. There was once a demand in London for what were called "Brucksey hams,"—that is to say, for the hams of sheep which had been killed in a state of fever or the rot. A farmer found out that he could meet the demand at pleasure after May, by flooding and afterwards stocking his water meadows, when they were saturated with moisture. From the experience of the noxious effects of irrigations in the Lombardo-Venetian provinces, permanent irrigations are prohibited within five miles of towns.‡

Where the sun is more powerful decomposition will be more rife, and the noxious effects upon the living, from this method, will be greater. Such effects have been traced upon a great scale in India

* *Vide ibid.*

† *Vide* "Report of the General Board of Health on the Water Supply of the Metropolis."

‡ *Vide* "Minutes of Information on the Practical Application of Sewer Water and Town Manures to Agricultural Productions," printed by the General Board of Health for the information o loca lBoards of Health, 1852, pp. 8—11.

by Dr. T. E. Dempster, Deputy Inspector-General of Hospitals in Bengal, and are described in the very important paper which I herewith submit.

The difficulties attendant upon the subject of the disposal of the refuse of towns—the noxious effects of the products of decomposition upon the populations exposed to them, the expense of the constant removal of fœcal matter in the solid form, the inconveniences of mounds of it, or laystalls, near towns, the objections to the pollution of rivers—forced me to the investigation of remedies, in which I was led to propose the method of distribution in suspension in water, by steam or other power, through underground pipes and by jets, and enabled to impeach the method of distribution by submersion, for waste.

The outlay of capital for engine power and pipe distribution is about £5 per acre,* and the working cost of distribution on a large scale about 1*s.* 8*d.* for 100 tons; on a small scale, about 3*s.* 4*d.* per ton. The outlay of capital for the formation of water meadows ranges from £1 to £40, and £100 even, per acre.

In Italy the expenses of the chief works averaged £40 per acre. In England the average was £30 per acre, and the working expenses were £3 7*s.* per acre: the expenses of the cheapest method of distribution, by open gutters on natural inclines, was 14*s.* per acre, whilst an equivalent distribution by jet was 7*s.* per acre.†

But by the method of distribution by water meadows at Edinburgh, upwards of sixty inches deep of sewerage was put upon the surface in the year; whilst upon what may be called the gardeners' method of applying water and manure at the same time by the water-pot,—except that the jet is impelled by steam power,—about thirteen inches, or nearly one-third of the manure, produces an equivalent productive result.

The first applications of the principle of jet distribution, whether for towns or for farms, have been made without or against due advice, and have been made rashly and wastefully. Thus, in the application of the sewerage of Rugby, a town of about 6000 inhabitants, for which about seventy acres would have sufficed to receive about thirteen inches of sewerage in the year, the apparatus was extended over 450 acres, or three times the area which would have sufficed, with the result of distributing little more than four inches per acre per annum, and that, too, with a great waste of manure, by distributing it over the uneven surfaces of old ridges and furrows, in which the gutters got the chief benefit, instead of upon ground properly levelled; and it was applied upon old grasses, a large proportion of which were the least nutritious, and more than half of them the least fitted to profit by liquid manure; added to which, the mains for the distribution of the manure are so small as to occasion an expensive waste of engine power. Nevertheless, the proprietor declares that the results are a greater profit than on the old method of cultivation, and that he is "satisfied" even as it is. And

* *Vide* "Minutes of Information" last cited. † *Vide* p. 49.

so with liquid manure farms, where the farmers are satisfied with comparatively inferior effects. Those who are desirous of studying the later experience, as to the economics of the question, will find them exemplified in some evidence which I have cited from Mr. James Blackburn, a practical agriculturist and engineer, given in the *Gardeners' Chronicle* of the 18th and 25th of May, and the 1st and 16th of June last, including an exposition of trials by Dr. Kirkpatrick, of the Albert Agricultural Institution at Glasnevin.

Whilst a better economical result is obtained by the method of distribution by jet, the sanitary result is insured by operating upon a small portion of land at a time, by giving that land only as much as it can absorb at each dose, and by reducing any surface evaporation to the minimum. At higher rates of expense for apparatus, which may nevertheless in many cases of high culture be eligible, the surface evaporation may be altogether avoided.

Whatever may be the merits of the water leading in the main trunk lines of canals for irrigation, I aver that the method of subsidiary distribution, on which the evils described by Dr. Dempster are attendant, is ignorant, barbarous, and wasteful—wasteful of water and productive of inferior agricultural effect. It is true, that in India steam power will be more expensive and may for a long time be inaccessible, but they may have horse powers, which are in extensive use in America, and which in this country, for many cases of intermittent use, and for scales where less than a four-horse power is required, are cheaper than steam.* It is true, that in India they have not iron pipes, but they have the bamboo, which, hollowed out, serves for water leading, under low pressures, and might be made to suffice, in the method of water leading, by spouts and hollowed trunks of trees carried on tressels to movable troughs, whence it is distributed by scoops with great rapidity, as in use in Sweden and Norway.

