

Medical reports, on the effects of water, cold and warm, as a remedy in fever, and febrile diseases whether applied to the surface of the body or used as a drink, with observations on the nature of fever; and on the effects of opium, alcohol, and inanition / [James Currie].

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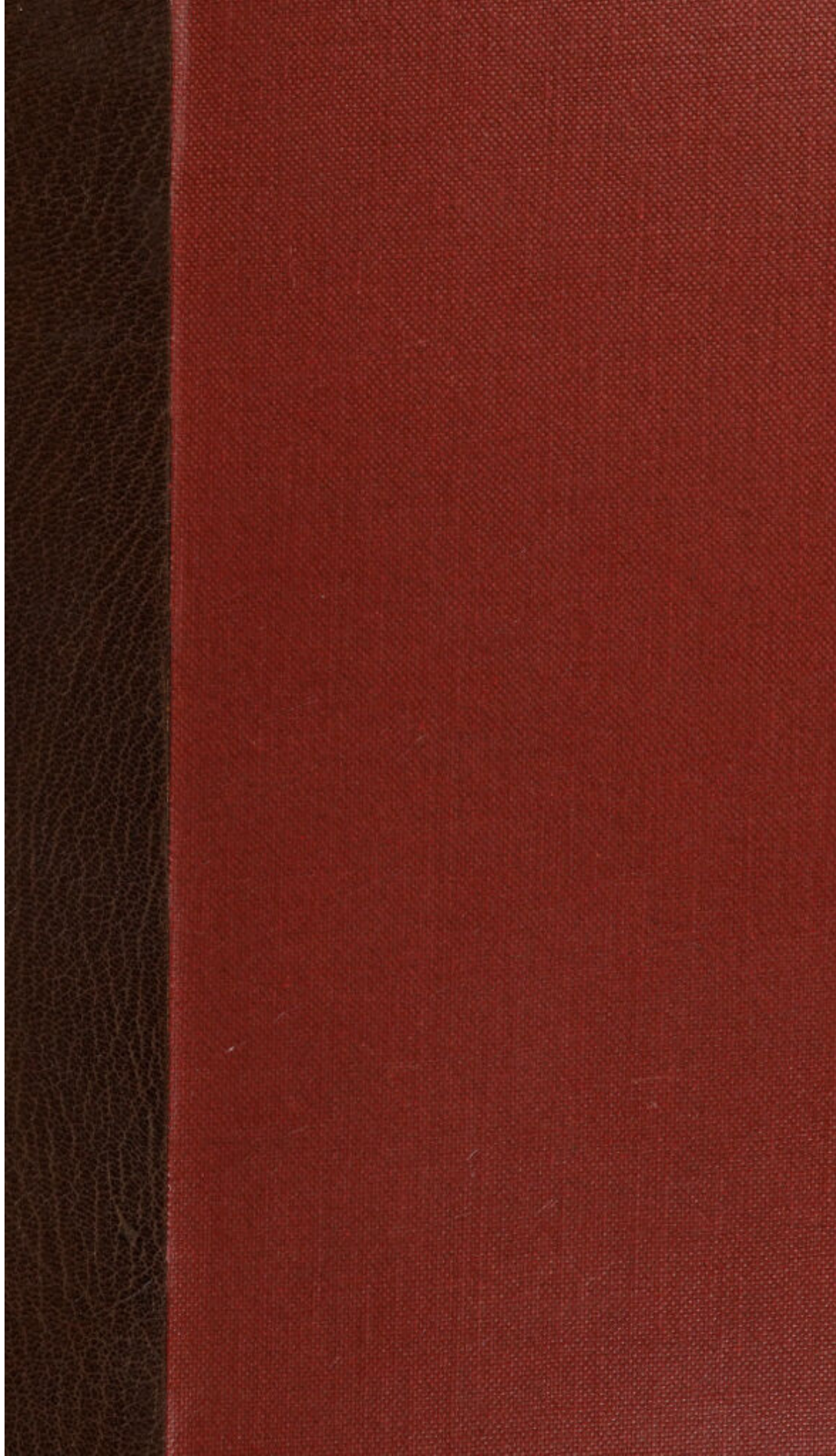
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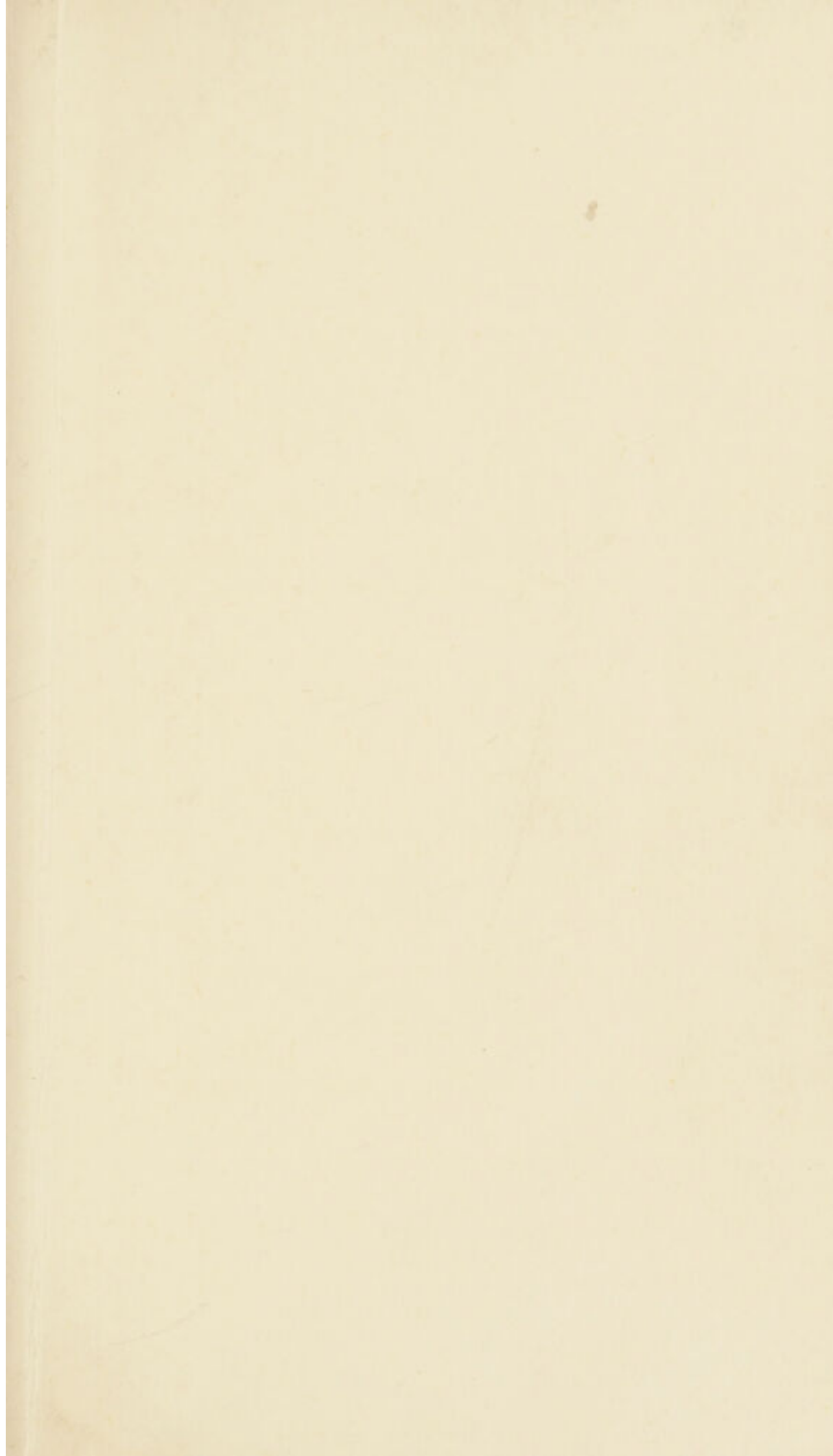
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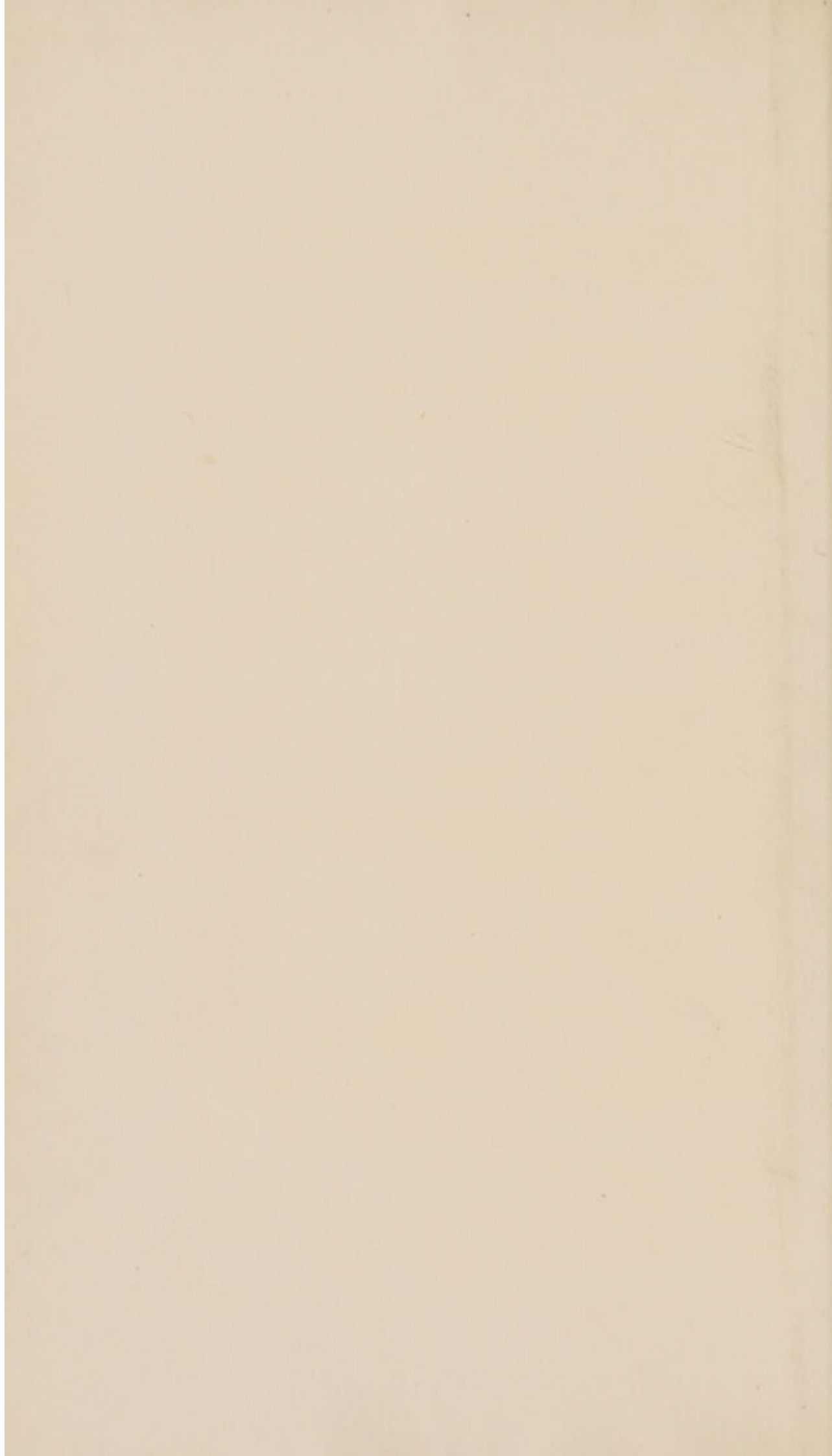
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LANSDOWN
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MEDICAL REPORTS,
ON THE
EFFECTS OF WATER,
COLD AND WARM,
AS A REMEDY IN
FEVER, AND FEBRILE DISEASES;
WHETHER APPLIED TO THE SURFACE OF THE BODY, OR
USED AS A DRINK :
WITH
OBSERVATIONS ON THE NATURE OF FEVER;
AND ON THE EFFECTS OF
OPIUM, ALCOHOL, AND INANITION.

BY JAMES CURRIE, M. D. F. R. S.

Fellow of the Royal College of Physicians, Edinburgh, and
Physician to the Liverpool Infirmary.

*Intentiones operationum, quas proposuimus (ut arbitramur) verissimae
sunt, remedia intentionibus fida. * * Rem ipsam experimen-
tum et comprobavit et promovebit. * * Opera consilii cujusque
prudentioris, sunt effectum admiranda, ordine quoque egregia, modis
faciendi tanquam vulgaria.*

BACON. Historia vitae et mortis.

LIVERPOOL,
PRINTED BY J. M'CREERY,
FOR CADELL AND DAVIES, LONDON.

CLARETOWN
1882

MEDICAL REPORTS

OF THE

TO THE

EFFECTS OF WATER

RIGHT HON. SIR JOSHUA LANKS

COLD AND WARM

Baronet and Knight of the Bath, President of the

AS A REPORT BY

JOHN CABILL, ESQ.

TENNER, AND FEBRILE DISEASES;

SIR

WHICH ARE APPLIED TO THE SURFACE OF THE BODY, AS

28366

IN PRACTICE, WITH THE VIEW OF

beg leave to say a few words on the subject of which it was written, and the circumstances that gave rise to the publication of

OPINION, ALCOHOL, AND EVAPORATION

About eighteen years ago, when I was at Edinburgh, it fell to my lot to write a paper on the influence of alcohol, in the Medical Society of the Association of Physicians, and in the member. In doing so, I was struck by some ingenious observations on the subject, which occurred as I was writing, to original authorities, and I was anxious to remove, for I discovered that the authorities of the temperature of the system under discussion, even by the most approved authors, and with a few exceptions, thought not of any exact measurement of heat, but of the sensations of the patient himself, or his attendants.

JOHN CABILL, AND DAVIES, LONDON



TO THE

RIGHT HON. SIR JOSEPH BANKS,

*Baronet and Knight of the Bath, President of the
Royal Society, &c. &c. &c.*

SIR,

IN presenting this volume to you, I beg leave to say a few words on the views with which it was written, and the circumstances that gave rise to the publication.

About eighteen years ago, when I was at Edinburgh, it fell to my lot to write a paper on the influence of cold on the living body, for one of the societies of students, of which I was a member. In defending my speculations against some ingenious opponents, a perpetual contradiction occurred as to facts, which a reference to original authorities, did not enable me to remove; for I discovered, that the accounts given of the temperature of the system under disease, even by the most approved authors, are, with a few exceptions, founded, not on any exact measurement of heat, but on the sensations of the patient himself, or his attendants.

Impressed with the belief, that till more accurate information is obtained respecting the actual temperature in different circumstances of health, and disease, no permanent theory of vital motion can be established, nor any certain progress made in the treatment of those diseases in which the temperature is diminished or increased, I have occasionally since that time, observed and recorded such facts as related to the subject; intending, one day or other, to lay my observations before the public, if they acquired an importance that deserved attention. In the outset of this undertaking, nothing seemed wanting but accurate thermometers, and a moderate portion of time and attention; and I embraced in imagination the whole effects of temperature upon health and disease; a range of inquiry which experience has convinced me it would be temerity and folly to hope to go through. In this general view of the subject, some valuable communications have however been made to me by my much respected friend Dr. Percival; which do not apply to the particulars treated of in the following volume, but which I am not without the hopes of specifying at some future period, when I may have occasion to employ them.

Though I have some time foreseen, that the
delay

delay of publishing till my original plan was executed, was likely to render my labours wholly abortive, or to convert the imperfect product from a gift into a legacy; yet I should not have given to the world so detached and unfinished a work as the present, according to the views I had originally entertained, but for the circumstances I am about to relate.

By the accounts received at the beginning of the present year, the fever of the West Indies appeared to continue its desolating progress with little abatement, and in America to be beginning its ravages anew.—With this pestilence, science seemed hitherto to have contended, in a great measure, in vain, and new methods of opposing it, were not merely justifiable, but requisite. At this time an account of the success of the nitric acid in Lues and Hepatitis, as employed by your correspondent Mr. Scott, of Bengal, was through your means given to the public. His theory, suggested by the new chemistry, did not appear promising; but it was neither wise nor candid to reject, on that account, his experience. The first trials which I made of his practice persuaded me, that though the success of the nitric acid might involuntarily have been somewhat exaggerated by a warm imagination and a benevolent heart, it assuredly did succeed in certain cases

cases of the diseases in question, and that a remedy of *great power*, and of *perfect safety*, was introduced into medicine. These opinions subsequent experience has fully established in my mind. In the fever of the West Indies mercury had been much employed, and though different notions were entertained of its mode of operation, it seemed on the whole the most approved remedy. Since the nitric acid appeared to be a substitute for mercury in other cases, it seemed reasonable to try its effects in this fatal fever. I suggested this practice by letter to some practitioners in the West Indies, and I submitted my notions on the subject to you; sensible that your character and station might bring that into immediate notice, which the influence of a private individual could but slowly effect.—Whatever difference there might be in some of our opinions, I was confident there was none in our wishes for alleviating human misery, and mitigating the destruction of this desolating war. Your conduct even exceeded my expectation.

Our correspondence on this occasion turned my views to the other means of opposing this pestilence. Ablution with cold water in fever had been so long employed at the hospital here, and in private practice, by my friends and colleagues Dr. Brandreth and Dr. Gerard, as well

as myself, that it was become general in Liverpool, and common in the county of Lancaster. So long ago as the year 1791, a general statement by Dr. Brandreth of its advantages had been published by Dr. Duncan, in the Medical Commentaries of that year. It had also been repeatedly mentioned by me in private correspondence; it had often been recommended to the surgeons of African ships in those examinations required by the legislature, and which are chiefly made by the physicians and surgeons of our hospital. On different occasions likewise I had not only explained, but exhibited the practice, to practitioners from a distance, and particularly to one or two going to the West Indies. A method of treatment so bold and so contrary to common prejudices, made however, as it appears, slow progress. The mode of operation of our remedy has been misapprehended; the proper period for using it has not been understood; and on some occasions having been resorted to improperly, the consequences have brought it into disrepute. Reflecting on these circumstances, and exposed by situation to the re-iterated sounds of death from the Western world, my decision was speedily made. I resolved no longer to delay an account of our treatment of fever, in the expectation of including it in a larger field of discussion, or in a form

more

more conducive to reputation ; and the fruit of this determination is the work now presented to you. In treating my subjects, perspicuity has been studied rather than rigorous method ; I have every where endeavoured to make my steps so plain, that they may be distinctly traced ; the most important points are impressed again and again to guard against mistake ; my thermometrical observations have enabled me to give a precision to the directions for the use of the affusion of cold water which otherwise they could not have had ; and, if I do not flatter myself, have laid a foundation for my reasonings, which speculations on fever have seldom possessed. I have guarded against the unnecessary use of technical as well as of general expressions. It were better perhaps that medicine, like other branches of natural knowledge, were brought from its hiding-place, and exhibited in the simplicity of science and the nakedness of truth. If it had been in my choice, I would not have adopted the language of theory, like Boerhaave, or Sydenham ; but have exhibited a medical work in the phraseology that Bacon, had he lived in our days, would have used.

Possibly this notice may procure me some readers among men of general science ; and this I confess to be one of my objects in dedicating the

the work to you. It is naturally an author's wish that his book may be read by those who can appreciate it, and who from their situations may have it in their power to bring its precepts into practice. In both these points of view I appeal to you—to your scientific knowledge, and to your generous heart. The work that I address to you, is in a great measure practical. A man of genius, at the head of a fleet or army, would probably find little difficulty in understanding it; and possibly, if he understood it, there might be occasions on which it would afford scope to his humanity and patriotism. But whatever be its fate with men professedly military, I trust it will not be overlooked by the medical practitioners of our fleets and armies; a most meritorious class of the profession, to whom a great part of the improvements in the modern practice of medicine are to be ascribed.

Conceiving that the circulation of this volume, as well as its usefulness, might be extended by connecting the history of the affusion of cold water in fever, with other views of the same remedy, and with a few observation on the other remedies in fever, I have entered into these points, without any very strict regard to method; and have been insensibly led to speak of some of the operations of temperature on the
body

body in health, a subject which I had reserved. Such as it is, this volume may serve as the first of a series on similar subjects, if I should ever write them ; and it may, I hope, stand alone, if I should write no more.

I am sensible that some of these particulars would have appeared with more propriety in a professed preface ; but having entered on certain explanations in my address to you, I have concluded these preliminary observations in the same form ; a freedom that I trust you will forgive.

I cannot conclude without declaring the sense I entertain of your candour and politeness. Accept the tribute of my respect.—May you live long to cultivate and protect the sciences—the sciences, whose utility is beyond dispute ; whose progress is superior to obstruction ; and which, of all the possessions of man, seem least to partake of the imperfection of his nature !

I have the honour to be,

Sir,

Your faithful

And very obedient Servant,

JAMES CURRIE.

Liverpool, 31st Oct. 1797.

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ERRATA.

Page 10, line 6, *dele* the comma.

18, 13, *for* illustriate *read* illustrate.

34, 5, straight streight.

63, 6, *dele* as well.

78, 18, *for* used drank.

139, 2, facts points.

140, 23, fet sets.

141, 2, fet sets.

230, 8, was were.

240, 18, 56th 5-6ths.

Appendix, page 16, line next the bottom, *for* conclusive *read* convulsive.

Dr. Ferriar corrects the information in page 217, last sentence of the note, thus; "from the 4th of May, to the 7th of October, 1797, inclusive, "149 patients have been admitted into the House of Recovery under fever, "four of whom have died."

CHAP. I.

Narrative of Dr. Wright.

IN the London medical journal for the year 1786, Dr. William Wright,* formerly of the island of Jamaica, gave an account of the successful treatment of some cases of fever by the ablution of the patient with cold water.

“ On the 1st of August, 1777,” says Dr. Wright, “ I embarked in a ship bound to Liverpool, and sailed the same evening from Montego Bay. The master told me he had hired several sailors on the same day we took our departure; one of whom had been at sick quarters on shore, and was now but in a convalescent state. On the 23d of August, we were in the latitude of Bermudas, and had had a very heavy gale of wind for three days, when the above-mentioned man relapsed,

B and

* Now I believe physician to the army in the West Indies

and had a fever with symptoms of the greatest malignity. I attended this person often, but could not prevail with him to be removed from a dark and confined situation to a more airy and convenient part of the ship ; and as he refused medicines, and even food, he died on the eighth day of his illness.

“ By my attention to the sick man I caught the contagion, and began to be indisposed on the 5th of September, and the following is a narrative of my case, extracted from notes daily marked down : I had been many years in Jamaica, but, except being somewhat relaxed by the climate, and fatigue of business, I ailed nothing when I embarked. This circumstance, however, might perhaps dispose me more readily to receive the infection.

“ Sept. 5th, 6th, 7th, small rigors now and then—a preternatural heat of the skin—a dull pain in the forehead—the pulse small and quick—a loss of appetite, but no sickness at stomach—the tongue white and slimy—little or no thirst—the belly regular—the urine pale and rather scanty—in the night restless, with starting and delirium.

“ Sept. 8th, every symptom aggravated, with pains in the loins and lower limbs, and stiffness in the thighs and hams.

“ I look

“ I took a gentle vomit in the second day of this illness, and next morning a decoction of tamarinds; at bed-time, an opiate, joined with antimonial wine, but this did not procure sleep, or open the pores of the skin. No inflammatory symptoms being present, a drachm of Peruvian bark was taken every hour for six hours successively, and now and then a glass of port wine, but with no apparent benefit. When upon deck, my pains were greatly mitigated, and the colder the air the better. This circumstance, and the failure of every means I had tried, encouraged me to put in practice on myself what I had often wished to try on others, in fevers similar to my own.

“ Sept. 9th, having given the necessary directions, about three o'clock in the afternoon I stripped off all my cloaths; and threw a sea-cloak loosely about me till I got upon the deck, when the cloak also was laid aside: Three buckets full of salt water were then thrown at once on me, the shock was great, but I felt immediate relief. The head-ach and other pains instantly abated, and a fine glow and diaphoresis succeeded. Towards evening, however, the febrile symptoms threatened a return, and I had again recourse to the same method as before, with the same good effect. I now took food with an appetite, and for the first time had a sound night's rest.

“ Sept.

“ Sept. 10th, no fever, but a little uneasiness in the hams and thighs—used the cold bath twice.

“ Sept. 11th, every symptom vanished, but to prevent a relapse, I used the cold bath twice.

“ Mr. Thomas Kirk, a young gentleman, passenger in the same ship, fell sick of a fever on the 9th of August. His symptoms were nearly similar to mine, and having taken some medicines without experiencing relief, he was desirous of trying the cold-bath, which with my approbation, he did on the 11th and 12th of September, and, by this method was happily restored to health. He lives at this time (Jan. 1786) near Liverpool.”

To this interesting narrative, Dr. Wright adds some general observations on the traces that are to be found of the use of cold water internally and externally in fevers, in several works ancient and modern. But whether he himself pursued this practice any farther, I have not been informed.

Having before experienced that Dr. Wright was a safe guide,* I immediately on reading this narrative determined on following his practice in the present instance ; and before an opportunity occurred

* See a paper in the memoirs of the London Medical Society, Vol. III. p. 147 to be found in a subsequent part of this Volume.

red of carrying my intention into effect, I was farther encouraged, by learning that my respectable colleague Dr. Brandreth, had employed cold water externally in some recent cases of fever with happy effects.

CHAP. II.

History of a fever which broke out in the Liverpool Infirmary.

IN the 9th of Dec. 1787, a contagious fever made its appearance in the Liverpool Infirmary. For some time previously the weather had been extremely cold, and the discipline of the house, owing to causes which it is unnecessary to mention, had been much relaxed. The intensity of the cold prevented the necessary degree of ventilation, and the regulations for the preservation of cleanliness had been in some measure neglected. These circumstances operated particularly on one of the wards of the eastern wing, employed as a lock-hospital for females, where the contagion first appeared. The fever

fever spread rapidly, and before its progress could be arrested, sixteen persons were affected, of which two died.—Of these sixteen, eight were under my care. On this occasion I used for the first time the affusion of cold water, in the manner described by Dr. Wright. It was first tried in two cases only, the one in the second, the other in the fourth day of fever. The effects corresponded exactly with those mentioned by him to have occurred in his own case, and thus encouraged, the remedy was employed in five other cases. It was repeated daily, and of these seven patients, the whole recovered. In the eighth case, the asperision of cold water seemed too hazardous a practice, and it was not employed. The strength of the patient was much impaired by lues, and at the time of catching the contagion, she laboured under ptyalism. I was not then aware that this last circumstance, formed no objection against the cold affusion, and in a situation so critical, it was thought imprudent to use it. The usual remedies were directed for this patient, particularly, bark, wine, and opium, but unsuccessfully; she died on the 16th day of her disease.

From this time forth, I have constantly wished to employ the affusion of cold water in every case of the low contagious fever, in which the strength was not already much exhausted; and I have preserved a register of a hundred and fifty three cases,
in

in which the cure was chiefly trusted to this remedy. Of these, ninety-four occurred in the hospital in the four years subsequent to the period already mentioned, twenty-seven in private practice, and thirty-two in the 30th regiment of foot, when quartered in Liverpool in the year 1792. Of late I have not thought it necessary to register all the cases in which this remedy has been employed. Having satisfied myself of its extraordinary efficacy, and of the precautions necessary in using it, I have found it the shorter method as well as the more instructive, to record the instances in which it has proved unsuccessful. To relate the whole of my experience would be a tedious and an useless labour. I purpose to digest the results under a few distinct heads, supporting and illustrating each general proposition by an ample detail of cases. Before, however, this preliminary account is closed, it will be useful to enter more particularly into the history of the contagious fever which broke out in the 30th regiment, because the account of its rise, progress, treatment, and termination, will support in a striking manner the doctrines I wish to establish, and if I do not greatly deceive myself, may afford important instruction, as well as encouragement, to those whose duty may call them to oppose the progress of contagious fever in similar situations.

CHAP. III.

History of a Fever which occurred in the 30th Regiment.

THE 30th Regiment, as is usual with troops in Liverpool, was billeted in the town, but paraded and mounted guard in the fort, situated north of the town, and on the banks of the river. The general guard room had been used previous to the arrival of the 30th, as a place of confinement for deserters; it was extremely close and dirty, and under it was a cellar, which in the winter had been full of water. This water was now half evaporated, and from the surface issued offensive exhalations.

In a dark, narrow, and unventilated cell, off the guard-room, it was usual to confine such men as were sent to the guard for misbehaviour, and about the beginning of June, (1792) several men had been shut up in this place on account of drunkenness, and suffered to remain there twenty-four hours, under the debility that succeeds intoxication. The
typhus,

typhus, or jail fever, made its appearance in two of these men about the first of the month, and spread with great rapidity. Ten of the soldiers labouring under this epidemic, were received into the Liverpool Infirmary, and the wards allotted to fever could admit no more. The contagion continuing its progress, a temporary hospital was fitted up at the fort, and I was requested to give my assistance there to the surgeon of the regiment, by Captains Brereton* and Torriano.†

In two low rooms, each about fifteen feet square, were fourteen patients labouring under fever. They were in different stages of its progress: one was in the fourteenth day of the disease, two were in the twelfth, and the rest from the ninth to the fourth inclusive. The symptoms of the fever were very uniform. In every case there was more or less cough, with mucous expectoration: in all those who had sustained the disease eight days and upwards, there were petechiæ on the skin; in several there were occasional bleedings from the nostrils, and streaks of blood in the expectoration. The debility was considerable from the first, and this had been increased in several cases by the use of venesection, before the nature of the epidemic was understood.

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understood.

* Now Colonel Brereton of the 63d foot.

† The gallant and accomplished officer who fell soon after at the heights of Pharon, in the defence of Toulon.

understood. The pulse varied from 130 strokes in the minute to 100; the heat rose in one case to 105° of Fahrenheit, but was in general from 101° to 103° ; and towards the latter stages of the disease it was scarcely above the temperature of health. Great pain in the head, with stupor pervaded the whole, and in several instances there occurred a considerable degree of the low delirium.

Our first care was to ventilate and clean the rooms, which were in a high degree foul and pestilential. Our second was to wash and clean the patients themselves. This was done by pouring sea-water, in the manner already described, over the naked bodies of those whose strength was not greatly reduced, and *whose heat was steadily above the temperature of health*. In those advanced in the fever, whose debility was of course great, we did not venture on this treatment, but contented ourselves with spunging the whole surface of the body with tepid vinegar, a practice that in every stage of fever is salutary and refreshing.

Our next care was to stop the progress of the infection. With this view, the guard-house was at first attempted to be purified by washing and ventilation, the greatest part of its furniture having been burnt or thrown into the sea. All our precautions and exertions of this kind were however found to be

be ineffectual. The weather was at this time wet, and extremely cold for the season; the men on guard could not be prevailed on to remain in the open air; and from passing the night in the infected guard-room, several of the privates of the successive reliefs on the 10th, 11th, and 12th of the month, caught the infection.—In several of these the fever ran through its course; and in others, it was immediately arrested by the affusion of sea-water as already described. No means having been found effectual for the purification of the guard-room, it was shut up, and a temporary shed erected in its stead.—Still the contagion proceeded; on the morning of the 13th three more having been added to the list of the infected.—On that day, therefore, the whole regiment was drawn up at my request, and the men examined in their ranks: Seventeen were found with symptoms of fever upon them.—It was not difficult to distinguish them as they stood by their fellows.—Their countenances were languid, their whole appearance dejected, and the adnata of their eyes had a dull red suffusion. These men were carefully separated from the rest of the corps, and immediately subjected to the cold affusion, always repeated once, and sometimes twice a day. In fifteen of the number the contagion was extinguished; but two went through the regular disease. On the same day, the commanding officer, at my desire, issued an order for the whole of the remaining

maining part of the regiment to bathe in the sea; and for some time they were regularly mustered, and marched down at high water, to plunge into the tide.

These means were successful in arresting the epidemic: after the 13th of June no person was attacked by it. It extended to fifty eight persons in all, of which thirty-two went through the regular course of the fever, and in twenty-six the disease seemed to be cut short by the cold affusion. Of thirty-two already mentioned, two died. Both of these were men whose constitutions were weakened by the climate of the West Indies; both of them had been bled in the early stages of the fever; and the one of them being in the 12th, the other in the 14th day of the disease when I first visited them, neither of them was subjected to the cold affusion. The water employed on this occasion was taken up from the river Mersey close by the fort. It was at that time of a temperature from 58° to 60° of Fahrenheit, and it contains in solution from a 32d to a 33d part of sea-salt.

In hospitals, manufactories, and prisons—situations in which the low contagious fever so frequently originates, the practice I have detailed may be followed with great ease, safety, and advantage; but it is in a more particular degree applicable to this contagion when it appears on ship-board, because in that situation

situation the usual means of prevention or cure are necessarily limited, and the imminence of the danger requires a remedy that operates with speed as well as efficacy. The waters of the ocean afford this remedy ; in every point of view a most happy one for mariners, since it can be applied almost as easily as it can be procured.

CHAP. IV.

The manner in which the affusion of cold water ought to be used in Fever.

HAVING given this general account of my experience of this remedy in fever, it will now be necessary to enter more particularly on the rules which ought to govern its application, and on the different effects to be expected from it, according to the different stages of the disease in which it is employed. It will be proper to premise, that when the term fever is used in the present work without any adjunctive, it is the low contagious fever that is meant. This is the Typhus of Dr. Cullen ; the contagious fever
of

of Dr. Lind ; the Typhus irritativus of Dr. Darwin. In popular language, it is generally called the nervous fever, and where particular symptoms appear, the putrid fever. It is generally produced in situations where there is a want of cleanliness, and more especially of ventilation ; and when produced, it is propagated by contagion. This is the common fever of England ; its symptoms have been detailed with great minuteness in a variety of modern publications, and I have therefore declined repeating descriptions that are every where to be met with. Dr. Cullen has defined the disease as follows—
 “ Morbus contagiosus ; calor parum auctus ; pulsus
 “ parvus, debilis, plerumque frequens ; urina parum
 “ mutata ; sensorii functiones plurimum turbatae ;
 “ vires multum imminutae.” In sixteen years practice I have found the contagious fever of Liverpool remarkably uniform, and in general to correspond exactly with this concise and perspicuous definition. This disease prevails chiefly among the poor, who from the nature of their diet and habits, are peculiarly exposed to the causes that produce it. Seldom extending itself in any considerable degree, among the other classes of the community, it has been supposed that Liverpool was little subject to fever ; but this will be shewn, from authentic documents, to be a great and a pernicious error. Let us proceed at present to inquire into the rules that ought to govern
 govern

govern the use of the affusion or aspersion of cold water in this disease.

Whoever has watched the progress of fever, must have observed the justice of the observation made by Cullen, Vogel, De Haen, and others, that even those genera which are denominated continued, are not strictly such, but have pretty regular and distinct exacerbations and remissions in each diurnal period. In this space of time, Dr. Cullen contends that an attentive observer may commonly distinguish two separate paroxysms.* My observations do not enable me to confirm his position in its full extent—but one exacerbation, and one remission in the twenty-fours, seems generally observable. The exacerbation usually occurs in the afternoon, or evening, the remission towards morning. These exacerbations are marked by increased flushing, thirst, and restlessness. If the heat of the patient be, at such times, taken by the thermometer, it will be found to have risen one or two degrees in the central parts of the body, above the average heat of the fever, and still more on the extremities.—The safest and most advantageous time for using the aspersion or affusion of cold water, is when the exacerbation is at its height, or immediately after its declination is begun; and this has led me almost

* Paroxysmis quovis die binis.

Gen. Morbor. vol. ii. p. 67.

almost always to direct it to be employed from six to nine o'clock in the evening; but it may be safely used at any time of the day, *when there is no sense of chilliness present, when the heat of the surface is steadily above what is natural, and when there is no general or profuse perspiration.*—These particulars are of the utmost importance.

1. If the aspersion of cold water on the surface of the body be used during the cold stage of the paroxysm of fever, the respiration is nearly suspended; the pulse becomes fluttering, feeble, and of an incalculable frequency; the surface and extremities become doubly cold and shrivelled, and the patient seems to struggle with the pangs of instant dissolution. I have no doubt, from what I have observed, that in such circumstances, the repeated affusion of a few buckets of cold water would extinguish life. This remedy should therefore never be used when any considerable sense of chilliness is present, even though the thermometer, applied to the trunk of the body, should indicate a degree of heat greater than usual.

2. Neither ought it to be used when the heat measured by the thermometer is less than, or even only equal to the natural heat, though the patient should feel no degree of chilliness. This is sometimes the case towards the last stages of fever, when

when the powers of life are too weak to sustain or react under, so powerful a stimulus.

3. It is also necessary to abstain from the use of this remedy when the body is under profuse perspiration, and this caution is more important in proportion to the continuance of this perspiration. In the commencement of perspiration, especially if it has been brought on by violent exercise, the affusion of cold water on the naked body, or even immersion in the cold bath, may be hazarded with little risque, and sometimes may be resorted to with great benefit. After the perspiration has continued some time and flowed freely, especially if the body has remained at rest, either the affusion or immersion are attended with danger, even though the heat of the body at the moment of using them be greater than natural.—Perspiration is always a cooling process in itself, but in bed it is often prolonged by artificial means, and the body is prevented from cooling under it to the natural degree, by the load of heated clothes. When the heat has been thus artificially kept up, a practitioner, judging by the information of his thermometer only, may be led into error. In this situation, however, I have observed that the heat sinks rapidly on the exposure of the surface of the body even to the external air, and that the application of cold water, either by affusion or immersion, is accompanied by a loss of

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heat

heat and a deficiency of re-action, which are altogether inconsistent with safety.—Each of these points will be illustrated more fully in the sequel.

Under these restrictions the cold affusion may be used at any period of fever; but its effects will be more salutary in proportion as it is used more early. Its general effects will be more clearly illustrated by the following cases. They are a selection from a great number, the records of which have been preserved, and which lead to the same results. They are so arranged as to exhibit the salutary effects of the affusion of cold water in the different stages of fever, and to illustrate the precautions laid down against using it improperly. If they should appear tedious after what has already been mentioned, this must be forgiven; on a subject so important and so little understood, it is better to incur the charge of tediousness than the hazard of being obscure.

CHAP. V.

CASE I.

*Cases in which the Affusion of Cold Water was used in
the different stages of fever.*

January 1, 1790.

A Nurse in the fever ward of the Infirmary having several patients under her care, caught the infection. She was seized with violent rigors, chilliness, and wandering pains, succeeded by great heat, thirst, and head-ach. Sixteen hours after the first attack, her heat at the axilla was 103° of Fah^t. her pulse 112 in the minute and strong; her thirst great, her tongue furred, and her skin dry.

Five gallons of salt water, of the temperature of 44° , were poured over her naked body, and after being hastily dried with towels, she was replaced in bed: when the agitation and sobbing had subsided, her pulse was found to beat at the rate of 96 strokes in the minute, and in half an hour afterwards it
had

had fallen to 80. The heat was reduced to 98° by the ablution, and half an hour afterwards it remained stationary: The sense of heat and the head-ach were gone, and the thirst nearly gone. Six hours afterwards she was found perfectly free of fever, but a good deal of debility remained.

Small doses of colombo were ordered for her with a light nourishing diet, and for several days the cold affusion was repeated at the same hour of the day; the fever never returned.

During the progress of fever when epidemic, a great number of cases similar to the above have occurred, in which the disease was suddenly cut short by the use of the cold affusion on the first and second day; twenty six of these cases were in the 30th regiment, as has already been stated. In such instances, the result was so precisely similar to what occurred in the case I have related, that it would be to no purpose to detail them.

When an epidemic fever is spreading, and the danger is known, patients will take the alarm on the first attack, and the power, as well as the utility of such a remedy as the cold affusion, in such situations of general danger, will be easily imagined.— It cannot be employed too soon after the first attack

tack, provided the original chill is over, and the hot stage is firmly established.

In cases in which the affusion was not employed till the third day of fever, I have seen several instances of the same complete solution of the disease. I have even seen this take place, when the remedy has been deferred till the fourth day; but this is not common.—The following case will point out the usual effects of this remedy in the third and fourth days of the disease.

CASE II.

Jan. 17, 1790. A. B. aged nineteen, a pupil of the Infirmary, caught the infection in attending the fever-ward. When I saw him, seventy-eight hours had elapsed since the first attack: he was of course in the fourth day of the disease. He had all the usual symptoms—head-ach, thirst, furred tongue, pain in the back and loins, with great debility. His heat was 101° , and his pulse 112 in the minute.

A bucket full of salt water was poured over him as usual at noon on the 17th. His heat sunk to 99° , and his pulse to 98 in the minute. A profuse perspiration followed, with the cessation of all his feverish symptoms.—This intermission continued for several hours, during which he enjoyed some comfortable

comfortable sleep: but at five in the afternoon he was again seized with feverish rigors, followed by heat, thirst, and head-ach, as before. An hour afterwards, the hot stage was established; his heat was 100° , his pulse 100. The same quantity of cold water was again poured over him, and with similar effects. His pulse fell immediately to 80 and became more full, his heat became natural. The following night he took twenty drops of laudanum and slept well.