I have had evidence that the rice culture by stagnant irrigation, so injurious to the health of populations, is one which an improved culture having no such insanitary effects would supersede.

I might, if it were necessary to do so, here give extended illustrations to support my principle; that special sanitary engineering, which prevents such evils as Dr. Dempster describes, does so with an improved productive and economical result, and that where it is otherwise, it is the default of the engineer, in the want of proper knowledge of agricultural as well as sanitary science.

Finally, I would give warning, that for India and the tropics, comparatively inferior general sanitary improvement will be obtained by mere changes of stations from unprepared sites and ill-constructed barracks and habitations on the plains to improved barracks and huts on the cool, but sometimes sharply cold, unprepared, un-

* *Vide* a description of these powers, with other cheap powers, in a paper which I read at the Royal Agricultural Society of England, on June 17th, 1857, and given in the *Gardeners' Chronicle*.

drained upland sites, often on swampy hills; nor by the mere appointment of officers, with the name of health officers, without any special training and testing by competitive examinations in sanitary science. Where such qualifications are absent, such appointments often serve only to indorse expensive apologists for the maintenance of evils which are preventable, with which the persons appointed have no capacity to deal properly or efficiently. Nor will the appointment of properly qualified health officers avail much more than for the reiteration of remonstrances, unless those officers are provided with the means and invested with the power of getting their prescriptions made up, which prescriptions for prevention must be, I repeat, not for drugs from the apothecary or the medicine store, but for well-devised works from the engineer. For these works a special training is needed for our military engineers, whose present peculiar training is only for old works for war, and for those imperfectly; works for the maintenance of the health of an army being necessary means to the maintenance of its military strength. The one-sided character of the common training of our military engineers was displayed in the Crimea, in the proved need of a special sanitary commission to give instructions for the selection and for the practical drainage of proper sites for healthy encampment—for the choice, collection, and the proper distribution, of wholesome water—for the construction of wholesome huts, and the proper shelter and treatment of horses as well as of men; it also demonstrated to the public the need of an army works corps, under civil engineers, to construct military roads. Even now, young military engineers complain that the application of sanitary principles is expected of them, for the amendment of old constructions and the planning of new ones, for which they have had no preparation. The defects of practical engineering and construction is partially supplemented by clerks of works, at great expense, who really give an imperfect command to workmen which ought to be given perfectly by officers. In remote dependencies clerks of works are not to be had, though artisans are to be found in the ranks even of the line, if there were engineer officers competent to lay out works for them, and directly superintend their execution. On the Continent, engineer officers in the best armies are not such very fine gentlemen that they cannot dirty their hands with mortar; and although they are men of science and gentlemen in our sense, they are head work masters and practical leaders of artisans, ready to apply sanitary science, if sanitary science were there provided, which it has yet to be, and to be placed in its proper position. The needed preparation and practice of our engineer officers in the application of sanitary science to works during peace would save the country much expense and loss of force, would relieve the officers of the ennui of useless routine occupation, and would give them higher qualifications than they now have for meeting the changing exigencies of war. At home, instead of servilely yielding place to the expensive and blundering empiricism of civil practice, they would correct it. In our remote colonies,

whilst they would prevent such defaults from the absence of sanitary science as Dr. Dempster's paper in part displays, they would become the pioneers of civilization by rendering countries habitable by a higher order of colonists and civilized races, and give us the advance due to our age upon the colonizing legionaries of Rome, in the times of Frontinus and Agricola.

Communicated by T. E. DEMPSTER, *Late Superintending Surgeon, Bengal Army.*

Two most important subjects connected with British India are at present engaging public attention, viz.—first, the sanitary management of our European troops in the East; and secondly, such an extension of the existing works of irrigation as guard the native inhabitants from the famines which periodically devastate certain provinces, and at the same time enable India to raise an ample and certain supply of raw material for our cotton manufacturers at home, instead of allowing them to remain, as they now are, almost wholly dependent on the precarious political and commercial condition of the States of South America.

Very probably, few will reflect that these two widely different objects may have a most important relation to each other; and it is almost certain that the classes whose minds are directed to the second may be wholly careless of the first, and that they will be disposed to resist any attempt to modify or otherwise interfere with their favourite schemes, on account of sanitary considerations in which they feel no direct interest or personal concern. Circumstances have given me special opportunities of making observations and recording facts in India, relating to both these very subjects. I have long desired to turn the experience so acquired to some useful practical account, and if the opinions I have formed shall be found to rest on carefully observed and scrupulously recorded facts, I think they cannot fail to be regarded as of some value at the present time.

In 1846 the Government of Bengal directed a Special Committee—of which I was the sole medical member—to investigate and report on the causes of the unhealthiness which had prevailed at Kurnaul and other portions of the country along the line of the Delhi Canal. In the course of our inquiry we examined the irrigated and unirrigated districts on both sides of the river Jumna; we visited the notorious "Nugufghur Jheels," and followed the course of the then projected Ganges Canal for eighty-three miles, viz., from Hurdwar to the latitude of Meerut. We travelled in all about 1,460 miles; inspected more than 300 inhabitated localities; and personally examined 12,000 individuals of all ages. I do not now possess any complete copy, either of the official report, or of the appendix subsequently written by myself alone. Both these documents were originally printed at the public expense, and were at one time sold at the Government Press at Agra. But in 1854, when the new Ganges Canal was publicly opened by the Lieutenant-Govenor of Agra with great pomp and ceremony, amidst a vast assemblage of British officials and natives of rank, all allusion to our Committee or its results was scrupulously avoided, and from that time forward not a single copy of the official report or appendix has been anywhere procurable. It is not, therefore, in my power to supply complete copies of these documents; but I submit the following brief account of the nature and objects of our inquiry, and some of the principal conclusions to which it led.

When we commenced our labours, public opinion was violently divided on the subject. One party—chiefly consisting of medical men—held that all the notorious unhealthiness of certain districts was solely to be ascribed to the influence of existing canals and canal irrigation; another party as confidently maintained, that no sanitary question at all was involved in the construction of works of this nature. Among the latter were persons of high position and great influence, who did not scruple to talk openly of the "sanitary humbug." Such was the state of

the question when it was proposed to construct the Great Ganges Canal, "the most magnificent work ever undertaken in India—one of the most magnificent works in the world."* Lord Hardinge, then Governor-General of India, wisely hesitated to sanction the scheme until he had satisfactorily solved the sanitary question. He, therefore, appointed a Committee minutely to investigate and report upon the subject.

The task assigned us was one of no ordinary difficulty, nor was it a matter of ordinary importance to decide whether such a vast undertaking as the Great Ganges Canal was likely to bring with it a blessing or a curse to the people of India. But how was the inquiry to be conducted, seeing that the sickness had, for the time being, passed over; that medical or vital statistics in any authentic shape or form had no existence among the people to be subjected to examination; that certain obvious reasons rendered the oral testimony of the natives themselves absolutely worthless; and that any conclusions drawn mainly from the alleged aspect of the inhabitants could carry no weight. In this perplexity I thought of applying the test of organic disease of the spleen as a probable measure of the extent to which the people had previously suffered from endemic fevers. The manner in which this test was applied, and the singular and unexpected results it gave, are fully set forth in our Report. "Without it the inquiries of the Committee, based as they must have been on oral testimony, on which no credit could have been placed, would have ended in vague and unsatisfactory conjecture, and without a single fact collected among the agricultural population on which they could depend."† To preserve and improve the drainage of the country through which the canal was to pass would doubtless have been considered desirable objects if attainable at a moderate cost, but had it not been for the test I hit upon, and the incontrovertible nature of the evidence obtained, chiefly through its careful application, I am persuaded that the Government of India and the Court of Directors would never have consented to set aside all consideration of expense, and to make these main and indispensable conditions of the whole of this vast undertaking.

Our inquiry appears to me to have sufficiently established the following positions, viz.:—

1st. That canal irrigation carried on in the north-west provinces of the Bengal Presidency, under certain unfavourable conditions noted in the Report, is uniformly productive of endemic diseases, which from time to time assume the form of widespread and often fatal epidemics.

2ndly. That canal irrigation, carried on under certain favourable conditions, may consist with a very moderate amount of endemic disease, and a healthy and vigorous condition of the inhabitants generally, while it most certainly obviates that most formidable of all the accessory causes of sickness and mortality—the want of the comforts of life.

3rdly. That canal irrigation under all circumstances, even the most favourable, is liable to be attended with a certain amount of contingent evil, but that, due precautions being taken, the good will far outweigh the evil: the famines which have from time to time devastated the country be rendered impossible, as far as irrigation extends; and canals prove, on the whole, a blessing to the people. I would fain hope, therefore, that our labours went some way to solve that most important problem, viz., how to obtain the maximum of good with the minimum of evil, in constructing works of this nature in those provinces of British India.

In pursuing our investigations, we carefully avoided all speculative reasoning, allowing facts and figures alone to guide us to the conclusions at which we arrived. We were, however, alive to the fallacies which might mislead inquiry, in thus estimating the effects of canal irrigation; and it will be perceived that, in the statistical tables, we separated, when necessary, the inhabitants of large towns from agricultural labourers, and further noted the caste and calling of every male adult subjected to examination.

The great bulk of the people who came under our observation were living in

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* Kaye's "Administration of the East India Company."
† Baird Smith on Italian Irrigation.

small agricultural communities, composed, as nearly as possible, of the same classes—engaged in the same general occupations, having the same unchanging social and domestic habits; subject to the same climatic influences; and inhabiting a tract of country having throughout the same geological and botanical character. As communities they differed in little but in position with respect to the canals, and in cultivating soils of various quality, some of which possessed, while others were cut off from, the benefits of canal irrigation. Moreover, the same series of observations were carefully repeated a great number of times in a great number of situations. Our attention was especially directed to the condition of the people as regards "the comforts of life;" and it is worthy of particular remark, as affecting the value of our deductions, that those comforts were generally most abundant in the irrigated districts. We met with many localities, both in irrigated and unirrigated parts, the insalubrity of which could fairly be ascribed to local causes, totally unconnected with the canal or its waters. The most remarkable cases of this nature were specially noticed, but minor instances, being pretty fairly distributed over both descriptions of land, were sunk in general averages in the printed Report.