On the 18th at noon his pulse was 96 and soft; his skin moist, but a little above the natural heat. His tongue was a little furred, and his head ached: he also complained of thirst; the heat at the axilla was 100° .—The same remedy was again applied. He was greatly refreshed by it. The pulse fell to 90, the skin became cool, the thirst went off, and all the feverish symptoms vanished.

On the 19th his pulse was 88, his heat natural, the thirst and head-ach were gone, and his appetite improving. The ablution was repeated for the last time at the same hour of the evening.

On the 20th his pulse was 78 and soft, his tongue clean, and his appetite farther improved. He had still some remains of debility on the 21st, but on the 22d he was free of complaint. This patient
during

during his fever took no medicine but the effervescing mixture, the dose of laudanum excepted.—The affusion was used four times.

CASE III.

Dec. 8, 1791. A woman aged fifty-seven, who had caught the infection, in her attendance on a poor family labouring under fever, came under my care in the hospital, fifty hours after the first attack. She was of course in the third day of fever; she had the usual symptoms—head-ach, pain in the back and loins, and thirst: her tongue was furred and her eyes heavy: her pulse 96, her heat 101°. The affusion of cold water was performed at noon as usual. In a few minutes afterwards, the heat under the tongue was 98°, the pulse 80. Towards evening however, the feverish rigor returned, with all the usual consequences. As soon as the hot stage was established, the affusion was repeated, and with the usual happy effects.

Dec. 9.—Noon—pulse, 90 and feeble—respiration easy—heat 100°.—The affusion was immediately employed, and again repeated in the evening—perspiration, coolness, quiet, and sleep, were the consequence.

Dec. 10. This day the affusion was twice repeated

peated as yesterday, viz. at noon, and at six in the evening.—At eight in the evening the pulse was 76, the skin soft, the heat 97° , the respiration easy and natural.—The fever returned no more. This patient used no other remedies but an enema and after it an opiate, every night. The affusion was used twice every day, in all six times.

CASE IV.

Feb. 2. 1792. S. C. a healthy man, aged forty-four, about seventy-two hours after the first attack of fever, became my patient. His pulse 100—his heat 104° .—The other symptoms as usual—but the pain in the head and back particularly severe. Two minutes after the affusion—pulse 90, heat 101° ; six minutes after—pulse 90 and weak—ten minutes after, pulse 90, heat 100° .—This patient felt great refreshment, and was entirely relieved of the pain in the head and back.—In the evening however the exacerbation of fever was severe, and the head-ach returned with violence.—He passed a restless night. About four o'clock in the ensuing morning the affusion was repeated by his own desire. At 9, A. M. a general and gentle perspiration covered the surface of the body; the pulse was 84, the tongue moist, the skin cool, and the pains of the head and back entirely gone off. In the afternoon, however, the fever returned though in a slighter degree.

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The affusion was repeated the fourth time with the same happy effects, and after this he had no return of the disease.

Thus it appears, that the cold affusion used on the third and fourth days of fever, does not usually produce an immediate solution of the disease; but that it instantly abates it, and by a few repetitions brings it to a happy termination in two or three days.

CASE V.

Oct. 25. M. S. came under my care on the 24th Dec. 1791, on the seventh day of typhus, with the usual symptoms—pulse 108, heat 100°.—The cold affusion was immediately directed—two minutes afterwards the heat was 96°—three minutes afterwards 98°—the pulse 98. This patient experienced great relief. The affusion was repeated on this and the following day—a gentle diaphoresis always succeeded it, with tranquil sleep, and on the third day the fever was completely removed.

CASE VI.

A young lady of 19, in the 7th or 8th day of typhus, became my patient, Sept. 26, 1794. Her pulse was 112 and feeble, heat 101°. She had great

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pain

pain in the head and much prostration of strength—her eyes were suffused and dull—her tongue furred—her spirits greatly depressed. Saline medicines were used for this patient, with lemonade for her usual drink, and moderate quantities of wine were given mixed with water. The burning sensation in the palms of her hands and temples was assuaged by frequent sponging with vinegar, and every evening at six, P. M. three or four gallons of cold brine were thrown over her. The happy effects so frequently described, were in this case particularly striking:—The pulse fell almost immediately to 90, the heat to its natural standard, and the head-ach vanished—a gentle diaphoresis followed, with easy sleep:—in a few hours, however, the feverish symptoms returned, and towards the hour of six in the evening the fever was at its highest state of exacerbation. At this hour therefore the affusion was repeated with the same happy effects—though the fever returned as before, it was in a milder form; the same practice was continued, and on the second of October, she was entirely free from the disease.

CASE VII.

F. G. a soldier of the 30th regiment, aged 33, fell under my care on the 9th June, 1792, during the prevalence of the epidemic in that regiment, of which

I have

I have already given an account. He was in the 9th day of the disease—his pulse 100 and feeble—his heat 104° —his thirst was very great—his tongue foul and black—frequent cough occurred, with streaks of blood in the expectoration—and petechiæ appeared all over his body. His mind was at all times confused, and occasionally he was completely delirious. I directed that his strength should be supported by administering a bottle of wine every day, with an equal quantity of gruel;—that every night he should take an opiate draught, and that a complete operation of his bowels should be procured by a clyster administered daily, and if this did not succeed, by a few grains of calomel. I also directed that a bucket full of salt-water should be thrown over him immediately, and repeated according to circumstances. In a few minutes after the affusion, the heat was 98° —the pulse 98—his mind was more calm and collected: two hours afterwards he had relapsed into nearly his former state, but the night was passed more tranquilly. The whole of this practice was continued, with nearly the same result, till the 12th day of the disease, the affusion having always been performed in the evening, and occasionally at noon. The fever continued its usual period, but on the 12th day, the heat having sunk to its natural standard, the cold affusion was thenceforth omitted; we however, spunged the whole body once or twice a day with vinegar.—

vinegar.—The patient was in a state of convalescence on the 18th day from the first attack.

I have related this case the more circumstantially, because it contains the particulars of my practice in the epidemic in which it occurred, at the same time that it affords an example of the effects of the cold affusion used in the more advanced periods of fever. In such instances, as might be expected, it does not procure the same advantages, as in the earlier stages, when the strength is less impaired, and the morbid actions less firmly associated; nevertheless, it is evidently advantageous while the heat of the patient exceeds the natural standard, though it ought to be employed with caution in the more advanced stages of the disease, and according to my later experience, of a temperature from fifteen to twenty degrees only, below the human heat. In the greater part of the cases that I have related, the water employed was the pump water of our hospital, saturated with sea-salt, and of a temperature from 40° to 50° of Fah^t.

The cold affusion may also be employed with success in intermittent fevers, as I have found by repeated trials, and as the following case will demonstrate.

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CASE VIII.

Ann Hall, aged 22, was admitted into the Infirmary, July 19, 1792, under an obstinate quotidian of three months standing—she had from time to time taken the bark, but as the great delicacy of her stomach, would not permit her to use it in sufficient quantities, she was become very feeble and much emaciated. A gentle emetic was administered to her in the first instance, and on the commencement of the hot stage of the paroxysm, twenty drops of the tincture of opium were directed, after the practice of Dr. Lind. During the intermission, the bark was ordered to be taken in such doses as her stomach would bear; she was put on a nourishing diet, and was ordered a pint of port wine every day. This plan was pursued for fourteen days, but without success; the paroxysms returned daily, though with some irregularity—her strength was however rather improved. Still the delicacy of her stomach continued, and the bark, except in very small doses, was constantly rejected.

On the 8th of August, two hours before the expected accession of the fever, four gallons of brine
were

were dashed over her, of the temperature of 66° of Fah^t. and this day she escaped the attack. In the interval between this and the period of the next return, she took the bark in larger quantity, the tone of her stomach being improved ; but on the 10th, two hours later than usual, the paroxysm returned with unusual severity. *After the hot stage was completely formed*, the brine was poured over her, as before—the symptoms instantly abated ; she fell into a gentle perspiration, with profound sleep. She afterwards continued the bark as before, and from this time forwards was free of disease.

It would be easy to multiply these details, but their uniformity has already perhaps rendered them tedious ; a few general observations therefore shall conclude this division of the subject.

CHAP. VI.

General Observations.

1. **THOUGH** the patients were often startled at the first proposal of dashing the cold water over them, yet after one trial, there was seldom any difficulty in persuading them to have it repeated. The effects were in general highly grateful and refreshing to their sensations, the extinction or abatement of fever was commonly followed by more or less diaphoresis, and this again by refreshing sleep.

2. At first I used fresh water—afterwards fresh water mixed with vinegar—and lastly, a saturated solution of sea-salt in water. In the instance of the 30th regiment I used the water of the river, which contains about a thirty-third part of salt, as has been already mentioned, and this I commonly

monly employ in private practice.* I was led to prefer salt-water to fresh, on account of the stimulating effect of sea-salt on the vessels of the skin, by which I apprehend the debilitating action of cold is prevented. Salt-water either for the purpose of immersion or affusion is more grateful to the patient than fresh water, and it is well known that it may be applied to the surface for a length of time, with much less hazard. The countenances of persons immersed in sea-water, and especially in saturated brine, for some time together, preserve the lustre of the eye and the ruddiness of the cheek longer than those in fresh water, of

* It may be supposed that the degree of impregnation of the river water with salt, must depend on the time of the tide when it is taken up. Thus, that it must be saltier at the height of the flood, when the tide has run six hours from the sea, than at the period of low water, when it has run nearly the same time from the land.—I expected to find this the case, and endeavoured to ascertain the difference; but in a trial which I made by evaporating 40lbs. of water taken up at the height of the flood tide, and the same quantity taken up at low water, I could perceive no difference in the proportion of salt, a circumstance which I am unable to explain. The small difference that there was in the residuum in favour of the water taken up at the top of the tide, arose evidently from its being mingled with a large portion of dirt—the water at the top of the tide is mixed with dirt and feculencies, that taken at the lowest point of ebb is nearly pure.

of the same temperature, and such persons exhibit the vital re-action stronger when removed from it. I preferred the brine to vinegar, as being cheaper, and more easily procured of the necessary quantity : otherwise, it is well known how grateful vinegar is to patients in fever, and perhaps a mixture of vinegar and water of the proper strength might be preferable even to brine. But though I gave the preference to brine over fresh water, I have very often used the last, and it is seldom that any danger can result from the want of a saline impregnation, where the cold is employed in so stimulating a form as that which has been described, and for so temporary a duration.

3. In taking the heat of the patient, I have generally used a small mercurial thermometer of great sensibility, with a moveable scale, made for me by Mr. Ramsden, after a form invented by the late Mr. Hunter, and used by him in his experiments on the heat of animals, and I have introduced the bulb under the tongue with the lips close, or under the axilla indifferently ; having found by repeated experiments, that the heat in these two places corresponds exactly, and gives a just indication of the

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heat

heat of the surface of the body where sheltered by the necessary teguments, and secluded from the contact of the external air.

Finding, however, considerable risque in using the straight tubed thermometer in contagious diseases, I got some instruments of this kind made with a small bulb curved at the end. The bulb being introduced under the tongue or the axilla, the observer can stand behind the patient, and mark the rise of the mercury, without coming into the immediate sphere of his respiration.

CHAP. IX.

Precautions requisite in using the cold affusion, illustrated with Cases.

1. IT was before remarked, that the cold affusion cannot be used with safety during the cold stage of the febrile paroxysm : The following case will illustrate this truth. In the summer of 1792 I was requested by Mr. Hoffman, an ingenious Prussian gentleman, and a surgeon in the army then under the command of the Duke of Brunswick, to give him an opportunity of seeing the method of using this remedy. At that time there was a patient labouring under a tertian intermittent under my care in the Infirmary, on whom it could with propriety be exhibited. Accordingly a time for meeting Mr. Hoffman in the fever-ward was appointed, when the hot stage of the paroxysm might be expected to be fairly formed. It happened however that the accession of the fever had occurred an hour later this day than might have been expected, and when we arrived, the patient was still in the cold stage of the paroxysm; the assistants however proceeded: he was
taken

taken out of his bed shivering, his pulse small and frequent, his extremities shrunk and cold. In this state the brine was dashed over him as usual, but not with the usual happy effects:—his breathing was for some minutes almost suspended; his pulse at the wrist was not to be felt; the pulsations of the heart were feeble and fluttering; a deadly coldness spread over the surface; and when respiration returned, it was short, irregular, and laborious.—After the use of frictions on the surface, and particularly on the extremities—of a steady warmth applied some time to the scrobiculus cordis—and of cordials cautiously administered in small quantities—the pulse at the wrist returned; but for some time it was excessively quick and feeble. He recovered however in the course of an hour, and it was found that the paroxysm of fever had been extinguished: but the circumstances first related were evidently full of danger, and they produced at the time much apprehension and uneasiness. The same remedy was however used in the hot stage of the ensuing paroxysm, and with the usual happy effects.—Other cases to the same purpose might be adduced if it were necessary.

I have frequently used the cold affusion in the hot stage of the paroxysm of intermittents, and almost always with the immediate solution of the fit; but in general, if no remedy be used in the intermission,
the

the fever returns at the usual period. In some instances, however, the succeeding paroxysm has been prevented by using the cold affusion about an hour previous to the period of its expected return, and the disease been ultimately removed by continuing this practice through four or five of the following periods.

The use of the cold affusion in the absence of fever, requires however a constitution in a great measure unbroken; and many of the intermittents which we see in Liverpool, being transmitted to us from the warm climates, adhere to constitutions in which this practice is not perfectly safe. In such cases, it may notwithstanding be adopted in the hot stage of fever with safety and advantage. Indeed it ought never to be forgotten, that an application of cold which is safe in the violence of fever, is not safe when the fever is removed. Injury has sometimes occurred from continuing the cold affusion in the period of convalescence.

2. Neither is the cold affusion safe after the sweating stage of fever has continued some time, and the body is passing through that cooling process. The following case will illustrate this position. In the summer of 1791, a boy of eight years of age, in whom I am peculiarly interested, was attacked by fever. On the third day his pulse rose to 130,
and

and 140 in the minute, and his heat to 106° and 107° of Fah'. His thirst was very great, and delirium commenced on the second day, and continued without intermission. Various methods had been employed to abate the fever, and particularly to excite perspiration, but unsuccessfully. His heat was not lessened by repeated sponging of the surface of the body with cold vinegar and water; and after a copious bleeding, all the symptoms were as alarming as before. It seemed hazardous to repeat this evacuation, as the blood exhibited no size, and there was a suspicion that the disease originated in contagion. The patient had taken antimonials without any apparent effect, and after watching the state of the thermometer with the bulb at the axilla, upwards of an hour, though the mercury had sunk a single degree in that interval, it stood at the end of the time as high as 107° . In this state of things we resolved on trying the cold affusion, and every thing being prepared, he was stripped naked and lifted out of bed. As we were about to throw the water upon him, it was observed that a perspiration had broken out all over him, but the heat being so great, we persisted in our purpose, and four gallons of fresh water of the temperature of 60° were dashed upon him; the effects were altogether surprising. On replacing him in bed, the mercury in the thermometer (the bulb at the axilla as before) rose to 98° only, and the burning heat of the extremities was converted

converted into a coolness that was rather alarming; the pulse had sunk in frequency to 90° but was full and steady. Gentle frictions were applied to the legs and feet, but they were not long continued, for the general warmth speedily returned; the heat in the trunk of the body rose in about an hour to 100° and the pulse to 100. His delirium went entirely off; the fur on his tongue speedily disappeared; and twenty hours afterwards he was found free of every complaint but debility.

Subsequent experience has however convinced me that though in this case the termination was so happy, the cold affusion was not unattended with hazard. Perspiration had commenced and the heat was sinking. It had perhaps sunk more at the moment when the affusion was performed, than was indicated by the thermometer, for the bed-clothes often keep the body from cooling under perspiration to the degree that would otherwise be produced. In this case when the surface is suddenly exposed to the external air the heat sinks rapidly. If the perspiration had continued an hour longer before this remedy was used, the heat would have been still more diminished; a torpor of the vessels of the surface, and of the extremities, would have been produced, followed by a great, and probably a dangerous re-action of the centre. This observation will be illustrated in the sequel.

In

In recommending the affusion of cold water as a remedy in fever, an express exception is therefore made against its use during the feverish chill, or after the perspiration has begun to flow profusely, and more especially after it has continued to flow profusely for some time. An exception is also made against its being employed in the latter end of fever, when the strength is much exhausted, and the heat is sometimes as low or lower than the temperature of health. While, however, the heat rises one or two degrees above the healthy standard, this remedy may be used even in the latter stages of fever. I have employed it with advantage on the 11th, 12th, and 13th days. In instances of this kind it will however be prudent to make the degree of cold very moderate, as has been already observed; and as it is scarcely to be expected that at an advanced period of the disease the progress of it can be stopped, or its duration much lessened, it may perhaps answer every purpose to employ in such cases the *tepid* ablution. I have indeed often contented myself with sponging the body all over with tepid vinegar, or vinegar and water, from the 9th or 10th day forwards; but I have frequently in cases where the heat continued high, directed the general affusion of tepid water, by which the heat may always be speedily and effectually reduced, *when that is the only object in view.*

Under

Under these restrictions, the affusion of cold water may be used with perfect safety in the low contagious fever of this country, and the facts already stated will show that it is a remedy of great power and efficacy. In the first stages of fever, it appears very generally to cut short the disease almost instantaneously; and even when it fails of this effect, as is usually the case when it is applied in the more advanced stages, it nevertheless moderates the violence of the symptoms, and shortens the duration of the fever.

CHAP. VIII.

General remarks on fever. History of a case of fever in which the affusion of cold water was not salutary.

SINCE the introduction of scientific arrangements into medicine, diseases have been much reduced in number, and their nature has been more clearly understood. This is especially true of continued fever, which is exhibited by Dr. Cullen under three genera only, Synocha, Typhus, and Synochus. Of these genera, however, the Synocha, or pure inflammatory fever without topical inflammation, is confessedly a very rare occurrence in this island; the venerable professor used to declare that he had not met with a single instance of it in forty years practice.—And the typhus and synochus seem to be considered by him as the same disease, modified differently, by the difference of climate, season, and

and constitution. Both are described as contagious, and as occasionally producing each other. Doubtless the typhus, or low contagious fever, is the prevailing fever of this island, and of Europe. It is the epidemic of all our great towns, of our jails, hospitals, and manufactories; its origin and progress are clearly ascertained, and its symptoms generally understood. It is to this fever that the preceding observations chiefly apply.

I have my doubts, however, after much reflection and observation, whether we have not simplified too fast in our nosological arrangements of fever. The dreadful disease which prevailed lately at Philadelphia, and which now ravages the West Indies, cannot perhaps be included without some violence within our systems of Nosology; and its fatality under all the established modes of treatment, whilst it excites our deepest regret, must serve to abate the pride of modern science.—Even in our own island, it appears to me that cases of fever occasionally occur, which cannot be referred with advantage to any of the genera of Dr. Cullen*. The following

* I am aware that all questions respecting Nosological arrangement have a tendency to degenerate into verbal disputes, and I willingly avoid them, referring for my accuracy to those who have studied diseases, not in books only, but in the volume of nature.

lowing is a description of a fever of this kind ; I have not met with it often, but when I have met with it, it has very generally proved fatal, under the established modes of treatment ; and I am sorry to say, that in the only instance of this fever in which I have tried it, the affusion of cold water proved unsuccessful also.

The fever in question does not seem to originate in contagion, or to propagate itself by contagion. I have never been able in a single instance to trace it to that source, nor have I ever found it to be communicated from the patient to any of his attendants. The cases which I have seen have occurred chiefly in the winter season, in persons in the flower or vigour of life, possessed of considerable sensibility of mind, and in the habits of more than ordinary mental exertion. After some days of indistinct catarrhal complaints, the fever comes on (in general after some accidental exposure to cold) with a very violent and long continued attack of chills and rigor, and to this, as is usual, succeeds a state of heat and re-action. The patient complains of intense head-ach and of oppression at the præcordia, with occasional but not severe cough, and with some increase in the frequency of respiration. His pulse is not remarkable as to frequency or strength ; his sleep is not particularly disturbed ; and for some days the complaint goes on as if produced by catarrhal fever.

fever. From the first, however, there appears a great quickness and impatience about the patient: he talks more rapidly than usual; apprehends you quickly, and answers you instantly. He cannot, however, command his attention long, and is fatigued with the effort. His heat, which was at first moderate, becomes very great on the 7th and 8th day, reaching 109° or 110° of Fah^r.; he becomes delirious and talks incessantly. Throughout the fever, his senses of hearing and taste are uniformly acute, and this is true also of his sense of feeling. Great as his heat is, he is much alive to the impressions of cold on the surface of the body, and shrinks from them. At times he appears surprisingly calm and natural, gets out of bed and dresses himself, insisting that he is well. Often he starts up suddenly in bed and opens his curtains, seeming to look round the room for some person he supposes present; and sometimes he rings the bell violently, if within his reach, without apparent object. Indistinct conceptions rise and vanish in his mind, and the impressions of sense are confounded with the ideas of imagination. As the fever advances, the respiration becomes more hurried and laborious, and the pulse more frequent and feeble; and towards the latter end of the disease, but not before, perspirations break out, at first partial, and at length general and profuse, which however, though they reduce the heat, do not otherwise relieve him.

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The pulse sinks; the body is covered with petechiæ; wine, bark, opium, and blisters, afford no relief: the patient dies on the twelfth or thirteenth day of fever, and after death the body runs rapidly into putrefaction.

I have seen this fever treated by venesection and antimonials in the early stages, with a strict attention to the antiphlogistic regimen; and by bark and cordials, as the strength began to decline; but without success. I have also seen it treated from the first on the same plan as typhus, but with an equally unfortunate issue. In a case of this fever which occurred lately, I made use of the cold affusion, and as the mercury rose in the thermometer with the bulb under the tongue to 108° , I employed this remedy with some degree of confidence. The effects did not correspond with my former experience, or with my hopes. The patient felt the cold most acutely, but was not relieved. His pulse did not diminish in frequency; his heat subsided very little, and that for a few minutes only; neither diaphoresis nor sleep followed. This remedy was not repeated, but the surface of the body was sponged from time to time with vinegar, without however producing sensible benefit or refreshment.

I have already mentioned that the affusion of cold
water

water is not to be used after a profuse perspiration has taken place; and that it is not to be used in the cold stage which begins the paroxysm of fever, nor till the hot stage be fairly formed. In the typhus, however, this last restriction seldom requires us to wait long, the affusion may be used in general in twenty-four hours from the original attack, and often much sooner. The case I have just related is the only instance, out of many hundred trials, in which I found, that even on the sixth day of fever, with the actual heat of the body far above the temperature of health, the affusion of cold water was neither salutary nor refreshing. I have however to observe, that notwithstanding the great heat of the body, producing the utmost restlessness and anxiety, the *sensation of heat* was interrupted by chillness, on the slightest application of cold, and that the surface and extremities not only felt chilly, but grew cold even on the accession of the external air. In reality, through the greater part of the fever, the state of the patient had a considerable resemblance to what we see in the paroxysm of an intermittent, when the cold stage is terminating, but the hot stage not fairly formed—when the heat as well as the blood, is accumulated in the centre of the system, and the vital power is struggling to give them that propulsion to the superficies which terminates in profuse perspiration, and carries off the disease. I have little doubt that immersion in the tepid

tepid bath continued for some time (of the temperature that feels comfortably warm to the skin) is the proper remedy in the fever I have described, as it doubtless is in the struggle of the paroxysm of intermittent; and when an opportunity offers, I mean to ascertain the truth on this point. But this opinion will be illustrated when we come to speak of the warm bath more particularly.

If any one should contend that the fever I have described is in reality only a variety of the typhus, or synochus, I shall not be disposed to contest the matter. The question concerning *identity*, leads to endless disputes in every branch of science where it occurs, and he must know little of nosology, who supposes *it* has yet received a consistency, that would render such a discussion profitable. It is sufficient for me to observe, that the symptoms of the two diseases are in a considerable degree different, though with that general similarity that belongs to all cases of fever; that the state of the nervous system as to impressibility is widely different; and what is of most importance, that the methods of treatment, which according to my experience almost invariably succeed in the one disease, are unsuccessful in the other. Every practitioner knows, that in typhus, the sense of hearing is generally obtuse; and the same may be said of the taste, smell, and touch; whether the observation is applicable

cable to the sight also, and under what restriction, appears to me doubtful. The acuteness of all these senses in the fever which I have described, is very remarkable, and particularly in regard to the sensibility of the surface. I have observed this symptom to be produced by several narcotics and by some poisons. It is very remarkable in the hydrophobia; and in the last days of a person who died of hunger, the senses of touch and vision were extremely acute.*

* This case will be found in a subsequent part of this volume.

CHAP. IX.

Of the use of the affusion of cold and tepid water in small-pox, with cases.

THE singular degree of success that on the whole attended the affusion of cold water in typhus, encouraged a trial of this remedy in some other febrile diseases. Of these the small-pox seemed more particularly to invite its use. The great advantage that is experienced in this disease by the admission of cool air, seemed to point out the external use of cold water, which being a more powerful application, might be more particularly adapted to the more malignant forms of small-pox. The result corresponded entirely with my expectations. Of a number of cases in which I witnessed the happy effects of the affusion of cold water in small-pox, I shall give the following only.

CASE I.

In the autumn of 1794, J. J. an American gentleman in the 24th year of his age, and immediately on his landing in Liverpool, was inoculated under my care ; the prevalence of the small-pox rendering it imprudent to wait till the usual preparations could be gone through, or indeed till the fatigues of the
voyage

voyage could be recovered. He sickened on the seventh day and the eruptive fever was very considerable. He had a rapid and feeble pulse, a foetid breath, with pain in the head, back, and loins. His heat rose in a few hours to 107° , and his pulse beat 119 times in the minute. I encouraged him to drink largely of cold water and lemonade, and threw three gallons of cold brine over him. He was in a high degree refreshed by it. The eruptive fever abated in every respect—an incipient delirium subsided, the pulse became slower, the heat was reduced, and tranquil sleep followed. In the course of twenty-four hours the affusion was repeated three or four different times at his own desire; a general direction having been given him to call for it as often as the symptoms of fever returned. The eruption, though more numerous than is usual from inoculation, was of a favourable kind. There was little or no secondary fever, and he recovered rapidly.

In situations where the eruptive fever of small-pox is clearly distinguishable, and where it does not abate sufficiently on the admission of cold air, the affusion of cold water may be resorted to with confidence and safety, regulated however in this application, as in every other, by *the actual state of the patient's heat, and of his sensation of heat*. In the confluent small-pox, however, after the eruption is completely

pletely formed, this remedy cannot perhaps be used with advantage. The following case will illustrate this position.

CASE II.

H. A. aged 23, an American mariner fell under my care (*Dec. 7,*) on the third day of the eruption of the small-pox; that is, on the sixth day of the disease. His pulse 114 and feeble, his heat 100°. His head, back, and loins ached severely—thirst great—skin-livid—small-pox confluent.

He was put on a milk diet—gentle mercurial purgatives were ordered from time to time, and an opiate every night at bed-time. Lemonade was given largely, at first by itself, and afterwards mixed with wine, and the affusion of cold water was directed in the usual way. In ten minutes after the affusion, the pulse was 96, the heat 98°; the livor of the skin was much diminished, but the pains were not relieved.

Dec. 8. Noon—pulse 96, soft and regular—thirst gone—respiration slow and natural—heat 97°.—The affusion was ordered to be repeated; ten minutes after pulse 84 and feeble—heat 84°.

Dec.

Dec. 9. Noon—pulse 88, heat 93—the cold affusion was not repeated in this very reduced state of heat; the decoction of bark was ordered, and a pint of wine daily in lemonade.

Dec. 10. Noon—pulse 116, and full—heat 98°, respiration still easy—expectoration considerable and viscid—thirst less—eyes quite closed—head swelled—a complete union of the pustules on the face. Bark and wine continued, with the opiate at night.

Dec. 12. Pulse 118—heat 96°. A bucket full of water of the temperature of 92° was poured over him. He appeared refreshed at the moment; ten minutes after pulse 112, heat 94°. Complained of being chilly. Respiration still easy—free of pains and his face fallen. Complained of his throat. A blister was applied to it all round.

Dec. 13. Noon—pulse 118—heat 96°—respiration still free, but his throat very sore. Medicines were continued, but the affusion of tepid water was not repeated.

Dec. 14. Noon—pulse 138—heat 100°—respiration is now become laborious, and the expuition difficult. The throat is much swelled. He was frequently spunged with tepid water, and the medicines continued.

Dec.

Dec. 15. Noon—unfavourable symptoms increased.

Dec. 16. Noon—vomiting came on which was relieved by opium. His senses and his intellect remained acute to within an hour of his death, which happened at eight o'clock in the evening of this day.

If this case be more detailed than seems necessary, let this be excused, as it is the first on record, in which the actual heat in confluent small-pox has been recorded. It is here given accurately from the period when the disease came under my care.

In regard to the effects of the cold affusion, it may be observed, that this remedy was not used during the eruptive fever, nor till three days after the eruption had appeared, and the character of the disease was decided. In the stage in which it was employed, the fever and the heat were abating, as is usual after the eruption; and in all cases in which the heat is sinking, the application of cold must be made with great caution, as has already been mentioned. After the second affusion (on the 8th) the heat sunk below its natural standard, and continued below it for some time; so that this remedy became inadmissible. The disease went through its usual course. The tepid affusion on the eighth day of
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the eruption (*Dec. 12*) was used in part to wash off variolous matter, and in part to produce refreshment. The heat which was before 96° , sunk two degrees, so that it could not with safety be continued, for experience has proved that the tepid affusion is a powerful means of diminishing heat. The heat rose again with the secondary fever, and the patient died of the affection of the throat, as I believe is general in the confluent small-pox.* It will be at once perceived, on the principles already laid down, that in a disease like this, the affusion of cold water could only be essentially useful during the eruptive fever. It is during the eruptive fever that the quantity of the assimilation is determined, as well as its kind. This is invariably found to bear an exact proportion to the eruptive fever, and whether we consider the eruptive fever as the cause or effect of the assimilation, there is every reason to expect, from the laws of the living system, that the diminution of this fever will diminish the quantity, and meliorate the quality of the variolous eruption.

In the case just related, the heat during the eruptive fever (from trials in similar situations) had
doubtless

* See *Zoonomia*, Vol. II. page 237. The article on the confluent small-pox is very valuable, and displays the usual acuteness and comprehension of its author.

doubtless risen to 106° or 108° ; but it had sunk to 100° , before the cold affusion was employed. It may easily be conceived that this remedy could have been employed to a much greater extent, and that its effects would have been far more salutary, if it had been used throughout the previous fever. That it would have essentially altered the character of the disease, I presume not to assert. This however, I can declare, that in all the cases in which I have used the affusion of cold water during the eruptive fever, however severe the symptoms may have been, these symptoms instantly abated, and the disease assumed a benignant form. The case of Mr. Johnston (Case I.) already given, will illustrate this observation; and six or seven others I might adduce to the same purpose. As yet my experience extends no farther.

The inoculation of infants is so very seldom followed by any serious disease, that as far as respects them, the affusion of cold water may be seldom required. The inoculation of adults is not, however, quite so safe. Inoculation is seldom indeed performed in our island on adults that are natives, but foreigners frequently require it; and in Liverpool, our intercourse with America renders it often necessary to perform it on adults from that continent. We may also observe, that when the natural small-pox is epidemic, the eruptive fever will be generally

generally distinguished, and wherever it is distinguished with symptoms of violence, instead of trusting to cool air only, the cold affusion, or cold bath, are strongly recommended. To our brethren across the Atlantic this is more especially addressed. In America, as well as many parts of the old continent, in consequence of the neglect of early inoculation, the natural small-pox at times spreads alarm and devastation throughout extensive districts. In this island the ravages of the natural small-pox are on the whole very great, but they occasion little disturbance or alarm. The practice of inoculation among the more opulent classes of society, keeps up the contagion in all our populous districts, and destroys all opposition to the casual progress of this contagion, in the only quarter in which opposition can be effectual. Though therefore it is demonstrable, and has indeed been demonstrated, that the destruction of the natural, or rather the casual small-pox, might be entirely avoided, yet, as it falls almost wholly on the families of the poor, and as it has been an evil that has been long, and that is familiarly known, we submit to it through habit, as if it were inevitable—one of these natural ills, *that flesh is heir to*. The alarm produced by the casual contagion is therefore seldom so great in our large towns, as to give a practitioner frequent opportunities of treating the eruptive fever of the conflu-

ent small-pox, the only stage of that disease in which medical treatment is likely to be of much avail. Where such an opportunity does occur to the enlightened reader of these pages, it is hoped that the affusion of cold water, or the cold bath, will not be neglected*. The Chinese, it is said, have long followed this practice with extraordinary success.

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* The observations on the possible prevention of the casual small-pox will doubtless suggest to the medical reader, the "Sketch of a Plan" for that purpose published in 1793, by my respectable neighbour, Dr. Haygarth. That this plan is in itself practicable, and that it would be effectual, I have little doubt. Unfortunately, it requires the assistance of government (as I remarked at the time) and this I fear is a powerful objection. It is possible however that some scheme of this kind (including I hope all contagious diseases) may one day or another be attached to some comprehensive plan for the management of the poor.

The theory that suggested Dr. Haygarth's plan, but which formed no essential part of it, involved him in a discussion on the length of time that variolous matter may be exposed to the atmosphere, and retain its infectious quality. On this occasion, as there was some difference of opinion between us, he suggested several experiments to me which would doubtless have decided the question. (See pages 459, 460 of "*A Sketch, &c.*") It was fully my intention to have undertaken some experiments such as he suggested, and I even commenced them, but as my attention about this time, (April 1793)

was

The use of the cold affusion in fever was common among the physicians of the infirmary, (Dr. Brandreth, Dr. Gerard, and myself) while fevers were received

was forcibly drawn to other subjects, these experiments, which required extreme accuracy, were not completed, and my engagements have never since permitted me to recommence them. I have, however, since that time, inoculated with matter at different periods from its being taken from the patient, and the result is as follows. The length of time which variolous matter exposed to the air retains its contagious quality depends on its superficies. If it be spread very thin on a piece of flat or convex glass, it loses this quality much sooner than when it is collected in a mass. Spread thin upon glass, it sometimes disappoints the inoculator at the end of twenty days, though not generally; and I have known it succeed in communicating the disease, even when diffused over a large surface, at the end of seventy-three days. (*See Dr. Haygarth's Sketch page 447.*) But I find from the experience of Mr. Park, as well from my own, that this is not common. The instance in which I found by experience variolous matter to retain its infectious quality longest was the following. On the second of Feb. 1792, I took a considerable quantity of this matter on a piece of window glass, keeping it as much together as its fluidity would admit. It was exposed immediately to a stream of air, and the surface was speedily dry. On the second of March following, after moistening a portion of it with a little water, I inoculated three patients, and all with success. In the course of the summer I inoculated with another portion of it, previously liquified by the addition of warm water, and with success as before. On the twentieth of July, 1793, I again used a portion of the same matter in the same way, and again with success; but

received into that hospital, and its extraordinary success there, has rendered it in Liverpool familiar in private practice, and extended it, as I have already mentioned, to several other febrile disorders. The scarlatina anginosa has for many years prevailed in Liverpool, and though in general mild, has at particular seasons been malignant and fatal. To this disease, the affusion of cold water has lately been applied by my friend Dr. Gerard, and the particulars that follow are mentioned on his authority.

In the latter end of December 1796, all the children of a family in his neighbourhood, five in number, had been attacked in succession with scarlet fever, four of these were recovering, but one was dangerously ill, when the father of the family, with whom one of the children had slept, was himself seized with all the symptoms of the disease. He had excessive pain in his head and back, and flying pains all over him. He had frequent rigors, loss of appetite, and sickness, with some flushing of the face, but without any

but this success was long doubtful, and it was not till the twenty-second day after the operation, that the patient sickened.—I used the same matter in June 1794, when it entirely failed me. It is now by me and is not mouldy, nor any ways changed in its appearance. Variolous matter kept some time is certainly slower in producing the disease, even where it does succeed in the end.

any efflorescence on the skin or affection of the throat. This was his situation when Dr. Gerard was called in, about sixteen hours after the first attack. An emetic, and afterwards a cathartic were ordered, but their operation was slow and imperfect, and on visiting him, ten or twelve hours afterwards, he was not materially relieved.

Entertaining no sort of doubt of the nature of the attack, these symptoms foreboded that the epidemic would, in this instance, be severe; and reflecting on the importance of the patient's life, Dr. Gerard determined to try the affusion of cold water, from which in typhus he had seen such happy effects. Accordingly the operation was performed, and with a result that far exceeded his hopes. As he was much debilitated, half a pint of hot wine was given him after it, and on being put to bed the symptoms of fever were found nearly gone; a genial warmth diffused itself over the extremities of his body, followed by perspiration and sleep. Next day he complained of a slight degree of head-ach and lassitude; Dr. Gerard therefore ordered the affusion to be repeated, as well as the warm wine after it; the symptoms of the disease vanished and never re-appeared.

A day or two afterwards a maid who had been hired as an assistant to attend the sick children, and who had been about a week in the house, was attacked

tacked by the precise symptoms already related, and which had uniformly ushered in the epidemic. She took an emetic on the first attack with little benefit, and soon after the cold water was poured over her, the wine being administered after it. In this case the remedies were used earlier than in the former one ;—they were used once only : the febrile paroxysm was dissolved, and never returned.

The result of these cases communicated by Dr. Gerard, leads to a variety of important reflections. That the affusion of cold water extinguishes the incipient scarlatina as well as the typhus, can scarcely be doubted; and thus this powerful and simple remedy is extended to another, and a most important class of diseases. That the disease was extinguished without the specific efflorescence of the skin, or affection of the throat, is a circumstance not a little curious. It seems to demonstrate that this efflorescent matter is the product of the eruptive fever; and that the fever itself being destroyed in the first instance, the efflorescent matter is never produced. Thus we are freed from the apprehensions which a false theory might suggest against extinguishing a process by which nature was extricating itself from an acrimony which the system had imbibed.—Thus also our conclusion is supported that the eruptive fever of small-pox is the cause, and not, as some have supposed, the consequence of the progress

gress of assimilation, and that the diminution of this fever by cool air, and still more by the affusion of cold water, actually diminishes the quantity of matter assimilated, and in certain cases might perhaps wholly prevent the assimilation.* This last conclusion is indeed doubtful, as well as all analogical inductions must be between different diseases; and particularly where the difference is of this important kind, that the constitution in one case is susceptible of the disease once only, while in the other it may probably receive it indefinitely. We may also observe that the prevention of the assimilation of small-pox, by wholly extinguishing the eruptive fever, if it were in our power, would not be adviseable, since it must leave the patient exposed to the future influence of that contagion.

I have not had an opportunity of repeating Dr. Gerard's practice in the incipient stage of scarlatina, but after the efflorescence on the surface decides the nature of the attack, I have for the last fifteen months uniformly prescribed immersion in the tepid bath, (from 92° to 96°) and with striking benefit.

Whether

* Dr. Cullen has assumed, that in all the various degrees of small-pox, the quantity of matter assimilated bears an exact proportion to the bulk of the body, and that the difference in the nature and quantity of the eruption depends wholly on the permeability of the skin. This doctrine, which in his lectures he extended to all the other exanthemata, is, in my judgment, one of the weakest parts in his most valuable work.

Whether the affusion of cold water is applicable to the other exanthemata, must be left to future experience.

In the cases that I have related to illustrate the effects of the cold affusion, the temperature of the water may be judged of from the season of the year. In general it was from 40° to 50° of Fah°. In the epidemic which prevailed in the 30th regiment, the water of the river was employed, as has already been mentioned, which as the season was uncommonly cold, did not, though in the month of June, exceed 58° or 60° . I have, however, very often used the river water in private practice during the summer months of the last four years, when in general it has been from 65° to 70° , and the effects differed in no respect from those already described. The solution of fever, or to speak in language more precise, but as yet less intelligible, of the morbid febrile catenation, depends on the sudden, general, and powerful impression on the sensations, and this impression is less affected by the difference in the temperature from 40° . to 70° . as far as my observation extends, than might on a first consideration be imagined. Within these limits the efficacy of this remedy, as well perhaps as its safety, depends on the suddenness and momentariness of its application. The powerful impression on the sensations is much weakened when
the

the water is poured slowly on the body, and as the respiration is suspended or convulsed during this application, as well as during the act of immersion in the cold bath, it might in some cases incur hazard to protract it.

CHAP. X.

Of the affusion of tepid water on the surface of the body, in feverish disorders, and of spunging the body with water or vinegar. The affusion of tepid water practised in antiquity.

I EMPLOY the term *tepid* when water is heated to that degree which is warm, but not hot to the sensations, and which in the way of affusion is from 87° to 97° of the scale of Faht. According to my experience this term, when the body is immersed, may be applied to water some degrees colder, the reason of which will be easily understood by those who reflect, that under immersion no evaporation from the surface of the body takes place. At first I imagined that the tepid affusion might be employed in cases where the heat of the body is below the degree necessary to render the cold affusion safe. I employed it therefore in those stages of fever where the heat did not exceed the temperature of health.

A little

A little experience however convinced me that this practice was not without hazard, for I found, that in many cases, at least, the heat of the living body is lowered as speedily by the affusion of tepid water, as by the affusion of water that is cold ;—if I mistake not, in some cases the heat is lowered more speedily by the tepid water. To those who reason respecting the heating and cooling of the living body in the same manner as respecting inanimate matter, this observation will appear paradoxical ; I assert it however from actual observation, and a little reflection will explain the phenomenon. The evaporation from the surface is more copious from the tepid affusion, and on this the cooling of the body very much depends. But this is not all ; the tepid affusion is little if at all stimulating, and does not, like the cold affusion, rouse the system to those actions by which heat is evolved, and the effects of external cold are resisted. Where the object is to diminish heat, that may be obtained with great certainty by the repeated use of the tepid affusion, suffering the surface of the body to be exposed in the interval to the external air—and if the beams of the sun are excluded, and a stream of wind blows over it, the heat may thus be reduced where cold water cannot be procured ; even in the warmest regions of the earth—on the plains of Bengal, or the sands of Arabia. I have accordingly employed the tepid affusion very generally in those feverish affections
where

where the morbid actions are weakly catenated, depending rather on the stimulus of preternatural heat, than on contagion, miasmata, the morbid contents of the stomach and bowels, or local inflammatory affection. Of this kind are a great part of the feverish affections of children, in which the tepid affusion is a valuable remedy. It very generally produces a considerable diminution of heat, a diminished frequency of the pulse and respiration, and a tendency to repose and sleep. I have used it also in feverish disorders of various kinds where the lungs are oppressed, and the respiration laborious, and where of course the oppression might be dangerously augmented, by the sudden stimulus of the cold affusion. It is also applicable to every case of fever in which the cold affusion is recommended, and those may receive much benefit from it, whose fears or whose feebleness deter them from that energetic remedy. I have not however found its effects so permanent as those of the cold affusion, and I have never seen it followed by the total cessation of regular fever as often occurs after the cold affusion. In the hectic fever, however, where the actions are less strongly catenated than in synochus or typhus, the paroxysm is sometimes completely extinguished by the affusion of tepid water* in the commencement of the
hot

* See this fact mentioned in the *Zoonomia*, vol. ii. p. 296. where a relation is inserted by Dr. Darwin, of the author's (Dr. C's.) own case of hereditary consumption.

hot stage. In the hectic paroxysm, the heat seldom rises more than two degrees above the temperature of health in the trunk of the body, and three or four degrees on the extremities. By moistening the palms of the hands and the soles of the feet with vinegar, its effects may be moderated, for it is from the sensation of heat in the extremities that the stimulus to the system is chiefly derived; and this practice ought not to be neglected, if the tepid affusion is not employed generally. In all cases of fever indeed, where the burning heat of the palms of the hands and soles of the feet is present, this method of cooling them should be resorted to; it is uniformly safe and refreshing. I have not employed the cold affusion in the hectic paroxysm. This disease generally adheres to a debile system; the body parts with its heat in it easily; and the lungs being always affected in the pulmonary hectic, the sudden application of cold to the surface might produce unpleasant and perhaps dangerous effects on the respiration. Neither have I tried it in peripneumony or meazles.

When the affusion of water cold or tepid is not employed in fever, benefit may be derived, as has already been mentioned, though in an inferior degree, by sponging or wetting the body with cold or warm vinegar or water. The application is however to be regulated like the others by the actual state of the patient's heat and of his sensations.

According

According to my experience, it is not only less effectual, but in many cases less safe; for the system will often bear a sudden, a general, and a stimulating application of cold, when it shrinks from its slow and successive application.

I have also used the affusion of *cool* water as a remedy in febrile diseases, but more frequently in paralysis, and in other diseases of debility. By the term cool, I designate the temperature from 87° to 75° . It operates as a gentle stimulant, and may be used as a milder form of the cold affusion. Like the cold affusion its application should be sudden and momentary, when the object is to increase the tone of the system or to dissolve a morbid catenation; where it is employed to moderate inordinate heat, it may be used more slowly, provided it does not interrupt the catenation on which respiration depends.*.

The practice of giving cold water as a drink in fevers was common among the ancients, but the affusion

* I borrow this term (catenation) from Dr. Darwin.— It is employed to express a number of actions linked together, nearly in the sense of *association*: the *sympathies*, as they are usually called, are included under this term, and many *associated* actions to which the word sympathy has not been applied, as the connexion between the heart and the lungs, the stomach and the heart, &c. See *Zoonomia*, vol. i. sect. xvii.

fusion of it on the surface of the body seems to have been wholly unknown. This, as far as I can trace it, was first practised at Breslaw in Silesia, as appears from a dissertation under the title of *Epidemia verna quae Wratislaviam, anno 1737, afflixit*, to be found in the Appendix to the *Acta Nat. Curios. vol. x.* a work which I have not had an opportunity of consulting.* While, however, the laws by which the affusion of cold water ought to be regulated were not understood, the use of the remedy must have been extremely hazardous: and the fatal consequences of its improper application, we can easily believe to have prevented its gaining any ground on the continent, or having been adopted in Britain. These laws are now, I hope, ascertained by ample experience, and practitioners will I trust, find themselves directed in safety in the future use of this powerful remedy.

The affusion of tepid water in febrile diseases was not unknown to the ancients, though seldom employed by them.† It is I apprehend new in modern

* I mention this dissertation on the authority of Dr. Cullen.

† Some traces of its use in fever are to be found in Celsus.
 “ Quidam ex antiquioribus medicis, Cleophrantus, in hoc genere morborum, (tertian intermittents) multo ante accessionem caput ægri multa calida aqua perfundebat, deinde vinum dabat. Quod, quamvis pleraque ejus viri præcepta secutus

modern practice, and will be found an important addition to the list of our remedies. The effects differ considerably from immersion in the tepid bath, as will be more fully explained in speaking of that remedy. Though the affusion of tepid water was little in use as a remedy, it was familiarly practised as a part of their daily regimen, by the Greeks and Asiatics in the earlier periods of their history. That the Greeks in latter times, and after them the Romans, immersed themselves in the baths to which they were so much devoted, is certain†; but in the heroic age of Greece, the affusion of tepid water seems to have been the mode in which this luxury was enjoyed. Abundant proofs of this are to be found in Homer, particularly in the *Odyfsey*, that admirable record of ancient manners. Venus, after her public disgrace, is described as flying to the groves of Paphos, where she is *laved* by the Graces, and the improvement derived to her beauty is recorded in a strain

“ est Asclepiades, recte tamen præteriit, est enim anceps.
 “ *Celsus, lib. iii. cap. xiv.*” This use of the tepid or warm affusion is altogether different from what I propose, and was not only, as Celsus supposes, a doubtful, but probably an injurious practice. For by chilling the body it would dispose it to the accession of the paroxysm. The use of the tepid affusion as now proposed, may fairly be considered as a new practice.

† The baths in the luxurious days of Rome were conducted at a great expense and, formed a very complicated system.

strain of poetry worthy of the subject. (*Odys. lib. viii. l. 362 to 367.*) Ulysses is represented as *laved* by attendant nymphs in the court of Alcinoüs, and in the island of Circe the whole process of heating the water and pouring it over the naked hero is particularly described.* On this occasion also, nymphs administered to him, who after the ablution anointed him all over with oil; a service well calculated in every respect to increase the pleasure and to diminish the risk of the tepid affusion.

The Romans under their Emperors, carried the system of bathing to a height of luxury and expense which it never reached in Greece or Asia, as the ruins of their magnificent *Balnea* prove to this day; and the affusion of warm water was one of the methods by which they diversified this favourite gratification.†

* *Odys. lib. x. l. 358, &c.* compare this with the bathing of Telemachus in *lib. xvii. l. 85, &c.*

† See *Hieronymi Mercurialis de Arte Gymnast: lib. i. p. 44 and 45.*

CHAP. XI.

Of the use of cold water as a drink in fever.

TO conclude the account of my experience of the use of cold water in fever, it will be necessary for me to say something of its effects when swallowed, on the stomach, and through it on the system at large. Among the ancients the internal use of cold water in ardent fevers is recommended by Hippocrates, Galen, Celsus, and most of the celebrated physicians whose works have come down to us : among the moderns, that extraordinary man, Cardanus, wrote a dissertation in its favour ; and to pass over a multitude of inferior names, Hoffman, though with some restrictions, recommends it, not in fever only, but in various other diseases*. In our own country it was proposed as an almost universal remedy by Smith, and a treatise has been written on it under the title of *Febrifugum Magnum*, by Dr. Hancock. In Spain and in Italy the use of cold water in fevers obtained in the beginning of this century a greater and more general reputation than in any other of the countries in Europe, and

* *Hoffmanni Opera*, vol. i. p. 479.

and at one time, seems to have superceded the use of all other diet as well as of medicine. This treatment was celebrated under the title of *Dieta Aquea*, and an account of it may be found in the 36th volume of the Philosophical Transactions by Dr. Cyrillus, a Professor at Naples, to which the reader is referred. Besides the internal use of cold water, he mentions the advantage of laying powdered ice or snow on the bodies of the sick.

Nevertheless the propriety of giving cold water in fevers, has been disputed by men of high character, and particularly by the celebrated Boerhaave. His doctrine of a lentor in the blood led him to insist on the use of warm drink and the danger of cold; and his commentator Van Sweiten, though he allows cold drink in some instances, yet in general argues against it.* These learned theorists prevailed in their day over the voice of nature and the precepts of Hippocrates, and Hoffman.—In the writings of Pringle, Cleghorn, and Lind, we find little or nothing on the subject, though they expressly wrote on fevers; Dr. Cullen mentions cold drink, but gives no opinion on the propriety of its being used, and certainly did not recommend it in practice. He was even doubtful of the extent to which cold

* See *Boerhaavii Aphorism.* Sect. 743. with the commentary of *Van Sweiten*.

cold air might be admitted*. On the whole it may be asserted that the use of cold drink in fever is contrary to modern practice, and that where it is occasionally given, it is administered with caution, and rather permitted than enjoined.

It is not however to the doctrine and precepts of Boerhaave alone, that the disuse of cold drink in fevers is to be imputed. The propriety of giving it freely has been at all times controverted, not on the ground of theory only, but from experience of the dangerous and sometimes suddenly fatal effects of large draughts of cold liquids, various instances of which have been recorded from the earliest periods of medical history. While therefore some physicians have prohibited the use of cold drink in fevers altogether, those who have recommended it from experience of its salutary effects, have introduced various cautions as to its exhibition, founded on certain theories, generally fallacious, on the manner in which its deleterious influence is produced. To detail the various opinions that have prevailed on this curious and important point, would be to add another chapter to the ample records of human errors. That the danger arising from cold drink depended on the great difference between the temperature

* See his first lines—cure of fever.

perature of the liquid and of the body, and that it is therefore to be prohibited when the heat of the body is very great, is an opinion very generally received by the moderns; and among the ancients, though their doctrines were less erroneous, yet while the means of ascertaining the real heat of the living body and the changes it undergoes, were unknown, it cannot be expected that they should have arrived at the truth on this important subject.

The effects of cold water as a drink in fevers I was naturally led to examine by my experience of its effects as an external application. I have made this examination with the thermometer in my hand, and with all the attention in my power; and the following results, which will save the reader the fatigue of reading the particulars of various cases and experiments, seem to me to contain all the information necessary to direct our practice.

1. Cold water is not to be used as a drink in the cold stage of the paroxysm of fever, however urgent the thirst. Taken at such times it increases the chillness and torpor of the surface and extremities, and produces a sense of coldness in the stomach, augments the oppression on the præcordia, and renders the pulse more frequent and more feeble. Its effects in all these respects are similar to
the

the affusion of cold water on the skin in the same stage of the paroxysm as described in pages 16 and 35, though inferior in degree. If the thirst is gratified in the cold stage of the paroxysm, it ought to be with warm liquids.

2. When the hot stage is fairly formed, and the surface is dry and burning, cold water may be drank with the utmost freedom. Large draughts of cold liquid at this period, are highly grateful; they generally diminish the heat of the surface several degrees, and they lower the frequency of the pulse. When they are attended with these salutary effects, perspiration and sleep commonly follow.—These effects are similar to those produced by the affusion of cold water on the surface, as already described, but inferior in degree also. Though various cases are on record of the paroxysm of fever being dissolved by cold water, used in this stage of the disease, my experience does not furnish me with any instance of this kind*. Indeed since I became acquainted with the extraordinary efficacy of the affusion

* See *Alpinus. Med. Meth. lib. ii. cap. 3.* Where after reciting the effects of cold drink in diminishing heat and thirst, and exciting profuse perspirations and large discharges of urine, he concludes, *Mirabile est, quomodo tale præsidium, has febres expugnet; nam excretionibus, quas aqua suscitât, hæc febres finiuntur.* According to the same author this practice was followed by the Egyptians.—See *lib. ii. cap. 15.*

affusion of cold water on the surface, I have not trusted the solution of the paroxysm to its internal use. I have however employed cold drink when necessary as an auxiliary. Throughout the hot stage of the paroxysm cold water may be safely drank, and *more freely in proportion as the heat is farther advanced beyond the natural standard.* It may even be drank in the beginning of the sweating stage, though more sparingly. Its cautious use at this time will promote the flow of the perspiration, which after it has commenced seems often to be retarded by a fresh increase of animal heat. A draught of cold water taken under such circumstances will often reduce the heat to the standard at which perspiration flows more freely, and thus bring the paroxysm to a speedier issue.

3. But after the perspiration has become general and profuse, the use of cold drink is strictly to be forbidden. At this time, I have perceived in more than one instance, an inconsiderate draught of cold water, produce a sudden chillness both on the surface and at the stomach, with great sense of debility, and much oppression and irregularity of respiration. At such times, on applying the thermometer to the surface, the heat has been found suddenly and greatly reduced. The proper remedy is to apply a bladder filled with water, heated from 110° to 120° ,
to

the scrobiculus cordis,* and to administer small and frequent doses of tincture of opium, as recommended by Dr. Rush. By these means the heat is speedily restored.

This effect of cold water used as a drink during profuse perspiration is precisely analogous to the affusion of it at such times on the surface of the body, a practice known to be of the utmost danger, and enumerated by Hoffman among the causes of sudden death. *Inveniuntur in amplissimo regno naturæ plura quæ brevi tempore nocent ac perimunt, ut aqua frigida corpori sudore diffluentis immoderatus superingesta.* Vol. i. p. 194.

The pernicious effects of cold water applied internally and externally under profuse perspiration, depend on the same causes, namely, that perspiration itself is a cooling process, under which the heat of the body, whatever its actual state may be, is sinking; that under such circumstances, we find as a matter of fact, it parts with its remaining heat more easily; and on the sudden application of cold, that this heat sinks to a degree which disturbs, and sometimes

* See the Appendix, N°. II. p. 27.

The pernicious effects of cold drink during profuse perspirations was known to the ancient,—See *Celsus, lib. i. cap. 3.*

times wholly interrupts the catenations on which life immediately depends.

Thus then we may safely adopt the same general rules for the use of cold water in fever as a drink, that have already been laid down for its external application. It may be used as a drink at any time, *when there is no sense of chillness present, when the heat of the surface is steadily above what is natural, and when there is no general or profuse perspiration.**

Though we have arrived at these conclusions, the reader is entreated to believe, that the effects of cold water used as a drink have not been inferred from its external application, but made the subject of separate inquiry. Yet, that in the one case, and in the other, they should be similar in kind, though different in degree, will be expected by every one acquainted with the laws of the animal œconomy, and particularly with the sympathy that subsists between the stomach and the surface.

I have only to add, that in our common contagious fever, when I have used the affusion of cold water, I have seldom found it necessary to employ it largely as a drink, and my experience of its effects

M

when

* See p. 16.

when drank in large quantities, has been chiefly confined to those cases where the fears or prejudices of the patients or their friends, have prevented our having recourse to the more powerful method of affusion. For however burning the thirst may be, it is speedily abated, and even removed, with very little drink, and often without any, by the successful use of the affusion on the surface. Though the affusion in general suffices in *our* contagious fever, yet in the use of cold water in the dreadful fever of Philadelphia and the West Indies, it is probable that its internal and external use should be combined; a point that must be determined by the actual heat of the patients, measured by the Thermometer, and by their sensation of heat, circumstances of which it is to be regretted that we have as yet no accurate information.

CHAP.

CHAP. XII.

*Of the disease that arises from drinking cold liquids
after severe exercise.*

IT is here natural to inquire how far the fatal effects proceeding from drinking cold water, not in fever, but in cases where the system has been extremely heated by bodily exertions (of which the records of medicine afford so many instances) are to be explained on the principles already laid down. If they are explicable on these principles, we ought to be able to shew, that they have occurred in situations where the system, after having been much heated and enfeebled by severe exertions, is losing its præternatural heat from profuse perspiration, and in general also from the cessation of the exertions by which this heat was originally produced. Here two powerful causes combine to cool the body, and if under their operation, a sudden application of cold is made either to the stomach or the surface, the living power will, we know, resist it faintly, and the fatal consequences be accounted for.

1. In

1. In my own experience this sudden death has occurred once only, and that many years ago. It was in the case of a young man who had been engaged a long time in a most severe match at fives. After it was over he sat down on the ground, panting for breath, and covered with profuse perspiration. In this state he called to a servant to bring him a pitcher of cold water just drawn from a pump in sight. He held it in his hand for some minutes, but put it to his head as soon as he had recovered his breath, and drank a large quantity at once. He laid his hand on his stomach, and bent forwards; his countenance became pale, his breath laborious, and in a few minutes he expired. Various methods were employed to restore him, but in vain.

2. The following case resembles very exactly that just given. *Blasius, Senensis, familiaris noster et condiscipulus, dum longiusculo tempore sub ardentissimo sole pilæ lusu incaluisse, nec sudore adhuc aut fatigatione remissis, in subterraneum locum ubi vinaria erat cellula, descendisset, frigidissimi vini calicem hausit: quo epoto, statim deficit.* Benevent. cap. 17. De abditis.

3. *Elegans & optimæ staturæ juvenis Romanus, cum pilâ luderet, et sudore respersus, ac totus madidus, & fatigatus ad puteum, pro siti arcenda venisset,*
exhaustâ

exhaustâ frigidâ recens per caldarium extractâ, ilico in terram cecidit & obiit.

4. *Alterum novimus ex iis, qui in campo negotiantur, qui quum non minus corporis totius adapertis poris, madidus domum reverteretur, cyathum frigidioris aquæ ebibit, et mortuus fuit. Anat. Lusit. curat. med. cent. 2. curat. 62.*

5. Forrestus relates, that in the year 1544, Valerius Cordus, a young man of great learning and talents, went during the heat of the dog-days, to collect plants among the Florentine mountains. Exhausted with fatigue and thirst, he incautiously drank of a cold spring which issued out of one of the hills, and was immediately seized with a fever, of which he died; but the symptoms of which he has not recorded. *P. Forestus, lib. i. Scholio ad obs. 13.*

6. Scaliger relates the case of a reaper, who, stooping down to drink at a fountain after severe labour, instantly expired. *Scaliger de Subt. ad Cardan. exer. 13.*

7. In Heisters observations, a case is related of a young man, who, about the Christmas season, had been playing and dancing at a Miln with some young women, and had eaten greedily of some hot buttered

buttered cake. After this, being extremely thirsty, he took a large draught of some cold water mixed with snow. An inflammation in the stomach followed, terminating in mortification, of which he died. *Heister's Med. &c. Observations, translated by Wiseman, p. 17.*

8. *Villanum quendam nobis familiarem novimus, qui messis tempore, anno 1597, exhaustus viribus, et totus sitibundus præ nimio solis ardore, domum rediens, cum in magna quantitate, ad sitim explendam, gelidam (aquam) bibisset, exanimatus mox juxta puteum cecidit, ac intra tres horas animam expiravit. Georgius Graffeccius in Theatro Anatomico.*

These relations are chiefly taken from the collection of Schenck—they might be greatly enlarged, and I have collected a number of similar cases; which it were a tedious and an useless task to detail. In all of the cases which I have consulted, as well as in those I have related, three circumstances are either expressed or may be clearly inferred—1. The body had been previously heated beyond the temperature of health, by exercise carried to fatigue. 2. To this violent exertion a state of rest had in general succeeded. 3. A profuse perspiration had taken place. So far our reasoning is supported; but as these points are of the utmost consequence

consequence in explaining the operation of cold on the human body, and as direct experiments are attended with extreme hazard, the reader will excuse me, if I attempt to support them farther, by such evidence as history may incidentally afford.

1. In Quintus Curtius, (*lib. vii. cap. 5.*) an account is given of the march of the army of Alexander the Great in pursuit of Bessus, through the country of the Sogdiani, which is represented as destitute of water, sterile, and covered with scorching sands. The intolerable heat, fatigue, and thirst of the soldiers in their march through this burning desert, are described with all the florid eloquence of the historian. At length fainting under their toils, they reached the banks of the river Oxus, where by indulging in large draughts of the stream, Alexander lost a greater number of his troops than in any of his battles. *Sed qui intemperantius hauserant, intercluso spiritu extincti sunt; multoque major horum numerus fuit, quam ullo amiserat praelio.**

2. A

* The whole particulars of this march as described by Quintus Curtius, are very interesting. The desert, which contained not a drop of water, was four hundred Stadia across—(*per quadringenta stadia ne modicus quidem humor existit,*) that is, upwards of forty-six English miles. They began their journey in the night, directing their course by the stars, and for some time their march was tolerable, being refreshed by

2. A similar story is related by Appian—*Appianus Alexandrinus de bellis civilibus, lib. v. tradidit Cornificianos milites a Pompeianis pagna fatigatos & æstuentes, fontanam aquam avidè bibentes, ex iis plurimos emortuos. Marcel. Donat. lib. iv. cap. 6. Hist. med. mirab.*

3. A disaster of the same kind is recorded to have

the dews of night, and the coolness of the dawn; but when the sun rose, the heat became troublesome, and as the day proceeded, most oppressive; it was equally painful to stand still or proceed. After a day of dreadful fatigue, the van-guard of the army, and Alexander himself, reached the Oxus towards evening; and such as were themselves refreshed, were employed in carrying water back to the fainting troops behind. As they arrived in succession on the banks of the river, it may easily be supposed that they drank without moderation, and hence the destruction that ensued. It was on this occasion that Alexander displayed his magnanimity in refusing the cup of water brought to him as he advanced, because it was not sufficient both for him and his companions; and that he gave a proof of his genius by ordering fires to be kindled on the high banks of the Oxus, not merely to direct his way-worn soldiers through the darkness, but to animate their fainting exertions by a prospect of the end of their toils. Plutarch alludes to this story, but does not relate it fully. I fear it is not to be found in Arrian. A similar distress is mentioned by him (*lib. vi. p. 425*) to have occurred in Alexander's march through the deserts of the country of the Gedrosi, who inhabited the southern part of the Persian empire on the shores of the Indian ocean.

have occurred to the Christian army in the holy wars. *Gulielmus Tyrius, lib. iii. c. 16. scribit, Christianum agmen Pisidiam ingressum, regionem arentem & inaquosam, tandem invento fluvio; quod quidem, qui largius aquam frigidam ingurgitaverunt, sitis discrimen evadentes, mortem in aquarum opulentia reperere.*

These historical relations support very fully the doctrine I have already laid down. The cautious reasoner may not, on a hasty consideration, be inclined to rest with much confidence on this sort of evidence; but on reflection he will see that it is entitled to considerable authority; because the facts are in their nature not liable to be mistaken, and because they are not likely to be misrepresented. It is also entitled to much weight, because it is not given by these historians in support of any particular doctrine; and because the experiment having been made on such numbers of persons at once, it acquires an authority hardly to be ascribed to solitary cases, however accurately detailed. These considerations induce me to lay much more stress on evidence of this kind, than on the precepts respecting the effects of cold drink to be found in medical authors, ancient or modern. Nevertheless I have looked into the greater part of the ancients on this point, (for among the moderns there is not much on the subject) and have found nothing, that fully considered, invalidates the conclusions I have laid down.

Of the ancient physicians the most copious on the use of water in all its forms, is Galen. He not only used cold drink, but immersion in the cold bath, in burning fevers, with extraordinary success. His relations appear to me, in general tedious and obscure, but not destitute of truth; and the weariness of perusing him is occasionally relieved by the pleasure of rescuing a fact that was buried under masses of false theory. The reader who would consult him on this subject may use the references below.*

In the first volume of *Medical Inquiries and Observations*, published by Dr. Rush of Philadelphia, 1789, an account is given of the “ Disorder
“ occasioned by drinking cold water in warm wea-
“ ther,” which frequently occurs there. “ Three
“ circumstances,” he observes, “ generally concur
“ to produce disease or death from drinking cold
“ water. 1. The patient is extremely warm. 2.
“ The water is extremely cold. And 3. A large
“ quantity of it is suddenly taken into the body.
“ The danger from drinking cold water is always in
“ proportion to the degrees of combination which
“ occur in the three circumstances that have been
“ mentioned.

* Vol. i. 23. B.

Vol. ii. 78. C.

Vol. vii. 70. A. and forwards throughout the volume.

I quote from the Latin edition in folio, published at Venice, 1656.

“ mentioned.” p. 151. Dr. Rush goes on to state the symptoms of this disease, which are, I apprehend, given with accuracy. His method of cure is in my judgment proper and judicious. “ I know
 “ but one certain remedy for this disease, and that
 “ is *liquid laudamum*. The doses of it, as in other
 “ cases of spasm, should be proportioned to the violence of the disease. From a tea-spoonful to near
 “ a table-spoonful has been given in some instances
 “ before relief has been obtained. Where the
 “ powers of life appear to be suddenly suspended,
 “ the same remedies should be used which have
 “ been so successfully employed in recovering persons supposed to be dead from drowning.” To this I would add the application of a bladder filled with water heated to 110° or 115° of Fah°. to the pit of the stomach, from which I have seen powerful effects in restoring the vital heat*. But while I accede to Dr. Rush’s practice I cannot subscribe to his notion of the causes of this disease, or to the method of prevention founded on this notion.

Dr. Rush seems to entertain the popular opinion on this subject: *the body is extremely warm; the water extremely cold, and a large quantity is introduced suddenly*

* See Appendix, N°. II. p. 31, 32.

suddenly. He apprehends the danger to arise from the great difference between the temperature of the body and of the water taken in. As a means of prevention he therefore proposes to such as cannot be restrained from drinking cold water when præternaturally heated—1. To grasp the vessel out of which they are about to drink for a minute or longer with both hands; that a portion of heat may be abstracted from the body and imparted to the cold liquor. 2. If they are not furnished with a vessel to drink out of, but obliged to drink at a pump or a spring, always to wash their hands and face previously to drinking, with a little of the cold water. “By receiving,” says he, “the shock of the water first on those parts of the body, a portion of its heat is conveyed away, and the vital parts are defended from the action of the cold.”

The fact however is in my mind perfectly established, that there is no situation in which the application of cold to the body, whether to the surface or the stomach, is so safe, or in general so salutary, as when the heat of the body, from whatever cause, is præternaturally great, provided that the body is not already in a state in which it is rapidly parting with this heat; and where the body is præternaturally heated, the degree to which cold water may be

be drank, may be always decided by the steadiness of the sensation of heat, and the tenacity with which the præternatural heat is actually retained. Thus in continued fevers it may be drank to a greater extent, than in the hot stage of intermittents, because the heat is more firmly retained; the profuse perspiration not being at hand, by which the febrile heat of intermittents is carried off. The ancients who gave cold drink largely in continued fevers, were doubtful of its use in intermittents.* It may however be given (as I have already stated) with great safety in intermittents, provided it be taken in the time that intervenes after the hot stage of the paroxysm is fairly established, and before the perspiration that follows it, has become general and profuse. As however it is only in that interval that it can be given in intermittents with advantage or safety, we can easily understand that the ill effects arising from its being accidentally drank in the cold or the sweating stage of the paroxysm, (in both of which the thirst often demands liquids) may have produced the

* See Sennertus, lib. ii. cap. ix. p. 54. Itaque Græci auctores jubent in statu, cum febris acuta, sitis, inquietudo, cordis & arteriarum pulsatio est vehementissima, ægerque avidissime eam expetit, aquam frigidam copiose exhibere.—

* * *

In intermittentibus febribus vero aquæ frigidæ potus nunquam convenit.

the doubts which some have expressed in regard to its use in intermittents, and the interdiction which in such cases, others have pronounced against it. We may explain also from the same considerations, why in the accounts that have been handed down to us of injurious effects from the use of cold drink in fevers, the greater part of the cases have been intermittents.

The instances however that are recorded of the fatal effects of large draughts of cold liquids, have more frequently occurred after severe exercise and fatigue, than even in intermittent fever. The cause of this is obvious—the heat præternaturally accumulated by exercise, is held with less tenacity than even the heat in intermittents. It is dissipated by the perspirations that exercise occasions, and is speedily lost, when to profuse perspiration is added a state of rest. It is then that a large draught of cold liquid is especially dangerous. But while the præternatural heat is sustained by continued exertion, cold liquids may be taken in moderate quantities without producing any injurious effects. They may even I apprehend be drank copiously without producing suddenly the fatal effects already described—but in copious draughts they are found oppressive to the stomach during exercise, and they excite languor, nausea, and sometimes vomiting, as
I have

I have had occasion to observe. In the narrative already mentioned of the march of Alexander's army through the desert country of the Sogdiani, it is related by the historian, that a few of the soldiers, by the advice of the natives, had provided themselves with water, of which under their burning thirst they drank immoderately. The consequence was that they became heavy, feeble, and unable to support their arms, and this state of oppression was succeeded by severe vomiting. *Graves deinde avidè hausto humore, non sustinere arma; non ingredi poterant; et feliciores videbantur, quos aqua defecerat, quum ipsi sine modo infusam vomitu coegerentur egerere.* 2. *Curtius, lib. vii. cap. 5.* The water thus wasted, or worse than wasted, might have been used to advantage in wetting, from time to time, the garment next the skin. Thus the oppression of its weight on the stomach would have been prevented, and the surface of the body being kept cool by constant evaporation, the heat of the system would have been moderated, and the thirst alleviated.

If this account of the circumstances under which cold drink after severe exercise proves injurious, be just, the precautions of Dr. Rush to those who *will* drink in such circumstances, are founded on error. By abstracting a part of the præternatural heat of the body before drinking, the danger is not diminished,

nished, but greatly increased. This enlightened physician will excuse these observations, drawn from me by a consideration of the importance of the subject, but accompanied by sentiments of sincere esteem and respect.

If the effects of cold water used internally under severe exercise, are not entirely analogous to the effects produced by its affusion on the skin;—the difference will be easily understood, by those who consider, that where a quantity of water is swallowed, besides the influence of the cold, the stomach sustains a load, from the weight and the bulk of the liquid, particularly oppressive under constant action and agitation of the voluntary muscles, from which the surface moistened with water is entirely free; and on the other hand, that the evaporation from the surface promoted by the immediate access of the external air, must operate more directly in cooling the body, and particularly in counteracting the burning rays of the sun, than water taken into the stomach. With these exceptions, the operation of cold liquids on the stomach and on the surface of the body are analogous in the case of præternatural heat produced by bodily exertion, as in all other cases of præternatural heat. As it is safe to drink cold water in proportion as the heat from exercise is great and steady, so also is it safe according to this ratio, to pour it on the surface, or to immerse the body in the cold bath.

In the earlier stages of exercise, before profuse perspiration has dissipated the heat, and fatigue debilitated the living power, nothing is more safe, according to my experience, than the cold bath. This is so true, that I have for some years constantly directed infirm persons to use such a degree of exercise before immersion, as may produce some increased action of the vascular system, with some increase of heat; and thus secure a force of re-action under the shock, which otherwise might not always take place. The popular opinion that it is safest to go perfectly cool into the water, is founded on erroneous notions, and sometimes productive of injurious consequences. Thus, persons heated and beginning to perspire, often think it necessary to wait on the edge of the bath until they are perfectly cooled; and then plunging into the water, feel a sudden chillness that is alarming and dangerous. In such cases the injury is generally imputed to going into the water too warm, whereas in truth it arises from going in too cold.*

O

But

* Dr. A. Munro Drummond, in his inaugural dissertation, "*De Febris Arcendis*," the only specimen left of his admirable talents, speaking of the effects of the cold bath as a preventative against the action of contagion, observes, "Nec
 " frigida protinus fugienda vel calida temperanda, quamvis
 " cutis pallida aliquantisper fiat vel leviter aliquis inhorruerit.
 " Si exercitatio antecedit quæ citra lassitudinem & sudorem
 " est, hæc facile evitari posse experiendo didici: et fere, si
 " nil aliud obstat, quo ante quisque plus incalueret quam
 " aquam intraverit, eo calidior emerget.

But though it be perfectly safe to go into the cold bath in the earlier stages of exercise, nothing is more dangerous than this practice after exercise has produced profuse perspiration, and terminated in languor and fatigue. Because, as has already been repeated more than once, in such circumstances, the heat is not only sinking rapidly, but the system parts more easily with the portion that remains.

This account of the operation of the cold bath will explain some circumstances very generally mentioned by writers on the effects of cold on the human body, and hitherto not properly accounted for. That the Roman youth in the heat of their exercise in the *Campus Martius*, frequently plunged into the Tyber, is a fact universally known; they found in this practice a high enjoyment, and they believed it conducive to health, and more especially to sleep. On the other hand various relations may be cited of the injurious effects of an apparently similar practice; the most remarkable of which is the case of Alexander the Great, when covered with dust and sweat, he threw himself into the Cydnus, and was seized with a disease, of which he nearly perished; one of the best authenticated facts in ancient history.

In the dissertation *De febris arcendis*, by Dr.

A.

A. Munro Drummond, already quoted, these facts are brought together in the following words.—*Alexander, quondam diei fervidissimo tempore, liquore fluminis invitatus, vix dum in Cydnum amnem descenderat, cum gravi inde morbo implicitus est. Romana juventus, post quotidianas in Campo Martio exercitationes, pulvere simul & sudore perfusa, Tyberi impune lassitudinem cursus natandi labore deposuit. Mali nimirum adsuétude duramur in his sicut in cæteris rebus omnibus. Thef. Med. vol. iii. p. 154.* Doubtless the influence of habit has a considerable share in regulating the effects of cold on the human body; but the circumstances just mentioned seem capable of an explanation on other principles.

On the *Campus Martius*, the exercises of the Roman youth were carried on with all the vehemence of emulation. Swimming formed a part of those exercises*, and generally terminated the foot-race. The youthful candidates in this exercise directed their course towards the banks of the river, and plunged

* See *Horace, lib. i. Ode 8.* Where the poet, after questioning Lydia why her lover neglects his accustomed exercises on the *Campus Martius*, among other particulars asks,

Cur timet flavum Tiberim tangere?

See *Vigétius, lib. i. cap. x.*

See also *Heiron. Mercur. lib. iii. cap. 14.*

plunged headlong into the stream. Sometimes the contention did not terminate till the river was once, or perhaps twice swam across. Hence it will easily be seen, that they were accustomed to immerse themselves in the water in the very fervor of their exertions, when the heat was præternaturally great ; and not after the body was cooled by profuse perspirations, or exhausted by long continued fatigue. In this situation the practice was safe ; without taking into consideration, that the persons concerned were in the flower of life, fortified by early habits, and partly defended from the shock of immersion by the inunctions which seem to have been generally used among the Romans, before the cold, and after the hot bath ; and which were particularly

* See *Horace, Satyr, lib. ii. Sat. 1.*

——— *Ter uncti*

Transnante Tiberim, sommo quibus est opus alto.

The subject of the ancient unguents is treated of by *Hieronymus mercurialis, de arte Gymnastica, lib. i. cap. x.*

The same author, (*lib. iii. cap. 14*) speaking of swimming so much in estimation among the ancients, observes, *quo pacto vero similis exercitatio perageretur, tanquam res vulgatissima silentio præterita fuit fere ab omnibus, uno excepto Antyllo, qui nataturos prius moderate unxisse, et frictione corpora præcalfecisse deinde e vestigio in aquam se projicere debere voluit, quasi omnes sanitatis gratia natantes eas regulas observarent.*

This method of previously anointing the body, might be recommended to our modern swimmers, not only as defending them from the shock of immersion, but as enabling them to glide through the water with less effort.

ticularly employed by the *athletæ* of Greece and Rome in all their exercifes. It was the more safe, becaufe the ftream of the *yellow Tiber* being comparatively fcanty and flow, its waters fpeedily received the influence of the fun, and acquired the temperature of the atmofphere. Where the air and the water are of the fame temperature, the rarer element prepares the body for the contact of that which is more denfe.

The circumftances under which Alexander plunged into the Cydnus, were different in many effential points. He had marched at the head of his troops to feize a pafs in Mount Taurus, neceffary to facilitate his paffage into Cilicia. After having fecured his object, he defcended from his elevated ftation, through a road, difficult and full of defiles, to the city of Tarfus, which was fituated at the bottom of the mountains. His whole march, which probably continued feveral days, was attended by extraordinary exertion, not from the nature of the country only, but alfo from the preffure of circumftances. In afcending the heights, he had to haften forwards, leaft the enemy fhould pre-occupy the pafs by which Cilicia muft be entered. In defcending from the immense elevation he had reached, he was ftimulated by the defire of faving the city of Tarfus, the capital of the province, which the Perfians threatened to confume by fire. In both of thefe enterprizes

enterprizes Alexander was successful. It was at the close of this extraordinary march, according to the testimony of all the historians, that the conqueror, advancing into Tarsus at the head of his troops, covered with dust and sweat, and exhausted with long-continued toil, stripped himself in the sight of his army, and plunged into the pure and cold waters of the Cydnus, which ran through the city. The symptoms that followed, are described with sufficient minuteness and precision. *Vixque ingressi subito horrore artus rigere cœperunt: pallor inde suffusus est, et totum propemodum corpus vitalis calor reliquit. Exspiranti similem ministri manu excipiunt, nec satis compotem mentis in tabernaculum deferunt.* *Q. Curtii, lib. iii. cap. v.* From the length and difficulty of the march, it is natural to suppose that Alexander must have been cooled as well as debilitated by extraordinary perspiration and fatigue, and under such circumstances, immersion in the cold and rapid Cydnus, was followed by the consequences which we should expect from the principles already laid down.*

IN

* If an objection be urged against our laying much weight on a relation taken from a period of history so remote, I reply, that I am far from resting any part of my conclusion upon it, having the firmer foundation of actual observation. But as this adventure of Alexander is mentioned by almost every writer on the effects of cold on the living system, to exemplify

In his essay on swimming, Franklin makes the following observation : “ During the great heats of
 “ summer there is no danger in bathing, however
 “ warm we may be, in rivers which have been
 “ thoroughly warmed by the sun. But to throw
 “ ourselves into cold spring water, when the body
 “ has

the danger of its being applied when the body is præternaturally heated, it seemed proper to shew, that it is capable of a more just and natural explanation.

In regard however to the fact itself, of Alexander having suffered from bathing in the Cydnus, it might be easily shewn, that we cannot reject it without denying entirely the weight of historical evidence. 1. This exploit was performed before a host of witnesses, by some of whom it is recorded, and it is mentioned by all the historians. 2. The circumstances that preceded it, and the consequences that followed it, are also recorded with great minuteness, and form a natural chain of events. 3. The act itself of stripping before his army, and springing into the Cydnus, may have an air of improbability; but is not so inconsistent with Greek, as with modern manners; and however unlike the dignity of great commanders in our own days, is perfectly characteristic of Alexander—of that ardent and daring temper, and of that buoyant imagination, which were equally regardless of danger and decorum; a temperament, that joined to extraordinary talents, attached his soldiers to him in so singular a degree, and which in the æra of the world in which he lived, was calculated to carry him to the astonishing elevation which he attained. 4. The exploit itself was of a nature not likely to be feigned; and the issue of it had nothing marvellous—there was nothing in any part

“ has been heated by exercise in the sun, is an im-
 “ prudence which may prove fatal. I once knew an
 “ instance of four young men, who having worked
 “ at harvest in the heat of the day, with a view of
 “ refreshing themselves, plunged into a spring of
 “ cold water ; two died on the spot, a third the
 “ next

of it, by which the son of Ammon, or his followers, could be in any way gratified.

The effects of Alexander's bathing in the Cydnus, gave a celebrity to this river which it otherwise would not have acquired. I have called it cold and rapid, meaning to speak of it comparatively with the Tiber. The Cydnus was one of the principle streams that descended from Mount Taurus, (*Strab. xiv. p. 462.*) at the bottom of which stood the city of Tarsus. From the great elevation of the mountain, the Cydnus must in this situation have been rapid and cold ; and colder because rapid. From the same cause it would be easy to shew (if it were at all to the purpose) that the transparency ascribed to its waters was probably ascribed justly. Quintus Curtius imputes its coldness to the rays of the sun being excluded by the shadyness of its banks : the more accurate and philosophic Arrian, mentions as the cause, the loftiness of the mountains whence its fountains descended. Quintus Curtius speaks of it as gliding through a gentle descent, (*leni tractu e fontibus labens,*) and Tibullus of its silent and placid stream.