I would here prominently record my assent to the position, that the same kind of irrigation or obstructed surface drainage, which produces so much mischief in one part of India, is not necessarily attended with like consequences in other provinces, differently circumstanced as to climate, soil, level, &c. Observers in different parts of India may, therefore, widely differ in their report as to the effects of canal irrigation, without impugning the facts, or invalidating the evidence, independently brought forward by each other. For instance, in Rajpootana, the scene of Major Dixon's philanthropic labours, inclined strata of hard rock underlie a scanty upper soil, and appear to secure a ready under drainage towards the numerous natural lakes in the vicinity. In Bengal Proper, and in some of the provinces adjoining, the country is low and the periodical rains abundant, regular, and long-continued. In such districts the very excess of moisture seems to ward off mischief. On the other hand, the country traversed by the Delhi, Jumna, and Ganges canals, though to the eye a vast level plain like Bengal, is really much higher and drier, and subject to seasons of excessive drought; while—unlike Rajpootana—the ground to a considerable depth from the surface consists of mould, clay, sand, and other alluvial deposits. So naturally dry is the soil of some of the irrigated districts that many wells are found from 100 to 200 feet deep. In the neighbourhood of Hansie and Hussar the accession of the canal permanently raised the water in the old village wells 60 feet, and yet left it at a considerable depth from the surface. It is in such districts that canal irrigation instantly changes a sterile plain into a luxuriant garden: but it is also precisely under such circumstances that neglect of certain precautions may bring about the greatest amount of mischief in a sanitary point of view. This is the consideration I would urgently impress on the minds of all concerned at the present time.

The over-zealous partisans of canal irrigation have ever been anxious to show that all the notorious insalubrity of certain places is sufficiently accounted for by collections of filth and general neglect of local and personal cleanliness; and they triumphantly point to stenches, enough, in common parlance, to breed a pestilence anywhere. But they forget, or wilfully shut their eyes to the fact, that the nuisances alluded to are found to an equal extent in almost every large native community; while fevers of a particular type rage year after year in certain situations only.

All I witnessed during the canal sanitary inquiry, and all my previous and subsequent Indian experience, go to prove that there is no necessary connexion between malaria of the most deadly character and offensive odours of any kind, and that in many cases its worst effects are experienced just as we recede from the unavoidable impurities of large crowded native cities.

I have often feared that my statements regarding the extraordinary extent to which splenic disease exists in so many towns and villages in the old canal districts would be received by the profession at home with surprise—perhaps with incredulity. I can only say that these statements have now been before the Indian public for many years past; that they have never been impugned, and that wherever medical men have taken the trouble to go over the same ground in the

same manner, as in the "Zillas" of Delhi and Allyghur, my account has been fully verified.

Apart from the special objects of the Committee, perhaps its most important results were—1. The confirmation of a truth, often told, but too often forgotten by medical men, viz., that the external features of the ground, if seen at one period of the year only, and without the experience of several seasons, will often fail to enable us to distinguish a malarious from a comparatively safe and healthy locality. 2. The successful application of a simple test, by which this question—often involving interest of vast importance—may, in many instances, be speedily and correctly determined. In the central and upper provinces of the Bengal Presidency, (I speak with confidence only of those districts I have myself carefully gone over,) a distance of a few miles will often separate a healthy site from one of the worst character; and if the external visible features of the country be hastily observed, and alone implicitly relied on, they may lead to the most fatal errors. If, however, there are inhabitants who have been long subject to malarious influences, they will carry in their abdominal regions marks which no apathy or cunning can conceal. A careful exploration of the regions of the liver and spleen, especially of the latter organ, in a certain number of the people taken at random from each of the surrounding villages, and an accurate comparison of the results, will probably settle the question at once. At all events, such an examination cannot fail to give important information in many cases, where no other of a reliable character is to be obtained.

I enclose a printed copy of a letter addressed by me to the editor of the *Medico-Chirurgical Review* soon after my return from India in 1857. This letter will be found to contain a remarkable illustration of the terrible consequences of ignorance, or culpable neglect, of the leading principles laid down in our Report. It also affords a striking, and to me most gratifying, corroboration of the statements I had long ago made regarding the marvellous prevalence of splenic disease in similar cases, and shows the practical use to which this fact can be turned, in determining the true character and causes of epidemics in that part of India.

I am fully persuaded that both philanthropic societies and commercial associations in England will now urge on the Government of India the necessity of greatly extending works of irrigation over certain districts in the upper provinces, usually singularly fertile, but, from time to time, subject to excessive droughts and consequent famine. But unless such works are undertaken on correct sanitary principles, unless the preservation and improvement of the drainage of the country through which they are made to pass be accepted as main and indispensable conditions of the whole scheme, it is my duty to warn the public that very lamentable consequences will most certainly ensue. We may apply all the modern improvements of sanitary science to our military cantonments, barracks, houses, and native towns; we may feed, clothe, and exercise our European soldiers on the best and soundest principles; but if we place them near the swampy banks of Indian rivers, on clayey and moist soils, or in the neighbourhood of badly constructed irrigating canals, all such precautions will prove of little avail to diminish the rates of disease and death now prevailing in India.

A few days ago I stumbled on the subjoined passage in the *Saturday Review* of the 13th of April last—article, "Prisoner of Burmah." It furnishes an undesigned and unexpected confirmation of opinions which I have long upheld, from a source at once authentic and above suspicion:—

"It is a curious fact worthy of the consideration of sanitary reformers, that this den of evil smells was actually wholesomer than the fresh air outside. After a time, Mr. Gouger was removed to a single cell, which being built of wood, after the artistic fashion of the Burmese, was unimpeachable in the article of ventilation. In this cell he caught a dysentery, which brought him to the point of death. It was the rule of the prison that any one who died in these cells should be buried at the cost of the keepers of the prison. With an eye to economy, therefore, the keepers, as soon as they thought his case was hopeless, brought him back to the inner prison, whose aromas he has so feelingly described. No sooner did he arrive there than he began to recover. He found by experience that no amount of putrefying abominations was so deadly to breathe as the uncontaminated exhalations of the Irrawuddi."

Having so often alluded to the Sanitary Committee on Canal Irrigation, it is proper here to explain that practically the whole inquiry was conducted by Major (now Colonel) W. E. Baker, of the Bengal Engineers, as president, and myself as member. The test we employed, the reasons for using it, and its practical application to the people, all necessarily belonged to my department. But the general plan of the investigation, the precautions taken to guard against fallacies, and the numerous and valuable tabular statements appended to the official report, were mainly due to my colleague. Both, I am sure, lay equal claim to a sincere and honest desire to arrive at the truth. It is further right to state that I alone am responsible for all opinions or shades of opinion not clearly expressed in the official report which may be found either in the present paper or in any other I may have written on the effects of canal irrigation.

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ON A

VOLUMETRIC PROCESS

FOR THE

ANALYSIS OF WATERS.

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On a Volumetric Process for the Analysis of Waters.

By Edward Nicholson, F.C.S., Staff Assistant-Surgeon.

The want of a process by which surgeons and other scientific men interested in hygienic matters, could easily make an analysis of water, has long been felt; and attempts have several times been made to supply the deficiency.

Professor Clark, of Aberdeen, indicated the tincture of soap as a test for the presence of earthy salts in water; he adapted a burette, with a special graduation, to the determination of the hardness of water by the tincture of soap, and drew up a table for calculating the amount of the different earthy salts corresponding to the quantity of soap decomposed by the water.

The beautiful experiments of Professor Clark, after some examination and criticism by Professor Playfair, Mr. Campbell, and others, was adopted by MM. Boutron-Chalard and F. Boudet, as the basis of the so-called "Hydrotimétrie," for which a prize of 2,000 francs was awarded them by the Academy of Sciences. These chemists adapted the soap solution of Professor Clark to a more complete determination of the earthy bases, and as their very useful method has been used to some extent in France, and is employed in the Hygienic Laboratory of the Army Medical School at Fort Pitt, I will give a brief outline of the process they employ.

The solution of soap employed by MM. Boutron-Chalard and Boudet, is of such a strength, that 23 degrees of their burette (equal to 2·4 c.c.) form a permanent lather on agitation with 40 c.c. of a solution of chloride of calcium, containing 0·25 grm. per litre. One degree is deducted for the excess of soap-solution requisite to form the lather significative of the termination of the reaction. These 22 degrees correspond then to ·01 grm. of chloride of calcium, or to a quantity of any other soap-decomposing substance, varying according to the relation of its equivalent to that of chloride of calcium. The number of degrees of soap-solution decomposed by 40 c.c. of a water, when multiplied by

certain factors, given in a table, gives the amount of chloride of calcium, or of any other salt, *ad libitum*, contained in the water.

The operations for the analysis of water by this method, comprise the following determinations:—

1. The hardness of 40 c.c. of water; this hardness is caused by carbonic acid gas, lime, magnesia, and whatever iron and alumina may be present.

2. The hardness of 40 c.c. of water from which the lime has been precipitated by oxalate of ammonia; this gives the hardness caused by magnesia and by carbonic acid gas.

3. The hardness of 40 c.c. of the water from which carbonate of lime and carbonic acid gas have been expelled by boiling; this *permanent* hardness, after a deduction of 3 degrees for carbonate of lime still remaining in solution, is owing to salts of lime other than carbonate, and to salts of magnesia.