*At te, Cydne, canam, tacitis qui leniter undis,
 Cæruleus placidis per vada serpis aquis.*

Strabo, on the other hand, (*lib. xiv. 392.*) mentions its current as most rapid, and this to some of the scholiasts seems a contradiction. It is not so in reality. If the declivity was uniform, the current might be at once swift and

“ next morning, and the fourth recovered with
 “ great difficulty. A copious draught of cold wa-
 “ ter in the same circumstances, is often attended
 “ with the same effect in North America.” The
 authority of the American Bacon is of great weight
 in medicine, as in every branch of science ; and par-
 ticularly in what respects immersion in water ; for
 doubtless he spent more time in this element than
 any philosopher of modern days. It may however
 be easily supposed that he adopted the commonly
 received opinion, that the injury arose from the per-
 sons in question going in *when hot*, instead of from
 going in *when cooling, after having been heated* ; to
 which last circumstance, it can hardly be doubted,
 that the fatal accident he relates, was to be imputed.
 It is not however to be denied, that the difference
 between the temperature of spring and river water, at

P

certain

silent. The river Moffat (the source of the Annan) descends
 from the mountain of Hartfell, by a declination, which in
 three thousand yards, amounts to two hundred and thirty feet,
 with such uniformity, that in the course of some miles there
 is hardly a single ripple. To finish a digression by far too
 long, but which may relieve the dryness of a professional sub-
 ject, it may be observed, that our account of the illness of
 Alexander receives confirmation from a difference among
 the historians respecting its causes ; some imputing it to his
 having bathed in the Cydnus, and others to his previous fatigue :
 at the distance of two thousand two hundred years, it may be
 clearly determined that both circumstances combined in pro-
 ducing his disease.

certain seasons of the year, will make a great difference (in any circumstances of the body) in the consequences of immersion. Springs which issue copiously from the earth, are, as we know both from reasoning and observation, nearly of the temperature of the earth at some distance under the surface; and this temperature, when unaffected by chemical changes, is probably (for actual experiment is not yet sufficiently extensive to affirm the proposition universally) of the mean heat of the atmosphere, taking the year round, under which it lies.* On the other hand, rivers even of the largest size, acquire at a certain distance from their source, the temperature of the earth, and rise towards the end of summer, to nearly the highest degree of the summer heat.†

In

* See Dr John Hunter's valuable paper on this subject, in the Philosophical Transactions for 1788, p. 53.

† Thus the Mersey at Liverpool, in the middle of the tide, is in the month of August from 65° to 69° . On the 20th of August 1795, it rose in the middle of the tide to 70° , and under the rocks at High Park, the mercury stood on the 21st, at high water, at 72° .—In the air, at the same time, it was at 77° .—The weather had been uncommonly warm for fourteen days before, and 72° was probably the average heat of that fortnight. It seems to be this average that the tide of the Mersey acquires. Observations made in our different æstuaries every week, would give the actual and the comparative heat of the seasons (on the coast at least) with much more accuracy than observations in the atmosphere.

In countries where the temperature of the seasons has little variation, the difference between the heat of the rivers and springs will be very inconsiderable. That this is the case in Jamaica, we know from the experiments of Dr. Hunter; but in Pennsylvania, to which it is probable that Dr Franklin's observations more particularly refer, this difference at certain seasons of the year must be very great, the difference of the temperature of the seasons being so very considerable. The rivers of Pennsylvania in the latter end of summer, are probably nearly as warm as the Buxton bath, or from 78° to 82° ; and in the Buxton bath there is reason to believe, that even after considerable fatigue, the chill of immersion is too inconsiderable to produce much hazard. The springs of Pennsylvania, and more especially the deep funk wells, if they retain the subterranean temperature (the medium heat of the seasons) will probably be in the heat of summer and autumn, twenty or twenty-five degrees cooler than the rivers or the atmosphere*; a difference capable of producing, in the situation of the body which renders the application of cold dangerous, the most serious effects. It is doubtless owing to the great comparative coldness

* The wells at New York are from 54° to 56° , according to Dr. Routh. See *Philosophical Transactions* for 1788, p. 61.

ness of their springs and wells, that fatal accidents from drinking cold water, and bathing in cold springs, are so frequent in Pennsylvania. In the West Indies, where water is seldom to be procured below 77° , such accidents, if they ever occur, are very rare.

I shall close my remarks on the circumstances which render the cold bath safe or hazardous after exercise, with the following narrative :—

On the first of September, 1778, two students of medicine at Edinburgh, set out on foot on a journey, a considerable part of which lay along one of the rivers of Scotland. They started by sunrise, and proceeded with alacrity in the cool of the morning. At the end of eight miles, they breakfasted, rested for an hour, and then resumed their journey. The day grew warm as it advanced, and after a march of eight miles more, they arrived heated, but not fatigued, on the banks of the river abovementioned, about eleven in the forenoon.—Urged by the fervor of the day, and tempted by the beauty of the stream, they stripped instantly, and threw themselves into the river—The utmost refreshment followed, and when they retired to the neighbouring inn, this was succeeded by a disposition to sleep, which they indulged. In the afternoon they proceeded, and travelling sixteen miles farther

farther at a single stretch, arrived at the inn where they were to sleep, a little after sun-set.—The afternoon had been warm, and they perspired profusely ; but the evening was temperate and rather cool. They had travelled for some miles slowly, and arrived at the end of their journey, stiffened and wearied with their exercise.

The refreshment which they had experienced in the morning from bathing, tempted however one of them to repeat the experiment, and he descended perfectly cool into the same river, expecting to relax his limbs in the water, and afterwards to enjoy profound sleep. The consequences were very different. The Tweed, which was so refreshing in the morning, now felt extraordinarily cold ; and he left the water hastily. No genial glow succeeded, but a feverish chill remained for some time, with small frequent pulse, and flying pains over the body. Warm liquids and frictions brought on at length considerable heat, and towards morning perspiration and sleep followed. Next day about noon they proceeded on foot, but the traveller who had bathed was extremely feeble ; and though they had to perform a journey of a single stage only, yet as some part of it was difficult and mountainous, he was obliged to take the assistance of a carriage which overtook them on the road. It was several days before he recovered his usual vigour.

gour. This relation will not I hope be deemed of the less authority, because it is given by the person who suffered by his imprudence*. It is unnecessary to point out the application of these incidents to the doctrines already laid down.

It seems to be a general truth, that from whatever cause the heat of the body is increased, in proportion to this increase (provided no local disease has occurred) is the safety with which cold may be applied. In the celebrated experiments of Dr. Fordyce, Sir Charles Blagden, and others, of which an account is given in the Transactions of the Royal Society, *vol. lxx. p. 111*, and 484, it is repeatedly mentioned, that these gentlemen passed from a room heated to 200°. and upwards, into the cold air, with perfect safety. “ During the whole day,” says Sir Charles Blagden, “ we passed out of the heated room,”
(where

* Those who know the road from Edinburgh to Moffat will be at no loss to mark the different stages of this adventure.

I may here observe, that similar illnesses to the above occur frequently, from the imprudence of the country people, (the Boltoneers, as they are called) who make an annual visit to the river below Liverpool, for the purpose of bathing.—In such cases, I have found the disease that followed, was not inflammatory, as might be supposed, but rather a fever of debility, as in the instance detailed.

(where the temperature of the air seems to have been 240° , and sometimes 260°) “ after every experiment, immediately into the cold air, without any precaution ; after exposing our naked bodies to the heat, and sweating most violently, we instantly went into a cold room, and staid there, even some minutes before we began to dress ; yet no one received the least injury.” *Ibid.* p. 494.

The freedom from injury, and even from inconvenience, which these gentlemen experienced, depended on the increased heat of the body, and the increased action of the arterial system.— Had they continued exposed naked to the cold air till the heat sunk as low as its natural standard, and the heart and arteries subsided into their usual state of action, their situation would have been very hazardous.

In similar experiments repeated at Liverpool, of which a detail is given by Dr. Dobson, in the same volume of the Philosophical Transactions, p. 463, the gentlemen concerned, passed from the heated room into the cold air, with equal impunity. My friend Mr. Park assures me, that after remaining some time in the stove, where the heat was as high as 202° , he went into the external air without a great coat, or any other than his usual clothing, during

ing a hard frost, and perceived neither injury nor inconvenience.

In many manufactures, the persons employed are exposed to extraordinary degrees of heat, particularly in the manufacture of glass. Such persons, guided by nature, often endeavour to obtain relief, by exposing themselves to degrees of cold, which on the commonly received opinions, would in their situation appear extremely dangerous. Thus at Glasgow in the spring of the year 1780, I learnt, that it was common for the workmen in the glass manufactory, after enduring for some time the consuming heat of their furnaces, to plunge into the Clyde; a practice which they found in no respect injurious.

A great variety of the phenomena respecting the influence of cold on the living body, receive an easy explanation by attending to the principle already mentioned. Thus, after the heat of the body is increased two or three degrees in the hot bath, it is not only safe, but refreshing, to plunge into the cold bath, as I have repeatedly experienced. A practice of this kind prevails, as is well known, in Russia, where it is common, after remaining some time in the hot bath, to roll naked in the snow, returning to the warm bath as before. The Russian

hot

hot baths vary from $106\frac{1}{2}^{\circ}$ to 116° of Fahr.* and I find by experiment that the actual heat of the living body is increased in the hot bath (unless under particular circumstances afterwards to be explained) when the temperature is no higher than 100° . We may therefore safely conclude, that in making these singular transitions, the heat of the Russian is in the first instance increased beyond the natural standard; and it is to this increase that the safety, as well as the agreeableness of the practice is to be attributed.

It is in this way that we must account for the safety of a practice which prevailed at Rome under the first of the emperors. After the overthrow of the republic, the Romans consoled themselves for the loss of their freedom, by a more unbounded indulgence than ever in those sensual gratifications which had led to their fall. Of these, the pleasures of the bath formed a distinguished part, they sought every means of heightening and diversifying them, and connected them with other epicurean enjoyments. The mild and

Q

tepid

* See *Dissert. physica experimentalis de calore Animalium*, by J. A. Braun, in the *Nov. Comment. Academiæ Scientiarum Imperialis Petropolitanae*, vol. xiii. The Abbé Chappe D'Auteroche says, the Russian baths are as high as 60° of Reaumer, (160° of Fahrenheit) *Philosophical Transactions*, vol. lxxv. p. 112, but this is incredible, unless he speaks of vapour baths.

tepid immersion of the Greeks no longer satisfied them; they heated their baths to the utmost pitch of endurance; and as they rose reeking from their surface, vessels full of cold water were dashed over their naked bodies, as a high gratification in itself, and a means of stimulating the senses to gratifications still higher. Such practices could not however be continued without injury: In the bagnios of *Imperial* Rome, the firm republican melted down into a slave; the powers of his mind became enfeebled, the vigour of his frame decayed, and he lost for ever the bold impressions of freedom and virtue*. It

* This subject might lead to digressions, which my limited plan does not admit. I shall content myself with a few observations. Though private baths were in use in Rome from the earliest periods of their history, yet the system of public hot baths did not, it is understood, commence till the days of Augustus. According to Dion, Mæcenæ introduced it.—Agrippa followed his example—It was soon carried to an astonishing height, and the construction of baths where the people might be accommodated *gratis*, was an established and a successful method of gaining their affections. The extraordinary expense and magnificence of those structures are well known—the remains of the baths of Caracalla and Dioclesian, testify their grandeur in our own days. According to Fabricius, there were 856 public baths at Rome, and some of these were large enough to contain at once 1800 persons. The *rage* for hot bathing in Rome, under the first Emperors, exceeded all bounds.

In regard to the exact temperature of their baths, as the thermometer was not known to the ancients, we cannot speak precisely. We have however the authority of Seneca and Plutarch for saying, that the bath of the Greeks was of a

It was supposed by Dr. Cullen, who paid much attention to the operation of temperature on the living system, that in all sudden changes from a higher to a lower temperature, a sensation of cold takes place, even though the lowest point of change be such as when permanent, becomes oppressive by its heat. Thus that a change of the external air from 90° to 85° , is accompanied by a sensation of cold, though this speedily goes off, and is succeeded by a sensation of heat, if the temperature of 85°

be

moderate temperature; and as Alexander found refreshment in the bath in the burning fever of which he died, it probably did not exceed 93° , or at most 96° , of Fahrenheit. But at Rome, in the days of Seneca, the hottest baths were most in estimation, and those of Nero seem to have exceeded all others in heat—We may infer this from one of the best of Martial's epigrams.

Si temperari balneum cupis fervens

Faustine, quod vix Julianus intraret,

Roga, lavetur, Rhetorem Sabineum,

Neronianas is refrigerat thermas.

Lib. iii. 25.

A person was employed at one time to regulate the heat of the baths, but in Seneca's days this had fallen into disuse. (*Epist.* 37.) This rage for bathing was checked by Adrian, and regulated by Severus. The fashion of heating the baths to this extraordinary degree did not continue—We have the authority of Galen, who flourished soon after Seneca and Plutarch, that in his days very hot baths were no longer in use. See *Hier. Mercur. lib. i. cap. 10.*

be continued†. This observation ought, I think, to be restricted to degrees of heat inferior to that of the human body, for it does not seem true when applied to superior degrees of heat. If, for instance, a person is immersed in the bath heated to 104° , and a quantity of cold water be speedily admitted, so as to lower it to 98° , a sensation of a very agreeable nature takes place, not however to be denominated cold—Where the actual heat of the body has been raised, and the circulation accelerated, a much greater reduction of the temperature of the bath must take place before it becomes cold to the sensations. In the same manner a person under the steady heat of fever, (102° to 106°) suddenly throwing off his bed-clothes, and exposing himself naked to the external air, does not perceive it cold, but merely cool, a sensation too which goes speedily off. It is true there are some exceptions to this in fever, of which I have given one instance in detail. (*See page 46.*)

The manner in which our sensations are affected by changes of temperature, is a subject of importance

† See *Dissert. Med. Inaug. De frigore*, by A. Cullen, published at Edinburgh 1780, (p. 8 and 9) which contains the best general view of the doctrines of the author's celebrated father on the operations of cold.

tance, as well as of difficulty, for without a more precise knowledge of this, the action of temperature on life cannot be understood. In the state of health, I believe, however, that our sensations of heat and cold may be reduced to general principles.—But in certain of the Neuroses, as well as of the Pyrexiaë, these sensations are much perverted, and even in health they are much influenced by constitution, habit, and situation. To enlarge on this point would however lead into the general subject of the operation of cold on the living system, for which I am not sufficiently prepared, and which I studiously avoid.

CHAP.

CHAP. XIII.

*Use of the cold Bath in convulsive Diseases—In
Insanity—General Remarks.*

IT might now be expected that some observations should be offered on the operation of cold water applied to the surface, or the stomach, in the various cases that have been related; but besides that it is advisable that the reader should form his conclusions in a great measure for himself, we shall be better prepared for such general reasonings as may suggest themselves, when we have observed the operation of the cold bath on convulsive affections, and on other diseases, classed by Dr. Darwin under the same general title, the *diseases of volition**.—To save repetition, the reader is here supposed to have perused the paper in the Appendix, N^o. I, of which he will consider the following observations as forming a sequel.

Since the original publication of this paper, I have seen three different cases of tetanus arising
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* The third class of Dr. Darwin.—See *Zoonomia*, vol. ii.

from wounds, in which the affusion of cold water was employed alone, and in all of these the disease terminated fatally. I have seen a fourth case in which the affusion of cold water was conjoined with the liberal use of wine and opium, where the patient recovered. And I have seen two other cases in which the cure was trusted to wine and opium alone, in one of which the issue was fortunate, in the other unfortunate.

It is however proper to observe in the three first cases, the disease was far advanced, having resisted other powerful remedies before the patients fell under my care; and that as the power of deglutition was nearly lost, the affusion of cold water was employed under desperate circumstances, as a *dernier* resort. It was besides impossible to use this remedy to any extent, for the powers of life were too much exhausted to sustain the continued application, or the frequent repetition, of so violent a stimulus.—There is also in the advanced stages of tetanus, an objection to the use of a remedy that requires much change of posture. In such cases, every exertion of the will on the voluntary muscles has a tendency to induce a general convulsion.—From a consideration of all these circumstances, and from more extensive experience, I should now be disinclined to the use of the cold bath in any of its forms, in the symptomatic tetanus, unless in the
earlier

earlier stages of the disease, when the vigour is less impaired, and the convulsive actions less firmly catenated.

The practice, first introduced by Dr. Rush, of giving wine in large quantities in tetanus, of which a successful case is detailed in the paper already mentioned*, seems to me to be fully confirmed, as the most efficacious treatment of this very dangerous disease. The wine ought however to be combined with opium in considerably larger doses, according to my later experience, than in the case already referred to.

In the Appendix, N^o. I, several cases are given in which the cold bath was used in other convulsive disorders. This remedy I have now employed in various diseases of this class for fourteen years, and on the whole, it has been attended with considerable success.—One conclusion, of rather a singular nature, was drawn from those cases, which my subsequent experience has uniformly corroborated :—“ That the efficacy of the cold bath in convulsive disorders, is much promoted by its being employed during the presence of convulsion* ;” or, as I
would

* See Appendix, N^o. I. p. 9.

would now express it, *that the chief benefit derived from the cold bath in convulsive diseases, depends on its being used in the paroxysm of convulsion; that its efficacy consists in resolving or abating the paroxysm; and that when this effect is produced, the return of the paroxysm is greatly retarded, if not entirely prevented.* To this singular fact, for which I am unable to account, I invite the attention of physiologists: it may throw some light on the laws of association; a subject which Dr. Darwin has shewn to be of such vast importance in the living system, and which hitherto has been so little understood. The following case, taken from the records of our Infirmary practice, is in many respects curious, and will serve to corroborate the position just laid down.

John Westmore, aged 22, was admitted into the Infirmary on the 11th of October 1792. In consequence of a fright, he had been seized with fits two months before, which now recurred several times every day, of various duration, from two minutes to an hour. During these his consciousness was wholly abolished. These fits occurred without warning, and were peculiar in their appearance. At first the muscles of one side were strongly retracted, then those of the other alternately; and then the muscles of both sides acting together, the whole trunk of the body was drawn upwards to the head; this action resembling very exactly that of the victim

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of the law, suspended in the agonies of death. His faculties of mind did not seem as yet impaired, nor the animal functions much disturbed. No medicines were ordered for this patient, but a bucket-full of cold water was directed to be thrown over him, the instant of the accession of the fit. Some circumstances prevented this being done for a few days, during which he went into the cold bath daily, when the fits were off him, and with seeming advantage; the number of paroxysms being reduced from eight or ten in the twenty-four hours, to two or three. At length he was thrown into the cold bath on the instant of the accession of one of his fits, which was speedily terminated, and from this time forth he had no return for fourteen days, when he was discharged as cured. Westmore continued free of complaint till the beginning of February following, when his fits returned. He was re-admitted on the 24th of that month, and at this time his fits recurred six or seven times in the day. He was again directed to use the cold bath daily—and to have a bucket of water thrown over him on the accession of every fit. By this practice he speedily recovered, and since that time the disease has never returned. He is now, (*May 1797*) in perfect health.

I have used the cold bath during the paroxysm of epilepsy in various instances, but in general without

without the patient being roused to consciousness or sensation, and without advantage. In one case of this disease, which occurred in the hospital practice, the paroxysm returned periodically every afternoon. In this instance a cure was effected, by applying a cataplasm, formed chiefly of tobacco, to the scrobiculus cordis, about half an hour before the expected return, by which a powerful impression on the system was produced, and the paroxysm of epilepsy prevented. This practice repeated several days at the expected periods, destroyed the diseased catenation, and the cure was permanent.—In this mode of application, the peculiar effects of tobacco on the nervous system is speedily produced, and it is perhaps the safest way of exciting them; because the application can be discontinued at pleasure; an advantage of great importance in the use of so deleterious a medicine, and which cannot be obtained when it is thrown into the stomach or rectum. I was induced to use tobacco on this occasion, from having observed it to succeed in the cure of obstinate intermittents, when applied in the same manner, previous to the expected accession of the paroxysm. It is however an agent so powerful and so debilitating, that I do not willingly employ it; and it is obvious that it can only be used in convulsive diseases, when their returns are periodical.

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In spasmodic diseases which rise into general convulsions, I have seen these convulsions rendered less frequent, and for a time seemingly diminished in violence, by medicines used during the intervals; but seldom effectually cured, except by means used during the act of convulsion, at the instant of its accession, or at the period of its expected return. Of the medicines employed during the intervals of epilepsy, the oxyd of zinc seems to me to have some efficacy; but the *digitalis purpurea* still more.—In consequence of its powerful influence, I have used this last medicine in many cases of epilepsy, both in private and hospital practice; of twelve of which I have preserved particular registers. *In every one of these*, it diminished the number of paroxysms, and the intervals were so much lengthened, that in several instances we entertained hopes of a cure. It did not however finally succeed in any one of them; and when, as the constitution became accustomed to its influence, the fits began to return, and we increased the dose of the medicine, its deleterious qualities, so well described by Dr. Withering, presented a danger greater than that of the disease, and obliged us to abandon it. On one occasion, we had an opportunity of observing, that pushing this medicine to the utmost extremity did not effect a cure. A female patient took it so rashly as to produce the utmost danger of her life. Her pulse sunk to thirty-two in the minute, her heat

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at the axilla to 89° ;—her sight failed, her respiration became laborious, and incessant vomitings threatened immediate dissolution. She was however recovered by the warm bath and opiate clysters, but as her strength was restored the epileptic paroxysms returned.

In the Appendix, N^o. I, p. 17, I have mentioned the connexion between convulsive diseases and insanity, and conjectured that the same principles are in many cases applicable to the treatment of both. This connexion has been since explained, and the subject very happily illustrated by Dr. Darwin, (*Zoonomia*, vol. ii. c. 3.) who has arranged the whole of these diseases under one class, and thrown a new light on one of the most curious and obscure parts of pathology. The following case taken from the register of our Asylum, may serve as a new proof of this connexion.

June 2, 1796. L. I. aged 32, a man of very irregular habits of life, was admitted into the Asylum, in a state of furious insanity. His disease was supposed to have been brought on by excessive drinking. As cases of insanity, including the whole method of cure, are seldom recorded, I will give this in detail.

Very powerful methods of coercion were required

ed in the first instance, and the bowels were afterwards cleared by a saline purgative. At night he took eighty drops of laudanum, which produced imperfect sleep, and in the morning following he was more wild than ever.

Having in some cases of insanity, found very extraordinary effects from such doses of opium as induced profound sleep, I directed that five grains of this medicine should be given every four hours, till sleep succeeded. Next day (4th June) it was reported to me, that he had taken twenty-seven grains of opium in the twenty-four hours. From the first five grains there was no apparent effect; after the second, he slept an hour and a half; after the third, three hours. Though the medicine had been twice repeated in doses of six grains each, he had had no return of sleep—He appeared wild, agitated, and feeble, rather in a state of alarm than of fury. His pulse 100 and soft, with gentle and general perspiration.

It seemed not prudent to push the medicine farther, but having often in cases of this nature observed the soporific effects of opium to come on, many hours after the medicine had been discontinued, he was directed to have milk as his food, and to abstain from medicines of every kind for twenty-four hours.

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The report of the 5th is as follows: " He remained in a perpetual state of alarm till eight o'clock last night; after that hour he slept, but not soundly. He has taken nine pints of milk in all, having been very thirsty. It agreed with him till ten this forenoon, when he vomited considerably. Since that time he has been more tranquil and feeble." In this state, I directed all medicines to be discontinued, and ordered him a pint of wine, with two pints of gruel daily, and such solid food as his stomach could receive and digest. This plan was continued till the 17th, when his strength was considerably restored, but his insanity as violent as ever. It was now directed that he should go daily into the bath heated to 95° , and that he should take half an ounce of the infusion of the digitalis (according to the form of Dr. Withering) thrice a day.

He continued on this plan with little variation till the 29th, the report of that day is as follows: " Till the 25th the digitalis produced no obvious effect. On that day sickness came on and his pulse was hardly perceptible. The digitalis was therefore omitted. He has been regularly in the bath, and while in it, was once seized with *diliquium animi*, but the mental derangement did not afterwards abate. His pulse is now about 94, feeble and irregular.— He is a good deal emaciated, but more fierce than ever; he talks incessantly, with the utmost incoherence,

rence, and the affociation of his ideas seems wholly perverted."

In this state I ordered the digitalis and the tepid bath to be discontinued, as well as all other medicine. I directed a nutritious diet, but without wine or opium, and placed him in a situation to be as little as possible exposed to external impressions. For three days there was little change in his situation—his appetite improved, and he perspired much. At the end of this period, he had suddenly a lucid interval of several hours duration, but before I could witness it, he was again become furious.

At this time (the 16th *July*) I directed that he should take three drachms of peruvian bark, half a drachm of vitriolated iron, and the same quantity of aromatic powder, in the form of an electuary, daily; and that twice every day, he should be subjected to the tepid affusion for a minute or two at a time, the water being poured gently over him of the heat of 88°.

The following is the report of the 16th *July*:
 "The tepid affusion was continued till the 14th, but without any tranquillizing effect; the other medicines have been given regularly. On the 9th he became calm and rational: and slept the following

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ing night for eleven hours profoundly; but started suddenly from this sleep, as wild and furious as ever. This state of mind continued twenty-four hours, when he again became tranquil, and continued so till he went to bed. He slept a few hours quietly, but awoke as before, under extreme agitation, and continued fierce and raving for twelve hours and upwards. Since this time, he has had an almost regular succession of paroxysms of insanity, and of tranquillity of mind, which divide his time pretty equally. In general, he goes to bed tranquil, and sleeps quietly till about three in the morning, when he awakes under the horror of some frightful dream; and this introduces his insanity and fury, which continue from ten to fourteen hours."

In this situation I ordered an emetic to be administered to him late in the evening, in hopes that it might interrupt this beginning catenation. Being disappointed, I had again recourse to an opiate at bed-time; and this also proving inefficacious, I directed that he should be awoke before the expected accession, and kept awake beyond its period of attack. By these means we disturbed the regularity of the alternations, but without any advantage; on the contrary, his lucid intervals became shorter in duration, and less complete.

Perplexed with these extremes, and keeping in
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mind the success of the cold bath in convulsive diseases, I ordered it to be tried on the present occasion. The insanity returning with great violence on the 21st, he was thrown headlong into the cold bath—He came out calm, and nearly rational, and this interval of reason continued for twenty-four hours. The same practice was directed to be repeated, as often as the state of insanity recurred.

The following is the report of the 30th : “ The direction has been followed, and on the morning of the 23d, he was again thrown into the cold bath in the height of his fury, as before. As he came out, he was thrown in again, and this was repeated five different times, till he could not leave the bath without assistance. He became perfectly calm and rational in the bath, and has remained so ever since.”

This patient continued with us for some time afterwards, bathing every other day, and taking the oxyd of zinc in small quantities. He never relapsed, and was discharged some time afterwards, in perfect health of body and mind.

It has been contended by Dr. Darwin, that as convulsive diseases arise from inordinate action in the muscles, so maniacal diseases arise from the same inordinate action in the organs of sense :—and

as the muscles and the organs of sense are the proper instruments of the will, the diseased actions of the one and the other are by him arranged as one class, under the title of *Diseases of Volition*. But in the system of Dr. Darwin, the actions of the organs of sense constitute our ideas ; a deranged action of these organs is therefore no other than what is usually denominated a derangement of mind ; in other words insanity*. As therefore convulsion and madness, may be considered as the same disease differently situated ; and as the seat of the disease may be changed from various causes, and extended through various sympathies and catenations, we have thus an explanation of that connexion between convulsive affections and insanity, and particularly of their alternations with each other, which have been observed in every period of medicine.— That several of the modes of treatment applicable to the one, are also applicable to the other, has long been known. The arnica montana, the oxyd of zinc, the digitalis purpurea, and opium, are medicines used equally in convulsions and in insanity. The case which has just been related extends

* If, as is generally believed, the motions of the organs of sense rather excite ideas than constitute them, the reasoning of Dr. Darwin is not affected by this change of terms— That madness is a disease of the body, cannot be disputed, whether we admit motions in the organ of sense or not.

extends this analogy, and is the more striking in this point of view, because the success of the cold bath was almost instantaneous, and occurred in the paroxysm of insanity, in the same manner as has been before observed of its operation in convulsion.

It is supposed by Dr. Darwin, that the motions excited by volition and by sensation, proceed in different directions; the first passing from the central parts of the system towards the superficies, the second from the superficies towards the central parts. Hence he concludes that they are opposed to, and mutually destructive of each other. To increase the force of voluntary actions must therefore be to lessen positively, as well as relatively, the actions that arise from sensation, and the converse of this proposition is equally true. Whatever faith we may give to the hypothesis of Dr. Darwin, his conclusion seems to be supported by a great variety of phenomena. That the higher degrees of volition and sensation are incompatible with each other, is a truth of great importance in every part of the science of life, whether moral or physical*. It was the doctrine of
another

* The reader who is not already acquainted with this part of Zoonomia, will not be able to understand how convulsions, which in common language are considered as involuntary, are classed as diseases of volition. He is therefore referred to the work in question for a full explanation. In the mean time we may observe that Dr. Darwin considers all mo-

another great physiologist (whose praise will now be heard with approbation, since he is beyond the reach of praise) “that no two actions can take place in the same constitution, nor in the same part at the same time;”* and though he applied this doctrine chiefly to show the incompatibility of different diseased actions with each other, yet it seems applicable also to explain the operation of a great part of the more powerful remedies. The position of Dr. Darwin resolves itself into this more general principle of Mr. Hunter, and the operation of the cold bath in the paroxysm of madness, or of convulsion, receives an easy explanation under either doctrine. We may say with Dr. Darwin, that the powerful stimulus given to sensation, destroys the previous diseased volition, or in the more general and more simple language of Mr. Hunter, that the sudden application of cold water to the surface, produces an action of the system with which the previous diseased action is incompatible. In order however to the success of the cold bath in either of these species of disease, it will be readily perceived, that it is necessary that no considerable læsion of
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tions as voluntary which have originated in volition, though from their violence no longer subject to the will. Volition is used by him in a sense somewhat different from its common acceptation.

* John Hunter. *Treatise on the Blood. Introd. p. 3.*

structure shall have taken place, and that the morbid actions be not so strong as to produce insensibility to impression, and shall not have been so often repeated as to form indissoluble catenations. It seems also necessary that the diseases in question shall be such as are susceptible of general paroxysms; a fact which is not so easily explained. Finally, it is necessary that the digestion shall not have been much impaired, or the vigour of the circulation much debilitated, least the action of cold be too strong for the living powers. Under these restrictions, the cold bath, according to my experience, may often be applied with advantage, and always with safety, in convulsive diseases, and in insanity; for though in these diseases, even in their more violent forms, the temperature of the body is little, if at all, increased, yet the actual heat is retained with great tenacity, as I have found by many observations.

The resistance which the maniac opposes to cold, he opposes also to contagion, and to other noxious powers, as has often been observed with surprise and admiration. This resistance seems to belong to every species of increased voluntary exertion, where the functions of digestion and nutrition are not impaired. The illustration of this position would not be difficult, and the conclusions to be deduced from it are in a high degree interesting and

and important ; but a discussion of the subject would lead us too deep into the general doctrines of life.*

CHAP.

* Dr. Marcard, of Pyrmont, in his work on the effects of warm and cold baths, entitled, *Ueber die Natur, und Gebrauch der Bader*, lately published, has quoted my paper on the effects of the cold bath in convulsive diseases (Appendix No. I.) and it appears, that he does not assent to my conclusions. Dr. Marcard supposes indeed, that the cold bath may be useful in convulsive diseases, where there is no local affection stimulating the system, but he contends that it *must* be hurtful in cases where convulsions originate in stimuli, as worms, or crudities in the alimentary canal, teething, &c. It does not appear to me that Dr. Marcard has understood my paper perfectly, and I do not feel myself disposed to yield my experience to his speculations. The doctrine which Dr. Marcard seems to maintain, that where one stimulus is already acting, the application of another must be injurious, is contrary to experience, and as I apprehend, to the laws of the animal œconomy. The work of Dr. Marcard is a valuable one, and deserves to be translated ; but it seems to be too full of those general and sweeping observations, which though nearly banished from other sciences, continue in the writings of physicians, and serve at once as a proof and a cause of the imperfection of our art. I fear this little volume will not be found free of them.

CHAP. XIV.

General view of doctrines respecting fever.—Hippocrates—Galen, &c.—The ideas of the author respecting the nature of this disease.

THE great difficulty which men have in all ages experienced in the acquisition of knowledge, has arisen from the promptitude of the human mind to decide in regard to causes. To the weak and ignorant, presumption is as natural, as doubt is intolerable, and with such, belief is almost always a creature of the imagination. Nor is this peculiar to weakness and ignorance: to retain the mind unprejudiced and undecided in the investigation of striking and interesting phenomena, till by the painful steps of induction, the hidden cause is revealed, is an effort of the most difficult kind, and requires the highest and rarest powers of the understanding. The records of every part of science, bear ample testimony to this truth, particularly the records of medicine, and in a still more especial manner that part of medicine which treats of the nature of fever. The most eminent physicians in every period of the world, impatient of observing and delineating, have been eager

to explain and even to systematize ; and the science of life owes its corruptions more to the misapplication of learning, than even to the dreams of superstition. Passing over the theories derived from the splendored fictions of the Greek philosophy, various are the false doctrines introduced into medicine in modern times, and from the more certain branches of science. The principles of mechanics, of chemistry, of magnetism, and of electricity, have in succession been employed to explain the motions of organic life, and have served only to mislead and to deceive.

Hippocrates who lived at too early a period to be acquainted with the collateral branches of science, studied life and disease in the book of nature, and had the merit of an original observer. Perceiving the increase of heat to be the most remarkable symptom in fever, he assumed this for the cause, and founded his distinctions of fevers, on the different degrees of the intenseness of this heat. He had not an instrument that could measure this exactly, and necessarily trusted to his sensations. In forming his diagnosis, he placed his hands on the breasts of his patients, depending more on the degree of heat than on the state of the pulse, the nature and connexions of which he did not understand*. His practice appears to have been natural
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* Riollay's Introduction, &c. p. 9.

and judicious, and founded on his theory. He directed linen dipped in cold water to be applied to the hottest parts; drew blood away both by cupping-glasses and the lancet; and administered cold water and cooling drinks, particularly barley water and honey. This simple practice, will acquit the Coan sage with the candid and reflecting, of many of the idle theories which have been imputed to him, and which doubtless were the offspring of after times.

In the days of Galen, philosophy and science had made some advances, and the corruptions which he introduced into medicine from those sources are well known. Preserving however the doctrine of his master, that heat was the cause of fever, his practice founded on this notion, was in some respects bold and successful, as was before observed. To him followed the Arabians, who still retained the original doctrine of Hippocrates, but with new modifications and corruptions, by which the real nature of fever was still farther obscured.

In our own country, and in the last century, arose Sydenham. He also was an original observer, and to him medicine is doubtless much indebted. That he recorded symptoms with great accuracy; that he established many important facts as to the treatment of disease, and that he was a more cautious

ous reasoner than his predecessors or contemporaries, are facts that are indisputable. But, though he affected not to theorize, he was a theorist in every page of his works, and though he founded his reasonings on what appeared to him self-evident principles, yet time has proved them to be defective and fallacious. It was the postulate of Sydenham, that every disease is nothing else but an endeavour of nature to expel morbid matter of one kind or another, by which her healthy operations are impeded. In this endeavour she is not to be obstructed but assisted, and the process carefully watched and promoted by which she accomplishes her purpose. By one or other of the emunctories, this is finally effected, and till it be effected, health cannot be restored. Under this general notion, the inordinate actions of fever are perpetually compared to the motions of fermentation, by which nature separates the vitiated particles from the blood previous to their expulsion. The doctrine of Sydenham may be traced to remote ages ; under his sanction it spread over Europe, and has descended in one form or other to our own times. Sydenham's doctrine introduced the system of Boerhaave, (to which we have already alluded) as well as other chemical theories of lesser fame, and the erroneous modes of treatment to which they gave birth. The inordinate heat which Hippocrates considered as the cause of fever, in the eye of the chemists appeared naturally

naturally enough, a necessary, and within certain limits, a salutary consequence of the process stirred up by nature to expel the disease !

The dawn of a juster pathology of fever is to be found in the works of Hoffman. Though he also undertook to be the interpreter of nature's intentions, he contemplated her process in fever with more sagacity, and rejecting chemical and mechanical analogies, endeavoured to discover the cause of fever in the peculiar nature of the vital motions. He supposed the noxious cause producing fever (in the language of the schools the remote cause) to operate first on the living solids, occasioning a general spasm of the nervous and fibrous system, beginning in the external parts and proceeding towards the centre. In consequence of this a contraction of the vessels of the extremities must of course take place, impelling the circulating fluids in an increased ratio on the heart and lungs ; which stimulating these organs to increased action, the fluids are thereby repelled towards the extremities, and thus the phenomena of fever are produced. There are therefore two distinct set of motions in fever, the first from the extremities towards the centre, arising immediately from the spasm, and accompanied by a small pulse, anxiety and oppression ; the second, from the centre toward the surface, which is the effort of nature to resolve this spasm, and marked by a full strong

strong pulse, and increased heat. The first of these set of motions are baneful, and sometimes fatal ; the second are medicinal and salutary. By these views the physician is to be directed in counteracting the morbid actions, and assisting the sanative process of nature*.

Since to theorize seems to be the inevitable propensity of men of genius, this theory of the celebrated Hoffman, which accords with appearances, and has a considerable connexion with practice, may be allowed the tribute of applause.

The system of Hoffman, produced that of Cullen, which may perhaps be considered as the prevailing doctrine at present, when however theory of every kind has lost much of its weight on mature understandings.—According to Hoffman the first effect of the remote cause of fever is the spasm, producing a re-action, as has already been mentioned. Dr. Cullen introduced a previous link into the chain—He contended that the first effect of the noxious effluvia (the remote cause) was a general debility, affecting the sensorium commune. To this debility he attributed the spasm, and to the
spasm

* See Hoffman's Works, vol. i. tom. ii. page 10.—*Geneva edition.*

spasm the re-action of the heart and arteries ; which re-action continuing till the spasm is resolved, removes the debility and the disease. According to Hoffman the spasm belongs to the class of motions that he denominates baneful, but Dr. Cullen presumes it to be salutary, and therefore ascribes it, in the language of the schools, to the *vis medicatrix naturæ*. It is not my purpose to appreciate these changes introduced into the theory of Hoffman, or to attempt to estimate with precision the Cullenian doctrine of fever, as it arranges phenomena, or applies to practice. Debility of a peculiar kind, spasm, and re-action of the heart and arteries, seem all of them links in the chain of fever, and in the first lines of Dr. Cullen, the history of the disease is recorded with extraordinary minuteness and accuracy. I bow with respect and sensibility to the genius of this illustrious man ; but his doctrine seems erroneous, in as far as it enters into the supposed intentions of nature. and defective, in passing over the morbid heat, and the morbid association, which form the successive links of the chain.

This doctrine of fever, as well as all the other doctrines of its celebrated author, was assailed by Dr. Brown. Assuming the existence of an unknown principle, as inherent in the living fibres, to which he gave the name of excitability, he explained all the phenomena of life and disease, as dependent

pendent on this principle, acted on by stimuli ; which stimuli, applied in the due proportion, produce the just degree of excitement, that is, the state of health. If the stimuli are diminished below the healthy proportion, he supposed the excitability to accumulate ; if encreased beyond this proportion, he supposed it to be expended ; and from these different conditions he attempted a general theory of disease. Diseases he divided into two classes, Sthenic and Asthenic, or diseases of increased and of diminished excitement, in the last of which classes he placed typhus, the fever of which we treat. In the excitability, Dr. Brown admitted of no change, except in regard to quantity ; in the excitement, no variation, except in regard to strength ; and in all universal diseases he supposed the whole system to be equally affected.* Having therefore assigned to fever its place in his series of descending excitement, he refused to inquire into its symptoms, or to enlarge on its treatment. It is evident that such a theory could embrace none of the characteristics of the disease. Debility, the first link in the chain of Dr. Cullen, formed according to Dr. Brown the essence of fever. The existence of spasm he denied, re-action he

* This was his general position ; it is true he relaxed a little from it in his explanations.

he derided, and the morbid heat and morbid association, he wholly overlooked. It is not however to be disputed that his general views of disease had a salutary influence on the practice in typhus, by encouraging a more liberal use of wine and opium, remedies of the utmost importance, and now universally adopted.

The various modes of action of the living principle, or to use his peculiar language, of the sensorial power, which were unknown to Brown, have been observed and illustrated by the author of *Zoonomia*.

In the theory of fever delivered by Dr. Darwin, the influence of morbid association is very fully explained. I am not however disposed to adopt this theory, which the learned and candid author himself considers as incomplete, because it assumes the truth of his peculiar doctrines, to which it cannot be expected that a hasty assent should be given—considering their vast extent and importance, and considering also that many other fabrics of genius of the same kind, have crumbled down into the sand of which they were formed.*

Dismissing

* See *Zoonomia*, vol. i. p. 625, *conclusion*. Of this great work, so recently published, the opinion of the learned is not yet expressed, and it is not probable that it will be fairly appreciated in the present generation. Much as I admire this

Dismissing therefore as far as it is possible, all theories from the mind, let us briefly consider the process of nature in fever, and examine what inferences may be safely drawn from the succession and catenation of the leading symptoms, and the remedies which experience has pointed out as most successful. Our observations must of course be considered as applying to the typhus, or low contagious fever of Britain, more particularly, but generally to all idiopathic fevers.

Medical science has not ascertained the various remote causes which may produce fever, and I avoid this inquiry on which I have nothing new or satisfactory to offer*. The first symptom

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offspring of profound reflection, and of singular ingenuity, the position common to Dr. Darwin and Dr. Brown, that the sensorial power, or excitability, is a substance which accumulates and diminishes in the inverse ratio of the stimulation, has not my assent. On the contrary, it appears to me, that whatever the nature of the vital energy (the sensorial power or excitability) may be, it does not act in a way that admits the relations of quantity to be applied to it, and the contrary doctrine, which introduces into the ~~the~~ theory of Dr. Darwin so many epicycles, seems to me the mortal part of his immortal work. I am aware that Dr. Darwin holds the doctrine mentioned with certain modifications; which however do not appear to me satisfactory.