4. The hardness of 40 c.c. of the boiled water from which the *permanent* lime has been precipitated by oxalate of ammonia; this gives the magnesian hardness.

5. The sulphuric acid is estimated by adding to 40 c.c. of water, a measured quantity of solution of nitrate of baryta, of known hardness; the hardness of the mixture is determined, and the loss of hardness indicates the hardness of the sulphuric acid contained in the precipitated sulphate of baryta.

The distinguishing features in this improvement of Clark's process, are the estimation of the permanent lime and magnesia salts, and of the sulphuric acid.

This easy method of estimating the more important constituents of water render this process most valuable in the economical analysis of waters, as a means of determining the effect of a water on steam boilers and in domestic operations, and also as a method for calculating the exact amount of lime that must be added to water, to eliminate the carbonic acid and carbonate of lime. But, apart from its economical value, considering the process in the point of view of chemical analysis, it is liable to some objections, and appears susceptible of certain improvements.

Two of the determinations are made after the addition of oxalate of ammonia; and I find that this introduces a possibility of error, since the oxalate of ammonia, when added even in small excess, either gives a peculiar hardness of its own, or else deranges the production of a lather, so as to render the result uncertain. It is also impossible to express the exact constitution of the solid

ingredients of the water, or give any precise idea of their composition. No account is taken of the alkaline salts, and thus the advantages of the method are not fully brought out.

Impressed with the delicacy of the reaction given by the solution of soap, with the minutest quantity of earthy base, or of carbonic acid gas (·00002 grm. of lime will cause a detectable hardness of 1-7th of a degree), I have endeavoured to adapt this delicate test to a more complete and reliable method of volumetrical analysis; and I believe I have succeeded in bringing the process of MM. Boutron and Boudet, by several modifications and additions, to an exactitude which leaves little to be desired. I have also simplified the calculations, so as to render them even easier than those necessary in ordinary gravimetrical analysis.

The burettes employed are divided into tenths of cubic centimetres or degrees, each 0·1 c.c. = 1°. These, with two pipettes of 10 c.c. and 50 c.c. respectively, a few basins and beakers, a few three-ounce stoppered bottles, and a graduated litre-measure, form all the apparatus required.

The following solutions are employed as test-fluids:—

1. *An Alcoholic Solution of Soap.*—The solution employed by MM. Boutron and Boudet is made with hard Marseilles soap, and in consequence it is solid at ordinary temperatures. This is a great inconvenience, from the necessity of heating the test-fluid; but, after experimenting on a considerable number of soaps, Dr. Parkes has found that the soft potash-soap of the London Pharmacopœia is the best; and this has accordingly been used by me. The solution is made by dissolving the soap, without heat, in a mixture of equal weights of alcohol and water.

The soap-solution is made of such a strength, that 20 degrees (2 c.c.) are exactly equivalent to 50 c.c. of a water containing 0·1 grm. per litre (or 7 grains per gallon) of carbonate of lime, and on adding to 50 c.c. of such a water 22 degrees, a permanent lather is produced by agitation. This requisite excess of 2 degrees per 50 c.c. is to be deducted from all determinations of hardness.

2. A solution of *nitrate of baryta*, containing 0·26 grm. per litre and equivalent in point of hardness to the aforesaid standard water containing 0·1 grm. per litre of carbonate of lime. 50 c.c. of this solution mark 20 degrees.

3. A stronger solution of *nitrate of baryta* is usually employed; it contains 1·300 grm. per litre; 50 c.c. of it mark 100 degrees.

4. A solution of *nitrate of silver* containing 8·500 grm. ($\frac{1}{20}$ of the equivalent of the salt) per litre.

5. A solution of *oxalate of ammonia*, containing 0·355 grms. ($\frac{1}{140}$ of the equivalent of the salt) per litre.

6. A solution of *permanganate of potash* containing 0·159 grm. $\frac{1}{1000}$ of the equivalent of the salt) per litre.

The above graduation of the solutions has been adopted, as the important advantage is thereby obtained, of being able to calculate the quantity of any substance per litre of water, by multiplying the number of degrees obtained by the atomic weights of the substance. Thus—

20 degrees × 50	(eq. of $CaO.CO^2$)	= ·1000 grm. per litre, of carbonate of lime.
20 degrees × 28	(eq. of CaO)	= ·0560 grm. per litre, of lime.
20 degrees × 35·5	(eq. of Cl)	= ·0710 grm. per litre, of chlorine.

The quantities thus obtained, when multiplied by 70, show the number of grains per gallon of water.

The Analytical Process.

1. 50 c.c. of the water to be analysed are measured by the pipette into a stoppered bottle of about three-ounce capacity. The soap-solution is gradually dropped in from the burette, the bottle being strongly shaken at intervals, until a lather begins to form on the surface. The soap-solution is then added more cautiously, and enough has been added, when the water, on agitation, presents an iridescent, large-bubbled lather, breaking down very slowly, and, after a few minutes, leaving the surface perfectly covered with a beady film, reconvertible into a lather on again agitating. After a little practice, the exact point where the lather becomes permanent is attained by the addition of one small drop, about one-sixth degree, of soap-solution. The process thus indicates the presence of ·0005 grm. per litre of lime.