* In confining the remote causes of fever to contagious

of the disease is a sense of debility or languor, very distinctly marked on the countenance, followed by paleness, cold and tremor; the functions of the mind are weakened in a correspondent degree with those of the body, and all the actions of the system are enfeebled. This general debility is peculiar in its kind. The symptoms resemble those produced by inhaling certain gases whose properties are known; and this circumstance serves to strengthen those views of the nature of contagion which the new chemistry has suggested. They seem also to have a resemblance, though a more remote one, to the effects of certain poisons operating on the stomach, or introduced into the circulation by the absorbents. The remote cause of fever may be considered as itself a poison acting directly on the sensorium commune. Where this poison is peculiarly concentrated and malignant, or where the system is much debilitated, the powers of life are sometimes oppressed and extinguished in the first stage

human effluvia, and to marsh miasmata, Dr. Cullen probably simplified too far. Cold, under certain circumstances, seems to produce fever, and the constitution seems at times to *take on* fever from unknown and internal causes. The conjecture of Dr. Mitchel of New York, that the gaseous oxyd of nitrogen is the cause of the dreadful fever of America and the West-Indies, is highly ingenious, and deserves great attention.

stage of the disease. In general however, a re-action or resistance commences ; the heart and lungs are roused into increased exertion by the pressure of the accumulating fluids, and strive as it were, to repel them back on the surface and extremities ; while a spasmodic, or morbid stricture of the extreme vessels opposes the reflux of the fluids, and thus maintaining the inordinate pressure on the centre, excites the heart, arteries, and lungs, to still more violent exertions. In this contest the stomach is usually brought into sympathy, and nausea and vomiting are often induced.

This constitutes what appears to be a struggle between the living energy, and the morbid cause—between the power of the centre, and the resistance of the extreme vessels—in the course of which a degree of preternatural heat is generated, and the phenomena of the hot stage are produced. When the powers of life prevail, the stricture on the extreme vessels, and on the exhalents of the skin, at length gives way, and a profuse perspiration being poured out on the surface, the heat is carried off, and the febrile symptoms subside. Without entering into detail, this may be considered as a general view of the single paroxysm. It often however occurs, that the solution of the spasm on the extreme vessels does not take place, or is incomplete, and that the morbid heat is not carried off. In this case the
 morbid

morbid actions go on, and the disease runs into continued fever. For some time the spasm on the extreme vessels remains, and the heat is præternaturally great; but these symptoms do not continue through the whole course of the disease. On the contrary, the heat towards the latter stages, will sometimes be found as low as the natural standard, sometimes lower, and the capillaries of the skin be completely relaxed; while the inordinate action of the heart and arteries continues, being carried on by the diseased association produced in the course of the disease, which retains its influence in this as in other cases, after the cause that produced it ceases to operate.

To this general view of fever, it is probable that little objection will be offered, by those who are familiar with the disease. But exceptions may be taken to the language as not sufficiently clear of theory, against which the author had declared. It may be said, for instance, that in applying the active forms of speech to the re-action or resistance of the constitution, we seem to run into the Sthaalian doctrine, or at least to assume the existence of the *vis medicatrix naturæ* of Dr. Cullen; and that to enumerate spasm as a link in the chain of fever, is in fact to admit the leading peculiarity of his system. To this it may be replied, that there is no subject on which the imperfection of language is so much

much perceived, as in our attempts to describe the phenomena of life. In the strictness of speech we properly employ the passive mood of our verbs, in recording the phenomena of inanimate matter, and confine the active mood to those vital motions, which are accompanied with consciousness and design. But there are various actions peculiar to life, which are not accompanied by consciousness, or subject to the will, and which depend on laws wholly distinct from those which regulate inanimate matter. If we borrow the phraseology and the *mood* in which we speak of inanimate matter in recording these actions, we are apt not only to form indistinct conceptions of their nature, but to apply the principles which regulate inanimate motions to the motions of life. This is an obvious, and as experience teaches us, an ample source of error. If, on the other hand, we employ the active forms of speech, these immediately suggest consciousness and design, and the imagination forms to itself an ideal being, as directing these actions, in whom consciousness and design may reside. This also is a natural and fruitful source of error.—Both these extremes we would avoid. But the penury of language obliges us to use one or the other mood in treating of the phenomena in question, and on reflection it appears, that in our present ignorance of the first principles of life, a clearer notion will be formed of the nature of those motions in which the
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whole system sympathizes, destitute though they be of consciousness and design, by the occasional use of the active forms of speech, since they have a much stricter analogy with those vital actions, to which these forms are justly applicable, than with the motions of inanimate matter. Considerations of this kind may have influenced the late John Hunter in the use of his terms, which are chiefly *active*, and which, though far from perfect in themselves, are more happy than those of former physiologists, as his views of organic life were more original, more unprejudiced, and in general more accurate and profound.

Debility of a peculiar kind, is then the first operation of the poison producing fever—the necessary consequence, or as some contend, the concomitant effect, is a spasm, or contraction of the arteries; but more especially of the extreme vessels, and the capillaries of the surface—hence follows an accumulation of blood on the heart and lungs—the re-action of those organs—the generation of morbid heat—and of morbid association. On each of these links in the chain of fever, let us offer a few remarks.

1. It has been asserted by some inveterate theorists, that the debility in fever has nothing in it peculiar. It is enough to reply, that simple debility often exists even in extreme degrees, without producing the phenomena that constitute fever.

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2. It has been asserted, that a spasm on the extreme vessels does not exist in fever, or that if it does exist, it may safely be disregarded. Those who hold the first opinion, suppose the paleness and shrinking of the surface to arise merely from the enfeebled circulation, by which the blood is not propelled into the extreme parts, and doubtless this has its effect. In syncope, however, where this paleness and shrinking arise from pure debility, as soon as the heart and arteries recover their energy, the blood flows immediately back into the extreme vessels as before. That this is not the case in fever, the most cursory observation will convince us. After the re-action of the heart and arteries has been some time established, the blood is indeed propelled through the vessels of the surface that circulate the undivided fluid; but the capillary arteries that separate the aqueous part remain constricted, as well as the orifices of the skin that pour it out on the surface.

3. It is however contended, that this stricture may be disregarded, since it is now very generally admitted, that the perspirable matter is not excrementitious, and since we find that its obstruction in other circumstances, and from other causes, produces little or no injury to the constitution. A little reflection will serve to refute this position. Spasm on the extreme vessels must necessarily affect
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the condition of the heart and lungs, from the increased pressure of the circulating fluids on these organs: it must also affect the stomach not only from its connexion with the heart and lungs, but from its direct sympathy with the surface.—Dr. Cullen has put these truths beyond controversy. But this is not all; the obstruction of perspiration—of profuse perspiration—in the paroxysm of fever, obstructs the process by which the constitution expels the morbid heat, and thus leaves the system under the influence of a general stimulus of the most powerful nature. It was a position of the celebrated Boerhaave, that the morbid heat in fever being a symptom only, might therefore be disregarded. But can we suppose, that a heat six or seven degrees greater than that of the blood in health, however generated, will not have the most important effects on the system, and if it stands in the relation of effect to the preceding symptoms, that it will not operate as a cause on those which succeed?—Doubtless this morbid heat re-acts on the heart and arteries; stimulates the inordinate exertions by which it was excited; irritates the spasm of the extreme vessels which prevents its being expelled; and prolonging the increased action of the heart and arteries, establishes a morbid association, which carries on this action after the heat itself has subsided, and the spasm relaxed.

4. What then, it may be inquired, is the actual state of the animal heat in the different stages of the paroxysm of intermittent, as measured by the thermometer? In different trials it seemed liable to considerable variety, but the following is the general result, which however the reader will receive as subject to the corrections that a more extensive experience may suggest. In the cold stage, the heat is diminished, not on the surface only, as some have imagined, but very probably over the whole system. I have found it under the tongue, and at the axilla, as low as 94° , 93° , and 92° , and on the extremities many degrees lower. At this time the stomach feels cold, and universal tremor takes place. Warm, and even hot liquids, are highly grateful, and the warm bath, heated to 100° , more grateful still. The drinking of warm liquids should be freely indulged in, and there is reason to believe that immersion in the warm bath (as practised by Galen) would be found as salutary as it is grateful. By degrees the pulse increases in frequency and force, and the heat begins to rise, but with much irregularity. It doubtless accumulates first in the centre of the system, and from the centre is pushed along with the blood, towards the surface. This process does not however go on in any regular progression, but like almost all the other animal processes, with alternate increase and relaxation. At times it appears retrograde ; and even when it is so far advanced

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that the heat taken at the axilla, and under the tongue, is greater than the standard of health, a slight accession of external cold will produce a general chillness, and bring back the oppression on the heart and lungs. On the surface itself the restoration of heat takes place with no regularity.—Certain parts are heated first. In certain parts the heat is above what is natural, while in others, it remains below this standard; and hence arises that mixed sensation of heat and cold, which every one acquainted with fever must have experienced in the transition from the cold to the hot stage of the paroxysm.

The irregularity with which the heat of the surface is restored, probably arises from this circumstance, that two causes conjoin in producing this effect—the reflux of warm blood from the centre, and the sympathy between the stomach and skin. To this last is attributed the circumscribed heat of certain parts of the surface, while the rest remains cool, this local heat being excited by the increased action of the vessels of these parts, awakened by the restored heat and tone of the stomach, which in other circumstances produce similar effects. In general the sense of cold predominates, even after a morbid heat has taken place at the axilla, under the tongue, and in different parts of the abdomen and thorax; because a considerable part of the surface,
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and the whole of the extremities, still remain below the natural temperature, and the sensation which this produces, arising from parts of great sensibility, overcomes the sensation of heat from the deeper seated parts, whose sensibility is so much inferior. At length however the heat of the surface becomes general and uniform, rising to 102° , 103° , 104° , and sometimes 105° of Fahrenheit. I have not seen it higher than this last degree in the paroxysm of intermittent, and seldom in continued fever, though different authors speak of febrile heat four, or even five degrees higher. The sensation of heat is now strong and steady, and the accession of external air does not produce a return of chillness as before.— This is the time for the affusion of cold water, as has already been mentioned. The sensation of heat is most powerful on the extremities, particularly on the palms of the hands and the soles of the feet.— This arises in part from the great sensibility of these parts, but in part also from this circumstance, that in their natural state they are two or three degrees cooler than the trunk of the body, and cannot be raised to the general temperature of health without an uneasy sense of heat, which is frequently relieved by a partial perspiration. When raised to the general fever-heat, their temperature is therefore increased in a more than a proportional degree beyond its usual standard.

After

After remaining some time in this hot stage, the skin begins to relax, and to become softer and smoother to the touch ; insensibly a moisture takes place, terminating generally in profuse perspiration. Neither however does this process go on regularly ; after the moisture commences, it sometimes goes off, and a dry and burning state of the skin returns : again the sweat recommences, and when it becomes general and continues steady, it is critical, that is, it terminates the paroxysm. As it commences, the heat declines, though at first very slowly : as it proceeds, the heat subsides gradually ; and when it terminates, the temperature of health is restored. The sinking of the morbid heat is however a good deal regulated by the quantity of the bed-clothes, and the closeness with which the body is enveloped.—Where the whole covering that was laid on during the cold stage, is kept on during the whole paroxysm (as often happens through a mistaken wish to force the perspiration) the heat is carried off with difficulty, and it requires a very profuse perspiration to reduce it to its natural standard. On the contrary, if the clothes be lightened after the hot stage is fairly established, the heat passes off with less difficulty, and the perspiration requisite to remove it is much less profuse.

These details will not be thought superfluous or tedious

tedious by those who consider, that after all that has been written on the subject of fever, thermometrical observations on the rise and progress of febrile heat, are in a great measure new*.

5. Whether it be owing to the nature or force of the contagion; to the state of the constitution; or to some other unknown cause; the re-action of the system does not always resolve the spasm or morbid stricture on the extreme vessels. When this stricture is not resolved, the sweat is not effused, the morbid heat is not carried off, and the diseased actions run into continued fever.

If a person is confined in a hot room, or in the hot bath, till his heat rises four or five degrees above the natural standard, his pulse will be found of a feverish rapidity; wandering pains will soon be felt over the body; languor, lassitude, and at length great debility will take place, with most of the symptoms of regular fever. It is evident that these symptoms cannot be expected to go off till the inordinate

* I intended to have introduced here one or two registers of the heat and pulse, taken every half hour during the paroxysm of intermittent, but this is delayed till I am enabled to speak from more numerous observations.

ordinate heat is removed, and if the person remain some time in the heated medium, he will find that the inordinate action of the heart and arteries continues after leaving it, and even after his own heat has subsided to its natural standard. This depends on a principle peculiar to life, to which the name of habit or association has been given, and which extends its influence to all the vital phenomena, whether intellectual or corporeal.

In fever this morbid heat does not arise from the surrounding medium, but from certain motions in the system itself. But however generated, a heat five or six degrees above the natural standard must be a powerful agent, and it cannot be expected that the diseased actions should subside under so strong a stimulus. The rapidity of the circulation, and the labour of respiration, are consequences of a heat of this degree, from whatever cause arising, and must continue till the heat is reduced.

We may here observe, that it is not by any means easy to make an accurate comparison between the state of the system under the heat of fever, and under an equal degree of heat introduced from the surrounding medium. Because it is in fact very difficult to raise the heat of the body in a state of health, to the highest degree of fever heat, either by heated air, or heated water. The experiments re-
corded

corded by Sir Charles Blagden, prove this in respect to a heated atmosphere; the heat as it is accumulated in the system, being dissipated by profuse perspiration, or by some other living process, of which perspiration is a concomitant effect. I have found the same difficulty in heating the body in the hot bath, for there also the heat is with difficulty increased beyond 100° or 101° , when sweat, as is usual, breaks out over the surface. Even in these degrees the greater part of the symptoms of fever will be felt. The heat however is moderated, and, when the temperature of the external medium is reduced, it is carried off by the discharge from the surface. But in fever this is prevented; for the peculiar debility induced by the remote cause, occasions, or is attended by, a spasm, or morbid stricture, of the capillaries of the surface and of the skin itself, by which the insensible perspiration is lessened, and the sensible perspiration obstructed. Hence the difficulty of reducing the heat in fever; and thus it appears, that the spasm on the extreme vessels, which some of our latest physiologists have wholly neglected, is perhaps the most important peculiarity of the disease.

It may be observed, and it furnishes a subject of interesting inquiry, that this stricture, which often gives way under a moderate re-action, maintains itself with rigidity where the re-action is great. Thus where the heat rises to 99° , 100° , or 101° ,
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the orifices of the skin often relax, and carry it off by increased perspiration, while at 104° and 105° , with a proportional force of circulation, they are in general obstinately constricted. This is very striking in fever, but not peculiar to it. Even in the state of health, while a moderate, gradual, and general stimulus from heat opens the pores of the skin, a sudden and considerable increase of heat constricts them; the violence of the stimulus, in this, as in other instances, occasioning a morbid resistance of the living fibre on which it acts. This resistance to inordinate stimuli extends to every part of the living system, and belongs to every species of vital action; it characterizes the mental as well as the corporeal functions, and a full consideration of its influence might afford the most important instruction, not to physicians only, but to moralists and legislators!

But, it may be justly remarked, that after fever is established, the reduction of heat to the natural standard, however desirable, is attended with difficulty and hazard, since the patient cannot in general bear the continued exposure to external cold, necessary for this purpose.

Even in the hot stage of fever, if the patient be exposed naked to a cold atmosphere, though he supports the application for some time with comfort and

and even with advantage, yet as the heat of the surface approaches the standard of health, a sudden sense of chillness comes on, with a return of oppression on the heart and lungs, and all the symptoms of the first stage of the paroxysm. The length of application, and the degree of external cold producing this effect, are indeed various in various constitutions, and in different stages of the disease: the degree of reduction of the animal heat at which the chillness commences, is also uncertain; but the general truth of the position laid down is established on ample experience, and will not, I believe, be controverted. In cooling the surrounding atmosphere in fever, or in any other continued application of cold, care must be taken to keep it within the limits in which it is grateful to the sensations; and within these limits the cool treatment, as far as my observation extends, is uniformly advantageous. But though it moderates re-action, it does not remove the spasm on the capillaries, or break the catenation by which fever is prolonged.

This is effected by the sudden affusion of cold water over the naked body; and the mode of its operation will now be easily understood. The sudden, general, and powerful stimulus given to the system, dissolves the spasm on the extreme vessels of the surface, and of the various cavities of the body: the sudden and general evaporation carries off a

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large portion of the morbid heat accumulated under the skin ; and the healthy action of the capillaries and exhalents being restored, the remaining superfluous heat passes off by sensible and insensible perspiration. The stimulus of morbid heat and of morbid stricture being removed, the inordinate action of the heart and arteries subsides, and the harassed, and toil-worn patient sinks into that peaceful sleep which nature has provided as the solace of our pains and sorrows, and the restorer of our strength.

If such be the explanation of the diminution of the heat, and of the frequency of the pulse ; which follow the affusion of cold water on the surface, it may here be inquired how the diminution of the thirst is accounted for. Are we to suppose, that a portion of the liquid is taken up by the absorbents of the surface, as is generally believed to be the case, during immersion in the bath ? I apprehend not. The absorption in the bath, if it occur at all, (of which there is no sufficient evidence) has been greatly exaggerated, and the diminution of thirst after the cold affusion, is too speedy to be ascribed to such a cause. It admits of a more satisfactory explanation. The morbid stricture on the extreme vessels, to which we impute so much, is not confined to the capillaries of the surface, but extends, as far as we have an opportunity of observing, to the capillaries of all the cavities of the body. The
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sense of thirst is produced by the heat and dryness arising from the morbid stricture of the exhalents in the inner surface of the mouth, fauces, and stomach; and this stricture being removed by the affusion on the surface of the body, from the sympathy between the surface and these cavities, so often alluded to, the healthy action of the exhalents of these parts, as well as those of the skin, is restored, and pouring out their moisture, the heat and dryness are removed, and the thirst diminished.

This indeed seems to be the way in which thirst is relieved in the first instance, by liquids taken into the stomach itself, where the effect is too sudden to arise from the absorption of any portion of the liquid into the mass of circulating fluids. We cannot indeed perceive this effect on the exhalents of the stomach, but we may reasonably suppose it to take place where we observe the swallowing of drink to be followed by a relaxation of the exhalents on the skin, which must proceed from their sympathy with those of the stomach previously relaxed; and it may illustrate and support this position, that when liquids swallowed even in large quantities in the hot stage, do not produce a sensible increase of perspiration on the skin, the relief they afford to the thirst is momentary only. Doubtless in such cases the stricture on the exhalents of the stomach has not been resolved. The relief from thirst afforded by liquids taken into the stomach is
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in general however more effectual and complete, than from affusion of water on the surface, because when the stricture on the capillaries is removed, a rapid absorption takes place from the stomach, and the circulating fluids are diluted. But on the surface of the body this absorption is doubtless slow and imperfect, and it will be afterwards shown, that there is reason to doubt whether it takes place at all. It was remarked that the affusion of tepid water on the surface, though effectual in diminishing heat, (page 68) is not followed by the entire cessation of fever, as is often the case after the cold affusion. The cause of this is obvious—the coolness produced by the tepid affusion arises from the increased evaporation, and continues only while this continues. The stimulus given by the tepid affusion is comparatively slight and transient—it does not resolve the spasm on the surface, or on the other cavities of the body, and of course it does not destroy the morbid catenation. The heat therefore speedily returns, when the remedy is withdrawn.

This explanation of the operation of the affusion of cold water seems to me satisfactory. The cases which have been related show, however, that it is only in the early stages of fever that it produces a solution of the disease. In the after stages, though uniformly advantageous while the morbid heat continues,

tinues, its effects are not so decisive, the morbid actions having acquired the force of habit, or in other words being carried on by the affociations or catenations that have been produced.

What then ought to be the indications of practice in fever? To diminish the cold in the cold stage; to moderate the heat in the hot stage; and to resolve the stricture on the extreme vessels by which the heat is retained, and the re-action prolonged; and where the inordinate action of the vascular system continues after these objects have been attained, to support the powers of life till the morbid affociations, or habits of action, gradually die away, from the removal of the causes by which they were introduced. In addition to these general indications, it will be essential to secure the proper action of the bowels; and in every case to unload the alimentary canal of its morbid contents; whether these contents have become diseased through the action of general fever, or, as there is reason to believe in some of the fevers of the warm climates, be the remote cause by which fever is produced.

If these general observations should excite attention, they will doubtless excite objections also, and perhaps animadversions; but whatever be the fate of his reasonings, the author rests with some confidence on the stability of the facts by which they

they have been suggested. In the view which he has taken of fever, the supposed intentions of nature are not inquired into; and of course no attempt is made to arrange the symptoms as they arise from the direct agency of the febrile poison, or the exertion of *her* medicating power. Such attempts are as unnecessary as they are difficult. It is not indeed to be denied, that the living system, after being excited into morbid action, passes frequently, unassisted, through a succession of symptoms into a state of health; differing in this as in every other respect, from any of the arrangements of unorganized matter. But it is equally true that it often sinks in the course of this process, sometimes destroyed in fever by the excess of its own re-action, and sometimes by the habits of action, or association produced in the course of the disease.

It is a serious error to suppose that the febrile poison, being received into the system, is the principal cause of the symptoms, and that they consist of a struggle of nature to expel it, without which health cannot be restored. It is safer to consider the febrile poison as an agent that excites the system into fever, which however is carried on, not by the continued presence and agency of this poison, but by the principles which regulate the actions of life. We are not therefore to wait for the sanative process, by which nature is supposed to separate this

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virus, and to throw it off, watching her motions, and assisting her purposes; but to oppose the fever in every stage of its progress with all our skill, and to bring it to as speedy a termination as is in our power. When we dispel the morbid heat, and reduce morbid re-action in the hot stage of the original paroxysm, by the powerful means of the cold affusion, the whole of the febrile symptoms vanish; a sufficient proof that in this stage of the disease these symptoms arose from inordinate heat and inordinate action, and not from a poison circulating with the blood. Hence the safety and the wisdom of decisive measures in the earlier stages, before the strength is materially impaired, or the diseased habits established. Those who practice within the tropics, where fever runs its dreadful course with such rapidity, ought especially to be aware of this truth, with which indeed the most enlightened of their number seem to be sufficiently impressed. The writings of Dr. Jackson and Dr. McLean inform us, that the affusion of cold water begins now to be employed in the destructive disease (popularly named the yellow fever) of Jamaica and St. Domingo, and with salutary effects*. In those climates

* See Dr. Jackson on the "Fevers of Jamaica." *London, printed by Murray, 1791*, and Dr. McLean's inquiry into the nature and causes of the great mortality among the troops in

mates, however, the disease ought to be combated, not merely by affusion of cold water on the surface, but by immersion of the patient in the cold bath. In this fever, hours, nay minutes are precious, and as the cold stage is short, the application of this remedy admits little delay. As soon as the second, or hot stage is formed, a judicious and resolute application of cold might supersede all other remedies. But the temperature of the sea, and even of the springs within the tropics, rising generally as high as 77° or 78° of Fahrenheit, affords a stimulus to the sensations from simple affusion, of a weaker kind, and hardly permits us to hope, that in the form of affusion the cold bath can be followed by those effects in the ardent fever of the torrid zone, which in the milder fever of this climate it so happily produces. Artificial modes of cooling the water may indeed be resorted to, and when this can be effected, the repeated

St. Domingo.—*London; Cadell and Davies, 1797.* Had I seen Dr. Jackson's work earlier, I should have mentioned him sooner; but I was referred to him for the first time by the work of Dr. McLean, just published, and which reached me after this chapter was nearly printed off. The works of these experienced physicians deserve great praise; but their accounts of the fevers of the West Indies—like all the other accounts, are without information in regard to the actual state of the heat of the patients. The thermometer has not yet been employed in the diseases of the tropics.

repeated use of the affusion may in all probability extinguish the disease. But on military duty, as well as in many other situations, artificial methods of cooling a sufficient quantity of water it may often be impossible to employ. In such cases, when the physician has ascertained that the heat of his patient has risen to the degree which justifies the practice, let him plunge him fearlessly into the cold bath, or the sea. The duration of immersion must depend on the effects on the pulse, on the sensations, and on the heat measured by the thermometer; and a greater degree of coolness will be produced by alternately raising him into the air, where the wind blows over his naked body, and sinking him in the water, than by continued immersion. (*See Appendix, No. II.*) The utmost care is necessary in a process of this kind, to guard against the effects of fatigue. Various instances might be adduced of the success of this practice in persons who have in the delirium, of fever on shipboard, plunged into the sea—The case of Sir John Chardin, who, when at Gambroon in the year 1673, was cured by this means of a burning fever, attended by delirium, after every other remedy had proved ineffectual, is a celebrated instance of this kind, and long ago suggested to Dr. Glass the propriety “ of making a farther trial of this uncommon and surprising remedy.” I have received a variety of authentic relations of the same nature. These have happen-

ed on board our ships at sea, during the delirium of fever, and chiefly in the warm climates ; and in every instance where the patient has been fortunately taken up, recovery has followed.

An accident of this kind occurred about three years ago to Captain S——, of this port, in the Irish channel. He sprung out of his cabin window in the height of delirium, and was upwards of twenty minutes in the water. He was taken up perfectly calm, and speedily recovered.—If it be considered, that in the Irish channel, even in summer, the temperature of the water is seventeen or eighteen degrees colder than in the West Indies, the importance of this fact will be clearly perceived. But besides the different modes of applying cold water to the surface, it ought to be poured into the stomach in large quantities, when the patient's heat will permit it, and the presence of nausea and vomiting is no objection to this practice, if a chillness of the stomach is not produced.

Considering the general adoption of cold drink in the ardent fever of the ancients, its success in the Hungarian fever, to which the yellow fever bears such analogy, and the pointed recommendation it has received from Hoffman in bilious vomitings and dysentery, it appears rather extraordinary that it has
not

not hitherto been resorted to in the diseases of the West Indies.

The salutary effects of the cold bath, and of cold drink in fever, strongly recommend the adoption of these remedies in the plague. On the coasts of the Mediterranean, where the liberal use of cold drink in fevers prevailed throughout antiquity, and on some parts of which it seems to have been carried to a great extent in the beginning of the present century, there is reason to believe that it has now fallen into disuse. If we give credit to the answers made to the queries of Mr. Howard, in regard to the treatment of the plague, the administration of cold drink forms no part of the regular practice in that terrible disease. The Jew physician of Smyrna indeed says, “ that the Turks in the
“ violence of the fever, take handsfull of snow and
“ apply it over their bodies, and also eat it; and
“ likewise sometimes throw cold water on their
“ feet.” But the learned Hebrew cannot determine whether it is of service, “ as these people in
“ other respects pay no regard to the rules of diet.” *Howard on Lazarettos, page 39.* Morandi, physician at Venice, observes, “ that some sailors at Con-
“ stantinople, in the phrenzy of the plague, have
“ thrown themselves into the sea; and it is said,
“ that on being taken out, they have recovered.” But this happy temerity the regular practitioners do

not

not appear to have imitated, a fact that is further established by Dr. Ruffel, in his account of the treatment of the plague at Aleppo.

The administration of cold drink in the plague, as well as the external application, must however be regulated by the actual state of the patient's heat, and of his sensations of heat, of which also we have to lament that we have no accurate information. If it should be found that in this malignant disease the heat is little or not at all above the natural standard, (as is the case in the advanced stages of the confluent small-pox) our hopes from the exhibition of this powerful remedy would probably be disappointed. But the trial is recommended by every consideration*.

CHAP.

* When Mr. Howard was printing his work on *Lazarettos*, at Warrington in 1788, I communicated to him an account of the successes of our first trials of the affusion of cold water in fever, in the Liverpool Infirmary, and he promised to make more particular inquiries in regard to the empirical use of this remedy, in his ensuing journey to the East, in the earlier part of which, it is well known, his career of benevolence terminated.

CHAP. XV.

Animal heat—its origin.—Perspiration—its cooling influence.—Mode of operation of other remedies in Fever—Antimonials—Opium, &c.

I HAVE elsewhere observed, that if a definition of life were required, it might be most clearly established on that capacity, by which the animal preserves its proper heat under the various degrees of temperature of the medium in which it lives. The more perfect animals possess this power in a superior degree, and to the exercise of their vital functions this is necessary. The inferior animals have it in a lower degree, in a degree however suited to their functions. In vegetables it seems to exist, but in a degree still lower, according to their more limited powers, and humbler organization. As the capacity of preserving nearly an uniform temperature in all the varieties of climate and season, is the criterion of life in the more perfect animals, so among individuals of the same species, the degree of this capacity may be considered as the criterion of the strength of the living principle.

There is reason to believe, that while the actual
temperature

temperature of the human body remains unchanged, its health is not permanently interrupted by the variation in the temperature of the medium that surrounds it; but that a few degrees of increase or diminution of the heat of the system, produces diseases and death. A knowledge therefore of the laws that regulate the vital heat, seems to be the most important branch of physiology.

Modern chemistry assumes to itself the discovery of the origin of animal heat, which is supposed to depend on those changes in the ingesta, which the functions of life are always producing. Among the breathing animals, the principal of these changes is occasioned by the lungs on the atmospheric air which they inhale, and respiration is considered as the principal source of the heat of this class of animals. That the oxygen contained in the atmosphere furnishes the largest portion of the pabulum of life, is no longer doubted, respiration being a process in which it passes from its gaseous to its concrete state, giving out a portion of the heat it held in vapour; in the same manner as steam, in its conversion into water, gives out a portion of its heat. The heat thus extricated, being conveyed by the circulation to all the parts of the body, is the principal means by which the whole is warmed and animated.*

* Respiration is a case of compound elective attraction, in which the oxygen gas is decomposed, and enters into new

Some physiologists of our own country, and on the continent, have of late supposed, that a similar process is carried on by the surface of the body, through which also, though in an inferior degree, the oxygen of the atmosphere is inhaled. Experiments are wanting to establish this position, or to shew us how far it extends, and there is reason to believe that the principal function of the skin, in the breathing animals at least, is of a different and opposite nature. That an animal possesses to a certain extent, the faculty of rendering sensible heat latent, or to speak more philosophically, of resolving heat into caloric, in cases in which the stimulus of heat might otherwise overpower the living energy,

compounds; a part unites with the iron of the blood, and forms it into an oxyd; a part with the hydrogen of the venous blood, and forms water; another part with the carbon of this blood, and forms carbonic acid gas. In the two first cases the language in the text applies strictly, but in the last case the heat extricated does not arise from the oxygen becoming concrete, but from its entering into the composition of a gas which has a less capacity for caloric than itself. The heat disengaged in these different processes, unites with the blood, which in losing its hydrogen and carbon (hydro-carbonat) is converted from venous to arterial, and has its capacity for caloric increased. Thus inflammation in the lungs is prevented. But the arterial blood, in the course of circulation, again absorbs by little and little a portion of hydro-carbonat, parting with caloric in the same proportion. Hence the uniformity of temperature throughout the body. This seems the modern theory of respiration, which it must be confessed is not without its difficulties.

energy, there is reason to believe, from a variety of experiments and observations. And that this is in part performed by the perspiration from the surface, can scarcely admit of a doubt. The process of perspiration which is continually going on from every part of the body, is in this point of view the converse of that of respiration: as in respiration a gas is constantly converted into a solid or fluid, and thus heat evolved, so in perspiration a fluid is continually converted into a vapour, and thus heat is absorbed. If then we suppose, that while the proportion of oxygen received into the system continues the same, the temperature of the atmosphere is increased, we can understand why our heat is not increased, by supposing an increase of perspiration. And if the temperature of the atmosphere remains unchanged, while the oxygen received by the lungs is increased, we can still explain the stability of our heat, by supposing an increase of perspiration. The first of these suppositions is nearly realized, when a warm day comes on after cold weather; the second is realized when an increased respiration takes place under exercise—thus perspiration appears to have a principal share in regulating the animal heat, and the chain of life seems connected with the physical world by two links, which the recent discoveries in chemistry enable us to unveil*.

* I have said *nearly* realized, in the beginning of the sentence. Supposing the same bulk of air breathed in warm as

A vessel filled with water, and exposed to the air, cannot be raised above 212° of Faht. by any quantity of fuel, because, as heat is applied from below, evaporation carries it off from the surface. Hot springs are of the same heat at their fountains throughout the year, probably because the evapora-

A a

tion

in cold weather, the proportion of oxygen will be rather less in the first case, from the diminished density of the air. There is reason to believe also, that an animal contaminates the air more slowly in warm weather, that is, receives a less proportion of the oxygen it inhales, into the system. But these particulars, in the rapid and general views which I offer, are necessarily overlooked.

Dr. Mitchel, of New York, in his ingenious paper on the nature of contagion, has unguardedly asserted, that the actual heat of the animal is always proportioned to the quantity of oxygen inhaled; but a very cursory examination of facts will shew that this is erroneous. By the experiments in No. II. of the Appendix (and various others might be adduced) it will be seen, that the living body has the power of preserving its heat nearly unchanged for a considerable length of time in so dense a medium as water 50° colder than the blood. This could not arise from an increased inhalation of oxygen. The phenomenon is partly to be explained from the sudden contraction of the perspiratory organs; but principally, from the powerful impression on the sensations rousing the vital principle to increased exertion, and to increased extrication of heat. It is to be observed too, that it was the trunk, and more solid parts of the body, that preserved their heat, in the experiments referred to; the extremities became cold.

tion from the surface of their waters increases and diminishes with the heat of the atmosphere. In like manner we may suppose the heat of the living body to be kept uniform by the evaporation from its surface increasing or diminishing according to the quantity of heat extricated in the system, or received from the surrounding medium. But the cautious reasoner, aware of the deceptions arising from such analogies, will here very properly inquire—Does the perspiration by the skin, the body remaining at the temperature of health, actually go on more rapidly in warm than in cold weather? Is it greater under exercise than when at rest? Is it more plentiful when oxygen is received in abundance into the system, than when it is imbibed more sparingly? We run little hazard in answering the two first of these questions in the affirmative, but in regard to the last, farther experiments are requisite to enable us to decide.

The insensible perspiration attracted the notice of physicians very early, and it was a common dogma among the ancients, which has descended with too little examination to our own times, that the whole surface of the body inhales and exhales. The subject has been considered more accurately since the experiments of Sanctorius in the middle of the last century, and the great quantity of matter supposed by him to pass off by this process, pointing

pointing out its importance in the animal œconomy, theories of disease, founded on the diminution or obstruction of this discharge, have since his time prevailed universally. The quantity of the matter of perspiration is not easily ascertained, and this uncertainty must continue while the absorption by the lungs, (and perhaps by the skin,) from the atmosphere, remains uncertain. It was for some time believed, that the quantity of perspiration from the surface, had been exaggerated by Sanctorius, but since a notion has been entertained of the great absorption by the skin, his calculations have been supposed to fall short of the truth. If however we calculate that fifty ounces of water are converted into vapour on the surface of the body in twenty-four hours, this must produce a very considerable absorption of heat, and have a powerful influence on the temperature of the living system.*

And

* Very various calculations have been made of the quantity of matter perspired. The only experiments on this point that deserve much notice, are those of Mr. Cruikshanks. He appears to have lost upwards of seven pounds weight in this way in twenty four hours, when at rest, in an atmosphere of 71°.; but when exercising, a much larger quantity. This exceeds the calculation of Sanctorius, and the experiments of Mr. C. point out what Sanctorius did not know, the great absorption by the lungs; for there is reason to believe, that the absorption of air, vapour, or water, by the skin, if it occur at all, has been much exaggerated.

And however we may distrust the experiments hitherto made, on the quantity of the matter of perspiration, there is little reason to question the points in which they all agree—that this discharge is greater in warm weather than in cold—under exercise, than when at rest.

Important as the evaporation from the surface of the body must be in regulating the heat, it is remarkable how little it has hitherto been considered in this point of view. In the year 1755, Dr. Cullen published his discovery of the cold produced by the evaporation of fluids, (*Essays and Observations Physical and Literary*, vol. ii.) a phenomenon long known in Asia, but till then unobserved in Europe, and which has paved the way to so many other discoveries of the modern chemistry. It does not however appear that Dr. Cullen applied his discovery in explaining the function of perspiration. The effects of evaporation from the surface in cooling the body, was however soon after noticed by Dr. Franklin. In a letter, dated June 1758, is the following observation, “ During the hot Sunday at
 “ Philadelphia, in June 1750, when the thermome-
 “ ter was up at 100° in the shade, I sat in my cham-
 “ ber without exercise, only reading or writing, with
 “ no other cloaths on than a shirt and a pair of long
 “ linen drawers, the windows all open, and a brisk
 “ wind blowing through the house; the sweat ran
 “ off

“ off the backs of my hands, and my shirt was often
 “ so wet as to induce me to call for dry ones to put on.
 “ My body however never grew so hot as the air, or
 “ the inanimate bodies immersed in the air.*” It
 does not indeed appear that Dr. Franklin actually
 measured his heat, but he makes the inference of
 his comparative coolness from remembering, that
 all the bodies about him, even the shirt out of his
 drawer, felt warm to the touch, and he concludes
 that he was kept cool “ by the continual sweating,
 “ and by the evaporation of that sweat.” Doubt-
 less this reasoning was suggested to Dr. Franklin,
 and perhaps the whole circumstances recalled to
 his mind, by the paper of Dr. Cullen, then recently
 published. When, by the observations of Mess.
 Du Hamel and Tellet, in France, and the experi-
 ments of Dr. Fordyce and Sir Charles Blagden in
 England, a discovery was made of the very extra-
 ordinary degrees of heat which the living body can
 support, philosophical minds naturally endeavoured
 to account for so singular a phenomenon. That
 the animal possesses a power of generating cold as
 well as heat, was the more general opinion; but
 the conclusiveness of the experiments of our Eng-
 lish philosophers to establish this opinion, was ques-
 tioned by many, and among others by my late
 ingenious friend Dr. Bell, in the paper that forms
 the

* See *Franklin's Letters and Papers*, p. 365.

the first number in the *Memoirs of the Society of Manchester*. In this paper the effects of the evaporation from the surface in reducing the heat during the experiments in question, is particularly insisted on. In discussing this subject with Dr. Bell, it naturally suggested itself, that the principal office of the insensible perspiration might be to regulate the animal heat, and this opinion, which seems so reasonable, has been confirmed by reflection and observation.

But whatever may be the influence of the insensible perspiration in cooling the body, it does not seem to be the only process by which this effect is produced. From some experiments in the hot bath, it appears to me that the temperature of the body is with difficulty increased after the sweat begins to flow profusely, and as there can be no evaporation from the skin when the body is immersed in water, should my observation be confirmed by future experience, it will shew, that in the production of sweat itself, a degree of heat is absorbed, and thus explain in some degree the reduction of heat that follows profuse perspiration in other cases. It was indeed supposed by Albinus, Haller, and William Hunter, that the sweat, as well as the insensible perspiration, is an exudation of the watery part of the blood through the cuticle; but this opinion is contrary to all analogy, and depending on
experiments

experiments made on the dead body, may be safely rejected, notwithstanding the illustrious names that countenance it. The opinion of Dr. Fordyce and Mr. Cruickshanks seems to be the true one. The matter of perspiration is separated from the blood by the capillary arteries, and thrown out on the surface by organic pores in the cuticle (however difficult to be discovered) connected with the extremities of these arteries; and in this process there is not a separation merely, but a new combination, as in similar instances. In this combination there may be an absorption of heat, and thus the coolness produced by sweating be in part accounted for. The absorption of heat may however take place in various other processes, besides the production and evaporation of perspirable matter; as doubtless its extrication takes place in various other processes besides respiration; and after all, the sudden changes of temperature that take place in certain circumstances, render it probable that the animal possesses powers over its heat not yet understood, and which no chemical theories can explain.

Leaving this point for future inquirers, the importance of perspiration to the animal œconomy may safely be affirmed. By this process the stimulus on the extreme vessels arising from morbid distension, is diminished or removed, and whatever other

other methods the system may possess of diminishing its heat, this discharge seems in certain circumstances essential to that object. In situations where the organs of perspiration are spasmodically constricted, while by the increased momentum of the circulation, heat is præternaturally evolved (as in the commencement of fever) we can easily understand the disorder of the system that ensues.

It is observed, that persons who engage in excessive hard labour, speedily sink under it, unless they perspire freely, and support their perspiration by drinking some thin and moderately stimulating fluid. This is the case with the reapers in Pennsylvania, where the harvest occurs in the hottest season of the year, and who by means of profuse perspiration, are enabled to work in the sunshine, in which the thermometer rises very often above the heat of the blood.* This is the case with our coal-heavers, who probably lose a fifth or sixth part of their whole weight by this discharge daily, and who supply this waste chiefly by large draughts of porter. In instances of such extreme labour, a sudden stoppage of perspiration from the cessation of exertion, and the accession of cold, is frequently fatal, as has already been explained.

Europeans

* See *Franklin's Letters, and Papers*, p. 366.