Two degrees are deducted for the excess necessary to produce a lather. The number of degrees found represents the hardness due to lime, magnesia, iron, and carbonic acid gas. The alkaline salts usually found in water, have no effect on the soap-solution.*

* If the hardness exceed 80 degrees, or if much magnesia be present, the earthy soap often assumes a curdy form, deranging the production of a lather; in this case only 25 c.c. should be taken for experiment, the 50 c.c. being made up with distilled water.

2. The amount of *lime* and *magnesia*, and, by difference, of free *carbonic acid gas*, is found by taking the hardness of the water after expulsion of the carbonic acid gas. To this effect 50 c.c. of the water are evaporated to dryness with one or two drops of sulphuric acid, and the residue is ignited to expel excess of acid; if the vapours be offensive, the residue may be neutralized by a few drops of ammonia, before ignition. The residue is dissolved in 50 c.c. of distilled water, and the hardness is ascertained. Oxide of iron will remain insoluble; its amount is to be deducted from the carbonic acid.

3. The *lime* is determined by the well-known application of permanganate of potash to the oxidation of oxalic acid.

To 50 c.c. of the water, add 50 c.c. (or, if the hardness exceeds 50 degrees, 100 c.c.) of the standard solution of oxalate of ammonia, let the mixture stand in a warm place for an hour, and filter. The filtrate and washings are heated in a basin to about 70° C., with a few drops of hydrochloric acid, and the standard solution of permanganate of potash is added from a burette. Subtract the number of cubic centimetres of permanganate required for oxidation of the excess of oxalic acid, from the number of cubic centimetres of oxalate of ammonia added to the water: the difference gives the number of degrees of lime.

50 c.c. of the permanganate-solution ought exactly to oxidise 50 c.c. of the oxalate of ammonia-solution.

4. *Determination of the Alkalies.*—The amount of lime and magnesia once obtained by the processes described, the ordinary process of estimating the alkaline salts by evaporating a certain quantity of the water with sulphuric acid, and weighing the resulting sulphates, is much facilitated. The lime and magnesian hardness have merely to be multiplied by the equivalents of sulphate of lime and of sulphate of magnesia, and the numbers thus obtained to be deducted from the amount of mixed sulphates per litre of water. I have however devised the following method for the volumetrical determination of the alkaline salts:—

To 50 c.c. of the water, ignited with sulphuric acid, as before described (2),* add 20 c.c., or more, of the stronger solution of nitrate of baryta, taking care that the hardness of the quantity added (2 degrees per 1 c.c.) be much greater than that of the

* It may be as well, at process No. 2, to evaporat 200 c.c. of water with sulphuric acid, dissolve the ignited residue in 200 c.c. of distilled water, and take 50 c.c. for analysis.

water, as previously ascertained. If no alkaline sulphates are present, the amount of sulphate of baryta precipitated will be exactly equivalent in hardness to the amount of earthy sulphates; and the hardness, when ascertained by the soap-solution, will be exactly that of the baryta-solution added. If, for example, 20 c.c. = 40 degrees of baryta-solution have been added to 50 c.c. of water containing 35 degrees of sulphate of lime and of magnesia (total 40 + 35), 35 degrees of sulphates of baryta will be precipitated and the hardness will be reduced to 40 degrees, exactly the hardness of the baryta added. But, on the other hand, if sulphate of soda be present in the water, in addition to the earthy sulphates, a greater quantity of sulphate of baryta will be precipitated, and the hardness will be reduced to less than 40 degrees. Should it be reduced to 36 degrees, that will show that 4 degrees of alkaline sulphate were present.*

5. The *chlorine* is determined in 50 c.c. of the water by the solution of nitrate of silver. If the quantity be very small, it is best to evaporate 500 c.c. of water to a small bulk, and count cubic centimetres as degrees.

6. The *sulphuric acid* is determined by adding to 50 c.c. of the water, 10 c.c., or more if necessary, of the stronger baryta-solution, and ascertaining by the soap-solution the hardness of the mixture. The loss of hardness from the precipitation of sulphate of baryta, gives the number of degrees of sulphuric acid.

7. *Iron* is determined in the usual manner by the permanganate of potash solution. 500 c.c. of the water are evaporated to a small bulk with hydrochloric acid; the iron is reduced by sulphurous acid, and estimated by the permanganate of potash solution. Ten cubic centimetres are counted as one degree of Fe^2O^3.

If silica be present, it will remain on redissolving the ignited sulphates, and if 200 c.c. of the water have been evaporated with sulphuric acid, it may be estimated by weighing.

In process 2, the oxide of iron becomes insoluble, and increases the amount of carbonic acid gas, from which it must be deducted.