Europeans who go to the West Indies are more healthy in proportion as they perspire freely, especially if they support the discharge by a moderate use of gently stimulating liquids, stopping short of intoxication; and guard against the effects of too excessive an evaporation when the vigour is impaired by fatigue. In the extreme heats of the torrid zone, this indeed is not easy. The highly excitable system of the youthful European, is acted on powerfully by the climate. If the orifices of the skin do not pour out a proportional quantity of perspiration, disease must ensue from the direct stimulus of heat; and if the necessary quantity of perspiration takes place, the system is enfeebled by the evacuation, and the extreme vessels losing their tone, continue to transmit the perspirable matter after the heat is reduced as low, or perhaps lower than its natural standard—as occurs in the cold colliquative sweats in the latter stages of fever. In this situation we can easily suppose, that even a slight degree of external cold may become dangerous. The damps and chillness of night, joined to the increased evaporation produced by the night-breeze, must often prove pernicious, especially after exercise and profuse perspiration. They rob the surface of its necessary heat, produce a torpor and contraction of the extreme vessels, and the dangerous re-action of the centre, which has already been explained. The proper treatment of

the European on his landing in the West Indies, may probably consist in his being placed for a time in some inland and elevated station, where the air is less sultry than on the coast; on his avoiding as much as possible any violent exercise; on his guarding against all intoxicating liquids, and whatever increases the heat and diminishes the strength of the body; taking care however to supply the circulation with liquids proportional to the waste. By such means his system will gradually accustom itself to the climate, the organs of perspiration adapt themselves to the increased heat, and the dangers of sudden change be averted.

The perspirable matter of the European, does not appear to be well fitted to the torrid zone. Consisting nearly of pure lymph, it is speedily dissipated by evaporation, and without a profuse discharge, the surface cannot be kept moist and cool. On the other hand, the profusion of the discharge debilitates the system, and renders even the cold of evaporation dangerous, especially when this evaporation is increased by an accidental breeze, or the effect of the cold promoted by rest after fatigue. The negro, fitted by nature to the climate, is less accessible to the stimulus of heat, and his unctuous sweat less easily dissipated, keeping his skin uniformly moist, sustains a more uniform perspiration as well as evaporation, and guards the system against the waste

waste and danger of profuse sweating under fatigue, as well as the other consequences already explained. The pungent and stimulating quality of his perspirable matter will promote these salutary effects. In this view of the subject, it may be worthy of investigation, whether the practice of the ancients of using unguents on the skin, still general among the eastern nations, and common among all savages, whose defective cloathing obliges them to guard by this means against the vicissitudes of temperature, should not be revived by our countrymen in the West Indies. It has been imagined, that those unguents effectually obstructed the perspiration; but this notion has been adopted without inquiry, and against probability. These unguents, like the perspirable matter of the negro, may be formed of a consistence, that while it retards excessive sweating, does not obstruct moderate and necessary perspiration, and being themselves evaporable, they may keep up a coolness that shall diminish the necessity of the natural discharge. In the warm climates the tepid bath seems a necessary adjunct to inunction. It has been for some time used among the French in the West Indies, and is now, (as we are informed) beginning to be adopted by the English; and with proper restrictions, it may produce the happiest effects. After exercise, under a burning sun, when the strength is wasted by fatigue and perspiration, immersion in the bath
heated

heated from 90° to 95° of Faht. will be found most grateful and salutary. It restrains the profuse and colliquative sweating, keeps up the heat of the surface and extremities, and prevents the dangerous re-action of the centre, which a torpor of the extremities so generally produces. It allays the violent action of the heart and arteries, and soothes the system of sensation. On leaving the bath, friction, and inunction of the surface prevent the chill of evaporation, and while they ensure the safety of the practice, they prolong this classic gratification. The refinement of modern manners has introduced linen teguments next the body, and abolished inunctions of the surface. Hence the warm bath has become less safe, as opening the pores of the skin, and exposing the naked body to the chills of evaporation; and thus through the greater part of Europe it no longer forms a part of the regimen of health. In the east it still prevails. If it should be revived among our countrymen in the west, they must conjoin with it the inunctions of the surface, and the fine flannel teguments next the skin, which accompanied its use among the Greeks and Romans. In recommending a trial of unguents to the enlightened practitioners of the torrid zone, I may shelter myself under the authority of the celebrated Lord Verulam, unquestionably the first physician, as well as the first philosopher and statesman of the century in which he

he lived. “ *Inunctio ex oleo, et hyeme confert ad san-*
nitatem, per exclusionem frigoris, et æstate, ad deti-
nendos spiritus, et prohibendam exolutionem eorum,
et arcendam vim aeris, quæ tunc maxime est præda-
toria. Ante omnia igitur usum olei vel olivarum vel
amygdali dulcis, ad cutem ab extra unguendam, ad
*longævitatem conducere existimamus.**

The operation of unguents on the surface of the body, presents indeed a subject for important and original observation. The effects of the warm and tepid bath, though more investigated, are scarcely better understood; for perhaps there is no part of medicine on which so much has been written, and so little been decided. These subjects are connected together, and might form, with great advantage, part of an experimental inquiry into the laws of animal heat. The commonly received opinion, that the warm bath relaxes and enfeebles the system, must, I apprehend, be admitted with many restrictions. Immersed in water, or in air, heated to the degree that quickens the

* See *Fran. Bacon. Opera fol. Francofurti ad Moenum, 1665. p. 536, 537. 538*, where the practice of various nations respecting unguents, is considered at some length, and the cautions requisite in adopting this practice, least the body should be overheated, &c. are very ingeniously detailed.

the circulation, we are doubtless speedily enfeebled. But by a heat short of this effect, it may be disputed whether debility is ever produced. The degree to which the bath must be heated in order to quicken the circulation, approaches nearly to that of the blood. In my own case, I have found the pulse became more frequent at 96° . when the stomach was empty, but at 94° after dinner; and the practice said to have been adopted by the ancients of going into the hot bath to relieve themselves from the oppression of an over-loaded stomach, would appear to me to have been attended with some hazard, and with great inconvenience. It does not indeed appear how the desired effect was obtained, except through the means of profuse perspirations. In future experiments respecting the effects of the warm bath, it will be of importance to notice the heat at which the sensible perspiration begins to flow; which probably varies a good deal in different constitutions, and which as it varies, will materially affect the results. It will be important also to notice the state of the stomach as to fullness; the condition of the pulse; the previous degree of exercise; and the actual heat of the surface; all of which, according to my observation, will influence the experiments.

In all inflammatory diseases, it is of importance not to use the bath heated to the degree that
materially

materially quickens the circulation : where this is not attended to, the symptoms are inflamed, unless a speedy and profuse perspiration ensues. In the degrees in which it does not quicken the circulation, the warm bath is soothing and sedative, especially when the immersion is prolonged ; and it is the temperature from 95° . to 90° . that is so singularly restorative after fatigue, though a still lower heat is safe and refreshing, as those who have used the baths of Buxton can testify.—The warm bath is frequently employed to excite a sensible perspiration, which may be prolonged after leaving it ; and in this way it may be used with great advantage. Where this object is in view, it is advisable to immerse the patient in the water heated to 94° . or 95° . and very gradually and slowly to increase the heat to 97° . or perhaps 98° , watching its effects. When the sweat begins to appear on the forehead, if the pulse remains calm, and the patient feels at ease, an increase of heat to 99° . or even 100° . may be ventured on with safety, if profuse perspiration be required. But when the bath is heated *in the first instance* to 100° . the stimulus of heat produces a feverish circulation, which the subsequent imperfect perspiration cannot allay. The injurious effects are still greater where the bath is heated at first to 105° . or upwards, and sweat, instead of flowing more freely in consequence of the increased temperature, is discharged

discharged with greater difficulty, the stimulus of the heat, and the suddenness of its application, inducing a contraction of the orifices of the extreme vessels of the skin. In this respect, as in most others, the analogy is perfect between the stomach and the surface; for it will uniformly be found, that perspiration is excited more freely by draughts of *tepid* liquor, than an equal quantity of the same fluid swallowed as hot as it can be borne.

The sensible perspiration excited in the warm bath, does not lower the temperature of the body while immersed, but being prolonged afterwards, it becomes powerfully refrigerant, and is a remedy of great efficacy. But these observations shew the importance of regulating the temperature of the warm bath by the thermometer, and demonstrate how little dependance can be placed on the observations of those writers who speak of its effects without noting its temperature. A variation of two or three degrees, often impossible to be ascertained by the sensations, will not merely vary the degree, but alter the nature of its effects.

The view given of the nature of fever, and of the functions of the perspiration, seems to afford an obvious explanation of the operation of those antimonial emetics, and sudorifics, by the early exhibition of which, fevers are often stopped in
their

their first stages. The direct action of these medicines on the stomach resolves the spasmodic stricture of the capillaries of that organ and of the surface, by which the morbid heat is confined; while the concussion given to the whole system, dissolves the morbid catenation, and terminates the disease. These remedies are however uncertain in their beneficial effects, and always highly debilitating. They cannot enter into competition with the affusion of cold water on the surface, but may be employed when the presence of local inflammation precludes the use of that powerful remedy.

These general views cast some light also on that most curious subject, the operation of opium on the living principle. In former times it was disputed whether opium was in its nature cold or hot; in our own days it has been disputed whether it is stimulant or sedative. Such abstractions afford exercise for the ingenuity, but in the way in which they have been conducted, they soar above utility and truth. Opium relieves pain, and produces sleep, and these effects being in general concomitant, may be treated of together. But though opium in general produces sleep, yet we are sometimes disappointed in this effect, and especially in those feverish disorders where sleep is of such high importance. About nine years ago, I attended a boy of ten years of age, the son of a friend, dan-
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gerously

gerously ill of fever. His nights had been sleepless, and the general irritation was very great. Opium had been administered in vain. I determined to give it in larger quantities, and to watch its effects. At ten at night he took forty drops of laudanum; at twelve the same dose was repeated. As I stood by his bed two hours afterwards, he appeared in an imperfect and agitated sleep: his eyes were half open, his face was livid; his lips and skin parched; he was evidently much disturbed, and moaned in his breathing. At this time I perceived that he had tossed the cloaths off his feet, which lay naked; and that he grasped the cold bed-post with one of his hands. On examining his hands and feet they felt dry and burning. There was tepid vinegar in the room, and I moistened first his hands, and then his feet with it, without awaking him, repeating this practice from time to time: he became more quiet. Thus encouraged, I gradually moistened his legs and thighs in the same manner, and at length his breast and neck, and removing the rest of the bed-clothes, left him covered with a sheet only. In a little while the agitation subsided, and he sunk into a sound, and seemingly peaceful sleep, which continued several hours, the surface of his body being bedewed with a gentle perspiration.

This interesting case pointed out to me clearly
that

that the sedative effects of opium are often counteracted by the stimulus of heat on the surface and extremities, and that the actual state of the heat of the patient is a circumstance requiring particular attention in the administration of this powerful remedy. The following observations are the result of the inquiry which these reflections suggested.

Opium given in health generally produces sleep, *if the mind be vacant, the stomach empty, and external impressions be excluded.* In this case, its first effect is to increase the sensibility, to give a gaiety and liveliness to the imagination, and to diffuse a genial glow over the surface and extremities. The actual heat of the trunk of the body is little if at all increased, but the surface and extremities are brought up to the general temperature, (97° or 98°) and a gentle, and as it has been called a breathing perspiration is diffused over the skin. In this state we sink into those happy slumbers which are ill exchanged for the realities of life. On the approach of sleep, the pulse is generally increased in frequency by four or five pulsations in the minute, and the respiration is slightly irregular, as in the gentler degrees of pleasurable emotion; but as the sleep becomes fixed and profound, the pulse subsides to its slowest and most tranquil state, and the respiration becomes regular, deep, and rather slower than natural. The various circumstances that prevent

vent this favourable operation of opium, even in the state of health, it is not our purpose to consider at present.

When opium is given in fever, if the heat be two or three degrees or upwards above the natural standard, and the skin dry, it seems very generally to increase the heat and restlessness. There are exceptions. If the heat, though præternaturally great, is subsiding, and the skin beginning to soften, though not yet moist, opium very often accelerates the perspiration, and by this means diminishes the heat. In such cases its salutary effects generally follow—tranquillity and sleep. Thus it will happen, that an anodyne draught given early in the evening shall occasion increased heat and agitation, which if deferred till two or three in the morning would have produced perspiration and repose. In the evening the exacerbation of fever is on the increase or at its height, which towards morning is subsiding, the difference in the actual heat of the surface being often not less than two degrees or upwards. A dose of opium given in the hot stage of intermittent fever, will often accelerate the sweating stage and shorten the paroxysm, which under similar circumstances in continued fever, has a contrary effect; because in the former case the disposition to perspire is more easily excited. But even in intermittent fever, opium when given in the
hot

hot stage, will be much promoted in its diaphoretic and salutary effects, by moderate draughts of tepid, or if the heat be great, of cold liquids. In continued fever where the heat is great and the skin dry, it is proper to lower the temperature of the surface, and if possible to excite sensible perspiration before opium is administered, if we wish to ensure its diaphoretic and soporific effects. But even after opium has been exhibited, when the inordinate heat prevents its sedative operation, it will be found safe and salutary to use the tepid or cold affusion; and when the heat is by this means reduced, repose and sleep will follow. Tepid or cold drink will produce, though in a weaker degree, similar benefit. These methods of promoting the diaphoretic effects of opium, seem more certain and advantageous in fever, than the practice of combining it with ipecacuanha or the preparations of antimony; but where opium is to be used in inflammatory diseases, or in dysentery, doubtless this last method is to be preferred. These remarks must be considered as applying to opium in its ordinary doses, that is, from half a grain to two or three grains of the extract, or from ten to sixty drops of the tincture. Perhaps it has been too much the practice of late to give this medicine in large doses, and to overlook its effects in smaller quantities. Experience has convinced me that considerable effects are produced on the system by a very few drops of the tincture properly

properly administered, and that it is always unwise to employ it in doses larger than necessary to produce the desired effect.

The effects of alcohol (under which term I comprehend the spirituous and vinous liquors) on the system, have a striking resemblance to those of opium. Alcohol is more heating, less diaphoretic, and less soporific. When however *the mind is vacant, the stomach empty, and external impressions excluded*, alcohol like opium has a tendency to induce sleep. As sleep however approaches, the heat of the body rises, especially on the surface and extremities, and stimulating the heart and arteries to increased action, produces a state of agitation with which sleep is often incompatible. Or if the dose has been such as to benumb the senses, with the first return of sensibility the inebriate is roused by intolerable heat from his apoplectic slumbers. The degree of heat in the fever of intoxication is doubtless various in various constitutions. I have observed it to rise to 105° , nearly the highest degree of heat in the typhus of this island; and Dr. Alexander in his own case, found it as high as 107° .—Under these degrees of heat, the thirst, agitation, and consequent debility are very considerable, the skin being in general obstinately constricted. The proper treatment in this, as perhaps in all other cases of morbid heat and dry skin, when local inflammation

mation is absent, is to pour large draughts of cold water into the stomach, or to affuse it on the surface. By this practice the heat is reduced, the orifices of the skin opened, sensible perspiration is produced, and one of half the mischief of intoxication is prevented. Similar effects may be produced, though in a weaker degree, by tepid drinks or the tepid affusion.

The administration of alcohol in fever requires similar precautions as that of opium. It should not be given when the heat is great and the skin dry and burning; but it may in general be given with great safety and advantage, when the heat is nearly of the natural standard; and even when it is somewhat above it, if the orifices of the skin are open and the surface is moist. Opium, as was before remarked, is more sudorific than alcohol, and given in that stage of the fever of intoxication in which the skin begins to relax, it often accelerates sensible perspiration, and sometimes occasions it, when it might not otherwise have taken place. In this way I explain a phenomenon which has occurred to others as well as to me, that a moderate dose of opium sometimes gives extraordinary relief to the drunkard, under the sufferings through which he must pass to sanity and strength.

These observations are not offered to the reader
as

as including a complete view of the subject of which they treat. My principal object has been to establish the use of a new and powerful remedy in fever, and the general remarks and reasonings which are added, are chiefly with a view to explain its operation and enforce its safety. As however these additional observations are on subjects of great importance, it is my intention at some future period to resume them. In the mean time, it may be objected that in this rapid sketch assertions are sometimes given instead of experiments and proofs. In such cases however, it will be found that the points at issue may be readily brought to the test of experiment; and as general and obscure expressions are every where avoided, it will be easy to refer to this trial; a circumstance which will procure from candid minds a patient hearing, as well as forgiveness for those errors into which I may have involuntarily fallen.

I have only to add, that the application of cold under any form, where fever is combined with local inflammation, I have purposely avoided to discuss. It is a subject of much difficulty, and must wait for the elucidations of future experience.

CHAP. XVI.

Population of Liverpool.—Prevalence of fever among the poor, with documents.—Benefit derived from the Manchester House of Recovery in contagious diseases.—Propriety of the general adoption of similar establishments.

THE Typhus, or low contagious fever, prevails in all large cities and towns to a degree that those are not aware of, who have not turned their attention to the subject, or whose occupations do not lead them to mix with the labouring poor. In Liverpool it has been supposed that this disease is seldom to be met with, and it is certainly true, that the upper classes of the inhabitants are not often subjected to its ravages.* It has never, in the last

D d

sixteen

* “ Such is the general healthy state of the town, that infectious fevers are *never known to prevail*, and it is very rare to hear of a person dying of a fever of any sort.”

Liverpool Guide, p. 134.

sixteen years, spread among the higher classes so as to occasion any general alarm; and when the extent to which it is constantly present among the poor, shall be proved by authentic documents, this circumstance will serve to demonstrate the narrow sphere of the contagion, and to shew how much it is within the limits of human power to extirpate the disease. Before we produce these documents, it will be proper to offer a few general observations.

The population of Liverpool, as taken by actual enumeration, amounted on the first day of January 1790, to nearly 56,000 persons, and admitting the increase since that time to be in the ratio of preceding years, it would now (October 1797) exceed 63,000. But as the progress of the town has doubtless been checked by the war, something may be deducted from this last number; though we shall probably be under the truth in fixing it as low as 60,000.* Of the inhabitants of Liverpool, it

* The enumeration mentioned, was made by Mr. Makin Simmons, and published in Mr. Gore's directory in the year 1790, but omitted in the last edition. It occupied him three months, viz. from October 13th, 1789, to January 13th, 1790, and was executed with great care and accuracy. Mr. Simmons gave the population of each street separately, enumerating also the front houses, back houses or cottages, and the

it is ascertained, that about 7,000 live in cellars under ground, and nearly 9,000 in back houses, which in general have an imperfect ventilation, especially in the new streets on the south side of the town, where a pernicious practice has lately been introduced of building houses to be let to labourers, in small confined courts, which have a communication with the street by a narrow aperture, but no passage for the air through them. Among the inhabitants of the cellars, and of these back houses, the

inhabited cellars, with the number of persons in each of these descriptions of habitation. The general result was as follows.

Front houses	6540, containing	39,118 Inhabitants.
Back houses or Cottages	} 1608, containing	7 955 Inhabitants.
Inhabited Cellars		
The Workhouse and different Charities,		1,879

In all, 55,732.

There were besides }
empty houses } 717,

Making in all 10,593, Houses, or if the Cellars be
Deducted 1,728, 8865, will be the number.

There is no town of an equal size in the kingdom that possesses (as far as I have heard) so authentic a document of its population. The numeration of Mr. Simmons fell short of what many supposed to be the number of our inhabitants; but popular calculations on this subject always exceed the truth—perhaps not less in general than by a fourth part. The popular calculation of the inhabitants of Liverpool, compared with other towns of which there is no accurate enumeration, may be taken at 75,000.

the typhus is constantly present, and the number of persons under this disease that apply for medical assistance to the charitable institutions, the public will be astonished to hear, exceeds 3,000 annually.*

The public charitable institutions in Liverpool for the relief of the sick poor, are the Infirmary and the Dispensary. Fevers, by one of the original rules of the Infirmary, are excluded from that hospital, though this rule, as may be seen from the narrative with which this little volume commences, has been occasionally departed from. But with a few exceptions, the care of the poor in fever falls on the Dispensary. Of this institution I was for several years one of the physicians, and such of my observations respecting it as are not supported by authentic documents, are founded on personal observation. Unless in cases where they are removed into the Infirmary, the care of almost all the

* From the first of January 1787 to the last of December 1796 inclusive, a space of ten years, it will appear by the table which follows, that 31,243 cases of fever were admitted on the books of the Dispensary alone, which on an average, is 3124 yearly. If it be supposed that some cases may be denominated typhus by mistake, let it be considered, how many cases of this disease do not appear on the books of the Dispensary, though occurring among the poor, being attended by the surgeons and apothecaries of the benefit clubs to which they belong, &c.

the inhabitants of cellars when sick, and of a great part of the inhabitants of the back houses or cottages, devolves on the physicians, surgeons, and apothecaries of the Dispensary. This description of persons, amounting in all to about 16,000, do not appear to be healthy, the number of cases admitted annually on the books of the Dispensary, on the average of the last ten years, exceeding 13,000. In the commencement of the year 1780, a register of these cases was begun by Mr. Avison, late apothecary to this charity, and continued by him to the summer of the present year, when he terminated a life of spotless integrity, singular usefulness, and incessant exertion*. From this valuable record I have formed the following table.

GENERAL

* I insert the diseases of September 1790, extracted from the Register, which at the same time will convey a specimen of our most prevailing diseases, and shew that inflammatory and symptomatic fevers are not included under the general title of fever.

<i>September 1790.</i>					
Febris	310	Catarrhus	24	Debilitas	19
Ophthalmia	59	Dysenteria	2	Hydrops	8
Cynanche	13	Cephalalgia	10	Scrophula	11
Pneumonia	28	Apoplexia		Rachitis	
Hepatitis		Paralysis	4	Syphilis	24
Gastritis		Dyspepsia	21	Icterus	1
Phthisis	19	Epilepsia	1	Dysuria	5
Rheumatismus	52	Asthma	16	Vermes	5
Erysipelas	8	Pertussis	11	Pfora	142
Variola		Colica	24	Partus Difficilis	1
Rubeola	29	Cholera	24	Urtio	14
Scarlatina		Diarrhoea	24	Ulcus	61
Aphtha	13	Hysteria	4	Vulnus	89
Hæmorrhoids	3	Convulsio	2		
Hæmorrhagia	4	Infania	1	Total	1093

GENERAL TABLE,

Shewing the number of Patients admitted on the books of the Liverpool Dispensary from the first of Jan. 1780, till the last of Dec. 1796, a space of 17 years, distinguishing the numbers of each year, and of each month of every year.

Year	Jan.	Feb.	Mch.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1780	890	888	1147	995	827	805	787	672	557	825	730	855	9978
1781	893	755	1074	1028	940	846	951	889	981	1212	1081	1099	11749
1782	1106	1041	1150	1243	811	1605	686	619	722	736	704	760	11183
1783	975	858	1199	1232	1096	1035	1064	1062	1050	1094	992	966	12623
1784	738	915	976	969	968	934	895	877	929	934	1055	1009	11199
1785	1092	1075	1124	1082	992	1015	856	850	1005	1057	882	885	11915
1786	982	760	1117	969	986	791	816	1010	930	895	858	959	11100
1787	1092	881	1060	1015	1041	964	820	821	868	848	958	900	11268
1788	1022	960	882	1002	944	903	916	1115	1009	927	951	1140	11771
1789	1415	1053	1044	1153	1113	1070	1123	930	1017	908	982	1095	12903
1790	947	1052	1361	1123	1152	1098	1039	1001	1093	1175	1162	1034	13237
1791	1223	1126	1323	1118	1176	1166	1091	1112	1241	1257	1274	1093	14200
1792	1307	1302	1427	1277	1159	1353	1106	1013	985	1343	1143	1030	14444
1793	1088	1037	1188	1228	1247	1065	1077	1065	1128	1335	1215	1159	13832
1794	1051	1175	1170	1138	1112	1105	1066	1089	1160	1022	1306	1273	13667
1795	1298	1369	2003	1171	1209	1151	1266	945	1064	1259	1300	1200	15235
1796	1120	1141	1230	1402	1030	988	948	918	934	1087	967	1236	13001
	18239	17388	20475	19172	17803	17894	16507	15988	16673	17923	17560	17093	213,305

By the foregoing table it appears, that the number of patients admitted under the care of the Dispensary annually, taking the average of the last seventeen years, is 12,548. But if the last ten years only be taken, the average number will be found to be 13,355. It appears that the greatest number of patients admitted in any one year, was in 1795, amounting to 15,235, exceeding the average of the last ten years by 1880; and that the smallest number admitted for the last seven years, was in 1796, falling short of that average by 354, and of the number admitted in 1795, by 2234. When it is considered that the difference between these two years falls chiefly in the winter and spring months; that the winter and spring of 1795 were the coldest, and those of 1796 the mildest, experienced in our climate for a long series of years; these striking facts corroborate the statements of Dr. Herberden, in proving that the common opinion, which supposes a mild winter in our island to be unhealthy, and a severe winter to be favourable to health, is in both particulars the reverse of the truth. It appears also, that though the number of patients in the winter months of 1794-5, greatly exceeded the general average, yet it was in February, and more especially in March, that the excess rose so very high; on this last month the astonishing number of 2003 patients having been admitted. In the three preceding months the cold had

had been intense, but in March the weather became warmer, uncertain, and stormy. Hence it appears, that though intense cold is directly unfavourable to the health of our poor, yet that it is in the transition from this intense cold to warmer weather, that their constitutions sustain the severest shock ; a position that is still more fully supported by the decisive evidence that the month of March is the most unhealthy of the year, and next to it the month of April, taking the average of seventeen years together. On the same evidence we may state the succession of the months in respect to their unhealthiness in the following order—*March—April—January—October—May—December—November—February—June—September—July*—and *August*.* But though on the whole, summer and autumn are more healthy than winter and spring, the difference is perhaps less than might have been expected ; and the difference even between the two months that forms the extremes, is not very great. In the seventeen years recorded in the table, the average number of patients for each month of the whole is 1045 ; the average number

* It appears that June stands in the table higher than May or December, but this arises from the vast number admitted in June 1782, when the influenza was prevalent, and was confined nearly to that month. Allowance being made for this, June will stand as inserted.

number in the month of March is 1204; in August 940. These observations however are strictly applicable only to a particular description of persons in a particular situation—to the poor of Liverpool—and without the corroboration of other documents, must not be extended to the general mass of society, or to the kingdom at large.

I proceed to give, from the same authentic register, the table of typhus, the more immediate object of our inquiries.

E E

A TABLE

A TABLE,
 Shewing the number of Fevers admitted on the books of the Liverpool Dispensary from the first of January 1780,
 to the last of Dec. 1796, inclusive; distinguishing the numbers admitted every year, and each month of every year.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1780	150	125	179	173	168	183	191	150	129	186	150	133	1917
1781	130	146	180	200	187	154	157	127	167	234	208	223	2113
1782	268	265	231	292	148	159	120	140	143	182	150	158	2256
1783	210	158	184	207	222	212	286	227	265	316	257	273	2817
1784	170	194	245	247	232	225	270	230	266	247	369	297	2992
1785	285	268	296	294	219	187	173	180	186	250	244	182	2764
1786	191	166	216	244	202	155	159	188	169	211	167	197	2265
1787	256	209	301	234	313	356	255	192	218	234	283	326	3177
1788	236	174	213	255	253	245	271	311	258	341	315	295	3167
1789	319	176	338	323	391	205	184	162	212	214	204	208	2936
1790	176	248	337	294	281	247	343	270	310	340	355	269	3470
1791	253	247	277	230	233	240	266	248	300	344	335	371	3344
1792	359	361	269	278	261	237	236	223	211	330	212	174	3151
1793	174	209	221	259	237	334	199	197	338	305	224	228	2925
1794	157	230	383	280	337	305	291	245	303	290	258	326	3405
1795	152	265	546	204	234	230	248	159	196	239	317	180	2970
1796	197	161	266	242	288	176	203	182	254	329	153	247	2698
	3683	3602	4682	4256	4206	3850	3852	3431	4025	4592	4201	4047	48367

Thus it appears, that of 213,305 patients admitted in seventeen years at the Dispensary, 48,367 have laboured under typhus; nearly a fourth of the whole; an immense proportion! It is curious to observe, that March takes the lead in respect to the prevalence of fever, as well as of diseases in general, and that August, as before, brings up the rear. It appears also that the month of March 1795, which exceeded every other month in the production of diseases in general, exceeds in a still greater proportion in the production of fever; no less than 546 patients, having been admitted in that month under this single disease. The year 1795 has not however the same unfortunate pre-eminence here as in the table of general disease, being surpassed in the number of fevers by several others. But the year 1796 enjoys a similar distinction as formerly, having produced fewer fevers than any other of the last ten, and 545 fewer than the average of the whole. Taking the seventeen years in the table, the average number of fevers annually is 2845, and the average number monthly is 237. The average number of March rises to 275, and of August, sinks to 202. On the whole the prevalence of fever is greater, and the influence of seasons upon it less, than might have been expected.

For the last ten years there have been, on an average, 119 patients ill of fever constantly on the books

books of the Dispensary ; or if the last seventeen years be taken, the constant average number will be 109. Of convalescents, unfit for labour, the average number will be nearly as great. Thus, in Liverpool, 240 of the poor may be considered as constantly rendered incapable of earning their subsistence by this single disease ; and as the poor seldom lay up any part of their earnings for a season of sickness, the expense of their maintenance must, in one form or other, fall on the public. If we take this as low as 10l. for each, it will amount to 2400l. annually.*

It would afford me particular pleasure to introduce authentic documents of the success attending the treatment of the typhus by my brethren of the Dispensary ; but the valuable register which furnished

* These calculations will not be expected to be minutely correct, but I apprehend they will in general be found under the truth. The average number of fevers annually for the last ten years, is 3124, and the mean duration of each fever is supposed to be fourteen days ; $\frac{3124 \times 14}{365} = 119.8$ daily. If the average of the last seventeen years be taken, this will give 2845 annually, which produces on the same principles 109 daily. I calculate that the period of convalescence after each fever is fourteen days, or upwards, which gives the same number of convalescents as of patients in fever, deducting those who may die, a much smaller proportion than could well be supposed.

nished materials for the preceding tables does not mark the issue of the particular cases. In general however it may be asserted, that where the assistance of the Dispensary is resorted to in time, even under the disadvantage of being attended in confined and dirty habitations, a great proportion of cases terminate favourably. The general treatment of fever at the Dispensary, consists in giving antimonial emetics in the first instance, and afterwards bark, opium, and wine. Nourishing food is occasionally administered. Ablution with cold water has seldom been used, and indeed it is in general difficult, if not impossible, to employ it in the obscure cellars in which this disease is usually found. The fever that prevails among our poor is remarkably uniform; it is the pure typhus, to which the cordial treatment can be applied with safety, and to a great extent. Whereas among the higher classes, fever is often attended with inflammatory symptoms in the first instance, sometimes with pneumonic symptoms through a considerable part of the disease; and in such cases the indications of practice being contradictory, success is much less certain.

Though the cure of this disease is a principal object of our charitable institutions in Liverpool, it is to be lamented that little or nothing has been done for its prevention; although it may be confidently

confidently asserted, that this object, great as it is, is not beyond the reach of human power.— This infection arises from a want of cleanliness, and ventilation; and its influence is promoted by damp, fatigue, sorrow, and hunger. When the subject shall be seriously taken up by the public, the means of securing cleanliness and ventilation even in the greater part of our subterraneous dwellings, may be clearly pointed out, and though the secondary causes, if I may so call them, seem less capable of being removed, yet much may be done to alleviate them, when a comprehensive inquiry into the condition and wants of the poor (the most pressing of all objects in the eye of enlightened patriotism) shall engage the attention of the legislature.*

Important

* The want of a diet sufficiently nutritious, is doubtless one of the causes that promote the typhus, and other diseases, among our poor. This does not seem to arise in general from the price of their labour being inadequate to furnish such a diet, but from their ignorance in the most advantageous modes of cookery, and still more from their indulging in articles that consume their means without adding to their sustenance. In the eighteen hundred cellars in Liverpool, there are many in which animal food is not tasted more than once a week; but there are very few in which tea is not drunk daily; it is often indeed drunk twice a day. The money spent on tea is worse than wasted. It is not only diverted to an article that furnishes no nutrition, but to one that debilitates the empty stomach, and incapacitates for labour. Hence the vast number of dyspeptic complaints among our patients

Important information in regard to the means of preventing the generation and progress of contagion, may be found in the writings of physicians of our own county and neighbourhood; of Dr. Percival and Dr. Ferriar of Manchester, of Dr. Campbell of Lancaster, and of Dr. Haygarth of Chester. The persevering exertions of Dr. Percival, Dr. Ferriar, and the other gentlemen of the faculty attending the Manchester Infirmary, have produced an institution in that town, which deserves to be imitated in every large city and town in the kingdom; a house of reception, or as it is justly called, a House of Recovery for the poor, when labouring under fever. Into this asylum, on the first notice of the disease, the patient is immediately removed, and proper methods taken to purify his habitation. By these means the contagion is extinguished in its birth; and the patient himself being removed to a situation where all the resources of art can be employed with advantage for his benefit, and removed at a period of the disease when these resources are of great avail, is very generally restored in health to his family and to the community.

The

at the public charities, which are almost all to be traced to the use of tea or spirits, often indeed assisted by depression of mind. At the Infirmary and Dispensary together, this class of patients exceeds five hundred annually. The great majority are females.

The benefits of this admirable institution in Manchester, no longer rest on the basis of theory; they are established on the immovable foundation of fact and experience. The prevalence of fever in the town is diminished to a degree that has exceeded all rational expectation; and the fears entertained, that the House of Recovery might spread the contagion through the streets in its vicinity, are found to be entirely groundless.*

The

* The following facts are extracted from the report of the *Board of Health*, dated *Manchester, May 26th, 1797*. Since the establishment of the *House of Recovery*, the whole number of home patients (i. e. patients requiring attendance at their own habitations) is reduced *one half*; but the number of fever cases, in a far greater proportion. In January 1796, 226 cases of fever were admitted at the Infirmary of Manchester, but in January 1797, only 57. Fears had been entertained that the fever might spread from the House of Recovery into the neighbouring buildings, and so through the town, and this had given rise to a considerable opposition. The streets in the immediate vicinity of the House of Recovery, are Silver-street, Portland-street, &c. In the first eight months *after* the establishment of the House of Recovery, the number of cases of fever admitted on the books of the Infirmary from these streets was 25. In eight months of the preceding year, viz. from the 20th of September 1795, to the 20th of May 1796, the same streets furnished 267 cases of fever. From the 20th of Sept. 1794 to the 20th of May 1795, they furnished 389 cases; and from the 20th of Sept. 1793 to the 20th of May 1794, 400 cases. Facts such as these, require no comment; they have made a forcible impression in Manchester, as

The utility of the House of Recovery in Manchester has been still more completely ascertained in the course of the present summer.—“ Within “ this last four months (I copy a paragraph in a letter from Dr. Ferriar) “ we have been threatened “ with the return of an epidemic fever, and dan- “ gerous cases of typhus have appeared in every “ quarter of the town; yet by selecting those pa- “ tients who were, from their symptoms and situa-
F F “ tion,

might be expected, and the Report I quote contains public testimonies in favour of this excellent Institution from the *Board of the Infirmary*, the *Stranger's Friend Society*, and *The Special Board of Overseers of the Poor*. The total number of fever-cases received into the House of Recovery from its being opened, the 19th of May 1796, to the 31st of May 1797, is,

	371
Of these are discharged cured,	324
Dead,	40
Remaining,	7
	— 371.

The benefit of this institution is not to be calculated by the number of persons cured. Every single removal into the House of Recovery, probably prevents on an average two or three cases of the disease. As the institution goes on, it may be confidently predicted, that the proportion of cures will be still greater than here stated, because experience will induce the poor to apply for relief in the early stages of fever, when the power of medicine may be exerted with the greatest advantage. I have the authority of Dr. Ferriar for saying, that since the 31st of May to the 25th of September, two persons only have died in the House of Recovery.

" tion, most likely to communicate infection, and
 " by removing them into the fever-ward, the week-
 " ly list of home-patients has been prevented from
 " increasing much beyond their usual number.
 " Our House of Recovery, which contains accom-
 " modations for twenty-eight patients, is sufficient
 " for Manchester at present. In the event of a
 " peace, and the influx of new inhabitants which
 " it must occasion, it may be necessary to provide
 " accommodation for a greater number. But I
 " think fever-wards capable of containing fifty pa-
 " tients, with separate rooms for the reception of
 " cases of *Scarletina Anginosa*, *Measles*, or *Small Pox*,
 " would answer every purpose here, in times of the
 " greatest emergency, even supposing a very con-
 " siderable increase of population."

'Till the latter end of the year 1787, there was
 no place for the reception of fever, or any other
 contagious disease, in Liverpool. At that time the
 fever broke out in the Infirmary, described in
 page the sixth of this volume, and two wards being
 fitted up for the patients infected, one for each
 sex, these were afterwards occupied by such cases
 of fever as occasionally presented themselves. The
 reception of fever into these wards continued for
 five years and one month, during which time 232
 cases of fever passed through them. The wards were
 small, and under ground; in every respect incon-
 veniently

veniently situated. They held at most eight beds each, but were properly adapted to six beds only. But they admitted of cleanliness and ventilation, and it was there that an opportunity was afforded of employing the affusion of cold water ; of remarking its effects ; and of establishing the rules that ought to regulate its application.

From the first however, the admission of fever into the Infirmary, (which was contrary to one of the original rules of the institution) was objected to by some of the friends of that charity. They allowed the benefit arising from a receptacle for fever, but they contended that the Infirmary was not adapted to that purpose ; and that the attempt to render it a hospital for fever, the wards already mentioned being all that could be allotted to that disease, did not afford the relief required, while it obstructed the original purposes of the institution. The want of an asylum for this disease elsewhere, overcame these objections. But about the beginning of 1793, a contagious fever having prevailed in the work-house, two spacious wards were fitted up in that building by the Parish Committee, for contagious diseases ; and an arrangement having been made for the reception of such cases of fever as presented themselves at the Infirmary into the wards of the work-house, from that time the admission of fever into the Infirmary has ceased.

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The wards for fever at the work-house, have secured that immense hospital, often containing 1200 persons, from the spreading of fever, to which, previous to their establishment, it was perpetually liable; and though they are in the very centre of the building, and cannot be entered but through the common stair-case, yet no single instance has occurred of the contagion extending from them into the other parts of the house. They have also relieved the Infirmary from the necessity of admitting those miserable wretches, who, under the influence of fever (perhaps caught on ship-board) and refused admittance into private lodging, were brought up to that hospital, where, if not received, they might have perished in the streets. But they have not been of sufficient size to answer the purpose of a general House of Reception for the poor labouring under fever throughout the town, nor has their power of accommodation been employed to its full extent with this view.* The physicians of the Dispensary who attend the work-house, have authority

* These fever wards contain eighteen beds very conveniently, and from the 20th of August 1793 to the 31st of August 1797, a space of four years, only 530 cases have passed through them. They have not therefore on an average contained more than six fever-cases at a time. Of these 530 cases, 51 have died, a small proportion, considering that 16 died in 24 hours after admission, and were in *articulo mortis* when received.

authority to remove patients on the first appearance of fever, from any part of the workhouse itself, into these wards ; but they have not the same authority to remove them from the town. The delay occasioned by the forms to be passed through in obtaining the admission of these patients, has very generally prevented the attempt being made, and sometimes where it has been made and succeeded, has occasioned the relief to come too late.

In consequence of considerations of this kind, a motion was made at the annual vestry in March 1796, that a set of fever-wards should be constructed at the expense of the parish, for the general use of the poor, on the plan of the Manchester House of Recovery. Two wards, each capable of containing twenty beds, were stated to be sufficient for the town ; it was proposed that they should be erected on the elevated and open ground contiguous to the work-house, and be supported out of the parish rate. And it was asserted that this would be a plan, not merely of charity, but of œconomy. The measure of establishing fever-wards was unanimously agreed to, and a committee appointed to carry it into effect ; but differences of opinion having arisen as to the execution of the plan, all proceedings on the subject have been suspended. It is earnestly to be hoped that they may speedily be resumed.

Contagious

Contagious diseases, and more particularly fevers, have in general been excluded from the hospitals of England ; but the evidence of our own Infirmary and work-house, of the Chester Infirmary, and of various similar institutions, proves, that under proper regulations they may be admitted under the same roof with other diseases, without any danger of the infection spreading through the building. It is not however to be denied, that the attendance and the arrangement requisite for patients under fever, render it a matter of convenience and propriety that they should be received into a separate building ; and it is a point capable of demonstration, that hospitals for such diseases stand pre-eminent in point of utility over all other hospitals, those for accidents that require the immediate assistance of surgery, alone perhaps excepted. The benefit derived from hospitals in other cases consists in removing disease, and is confined to the patient himself ; but in cases of contagion, the evils prevented are much greater than those remedied, and the benefit is by this means extended from the patient himself to the circle by which he is surrounded. The establishment of such hospitals was first suggested by tracing the contagion which propagates the contagious fever, to its origin, and ascertaining the power of ventilation and cleanliness in preventing and in alleviating the disease. The arguments for such hospitals are strengthened by the discovery

discovery of the chemical methods of destroying this contagion ; and if I do not greatly deceive myself, they are still farther strengthened by the success of that mode of practice in fever, which it is the chief object of this publication to explain and to establish. A vigilant exercise of all the means of prevention and of cure, might indeed in a short period, supersede the use of hospitals for fever, by extinguishing the disease ; a prospect in which the philanthropist might indulge with more safety, if he could calculate with equal confidence on the wisdom, as on the power of his species.