All the processes here described are of very easy execution. The method of estimating carbonic gas is unequalled in exactness and facility of execution by any method I know, and the process for esti-

* If 20 c.c. of baryta solution have been added, the excess of soap-solution, to form a lather, will be greater; 2·8 degrees must be deducted. But it is perhaps better always to add 50 c.c. (100 degrees) of baryta. The deduction is then 4 degrees, and the loss of hardness on 100 degrees is the amount of alkali.

mating the total capacity of saturation of the alkalies is extremely exact and satisfactory. The estimation of sulphuric acid, devised by M.M. Boutron and Boudet, is likewise of great precision.

I append examples of the calculation of an analysis performed by this process, to show the advantage obtained by the method of graduation I propose, in establishing an empirical formula for the salts contained in waters.

I. *Analysis of the Water supplied by the Chatham Water Company to Fort Pitt.*

	Degrees.	
1. Hardness	53°·7	Carbonic acid gas* Calcium Magnesium Iron
2. Hardness after ignition with sulphuric acid	49°·7	Calcium Magnesium
3. Calcium ascertained by permanganate	48°·3	Calcium
4. Hardness after ignition with sulphuric acid, solution, and 60 degrees of baryta added	53°·6	(Sodium loss 6°·4)
5. Chlorine	5°·5	
6. No sulphuric acid		
7. Iron	0°·2	

Deduction of an Empirical Formula for the Salts contained in the above Water.

This calculation, so tedious by the ordinary method, becomes here of extreme simplicity. I combine the 5·5 degrees of chlorine with an equal number of degrees of sodium, a balance of ·9 degrees of sodium is left. This with the calcium and magnesium is calculated as carbonate.

	Deg.	Equiva.		Grm.	per litre.		Grs. per gal.
Carbonate of lime	48·3	× 50	=	·2415	× 70	=	16·905
Carbonate of magnesia	1·4	× 42	=	·0058	× 70	=	·406
Carbonate of soda	·9	× 53	=	·0047	× 70	=	·329
Chloride of sodium	5·5	× 58·5	=	·0321	× 70	=	2·247
Oxide of iron	·2	× 80	=	·0016	× 70	=	·112
Silica			=	·0020	× 70	=	·140
				·2877			20·139
Carbonic acid gas	3·8	× 44	=	·0167	=		= 2·52 c.
	(2CO²)			8·93c.c.			in per gal.
Residue on ignition				·2810			= 19·68.

* The iron is to be deducted from the gross carbonic acid, 4 degrees.

II. *Water from a pump at Fort Pitt.*

	Degrees.
Total hardness	36·8
Calcium and magnesium	21.0
Calcium	16·9
Sodium	5·0
Iron (Fe^2O^3)	1·2
Sulphuric acid	4·8
Chlorine	3·6

	Degrees.			Grm. per litre.		Grains per gal.
Carbonate of lime	16·9	× 50	=	·0845	× 70	= 5·915
Carbonate of magnesia	·7	× 42	=	·0029	× 70	= ·203
Carbonate of iron	1·2	× 116	2(FeO,CO^2) =	·0139	× 70	= ·973
Sulphate of magnesia	3·4	× 60	=	·0204	× 70	= 1·428
Sulphate of soda	1·4	× 71	=	·0099	× 70	= ·693
Chloride of sodium	3·6	× 58·5	=	·0210	× 70	= 1·470
				·1526		10·682.
Carbonic acid gas	14·6	× 44	=	·0642	= 31·3 c.c. p. lit.	
			(× ·537)		(31.3 c.c. × 4·54 × ·061)	
Solids by evaporation ·1500 per litre.				= 8·67c. in. per gallon.		

I may mention that the solution of permanganate of potash, of the standard here employed, answers admirably for the estimation of organic matter in water. 500 c.c. of water are heated to 70°C., with a few drops of pure sulphuric acid, and the standard solution is added, 1 c.c. at a time, until a colour, lasting for 10 minutes, is obtained. Every 10 c.c. of test-solution thus decolorised is equal to one degree of organic matter requiring one equivalent of oxygen for complete oxidation (corresponding to C^3O^3,HO, for example).

I may say a few words as to the best manner of attaining the rapidity which forms one merit of this process. I first set 200 c.c. of water to evaporate with a few drops of sulphuric acid for processes 2 and 4; I also precipitate the lime in 50 c.c. for process 3. By the time I have taken the total hardness, and estimated the chlorine, sulphuric acid and iron, the evaporation is finished and the residue ready to be taken in hand. Two or three analyses can thus be easily performed in a day. One point must be carefully observed: that the distilled water contain no carbonic acid gas. The delicacy of the soap-test for this gas is so great that the distilled water will speedily acquire one or two degrees of hardness, if left exposed to the air. If it has acquired any hardness from this cause, it should be boiled previously to use.

In conclusion I must beg to acknowledge my obligations to Dr. Parkes, who, by his discovery of the fact, that, contrary to expectation, potash-soap might be employed to make a soap solution perfectly fluid at ordinary temperatures, removed what would have been an insuperable bar to any perfection of the method of analysis.

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PAMPHLETS

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