CHAP.

CHAP. XVII.

Is there an Inhalation by the Skin?—Case of P. M. Esq. who died of Inanition.—General Reflections.—Conclusion.

IN speaking of the origin of animal heat, and of the nature and office of perspiration (p. 175, 179) it was questioned whether the inhalation of vapour or water through the skin into the circulating fluids be established by a sufficient induction of facts, and if it occur at all, it was supposed that the quantity had been exaggerated. Among the ancients however, the doctrine in question was universally received, and it has been admitted by the most celebrated physiologists, not merely of the past, but of the present times. The facts and arguments in support of it are detailed by Haller in the 5th volume of the *Elementa Physiologiæ*; but on examination they will be found to afford no direct proof of its truth.

truth.* Of the great variety of authors quoted on this occasion, no one affirms the actual increase of the weight of the body in the warm bath, Deffault excepted, and this is a point that Haller himself never seems to have subjected to experiment.

The inhalation through the surface in vegetables, in insects, and in certain of the amphibia, are the analogies that give the most direct support to this doctrine, applied to the human species. It is however controverted by many facts, and if it should ultimately be established, it must be reared on a new foundation. When I was at Buxton in 1788, I made an experiment on the effects of bathing on the weight of my body, and after half an hour's immersion, I found it rather diminished than increased. This experiment had I believe been made

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before

* The arguments drawn from the appearances that occur in the dead body, may be wholly set aside; as may the instances of certain narcotic vegetables, applied to the skin, (e. g. tobacco and white hellebore) occasioning sickness at the stomach, which are cases of sympathy, or of absorption *after the cuticle had been eroded*. The arguments drawn from the increase of weight in moist air, and from the vast discharge of urine in diabetic cases, are also wholly fallacious. In diabetes we now know there is no absorption by the skin, and the phenomenon in question, which has been much exaggerated, must be accounted for by the action, not of the skin, but of the lungs.

before by Dr. Pearson, with the same result ; it has since been repeated frequently with great care,* and it is ascertained as a fact, that no increase in the weight of the body is produced by immersion in water of the heat of 82° . In the year 1790, I had a patient in diabetes, whose cuticle, as is usual in that disease, was in a morbid state ; and being desirous of trying how far the inordinate action of the kidneys might be affected by a gentle stimulus applied to the skin, I immersed him in the bath of the temperature of 96° , weighing him before and after immersion. There was no variation in the weight. This experiment has lately been made by Dr. Gerard, in another case of Diabetes, an account of which is given in the publication of Dr. Rollo ;* and as it was repeated a great number of times with the utmost care and accuracy, it may be considered as established that immersion in the warm bath in Diabetes, produces no increase of weight. I have made five different experiments of the same kind on myself, varying the heat of the bath from 87° . to 95° . but never in any instance found my weight augmented. It may be said however, (and it has been said) that though in Diabetes, where

* In one case, a sum of money depended on the issue, and a friend of mine submitted to be the subject of the experiment.

* Rollo on *Diabetes Mellitus*, v. ii. p. 72.

the epidermis is diseased, no liquid is inhaled; and though in health, where the vessels are full, no absorption may take place; yet that where the body is wasting from a want of the proper food through the stomach, the plastic powers of nature may be exerted to supply the defect, and to excite an inhalation through those pores on the surface, by which exhalation is usually performed.

The following case will throw some light on this point. I give it however not merely with this view, but as containing other particulars that appear to me curious and interesting.

In August 1795, a gentleman of —shire, aged 66, applied for my assistance in a dysphagia, (obstructed deglutition) with which he had been for ten or twelve months afflicted. At first the complaint was slight, and occurred only when he attempted to swallow dry and hard substances; it afterwards extended to solids of every kind; and at the time I first saw him, though still able to pass down liquids, the quantity he could swallow was not sufficient for his nutrition, and he was considerably reduced. On the introduction of the bougee into the gullet, it passed about two inches easily, but then met with an obstruction, which by a moderate pressure was overcome. It then passed easily seven or eight inches more, but experienced
a firm

a firm resistance in the lower part of the tube, towards its termination in the cardia, which the skill and patience of Mr. Park could not surmount, and which finally baffled every resource of his art. Though we had not an opportunity of examining the Oesophagus after death, yet the nature of this obstruction was evident. It doubtless proceeded from a scirrhus tumour, gradually increasing, which at first diminished the passage, and in the end obstructed it wholly; and it existed in that part of the tube, which, from its suddenly narrowing, is, as Dr. Hunter has remarked, most exposed to the causes, and most frequently the seat of this disease. Mr. M. never had any considerable pain from the pressure of the bougee on the tumour, and though he expectorated (if the expression may be used) much mucus, there never was any purulence discharged, or any reason to believe that the tumour had ulcerated.

The last time Mr. M. swallowed in any quantity, was on the 17th of October. On the evening of that day a sudden increase of the obstruction came on, and from this time forth he was able to swallow only a table spoonful of liquid at a time, and with long intervals. It was with difficulty that he got down seven or eight spoonfuls of strong soup in the day, and this quantity gradually diminished.

On

On the first of November, the passage seemed wholly obstructed. As he wasted rapidly, we were obliged, from the 18th of October to employ the subsidiary modes of nutrition, and he went into the tepid milk and water bath, and had a nutritive clyster administered once a day.

As Mr. M. himself was far from despairing of his recovery to the last, the affectionate friends around him did not wish him to be informed of his real situation. He continued therefore to swallow two or three table spoonfuls of milk daily, till about the 15th of November, on the supposition that some might pass; but though it rested in the Oesophagus some time, it was constantly ejected at last; and being fatigued by this expectoration, which disturbed his rest, and by which he perceived that the whole of the milk was thrown up, for the last twenty days of his life he made no attempt to swallow, but contented himself with washing his mouth and fauces with wine and water.

Mr. M.'s friends, though they could not but foresee the issue of his case after all attempts to remove the obstruction had failed, yet desired that his life might be prolonged to the uttermost. The following plan was therefore adopted with this view, on the last days of October, and it was persevered in with the variations afterwards to be mentioned,

tioned, till the commencement of the delirium that preceded his death.

Every morning at eight o'clock, he had a clyster, consisting of eight ounces of strong broth, made chiefly of membranous parts of beef (being the most nutritious, according to Dr. Fordyce) into which was rubbed two yolks of an egg, and to which was added forty drops of laudanum. This was repeated at three in the afternoon, and again at nine in the morning; but in the evening, instead of forty, one hundred and twenty drops of laudanum were added, to compensate the want of an anodyne draught, to which he had been accustomed at the hour of rest. Previously to this however, he was placed up to the neck in a tepid bath, of which one fourth was milk, and the rest water; the whole quantity amounting to twenty-four gallons. The temperature was fixed at 96°. to accommodate his sensations, and the time of immersion was gradually prolonged from forty-five minutes to an hour.

The size and repetition of the clysters were determined by our experience of what the rectum would retain; the laudanum being added to increase its retention, as well as to allay irritation, and to stimulate the living energy. In a few days the retention of the rectum improved, and enabled

us to enlarge the clysters to 10 oz. of broth and three yolks of eggs each ; to which, from the 12th of November, 8 oz. of white wine were added ; the laudanum being increased to 60 drops for each of the clysters in the day, and to 150, 180, 200, and 250 drops for the evening clyster. Thus the whole of his nutriment for twenty-four hours consisted of 30 oz. of broth, 24 oz. of wine, 9 yolks of eggs, and from 250 to 380 drops of laudanum, by clyster; with what liquid might be supposed to be taken up by the absorbents of the surface in the bath. Mr. M. was very tall, and naturally corpulent. In health he had weighed 240lbs. But imperfect nutrition had gradually reduced him, and at the time of commencing this process, he only weighed 179lbs. On the 20th of November he was reduced to 154lbs.; on the 24th to 149lbs. This was the last time we had an opportunity of weighing him. He seems to have wasted about 5lbs. in four days, and on the second of December, when his delirium commenced, he probably weighed 138 or 139lbs. having lost upwards of 100lbs. of his original weight. He lived till the 6th of December, but from the 2d, the rectum no longer retaining the clysters, they were of course omitted, as well as the bath.

About the 25th and 26th of October, there was reason to suppose that Mr. M. would have had

a shorter date. He had swallowed a very small portion of nutriment for the preceding eight days; and the plan of nutrition just mentioned, though adopted in part, was not fully established. His tongue and lips were at this time become dry; a blister applied to the sternum, discharged a thick coagulable lymph only; and his urine, reduced to a few ounces in the twenty-four hours, was become extremely high coloured, and almost intolerably pungent. In a few days however this state of the tongue went off; the skin became perfectly soft, and was often covered with a very gentle perspiration; the urine flowed without pain, and of the natural appearance, the quantity being from 24 oz. to 36 oz. in the twenty-four hours—more than the whole of his loss of weight in the same space of time.

Mr. M. had in general a stool after every fifth or sixth clyster, that is, three or four times a week. The substance of these stools was solid, and nearly of the natural fœtor, and the mass perfectly homogenous. The colour was lighter than natural, as is the case in obstructions of the bile duct; their whole appearance resembling what we find in cases of dissection in the termination of the Ileum or beginning of the Colon, with the exception of being much less liquid. The concoction of the Fœces, if I may so speak, was much more perfect

perfect towards the end, than at the beginning of this period; at first they looked curdy, but at last they approached to the natural appearance.

The heat, examined by the thermometer, was natural, and nearly uniform from first to last. After the clysters there was generally some flushing of the cheek, and drowsiness, with some increase in the warmth of the extremities; but under the axilla there was seldom any variation, and when it rose there a single degree, it was speedily lowered by a gentle diaphoresis.

The pulse, during the period of the scarcity and pungency of the urine, was disturbed, and more frequent. It afterwards subsided to the natural state, and during the whole of the month of November, was not to be distinguished from that of a person in health. On the morning of the first of December it became small and frequent; and still more frequent, though stronger, after the delirium commenced; the state of the pulse, as well as almost all the other symptoms, from that time forth, very nearly resembling the symptoms of the last stage of fever, when it terminates fatally. During this delirium, a perpetual and indistinct muttering occurred, with great restlessness and agitation; the surface and extremities were sometimes

of a burning heat, sometimes clammy and cold. The eyes lost their common direction, the axis of each being turned towards the nose. In this state however the sensibility of the retina was not impaired, but rather encreased, for he screamed out on the light of the window being admitted, to which before he had been accustomed. At this time also the sense of touch seemed more than usually acute, for he appeared disturbed with every accidental breath of air. The delirium, and the derangement of vision commenced nearly together, but we observed the derangement of vision first. On the first of December he complained that he saw objects occasionally double; but it was not till the succeeding day, that any considerable incoherence of mind was observed. The pulse became feeble and irregular on the fourth; the respiration, which had been singularly undisturbed, became laborious; the extremities grew cold; and in ninety-six hours after all means of nutrition, as well as all medicine had been abandoned, he ceased to breathe.

Mr. M. complained very little of hunger. Occasionally he expressed a wish that he could swallow, but not often, nor anxiously; and when questioned on the subject of his appetite, always declared that he had no hunger to occasion any uneasiness. The clysters evidently relieved the sense of hunger, and the opium they contained, seemed

seemed to have a principal share in producing this relief. It occasioned quiet and rest after each clyster, and allayed every kind of desire or appetite.

Neither was Mr. M. much disturbed with thirst. This sensation was indeed troublesome during the first days of his abstinence; but it abated, and as he declared, was always removed by the tepid bath, in which he had the most grateful sensations.

Mr. M.'s spirits were uncommonly even, and his intellect perfectly sound. He occupied himself a good deal in his private concerns, and as usual interested himself in public affairs. As we discouraged all unnecessary exertion, he spent a great part of his time in bed; but till the last few days of his life, he dressed and undressed himself daily, and walked, not only about his room, but through the house. His nights were quiet, and his sleep sound, and apparently refreshing. Towards the end of this period, he said he had very lively dreams, but they were all of a pleasant nature. The last conversation I had with him was on the morning of the second of December. He told me that he had had a very gay evening with two Yorkshire Baronets, whom he named; they had pushed the bottle about freely; many jokes had passed, at the recollection of which he laughed heartily, a thing uncommon with

with him. When I observed that this was a very lively dream, he seemed to endeavour to recollect himself, and for a moment appeared sensible that the scene had passed in sleep. But recurring to the circumstances, he spoke of them again as realities, and I made no further attempt to undeceive him. He said he had been walking out that morning, and was pleased to see the spring so far advanced—he had never felt the air so refreshing. At this time, though his pulse was become rapid, his respiration was natural, and his speech distinct, and without effort. He was extremely weak, and scarcely able to turn himself in bed, to which he had for several days been entirely confined. No man had ever perhaps approached death by steps more easy, and it was earnestly to be wished that his remaining moments might be few. This wish was not gratified. In about an hour afterwards his delirium became complete, during which his strength evidently increased, and the struggle commenced which has already been described, and which lasted ninety-six hours. He died in his sixty-seventh year.

I have been the more particular in noting this case, because I have not found the methods of supporting life under impaired or obstructed deglutition, sufficiently detailed, nor the death from inanition described with sufficient accuracy. A know-
ledge

ledge of the first may on many occasions be important ; and an acquaintance with the last may possibly throw light on some difficult questions that respect, not merely the vital, but the intellectual phenomena.

I have not found any case deserving of credit, in which life was so long preserved without the aid of the stomach, two excepted, one recorded by Ramazzini,* and the other mentioned by Mr. Cruikshanks.† The case described by Ramazzini was that of a nun ; and the obstruction was not mechanical, but spasmodic ; or as he himself supposes, arising from a paralysis of the Oesophagus. She is said to have lived sixty-six days without swallowing, the whole of her nutriment consisting of a single clyster of broth, and two yolks of eggs, administered daily. The dysphagia, which came on suddenly, seems also to have gone suddenly off, and she finally recovered. The case is not given with such minuteness by Ramazzini as to inform us whether any attempts at swallowing were made during the dysphagia. As the obstruction was not mechanical, it is probable that such attempts were made daily ; and if this be supposed

* *Ramazzini Opera Omnia Genevæ, 1717, p. 173.*

† *The Anatomy of the Absorbing Vessels, London, 1786, p. 101.*

supposed, a suspicion may be entertained from the nature of the affection, that more or less nutriment might be swallowed. It is observed by Ramazzini, that the sufferings of his patient were so great on the 30th day, that she was anxious for death, and refused to admit the clyster, which however was administered during Syncope, and with immediate and happy effects. In this respect her situation was perfectly contrasted by that of Mr. M. who enjoyed ease and serenity of mind till the last final struggle, as has already been mentioned.

The case of Mr. Cruikshanks is not given at length, but alluded to in the following words.

“ That the surface of the skin absorbs other fluids
 “ which come in contact with it, I have not the
 “ least doubt. A patient of mine with a stricture
 “ of the Oesophagus, received nothing, either solid
 “ or liquid, into the stomach *for two months*; he
 “ was exceedingly thirsty, and complained of
 “ making no water. I ordered him the warm bath
 “ for an hour evening and morning *for a month*;
 “ his thirst vanished, and he made water in the same
 “ manner as when he used to drink by the mouth,
 “ and the fluid descended readily into the stomach.”

It is to be regretted that a case so curious is not given in detail. It does not appear what other means of sustenance Mr. Cruikshanks employed besides the tepid bath, especially during the month
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of abstinence in which the bath itself does not seem to have been used. On some future occasion it is to be wished that he may supply these deficiencies ; especially as the information I am about to give, will shew that the conclusion he draws from this case, of the absorption of the skin, is fallacious.

Notwithstanding what I had observed formerly, I fully expected in the case of Mr. M. an increase of weight from the immersion, because he always expressed great comfort from the bath, with abatement of thirst, (which however was never great) and because subsequent to the daily use of it, the urine had flowed more plentifully and become less pungent. I expected it also from the authority of general opinion, and was curious to know the extent of the absorption. I weighed him three different times. The first time he was weighed with his cloathes on, before he went into the bath; and naked when he returned from it. Our process was therefore complicated. He appeared to have gained 30 oz. in weight, which gave him much comfort; and this circumstance prevented me from undeceiving him when I afterwards discovered our error.* The second time he stepped perfectly naked upon

Merlin's

* I discovered that we had been incorrect before the second experiment,

Merlin's balance immediately before immersion, and again immediately after it, his body being previously dried. The weights were never moved. The result surprised me : I could not distinguish the slightest variation in the weight of his body, though my beam would have detected a single drachm. I repeated this experiment four days afterwards, and with a similar result—On both of these occasions the immersion continued an hour, and a constant friction had been kept up nearly the whole of this time on the inner surface of the thighs, with the view of increasing the action of the absorbents.

It is worthy of observation that there was neither increase nor decrease of weight in the bath ; yet Mr. M. was at this time wasting twenty ounces in twenty-four hours, and consequently if there was no absorption in the bath, it might be supposed that he would have lost the 56th of an ounce during the hour of immersion. It is the more remarkable that there was no decrease, because in the bath the skin always softened, and the forehead became covered with a gentle moisture, which probably arose from the evaporation of the liquid in the bath. At the time however I considered this as the matter of perspiration, because after leaving the bath, and going into a bed previously warmed, he usually fell into a gentle and general diaphoresis, the foother of every irritation, and the harbinger of refreshing sleep.

So

So far the case is tolerably complete. I lament that I cannot give the appearances on dissection, as we were not permitted to examine the body after death.

The reflections suggested by this case are numerous: I shall present one or two that seem important.

The natural state of the pulse during the first month of Mr. M.'s abstinence, when his strength was daily decaying, demonstrates, that the motion of the heart and arteries gives no certain indication of the strength of the system. Pure debility, within certain limits, does not seem to produce a frequent pulse, nor in all cases, a feeble one; but when carried to a certain degree, it excites that commotion of the system, in which—first the contractions of the heart, and afterwards of the lungs, become more rapid; which in popular language may be denominated the last struggle of nature, and which may be considered as indicating the approach of death. To endeavour to reconcile these phenomena to any of the prevailing theories of vital motion, would be a fruitless attempt. Death has not an uniform aspect, but its *phases* do not appear to me numerous. The concluding scene in the life of Mr. M. may illustrate the form of its approach, as well as the nature

of the symptoms in the last stage of fever, and of various other diseases, in which similar symptoms occur.

The natural state of the heat, during the inaction of the stomach, might prove, if it were necessary, how little the vital heat is connected with the function of digestion, and renders it probable, that the general increase of heat which follows the application of many stimulating bodies to this organ, is not the direct effect of the action of the stomach itself, but of its influence on the heart, or diaphragm, or both. It is asserted by Haller, that in cases similar to that of Mr. M. the heat has been found diminished. The observations made by the thermometer in this case, throw a doubt on the assertion; while the great facility with which Mr. M. parted with his heat, concurs with a variety of corresponding facts to support the position, that in those situations, where the generation of heat is natural, the power of retaining it in the system is in the ratio of the force of the living principle.

But what shall we conclude respecting the absorption of water by the surface of the body in the warm bath?—Admitting that it did not take place in the case of Mr. M. it may be supposed this did not arise from the impermeability of the cuticle, but from the heat of the bath being too high. It may be

be added, that the analogy of the vegetable kingdom supports this supposition, since vegetables are found to exhale in warm and dry air during the day, but to absorb largely under the moisture and chillness of night. Considerations of this kind might probably influence some learned physicians in London who were consulted in this case, to propose that the heat of the bath should be as low as 80° .—It was however raised to 96° for two reasons: the first, that I had found no increase of weight in the Buxton bath at 82° ; the second, that as Mr. M. parted with his heat easily, he could not support immersion with comfort in a lower temperature.

It is however more likely to be supposed, that though there was no increase of weight in the case of Mr. M., there might be an absorption in the bath which was counterbalanced by the increased exhalation.—The experiments I have detailed do not enable us to decide this point absolutely; but from them, and from various other considerations, I entertain little doubt, that though the exhalents of the skin pierce the epidermis, and come into contact with the external air, the mouths of the absorbents terminate under it, and are covered by it; and that while it remains sound and entire, no absorption of solid, liquid, or aeriform elastic fluid, takes place on the surface. In the instances that are supposed to favour the contrary opinion, it will be found, that the

the article absorbed is forced through the epidermis by mechanical pressure; or that the epidermis has been previously destroyed by injury or disease; or if found, that the article applied to it is of an acrid nature, which first erodes this tegument, and then coming into contact with the mouths of the lymphatics under it, is of course absorbed.*

At the instant that these observations are committed to the press, my attention has been pointed to

* The absorption of mercury, sulphur, oil of turpentine, and similar substances, rubbed on the skin in the form of unguents, comes under the first of these descriptions; the absorption of the same substances, and in some rare instances of lead from the surface of wounds, and of herpetic or other eruptions, under the second; the absorption of cantharides, aloes, &c. under the third. I am not ignorant of the experiments of Dr. Falkner and Mr. Albernethy, nor wanting in due respect for those gentlemen; but my own observations, supported by the experiments of M. Séguin, induce me to reject their conclusions. A probable source of error in the experiments supposed to afford a direct proof of cutaneous absorption, is, that they were made on a small part of the body, e. g. the arm or leg, and not on the whole; though if the mouth and nostrils were left free for respiration, it would be as easy, and much more correct, to make experiments for this purpose, as well as for determining the quantity of exhalation, on the whole of the surface, as on a part. Dr. Marcand, who wrote expressly on the effects of the bath, has adopted the theory of absorption through the skin, without making any experiments.

to the valuable memoir on this subject, read before the Academy of Sciences by M. Séguin, of which some account is given by Fourcroy in the third volume of “ *La Médecine éclairée par les Sciences physiques*, p. 232.” The conclusions of M. Séguin, correspond in every particular with those which I have already laid down, and being founded on a great variety of experiments, made for the express purpose of determining on the cutaneous absorption, they appear to me to give his inferences all the solidity of truth. The objection, that though there is no increase of weight in the bath, there may be an absorption, which is countervailed by the exhalation, M. Séguin found a satisfactory mode of invalidating. He dissolved in the water of the bath, in which he made his experiments, substances which produce a specific effect when received into the system, by which their inhalation might be ascertained. He employed the oxygenated muriatic of mercury in solution, on a number of venereal patients, and while the epidermis was entire, he never perceived a single instance of salivation, or even of amendment of their complaints. But in cases where a considerable portion of epidermis was injured or destroyed, as in the itch, the specific effects of mercury on the system were produced. The experiments of M. Séguin are very numerous, and appear to be devised so as to meet every objection. He concludes from the whole, that while the

the epidermis is entire, the absorbents of the surface neither take up water nor air, nor any substance diffused or dissolved in either.

Admitting that the the inferences of the friend and coadjutor of Lavoisier are just, how are we to explain the refreshment and abatement of thirst, experienced by Mr. M. in the bath. Referring to what is said in pages 162, 163, on the nature of thirst, we may here shortly observe, that as liquids thrown into the stomach relax the exhalents of the surface, so doubtless this action is reciprocal; and the exhalents of the surface being relaxed in the warm bath, a relaxation in those of the stomach ensues, by which the sense of thirst is abated. In the cold, as well as in the hot state of intermittent fever, the thirst is great; but it is always lessened, and generally removed, on the accession of the sweating stage, though no liquid should have been swallowed.

Will this explanation, it may be asked, account for the benefit derived in accidents at sea, when no drink can be produced, from immersing the body in water, or applying wet substances to its surface? It will explain it in part perhaps, but not wholly.—In the torrid zone, where the greater part of these instances have occurred, the immersion of the body in water, or the application of wet clothes

clothes to the skin, will keep the surface cool, by defending it against the direct rays of the sun, and thus prevent the debility produced by an accelerated circulation; it will also defend it, in whatever climate, from the wasting effect of evaporation, and thus be a means of prolonging the strength. This reasoning is supported by a fact which may be inferred from the circumstances I have mentioned, and which is established by the experiments of M. Séguin; that the body wastes much less in water than in air.

In the Buxton bath, I found my weight very slightly diminished, but in the case of Mr. M. and in all our experiments on diabetic patients, there was neither diminution nor increase in the bath. In the experiments of M. Séguin, there was always some diminution in the bath of whatever temperature, which he ascribes to the pulmonary perspiration. How is this difference accounted for? Though the cutaneous exhalation may have been stopped in Mr. M. during immersion, yet allowing the perspiration by the lungs to have gone on, this alone, supposing no absorption, ought to have produced a diminution of weight in the bath. To this it may be replied, that though no absorption through the skin takes place in the bath, that by the lungs goes on, while in the heat of 96°. the evaporation from the surface of the water,
by

by loading with moisture the air inhaled, prevents its taking up the moisture in the lungs, and thus diminishes the pulmonary perspiration.—Against this source of error it is probable that M. Séguin guarded.* It is in this way that the increase of the weight of the body in moist air, which is said sometimes to occur, and which has been supposed to prove a cutaneous absorption, may be accounted for. In moist air the absorption of the lungs from the atmosphere goes on unchanged, while the pulmonary, as well as the cutaneous perspiration, is diminished, and thus the increased weight of the body may be explained. On this point however more accurate experiments are required.

It was observed, that the discharge by urine alone, in the case of Mr. M. exceeded much in weight the waste of his whole body; and it cannot be doubted that the discharge by stool and perspiration, exceeded the weight of the clysters. Thus it appears that the egesta exceeded the ingesta, in a proportion much greater than the waste of his body will explain. How, it may be said, is this accounted

* I say probable, because I have not seen the memoir of Séguin himself, but only the abstract of it given by Fourcroy, who does not enter into the details.—An account of this abstract is given very accurately, and pretty much in detail in the *Monthly Review Enlarged*, vol. xii. p. 514.

counted for, unless by cutaneous absorption? In the same way, it may be answered, by the action of the lungs.

That the oxygen inhaled in respiration from the atmosphere unites in part with the carbon of the blood, to form carbonic acid gas, and in part with the hydrogen, to form water, is generally admitted. In instances of inanition we may suppose the proportion in which it unites to these different substances to be varied by the plastic power of life; that the formation of water is greater than usual, and that of carbonic acid gas less. Thus a portion of the oxygen, which, in the ordinary course of things *is exhaled in the form of an elastic vapour, being absorbed in the form of water*, will serve to retard the waste of the body, and to furnish the blood with the proportion of lymph, which affords a proper supply to the secretions of urine and perspiration. In the case of Mr. M. there was no appearance of that acrimony of the fluids which might naturally have been expected from the cessation of the supply of chyle, and which Haller describes as the constant effect of inanition.

This theory of the increased formation of water in the lungs, has been employed by Dr. Rutherford of Edinburgh, to account for the vast discharge by the bladder in diabetes. It seems also

to account for the phenomenon of the egesta exceeding the ingesta, so often observed in that disease. It illustrates the doctrine of Séguin, in the memoir already quoted, of which Fourcroy gives an account in the following words—*Le diabète ne provient point de l'eau absorbée dans l'air par la peau, mais du reflux de celle qui ne peut pas être enlevée aux poumons par l'air trop chargé d'humidité*—a doctrine which appears to be defective, from not pointing out the source of the increased quantity of water in the lungs. Beautiful as the theory of Dr. Rutherford is, it cannot be considered as established in diabetes, or in inanition (to which I have extended it) till the air expired by patients under these diseases shall be examined. In the mean time I may observe, that the application of it to the case of Mr. M., accords with the usual œconomy of the living principle, which in remedying the defect of particular organs, does not transfer their powers entire to other parts of the system, but modifies or increases the natural action of some other organ, by which that deficiency may be to a certain degree counter-vailed. Such an exertion of the living principle was evident in the case of Mr. M., in the increased powers of the rectum, which have already been described. These vicarious actions of the system are however defective, whether arising spontaneously, or by the assistance of art. No applications of food to the inner surface of the rectum can long supply

ply the absence of food in the stomach, nor can the want of liquid in that organ be long counter-vailed by applications of moisture to the surface, aided by the modified action of the lungs. After a certain time, though immersed in water to the chin, the thirst will prove intolerable without drink, as the shipwreck described in the Appendix will testify (*Appendix*, p. 24) and the sufferings of Tantalus, which the theories of Dr. Marcard led him to deride, will be rated as highly by the naturalist as by the poet.*

* Dr. Marcard, in the work quoted, p. 135, after asserting the great inhalation of water by the skin in the bath, declares, that no naturalist will estimate the sufferings of Tantalus highly. It seems probable, that immersion in tepid water is more effectual in abating thirst, than immersion in cold water.

The account I have given of Dr. Rutherford's theory of diabetes, I derive from the valuable inaugural dissertation of Dr. Marcet, of Geneva, just published, presented to me by the ingenious author. To Dr. Marcet I am also indebted for pointing out the memoir of M. Séguin, whose doctrine he himself has controverted, from giving, I apprehend, more weight to the authority of Haller, than on inquiry it will be found to deserve on this subject.

The explanation offered by Dr. Marcet of the increased heat in diabetes, will be found I believe irrelevant.—In three cases of this disease which I have examined, the heat previous to the medical treatment was less, not greater than natural, notwithstanding the almost unanimous concurrence of authors in the contrary statement; a proof among many others of the inaccuracy of the accounts we have of temperature in disease.

If the non-absorption of the surface of the body be established; it will ascertain, that contagion is received into the system, in the ordinary course of things, by the lungs only; and perhaps justify a practice common, as I am informed, among our more experienced seamen on the coast of Guinea, and other warm climates, who when exposed during the night to a breeze from the marshes, wrap their heads in a sea-cloak, or other covering, and sleep fearlessly on the deck with the rest of their bodies nearly naked, from the heat.

It is with pleasure I lay down my pen, though other observations crowd upon me. If what I have already offered seem tedious, the interest of the subject will plead my apology. It is no otherwise connected with the rest of the volume, than as it regards the most important functions of the living principle.—But I have not been very studious of rigid method in this little volume, which is much prolonged beyond my original intention.—In the present state of our science the enlightened reader will thank me for avoiding systematic arrangement; and recommending myself to his candour. I bid him adieu!

APPENDIX.

Nº. I.

Of Tetanus, and of Convulsive Disorders.

Read before the Medical Society of London, May 10, 1790, and
extracted from the 3d volume of their Memoirs.—Page 147.

THE various objects which engage your attention will not admit of much of your time being employed on a single paper, and I have undertaken to write on a subject of some importance. It will be proper for me therefore to come directly to the point, and to avoid as much as possible every thing that is superfluous. What I have to offer shall be confined to the treatment of convulsive disorders, and especially of tetanus.

For this disease, so terrible in its progress, and so generally fatal in its issue, several new remedies have been proposed within the last thirty years, and each in its turn has had some share of public confidence. But opium, mercury, the cold bath, and wine, are those only which seem entitled to any reputation, and of each, it has been my fortune to have had some experience. This experience I proceed to give you with all the clearness and faithfulness in my power.

In the course of nine years' practice I have seen seven cases of this disease; of which two were idiopathic, and five the consequence of wounds. Of these in order.

1. George Gardner, a soldier in the Staffordshire militia, was put under my care by his officers, on the 20th of February, 1781. About a fortnight before, after severe dancing and hard drinking at a country wedding, in which he had been employed two days and nights, he fell suddenly into a fit, which lasted an hour and a half, during which his consciousness was abolished. On recovery he was affected with slight twitchings, which gradually encreased, and were followed by fixed spasmodic contractions in different parts of the body, but more affecting the left side than the right. He had, when I saw him, all the symptoms of tetanus. The head was pulled towards the left shoulder, the left corner of the mouth was thrown upwards, the eyes were hollow, the countenance pale and ghastly, the face and neck bedewed with a cold sweat; but his most distressing symptom was a violent pain under the ensiform cartilage, with a sudden interruption of his breathing every fourth or fifth inspiration, by a convulsive hiccup, accompanied by a violent contraction of the muscles of the abdomen and lower extremities. He felt on this occasion as if he had received an unexpected blow on the scrobiculus cordis. Before I saw him he had been bled and vomited repeatedly, and had used the warm bath, not only without alleviation, but with aggravation, of his complaints. The three first remedies mentioned were used here in succession, viz. opium, mercury, and the cold bath.

He first took a grain of opium every other hour, afterwards a grain every hour, and at last two grains every hour; but

but he grew worse and worse during the two days on which this course was continued. The spasms extended to the the back and shoulders, the head was at times retracted, and the muscles of the abdomen partook of the general affection. Being no longer able to swallow the pills, he took no medicine of any kind on the night of the 22d, in the course of which general convulsions came on, and returned once or twice in every hour. The tincture of opium (liquid laudanum) was now directed to be given, and an ounce of the quick-silver ointment to be rubbed in on each thigh. In twenty-four hours he took two ounces and a half of the tincture without sleep or alleviation of pain. The dose being increased, in the next twenty-six hours he swallowed *five ounces and a half* of the laudanum, a quantity which, at that time, was I believe unexampled. He lay now in a state of torpor. The rigidity of the spasms was indeed much lessened, and the general convulsions nearly gone; but the debility was extreme; a complete hemiplegia had supervened; the patient's eyes were fixed, and his speech faltering and unintelligible.

As this young soldier appeared on the utmost verge of life, it seemed no longer safe to continue the laudanum, which had relieved spasm only in so far as it had brought on general paralysis. Intermitting this medicine therefore, small doses of camphor were occasionally given in a liquid form, but the chief attention was directed to supporting the strength by such nourishment as could be swallowed. Gruel, with a small quantity of wine, was ordered for him, though with much caution; for at that time I was not instructed with what safety and efficacy this last article might have been administered. For the next six days he seemed to revive: the general convulsions kept off, though the
twitchings

twitchings and convulsive hiccup continued. But on the night of the first of March he was seized, during sleep, with a convulsion as severe as ever, and this was followed by a return of all his symptoms with their former violence. The jaws were indeed more completely locked than before, deglutition was become impossible, and the pain under the ensiform cartilage was so extreme as to force from the patient the most piercing cries. At this time the effects of the quicksilver ointment were apparent in the fœtor of the breath, and in a considerable salivation.

Had poor Gardner been a man of any rank, or indeed had he been surrounded by his family, it is most probable that we must now have abandoned him to his fate. But our proceedings being neither obstructed by the prejudices of ignorance, nor the weakness of affection, another, and a last effort for his life was resolved on. Having heard that the cold bath had been employed with success in tetanus in the West Indies, particularly by Dr. Wright of Jamaica, and Mr. Cochrane of Nevis, and this practice corresponding with certain speculations of my own, I had recourse to it on this occasion with some little confidence. With the consent of his officers, Gardner was carried to the public salt-water baths of this town, then of the temperature of 36° Fah^t. and thrown headlong into it. The good effects were instantaneous. As he rose from the first plunge, and lay struggling on the surface of the water, supported by two of his fellow-soldiers, we observed that he stretched out his left leg, which had been for some time retracted to the ham. But his head did not immediately recover the same freedom of motion, and therefore he was plunged down and raised to the surface successively for upwards of a minute longer, the muscles of the neck relaxing more and more after every plunge.

plunge. When taken out, we felt some alarm : a general tremor was the only indication of life, the pulse and the respiration being nearly, if not entirely, suspended. Warm blankets had however been prepared, and a general friction was diligently employed. The respiration and pulse became regular, the vital heat returned, the muscles continued free of constriction, and the patient fell into a quiet and profound sleep. In this he continued upwards of two hours, and when he awaked, to the astonishment of every one, he got up and walked across the room, complaining of nothing but hunger and debility. The convulsive hiccup indeed returned, but in a slight degree, and gave way to the use of the cold bath ; which he continued daily a fortnight longer ; and in less than a month we had the satisfaction of seeing our patient under arms, able and willing for the service of his country.

That the opium, though it failed in affecting a cure, had considerable influence in mitigating the disease, and prolonging life, is, I think, apparent.

That the mercury had little effect is clear from the second convulsions coming on soon after the salivation appeared.

The success of the cold bath in circumstances so apparently desperate, was not lessened by bad effects of any kind. Though the patient was in a salivation when thrown into it, yet this was not stopped suddenly ; it lessened indeed immediately, and soon disappeared, but without any of those bad consequences so well described by Sir John Sylvester and Dr. Dobson. Subsequent experience has taught me to attribute some part of the suddenness of the benefit obtained

tained in this instance to a circumstance that distressed me much at the moment. The very instant that we were about to immerge poor Gardner, he was seized with a general convulsion. We hesitated, but kept our purpose, and happily plunged him into the water with the convulsion upon him. I am also inclined to think that our success is in part to be ascribed to the powerful, general, and sudden application of the remedy, and under this opinion I should prefer immersion in water, to its affusion, the method employed by Dr. Wright.

2. Soon after this I was sent for by a poor woman, who, in consequence of difficult labour, and, as she imagined, of local injury in some part of the uterus, was seized with the spasmus cynicus, locked jaw, and other symptoms of tetanus. She was immediately taken to the cold bath, and thrown into it in the same manner as the former patient, and with similar good effects. The spasms disappeared, and though they afterwards returned in a slight degree, they gave way entirely to a second immersion.

In the first of these cases I was assisted by Mr. Walker, surgeon's mate of the Staffordshire militia; and the second case the effects of the cold bath were witnessed by him and my friend Mr. Park.

So far of the idiopathic tetanus; my experience of the effects of the cold bath in the disease originating in wounds is neither so satisfactory nor so complete.

3. The first case that occurred to me was that of a master of a vessel returning from sea in the year 1784. The injury had been received on the leg, but the wound had

had little inflammation on it, though the patient was so far advanced in the disease as to go off in a general convulsion, before any remedy could be tried.

4. The second case seemed rather an instance of locked jaw, properly so called, than of tetanns. The injury having been received on the jaw itself, the affection was confined to the muscles of that part, and the disease seemed to be the trismus inflammatoria of Sauvages. It gradually yielded to bleeding and the topical application of warm vapour, the cold bath producing no good effect.

5. In the third case we contented ourselves with pouring cold water in successive buckets on the patient's head, partly because this was the most convenient method, and partly because it is that employed by Dr. Wright, whose paper on the subject in the sixth volume of the Medical Observations and Inquiries, had by this time appeared. While we were busy in this way, and flattering ourselves with some appearance of success, the unhappy patient suddenly threw himself on his back, and a quantity of water entered his mouth. The effects were highly distressing. The muscles of deglutition were unable to carry down or to expel the fluid, and such convulsions took place as led us to expect instant death. He recovered, however, so far as to regain his former situation, but the effects of his sufferings on the by-standers prevented our continuing this practice, and he was carried off a few hours after.

6. A fourth instance of this disease I saw about two years and a half ago. There was no room for new practice, for the patient was too far advanced. He had been treated with opium and mercury as usual, and as usual died.

These

These cases afford little inference either in favour of or against the use of the cold bath in tetanus arising from wounds, but they are stated shortly, that the account of my experience in this disease may be fair and complete.

It does not appear from Dr. Blane's History of the Diseases of the Fleet, that this remedy was used in any of the cases of tetanus that occurred among the seamen in the late war. In speaking of this disease Dr. Blane indeed mentions, that though Dr. Wright and Dr. Cochrane had found the cold bath successful in cases without local injury, they had acknowledged the practice to be ineffectual in the disease when arising from wounds. Dr. Blane may perhaps be accurate respecting Dr. Cochrane, whose publication on this subject I have not been able to procure, but he is mistaken respecting Dr. Wright. This gentleman, in the paper already quoted, informs us, that since he employed the cold bath, he has not failed in effecting a cure in a single instance of tetanus, without distinction or reservation; and of the six cases which he has detailed, in three the disease appears to have arisen from local injury. This point is of high importance, and a mistake respecting it in a work like that of Dr. Blane's, which will no doubt be much consulted in the future practice of the fleet, may, if passed unnoticed, have serious consequences.

It is worthy of remark, that the use of the cold bath in tetanus is a practice of very ancient date. Dr. Wright, whose precision and candour are exemplary, mentions that he received the first hint of it from Dr. Lind of Haslar. Hippocrates, however, was acquainted with it, as appears by Aphor. 21. lib. 5. It is also noticed by Avicenna, lib. 3. cap. 7. and in the collection of Schenkius, p. 120, an account

count of the success of this practice in two cases of tetanus is quoted from *Jason*, cap. 21. *De morbis cerebri, ex Valefco*. Hippocrates indeed, and after him Avicenna, restrict the use of this remedy to the young and corpulent, and to the summer season. They also confine it to cases in which the disease has not originated in local injury, for it appears, by another of his aphorisms, that the father of physic thought convulsions supervening to a wound, always fatal*. The experience of Dr. Wright encourages us to extend this remedy to tetanus originating in wounds, but if it should fail we are still not to despair, as the following case will testify.

7. In July, 1787, a labouring man was brought into our Infirmary with a wound in his hand. He was under my friend Mr. Park's care, and the fore was nearly healed, when an alarming rigidity appeared in the motion of the jaw. Opium and mercury were immediately prescribed, with which were conjoined first the cold, and afterwards the warm bath. Mr. Park, however, finding the disease to proceed with the most unfavourable omens, called a consultation, at which, in the absence of the rest of our colleagues, we agreed to make a trial of bark and wine on the authority of Dr. Rusch of Philadelphia, whose excellent paper on this subject, in the second volume of the American Philosophical Transactions, had just appeared. We had, however, little or no hope, for the disease was far advanced, and its progress had been very rapid. At this time the jaw was not only rigidly contracted, but the spasms had extended to the neck and back, the pain under the ensiform cartilage was most acute, and twice or thrice in every hour he was seized with general convulsions, each of which lasted about half a minute. The

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* Hippoc. Aph. lib. iv. sect. v. aph. 2.

The patient was, however, a man of a vigorous mind, and in his perfect senses; and his danger was not concealed from him. Death, he was told, must be the inevitable consequence, unless he swallowed wine in large quantity, but this we verily believed would save him. At first bark was infused in the wine, but he could not swallow the mixture, and therefore we trusted to wine alone. It was wonderful to see the exertions which this poor fellow made. If the liquid was offered to him at an improper time, the effort of deglutition brought on a general convulsion; nay a general convulsion was the consequence of advancing it at such a time towards his head. But watching the remission of the spasms, he was able to swallow a table spoonful or more at once, he himself giving the signal when the wine should be administered.* In this way, through the opening made by the lapping of the upper jaw over the under one, he drew up and swallowed a quart of port wine in the course of two hours; at the end of which time he thought himself refreshed, and was encouraged to proceed. At the end of twenty-four hours he had finished his third bottle, and at this time it was evident that the down-hill progress of the disease was checked. Though the pain under the ensiform cartilage (the most excruciating of all the symptoms of tetanus) was little abated, yet he felt himself more able to bear it; and the general convulsions were certainly less frequent and less severe. We continued our plan with patience and vigour, but for a long time life and death seemed to hang in equal scales. On the fifteenth day of this course he was affected with a slight nausea and vomiting,

* This circumstance suggested to me the similarity between this case and hydrophobia. I noticed it to my respected friend Dr. Percival, who has mentioned it in his valuable essay on that disease. V. Percival's Essays, vol. II. p. 366. 4th edition. I differ however from this experienced physician in his supposition that the two diseases are the same, or of the same origin.

vomiting, which soon went off, and thenceforward his recovery seemed more apparent. It was not however till he had been forty-two days under this treatment that his safety could be ascertained, and during this time he swallowed a hundred and ten bottles of Port wine.

In this case bark was administered along with the wine towards the latter period of the complaint; and during the whole of it, gruel or milk in the quantity of a quart a day, or upwards, was given by way of nourishment. The milk, however, he preferred, as agreeing better with the wine, and tending, as he conceived, to allay a burning sensation at his stomach, the effect of an acid ferment there.

Though the wine was given in such quantity, yet it never produced any symptom of ebriety—it soothed the irritation of his nerves, and comforted his mind, and, without increasing the frequency of his pulse, it augmented his strength.

Every night he took from sixty to a hundred and twenty drops of the tincture of opium, and, with the wine, this small dose seemed to have a more composing effect than thrice the quantity taken before he began it.

To allay the pain under the ensiform cartilage, clothes dipped in æther were applied externally with good effects. As I stood by him one day, pressing the doffils with my open hand to the scrobiculus cordis, he expressed himself relieved by the force which I applied. The same relief seemed to follow from a gentle and uniform pressure on the parts suffering from spasm. In consequence of this, rollers were applied round each thigh where spasmodic twitchings
had

had been very distressing, and afterwards, at his own request, a general pressure of the same kind was applied to the back and abdomen. These bandages he would not suffer to be removed, but we poured æther on them occasionally, over the parts most affected by spasm, guarding in the usual way against the cold produced by too speedy an evaporation.

At length our patient recovered. He is now a watchman, and calls on me occasionally. He complains of a stiffness at times in the muscles of his back, and though naturally a strong and healthy looking man, his features retain the indelible impressions of his disease. His eyes appear hollow, his face sharp and pale, his cheeks and lips are skinny, and the masseter muscles hard and shrivelled.

I have lately had an account of a case of this kind which occurred in a sailor on the coast of Guinea, who recovered under the care of Mr. Robson, an ingenious surgeon in the African trade, from a state apparently desperate, by a very liberal use of bark and ardent spirits.

To conclude this part of my subject, I have known two instances of this disease in horses, both originating in wounds; the first of these was treated in the method first described. The cold bath was used repeatedly, and large doses of opium employed in the form of clysters; but the disease terminated fatally. The second of these occurred in a horse of my friend Dr. Camplin (whose assistance in the case of the watchman I ought to have acknowledged), about a twelve-month ago in his journey to Bath. The doctor informs me that he gave him wine and opium, mixing sixty drops of laudanum with every pint of wine, and by this practice he had the pleasure of recovering him, though

though not till he had drank as much wine as he was worth. Brandy or gin may perhaps be as successful in such cases.

It may be supposed that these instances of success in the use of the cold bath and wine in tetanus, would lead me to the employment of these remedies in other convulsive disorders. This has accordingly been the case; but of the use of wine I am not yet prepared to speak. Of the use of the cold bath in such disorders I can speak with some confidence, as my experience of it is now of eight years' duration.

In the convulsions of children I have found the cold bath a most useful remedy, whether the disorder originated in worms or other causes. I have seldom known it to fail in stopping the paroxysms, at least for some time, and thereby giving an opportunity of employing the means fitted to remove the particular irritation. I must however observe, that in early infancy I have used it with caution; sometimes tempering the water when the weather was cold, and sometimes pouring it on the patient, rather than immersing the patient in it. I have in general made the application of cold in this way sudden and transient, have employed means to secure re-action, and have avoided the remedy entirely in all cases where the vital energy seemed much exhausted. With these precautions I have seen great success attend this remedy in a variety of instances. Minutes of nine of these I have preserved, but I mean to give one only in detail.

John Slater, aged eight years, came under my care in the month of January, 1782. About two years before, while at play, he was seized suddenly with a convulsion which continued for half an hour, and had returned ever since at short

short intervals. Various means had been employed for his relief but without success; the fits were become more and more frequent a hemiplegia had supervened, and the intellect was apparently lost. For twenty-four hours he had lain in a state of insensibility, motionless on the left side, and the muscles of the other side only agitated by the convulsive tremors. We put him immediately into a tub of cold water, which instantly stopped the paroxysm and threw him into a deep sleep, out of which he awaked after two hours with a shriek, and fell into convulsions as before. The cold bath was repeated, and afterwards continued daily, present relief being always obtained by it. The interval was employed in administering the tin powder, which was worked off with calomel, but no worms were observed to be discharged. After several days the convulsions returning, though with a considerable abatement, I became dissatisfied with the mode in which the bathing had been performed, the size of the tub employed never having admitted of sudden immersion. On this account we had the child conveyed to the public bath, into which he was thrown headlong, his father being stripped in the water to receive him. The temperature of the bath was 43° Fahrenheit. He was repeatedly plunged down and taken up for half a minute; was taken out of the water free of convulsion, fell immediately into a profound sleep, and awaked clear of complaint. In these respects this case resembles that of Gardner, first described. It resembles it also in this respect, that convulsion had taken place at the moment of immersion. The paralytic weakness of the side remained, however, for some time, but by the continued use of the bath it was at length entirely removed; and the powers of the mind, which had been totally suspended, gradually returning, at the end of six months were perfectly restored.

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He continued well upwards of twenty months, was healthy and vigorous in body, and in the acquirement of knowledge remarkably acute. But on the 30th of December, 1783, his mother having struck him and frightened him much, he was seized in the night during sleep with general convulsion, in which he continued several hours without intermission. Being again called to him, I employed the same remedy, but at the time of immersion the convulsion was not on him. Sleep and refreshment followed as before, but the paroxysm returned in the evening, though in a slighter degree. However, by perseverance in the daily use of the bath, and throwing him twice into the water with the *convulsions upon him*, in six days his health was restored.

I lament over the fate of this amiable boy. He continued from this time three years and a half in perfect health; grew strong and tall, and shewed great affection of temper and sensibility of mind. But being violently agitated with fear and grief, he fell again into convulsions in the month of July, 1787. I was sent for as usual, but was absent from town at a considerable distance. Having on former occasions launched him myself into the bath, his mother, a superstitious woman in a low walk of life, would not permit this remedy to be used till my return. He lay for thirty hours convulsed and senseless, and the first intelligence I had of his illness was accompanied by the account of his death.

This case differs materially from the convulsions of early infancy. I give it therefore not as an instance of these, but as a specimen of a disease affecting children from four to twelve years of age, and which, though not very uncommon,

mon, as far as I can judge, has not yet found its place in any systematic work that I know of. The nosology of convulsive diseases is indeed very imperfect, and the terms we employ in describing them are by no means precise. Those who have seen tetanus and the disease last mentioned, will know, that what is called convulsion in both instances, is in the one case and the other a very different affection. The convulsion of tetanus is a sudden and violent contraction of all the voluntary muscles, throwing the frame into strong contortions, but lasting only a minute at most, and seldom so long. The patient, where the case terminates fatally, dies in it at last, from the spasmodic affection extending to the heart, or sometimes perhaps, from the suspension of respiration. The convulsion in the other case, though it begins with violence, soon subsides, leaving the body in a state approaching to coma ; and though the separate fibres of many of the muscles keep in constant vibration, and the turbulence of general convulsion returns occasionally, yet in the intervals the respiration is natural, and the pulse little disturbed ; voluntary motion and consciousness, are, however, completely suspended.* If this state continues long, the violent commotions return more frequently, the breathing becomes laborious, the strength is at length exhausted, and the patient dies with the symptoms of apoplexy.

I conclude this paper, already too long, with a few general remarks.

1. It appears to me that the efficacy of the cold bath in convulsive disorders is much promoted by being employed

* This species of convulsion has been denominated *clonic*, in opposition to *tonic*, but with little propriety. All convulsions may be said to be clonic.

ployed during the presence of convulsion. How I came to be led into this opinion may be seen in the case of Gardner. Much experience is required to establish this as a general truth, and I give it as an opinion only. Yet it is an opinion so far confirmed in my mind, that, where left to my own judgment, I should act upon it in all such cases as I have described; and, should occasion require, I should be anxious to have the experiment tried in my own person, and "to run the hazard of the die." As madness is, I think, best combated in the height of the phrenzy, so I believe convulsive diseases are most capable of remedy in the agitation of convulsion. I seem to have a glimpse of a general principle in nature that connects these facts so apparently different; but the ground is not yet firm enough to lay the foundation of a theory.

2. It may however seem to strengthen the above remark, that in spasmodic diseases, which rise not to general convulsion, the cold bath seems to be of inferior efficacy. In chorea Sancti Viti I have tried it frequently, but never found it of any service. This is one of the few diseases in which electricity is of decided advantage.

3. In the hysteric paroxysm the cold bath, or indeed the plentiful affusion of cold water, is an infallible remedy. Those who suppose that the terror it occasions ought, in this case, to prevent our having recourse to it, are, in my opinion, mistaken. Though the hysteric paroxysm be the offspring of passion, it is never occasioned, I will venture to assert, by the passion of fear. A sense of danger will always, I believe, prevent it, or indeed a powerful dread of any kind. I have known a tub of cold water kept in readiness, with the certainty of being plunged into it on the

recurrence of the paroxysm, cure this disease, without the remedy being ever actually tried. I know the hysteric paroxysm often takes place when *danger is over*, but that is another case.

4. I have tried the cold bath in the epileptic paroxysm, but my experience of its effects is as yet too recent and too imperfect to be detailed. I am not so sanguine as to expect that experience will accumulate rapidly on this subject. Many there are who will think my practice too hazardous to be copied, even after the account of its success. This relates especially to the use of the cold bath in convulsive disorders in private practice; but in hospital practice, and in the practice of the fleet and army, the same objections do not present themselves; and in these departments of the profession it may be expected that its effects will be ascertained.

Dr. Girdlestone, in his account of the diseases among the troops in India, mentions that hot Madeira is given with success in the tetanus which occurs in that climate; but he tells us, though not from his own experience, that the cold bath has been very unsuccessful. To what circumstance it may be owing that a remedy, which has been so efficacious in the West Indies, should have failed in the East, does not appear; though if the circumstances under which it was employed were fully related, the difficulty might perhaps be explained. It may, however, be observed, that in the sultry climate of India, where the human frame is greatly relaxed, it will not be safe to use the cold bath with the same freedom as in more northern regions. And it will undoubtedly be more safe, in any future trials of this remedy in that country, to use the method of affusion employed

ployed by Dr. Wright and so successful in his practice in a similar climate, instead of immersion, which it appears was employed in the cases mentioned by Dr. Girdlestone.

I present these facts and observations to you, Gentlemen, with the confidence of a man whose intentions are good. I have not spoken under the warmth of new conceptions, for my experience is, you see, of several years' duration; and I anxiously hope that time will stamp my narration with the seal of truth. Be this as it may, I have written under the strong impression of the folly, baseness, and guilt, of sacrificing the interests of science to a selfish purpose; and if I am in any respect instrumental in deceiving others, I solemnly declare it is because I myself am deceived.

Nº. II.

An Account of the remarkable Effects of a Shipwreck on the Mariners; with Experiments and Observations on the Influence of Immersion in fresh and salt Water, hot and cold, on the Powers of the living Body.

Read before the Royal Society, April 19, 1792, and extracted from Part I. of their Transactions for that year.—Page 199.

THE following narrative is submitted to the Royal Society, as containing in itself some curious circumstances, and as having suggested the experiments afterwards to be recited.

On the 13th of December, 1790, an American ship was cast away on a sand-bank that lies in the opening of the river Mersey into the Irish Channel. The crew got on a part of the wreck, where they passed the night; and a signal which they made being discovered next day from Hillberry Island, a boat went off, though at a great risk, and took up the survivors. The unfortunate men had remained twenty-three hours on the wreck; and of fourteen, the original number, eleven were still alive, all of whom in the end recovered. Of the three that perished one was the master of the vessel; another was a passenger who had been a master, but had lost or sold his ship in America; the third was the cook. The bodies of these unfortunate persons

persons were also brought off by the men from Hillberry Island, and were afterwards interred in Saint Nicholas church-yard, amidst a great crowd of spectators. The cook, who was a weakly man, died a few hours before the boat reached the wreck, but the two masters had been long dead, and this united the sympathy for their loss with a curiosity to inquire into its circumstances and causes. When the following particulars came to be known, this curiosity was increased. Both the masters were strong and healthy men, and one of them a native of Scotland, in the flower of life, early inured to cold and hardships, and very vigorous both in body and mind. On the other hand, several of the survivors were by no means strong men, most of them had been inured to the warm climate of Carolina, and what was singular enough, the person among the whole who seemed to have suffered least was a negro.

What is extraordinary is seldom long unaccounted for in one way or other, and the death of the two masters was said to have been owing to their having taken possession of a keg which had contained cherry-brandy, and which still contained the cherries;—these, it was reported, they had kept to themselves, and eaten in large quantities after the shipwreck; and this having produced intoxication, was supposed to have hastened their death. Some experienced seamen were satisfied with this account, which indeed seemed very rational; for though spirituous liquors may fortify the body against the effects of heat combined with moisture, and may perhaps support it for a short time under great fatigue, they are, I believe, uniformly hurtful when taken under severe and continued cold. Pleased to see a doctrine becoming popular which has been so ably supported by Dr. Aiken,* and

* See Transactions of the Philosophical and Literary Society of Manchester, v. I.

and others, I believed it might receive a striking confirmation from this catastrophe, into the particulars of which I determined to examine accurately. I therefore obtained access to the survivors of the crew, and from them, but more especially from Mr. Amyat, the mate, I received the information which I required.

In repeated conversations with this intelligent young man, I learnt that Capt. Scott, the master of the vessel, died in about four hours after the ship struck; and that Capt. Davison, the passenger, died in about seven: but that the story of their having eaten cherries infused in brandy was entirely without foundation: of this he was certain, for he saw the keg, which contained the cherries, staved, while Capt. Davison was endeavouring to fill it with water to make grog for the crew; the cherries fell on the wreck, and were immediately washed into the sea. Mr. Amyat expressed his surprise at the early death of the two masters, but could not assign any cause for it. He said there was no liquor of any kind saved, nor any sort of food; that the whole crew were on an equality in all points, except that some were deeper in the water than others, but that the two masters had the advantage in this respect, for they sat on the only part of the wreck that was out of the sea, whereas the poor negro, who escaped almost unhurt, was perhaps deepest in the sea of any. He explained this in the following manner. When the ship struck they cut away her masts to prevent her from oversetting, and after this she drifted over the sand bank, into what he called a "swash" on the other side. Here she floated, and they let go their best bower anchor; but it dragged, and the vessel struck again in a few minutes on another bank. In this situation

she

she lay some time, beating against the sand, and the sea breaking over her. In a little while Mr. Amyat saw the tar barrels, which formed her cargo, floating towards the land, and soon after the bottom parted entirely, and was carried in the same direction. Happily for the men, the part of the wreck on which they were lashed was held by the anchor, and floated in the water, a small portion of the after part of the quarter-deck being above the surface. On this sat the two masters, generally out of the sea, but frequently overwhelmed by the surge, and at other times exposed to heavy showers of sleet and snow, and to a high and piercing wind. The temperature of the air, as nearly as can be guessed, was from 30° to 33° of Fah^t. and that of the sea, from trials in similar circumstances, from 38° to 40° . Immediately before the two masters was Mr. Amyat himself. As he was sitting, and the deck sloped pretty rapidly, he was generally up to the middle in the water. The situation of the rest may be supposed; some of them were up to the shoulders. They were not at any time able to change their position, but kept their legs in pretty constant motion to counteract the cold, their arms being employed in holding by the wreck.

The master of the ship, Capt. Scott, a native of North-Carolina, and about forty years of age, died first. As they were in the dark, Mr. Amyat could not see his countenance; but he was first alarmed by hearing him talk incoherently, like one in the delirium of fever. By degrees his voice dwindled into a mutter, and his hearing seemed to fail. At length he raised himself up in a sort of convulsive motion, in which he continued a few seconds, and then fell back dead on the deck. This happened about eight in the evening; four hours after the ship went aground.

Soon

Soon after this, Capt. Davison, who was about twenty-eight, began to talk incoherently, in the same manner as the other. He struggled longer, but died in the same way, at about eleven at night. The cook died in the forenoon of the succeeding day. He was a low-spirited man, and desponded from the beginning. All the rest held out, as has been already mentioned, though sorely pinched with cold and hunger, till they were taken up about three in the afternoon. Mr. Amyat said that his hands and feet were swelled and numb, though not absolutely senseless; he felt a tightness at the pit of his stomach, and his mouth and lips were parched; but what distressed him most was cramps in the muscles of his sides and hips, which were drawn into knots. Though immersed in the sea, they were all of them very thirsty; and though exposed to such severe cold, Mr. Amyat himself was not drowsy, nor were any of the men drowsy, nor did sleep precede death in those that perished. These facts are curious.

Reflecting on the particulars of this melancholy story, there seemed no doubt that the death of the two masters was to be imputed to their peculiar position on the wreck. Exposed to heavy showers of sleet and snow, they might suffer from being wet with fresh, rather than salt water: they might also suffer from being exposed to the cold of the atmosphere, probably seven or eight degrees greater than that of the sea. The chilling effects of evaporation might operate against them, promoted as these must have been by the high wind; or they might receive injury from their frequent immersions in the sea, producing an *alternation* in the media surrounding. This last supposition did not, indeed, strike me at this time; the others dwelt on my mind.

Of

Of the powers attending animation, that which seems fundamental, is the capacity of the living body of preserving the same heat in various degrees of temperature of the same medium, and, indeed, in media of very different density and pressure. If a definition of life were required, it is on this faculty that it might best be founded. It is known that some fluids, applied to the skin, vary in their effects according to their impregnation. In the same degree of temperature, pure water on the surface of the body is much more hurtful than water in which salt is dissolved. Seafaring men are universally acquainted with this, and a striking proof of the truth, as well as of the importance of the observation, may be found in the Narrative of Lieut. Bligh. Probably the saline impregnation may stimulate the vessels of the skin in some way that counteracts the sedative or debilitating action of the cold. At any rate, it seemed not unlikely that some light might be thrown on this curious subject, by observing the effects of immersion in fresh and salt water, of equal temperature, on the animal heat. And this might also assist in accounting for the death of the unfortunate men already mentioned.

EXPERIMENT I.

I placed a large vessel, containing one hundred and seventy gallons of salt water, in the open air. The atmosphere was damp, and what is called raw. The thermometer stood at 44° in the air, and this also was the temperature of the water. The subject of my experiment was Richard Edwards, a healthy man, twenty-eight years of age, with black hair, and a ruddy complexion. The hour chosen for his immersion was four in the afternoon, about

two hours after his dinner ; a time appointed rather for my own convenience, than as being most proper for the purpose. His heat was 98° before undressing, his pulse 100 in the minute. He was undressed in a room where the mercury was at 56° ; and afterwards stood naked before the fire till his heat and pulse were examined again, and found as before. He then walked pretty briskly through a flagged passage into an open court, where the north-east wind blew sharply upon him : he was exposed to it for a minute, and then plunged suddenly into the water up to the shoulders. The thermometer which had been kept in a jug of warm water, at the heat of 100° , was introduced into his mouth, with the bulb under his tongue, as soon as the convulsive sobbings occasioned by the shock were over. The mercury fell rapidly, and a minute and a half after immersion it stood at 87° . He remained motionless in the water, and the mercury rose gradually ; at the end of twelve minutes it stood at $93^{\circ}\frac{1}{2}$. While he sat in the water it occurred to me to examine his heat when he rose out of it into the air : I had reflected on the power that must be employed to keep up his heat in a medium so dense as water, and where an inanimate body, of the same bulk, would have cooled so much more speedily than in air of the same temperature. Supposing that this heat-producing process, whatever it may be, might continue its operations some time after the extraordinary stimulus (the pressure of the water) was removed, I expected to see the mercury rise by the accumulation of his heat, on changing the medium of water for air, and therefore kept him exposed, naked, to the wind two minutes after taking him out of the bath. To my surprise, although the attendants were rubbing him dry with towels during this time, the mercury fell rapidly. He was put into a warm bed, and his heat when examined under the tongue

tongue, was 87° , at the axilla 89° . Frictions were used, and brandy mixed with water administered; but I found on this, as on all future occasions, the best mode of counteracting the cold, was to apply a bladder, with hot water, to the pit of the stomach (the scrobiculus cordis), a fact which I think important: this being done, his shiverings, which before were severe, soon ceased, and he became more comfortable. Three hours afterwards, however, he had not entirely recovered his former heat; but by eight at night, he was in all respects as usual.

I have been very minute in detailing the circumstances under which this experiment was made; some of the particulars which, at the time, I thought of little consequence, I found afterwards of importance. The experiment itself I determined to repeat as exactly as possible.

EXPERIMENT II.

On the next day, at the same hour, the same person was again immersed, as before. His pulse previously was 85, his heat 100° . He had been put to bed an hour before to save the time spent in undressing. The heat of the water and of the atmosphere 44° . The wind north-east, and strong. On this occasion, as before, there was a rapid fall of the mercury; the following table will save words:

	Ther.		Ther.
2 min. after immersion	$89^{\circ}\frac{1}{2}$	9 min. after immersion	$95^{\circ}\frac{1}{4}$
3 ———	$90^{\circ}\frac{1}{2}$	10 ———	$94^{\circ}\frac{1}{2}$
4 ———	$92^{\circ}\frac{1}{2}$	11 ———	95
5 ———	$94^{\circ}\frac{1}{2}$	12 ———	95
6 ———	95	13 ———	$95^{\circ}\frac{1}{2}$
7 ———	$95^{\circ}\frac{3}{4}$	14 and 15 ———	95
8 ———	$95^{\circ}\frac{3}{4}$		

At

At the end of fifteen minutes he was taken out, and stood three minutes, naked, exposed to the north-east wind, at the end of which time the mercury had sunk to 88° . A draught of ale was given him, and he was put into a warm bed; in three minutes afterwards the mercury rose to 93° . An hour after his heat was 95° .

The effects produced by this alternate exposure to water and air of the same temperature, gave a new direction to my thoughts, and determined me to inquire again into this singular phenomenon. The most obvious method would have been to have prolonged the process of alternation, and replunged the person cooled by the external air into the bath; but this was running too great a risque, unless some more sudden and certain method could be found of restoring the heat that might be lost. It was prudent, therefore, to proceed more cautiously. In the next experiment I resolved to try the methods of heating as well as cooling the body.

EXPERIMENT III.

On the following day, at the same hour, the same person was again immersed in the salt water bath. His heat previously was 98° , his pulse 100. The temperature of the air and the atmosphere, as before 44° . The mercury sunk rapidly to 90° .

2 minutes after	-	88°	10 minutes after	-	$94^{\circ}\frac{1}{2}$
3 ———	- - -	88	11 ———	- - -	$94^{\circ}\frac{3}{4}$
4 ———	- - -	$88^{\circ}\frac{1}{2}$	12 ———	- - -	95
5 ———	- - -	$90^{\circ}\frac{1}{2}$	13 ———	- - -	96
6 ———	- - -	92	14 ———	- - -	96
7 ———	- - -	92	15 ———	- - -	96
8 ———	- - -	94	16 ———	- - -	96
9 ———	- - -	94			

He

He was now taken out, and stood in the wind three minutes, shivering violently. This circumstance rendered it difficult to ascertain exactly the fall of the mercury, which was, however, considerable. When examined in the room in which he undressed, it stood at 90° . He was now plunged into a fresh-water warm bath, heated to $97^{\circ}\frac{1}{2}$. What is very surprising, the mercury fell two degrees. The following table will shew the progress of the return of his heat.

1 min. after immersion in		5 minutes after	-	94°
the warm bath, mer-		6 ———	-	96
cury, - -	88°	7 ———	-	96
2 minutes - -	92	8 ———	-	96
3 ——— - -	92	9, 10, 11, 12, to 16,		96
4 ——— - -	94			

If the rise of heat in the cold bath at 44° , and the warm bath at $97^{\circ}\frac{1}{2}$, be compared, the first will be found more slow; but that after being sixteen minutes in the one and in the other, the heat was the same in both cases, when taken at the mouth. It must, however, be acknowledged, that in the cold bath, the extremities were chilled and cold, while in the hot bath, the heat was equally diffused. When Edwards got out of the hot bath, he put on his clothes, and was remarkably alert and cheerful the whole evening. Encouraged by the safety of these experiments, I resolved to increase the time of immersion in the cold bath, and to inquire more generally into its effects on the sensations, as well as heat.

EXPERIMENT IV.

At the same hour of another day, the same person was
again

again immerfed as before, his heat being previously $97^{\circ}\frac{1}{2}$, and that of the water 42° . Wind north-eaft, and brisk.

1 minute after,	heat	90°	12 minutes	-	-
2 minutes	-	92	13	—	- -
3	—	92	14	—	- - $94^{\circ}\frac{1}{2}$
4	—	$92^{\circ}\frac{1}{4}$	15 to 24,	- -	$94^{\circ}\frac{1}{2}$
5	—	92	25	—	- - 94
6	—	$92^{\circ}\frac{1}{2}$	26, 27	- -	
7	—	94	28	—	- - $94^{\circ}\frac{1}{2}$
8 9, 10, 11	-	94	29, 30	- -	94

It will be obferved, that in the above table there are blanks left in the report. At fuch times the thermometer was taken out of Edwards's mouth, to admit of his answering the questions put to him. He faid, that on plunging into the water he felt an extreme cold, which he could not but think was partly owing to his being expofed, naked, to the wind before; that this cold diminifhed, and in a little while he felt comfortable, but that after a while the fenfe of coldnefs returned, though lefs than at firft; diminifhing again, but in a lefs degree. At length his fenfations became pretty fixed. In this ftate, when the water was at reft, he fhould not even have known, by his feelings from the upper part of his cheft to the pubes, that he was in water at all. His feet and legs were very cold; fo were his hands and arms; and fo alfo the penis and fcrotum. He mentioned, likewise, that he felt a cold circle round the upper part of his body, though not constantly. On examining into this, I found it was greateft at firft, and that it extended over the fpace which, from the undulations left in the bath by the plunge of immerfion, was alternately above and under the furface of the water: when the bath fettled, it was little felt; but by agitating the fluid, I could re-produce

produce it at any time when the cold in the extremities was not so great as to prevent its being felt. This curious particular serves to explain a circumstance much dwelt on by Mr. Amyat, in giving an account of his sufferings on the wreck ; that what he felt most severely was the cramps in the muscles of his hips and sides, parts which, from his situation on the wreck, already described, must have been alternately under and above the surge. Here I must observe, that the sea did not break over the sufferers all the time they were on the wreck. The wind moderated, as well as the waves, and for the last fifteen hours, they were not at any time overwhelmed, or at least Mr. Amyat himself was not. The cold never abated. Being all lashed to the wreck, they never changed their positions ; the bodies of those who died occupied the space where they were originally placed. Mr. Amyat, therefore, during the whole time sat nearly up to the middle in water, but subject to the variations occasioned by the motion of the sea.

To return.—When exposed naked to the wind, the mercury, in this case, sunk as usual five or six degrees, and his shiverings were great. Desirous of restoring his heat as speedily as possible, we incautiously heated the hot bath to 104° : but after being half a minute in it, he screamed out with pain, especially in his extremities, and about his scrotum. When taken out, his shiverings almost amounted to convulsion. The bath was lowered to 88° , and he was replaced in it, and its temperature progressively, but pretty rapidly increased to 100° . He continued, however, to shiver much, his heat remaining about 90° ; but a bladder, with very hot water, being introduced under the surface of the bath, and applied close to his stomach, the
good

good effects were instantaneous, his shiverings ceased, and his heat mounted rapidly to 98° .

All these experiments having been made on one person, I determined to repeat this last on another.

EXPERIMENT V.

R. Sutton, aged 19, of a pale complexion, and a feeble frame, was immersed in the bath, under the circumstances of the preceding experiment. His heat was previously $96^{\circ}\frac{1}{2}$.

$\frac{1}{2}$ a minute after, heat 92°	18 minutes	-	$93^{\circ}\frac{1}{4}$
1 minute - 90	19 ———	-	$93^{\circ}\frac{1}{2}$
2 minutes - $88^{\circ}\frac{1}{2}$	20, 21 - - -	-	94
3 ——— - 89	22 ———	-	$92^{\circ}\frac{1}{2}$
4 ——— - 90	23 ———	-	$92^{\circ}\frac{1}{4}$
5 ——— - 92	24 ———	-	$92^{\circ}\frac{1}{4}$
6 ——— - $92^{\circ}\frac{1}{4}$	25 ———	-	94
7 to 10 - 92	26 ———	-	94
11 ——— -	27 ———	-	$92^{\circ}\frac{1}{2}$
12 to 15 - 92	28 ———	-	$92^{\circ}\frac{3}{4}$
16 ——— - $92^{\circ}\frac{1}{2}$	29 ———	-	94
17 ——— - 93	30 ———	-	94

Though this person seemed to bear the cold bath well, having lost in thirty minutes only $2^{\circ}\frac{1}{2}$ degrees of heat, yet when exposed afterwards to the wind, he shivered violently, and lost his heat very fast. He was put into a warm bath, heated to 96° , but recovered his heat very slowly, as the following table will show.

1 minute after,	heat 88°
2 minutes -	90
3 ——— -	$90^{\circ}\frac{1}{2}$

4 ———

4	————	-	90°	great shivering.
5	————	-	90	here the bath was heated to
			100°.	
6	————	-	90	shiverings still.
7	————	-	90	ditto.
8, 9	-	-	90 $\frac{1}{2}$	ditto.
10	————	-	92	ditto.
11	————	-	92	bath heated to 104°.
12	————	-	94	
13	————	-	93	—— heated to 108°. Shi-
				verings.
14	————	-	93	a bladder with very hot water
				applied to the stomach.
15	————	-	94	
16	————	-	96	very comfortable.

EXPERIMENT VI.

Richard Edwards, the original subject of experiment, was again immersed in the cold bath, of the temperature of 40°, and remained in it three quarters of an hour. His heat previously was 97° his pulse 90 in the minute. The mercury fell at first to 92°, was stationary for a few minutes, and then mounted, though as usual, with no regularity. In twenty-two minutes it stood at 96°; it then began to decline, and in twenty-three minutes more had sunk to 94°. Being exposed as usual to the wind, the mercury sunk as usual, and he shivered violently. In the warm bath at 96° his shiverings continued several minutes, his heat remaining at 90 and 91°. In seven minutes the mercury began to rise fast, and five minutes after was at 96°.

EXPERIMENT VII.

The effects of forty-five minutes immersion in the cold
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falt.

salt-water bath, at 40° , were proposed to be tried on Richard Sutton. He was much under the impressions of fear, and his heat previously raised the mercury only to 94° . The mercury sunk, as usual, on his immersion, but to an unusual degree. It did not stop in its fall till it got to 83° , which perhaps might in part be accounted for by the extraordinary chattering of his teeth, admitting some contact of the air. It then mounted in the usual irregular way, and at the end of thirteen minutes had got to 92° . Here it stood for nineteen minutes longer with little variation; at the end of this time it began to fall rapidly, though irregularly, and in three minutes was down at 85° . He had now been thirty-five minutes in the water, and I did not think it safe to detain him longer; we therefore hurried him into a warm bath, heated to 96° , where he shivered much. The bath was heated gradually to 109° , and in this heat he recovered his proper temperature in about twenty-eight minutes. Being then put into a warm bed, he fell into a profuse perspiration, which left him in his usual health.

One general remark will serve for the pulse in all these experiments. It was not possible to keep the subjects of them from some degree of previous agitation, and this always quickened the pulse. The natural pulse of Edwards was about 70 in the minute; but it may be observed, that it was never slower than 85 before immersion, and generally more. However this might be, it invariably sunk to 65, or from that to 68, in the water; became firm, regular, and small. After being long in the bath, it could hardly be felt at the wrist, but the heart pulsated with great steadiness and due force. In the last experiment, when the heat sunk rapidly, Sutton said that he felt a coldness and faintness at his stomach, which he had not perceived before, and
when

when I felt the motion of his heart, it was feeble and languid. In some future trials of the effects of immersion in fresh water (one of which I shall detail) the same coldness at the stomach preceded a rapid fall of the mercury ; and these facts, together with the effects I found from applying a considerable heat to this part when the body was chilled with cold, convince me that there is some peculiar connection of the stomach, or of the diaphragm, or both, with the process of animal heat. Whoever will consider the rapidity with which a dead body would have cooled immersed in water of the temperature of 40° , may form some estimate of the force with which the process of animal heat must have acted in the experiments already recited. These experiments, however, do not coincide with our generally received theories of animal heat. The increase of heat, in fever, has led some persons to believe that animal heat is produced by, or immediately connected with, the action of the heart and arteries ; here, however, it may be observed, that while heat must have been generated in the bath with more than four-fold its usual rapidity, the vibrations of the arterial system were unusually slow. Another, and a very beautiful theory of animal heat, supposes it immediately to depend on respiration ; but in the bath, after the first irregular action of the diaphragm from the shock of immersion was over, the breathing became regular, and unusually slow. Lastly, the curious phenomenon of the heat rising, and falling, and rising again, in the bath, with the body at rest, and the temperature of the surrounding medium unchanged, is, I think, fatal to those theories of animation which consider the living body as a mere machine, acted on by external powers, but not itself originating action, and differing from other machines only in the peculiarity

culiarity of the powers which are fitted to set it in motion.* I have said that the temperature of the medium continued unchanged, but it may be supposed that the bath was heated a little during the experiments; it was so; but being exposed, with a large surface, to the open air, the wind blowing briskly over it, its heat was little altered; in twelve minutes immersion it had gained nearly one degree, and in forty-five minutes, the longest duration of any of the experiments, it had gained three degrees. As this accession was regular, if it had been greater it would not have invalidated the foregoing observations.

Many other trials were made on the effects of immersion in water on the human heat, which I shall speak of generally, under the general conclusions which they suggested.

The experiments already recited, suggested to me the notion, that in all changes from one medium to another of different density, though of the same temperature, there is a loss of animal heat. I found, however, that this conclusion requires many restrictions.

1. My experiments being made on bodies of such very different density as air and water, do not admit an universal inference of this sort.
2. Being

* The author does not mean to object to the theories of Dr. Crawford and Dr. Goodwin. The decomposition of the atmosphere in respiration, is in all probability the principal source by which caloric is received into the system, but the actual state of heat in the body cannot safely be inferred (as some have supposed) from the quantity of air respired. Caloric is received into the system by other processes also, particularly from the food and drink in the state of digestion, and the evolution of it into active heat appears to be modified by the living power on its own peculiar principles, and cannot be explained by chemical or mechanical principles or analogies.

2. Being all made in a temperature fifty degrees under the human heat, no certain conclusion can be drawn as to what might happen in degrees of heat much higher, where it is probable, the effects of the change, if it appeared at all, might be less striking. It would seem, however, that after a person is long chilled in cold water, the first effect of passing through the external air into the warm bath, is first a fall of heat in the air, and after this a still greater fall in the warm bath, followed, however, by a speedy rise.

The air and the water being equally cold, and both 45° or under, I found the loss of heat in passing from the one to the other to be regulated in the following way.

1. If, instead of being exposed naked to the wind previous to immersion in the water, the body was kept warm by flannel covering, the mercury fell much less on the first plunge.

2. If, after plunging in the water, the person continued in it only a minute or two, a subsequent fall of the mercury did not always take place, on his emerging into the air. On the contrary there was sometimes a rise on such occasions in the mercury, especially if the atmosphere was at rest.

3. In one instance, after continuing in the water fifteen minutes, on rising into the air in a perfect calm, though during a frost, there was little or no seeming diminution of the heat; while exposure under similar circumstances, with a north-east wind blowing sharply, though the air was many degrees warmer, produced a rapid diminution. The effects of the wind in diminishing the human heat are indeed striking, and are not in my opinion explained by the common suppositions.

4. The

4. The loss of heat by a change of media, depends much on the rapidity of the change, for the plastic power of *life* in varying the process of animal heat, so as to accommodate it to the external changes, acts for a time with great celerity, though this celerity seems to diminish with the strength.

EXPERIMENT VIII:

I placed in a large room, where the mercury stood at 36° two flipper baths at the distance of six yards from each other. One was filled with cold salt-water of the temperature of 36° , the other with water heated to 96° , which was my own heat. Undressing myself in an adjoining room by a fire, I afterwards slipped on a loose flannel dress, and descended *slowly* into the cold bath, where I remained two minutes; I ascended *slowly* into the air, and then sunk myself in the warm bath, where I remained two minutes also: I returned to the cold bath, where I staid two minutes as before, and removed from it again to the warm bath. But during all these changes of media and temperature, the thermometer with its bulb under my tongue never varied from 96° . I attribute this partly to the heat of my body being in some degree defended by the flannel dress, partly to the calm of the air, but chiefly to the slowness of motion in these changes. It may be said that the time of staying in the different baths was not long enough to produce any sensible change in the heat of circulating fluids of such a mass, but this is not consistent with many of the other facts.

5. The influence of the application of cold water to the surface of the body on the heat, is in some respects regulated by the animal vigour, as the following experiment will show.

EXPERIMENT

EXPERIMENT IX.

In the same room I placed a large empty vessel, in which two young men sat down in succession, each with the bulb of a thermometer under his tongue. A man standing on a bench with a bucket of cold salt-water containing four gallons, poured the whole on the head and shoulders, suffering it to run down on the rest of the body. This process took up nearly a minute, during which I examined the mercury, and found it unchanged. They were both directed to continue sitting without motion for a minute after, during which, in both instances, the mercury rose two degrees. A third, much inferior in vigour, submitted to the same experiment, and the mercury continued during the affusion of the water unchanged, but in a minute after sunk half a degree. In fevers where the heat is generally increased from two to six degrees above the standard of health, pouring a bucket of cold water on the head always reduces the pulse in frequency, and commonly lowers the heat from two to four or five degrees. Of this salutary practice I hope soon to speak at large to the public

6. The power of the body in preserving its heat under the impressions of cold, and the changes of temperature, and of media, seems in some measure regulated by the condition of the mind. That fear increases the influence of cold, and of many other noxious powers, will not be doubted; but the state of the mind to which I allude, is that of *vigorous attention* to other objects. This, it is well known, will to a certain degree deaden, or, indeed, prevent the sensation of cold; and what does this, I apprehend, prevents, or at least weakens, its physical action. The astronomer, intent on the objects of his sublime science, it is said, neither feels, nor is injured by, the damps or the chillness of the night; and in some species of madness, where the ideas
of

of imagination are too vivid to admit the impressions of sense, cold is resisted to an extraordinary degree. I have seen a young woman, once of the greatest delicacy of frame, struck with madness, lie all night on a cold floor, with hardly the covering that decency requires, when the water was frozen on the table by her, and the milk that she was to feed on was a mass of ice.

7th. There are particular conditions of the atmosphere, not perfectly understood, that seem to have an influence in depriving us more speedily of our animal heat, than others where the cold is greater.

It may seem that by this time I had renounced my intention of trying the effects of immersion in fresh water on the animal powers, and particularly on the heat. Some trials, I have, however, made, of which I shall only relate the following.

EXPERIMENT X.

In the same vessel containing an equal bulk of fresh water, Richard Edwards, the subject of my first experiments, was immersed, at the same hour of the day. His heat previously was 98° , his pulse beat 92 in the minute: the heat in the air was $41^{\circ}\frac{1}{2}$, that of the water 40° . The wind was now in the west, so that in the court where the bath stood there was a perfect calm. As I had some fears of the issue of this experiment, instead of exposing him for a minute naked to the wind before immersion, he was covered with a flannel dress from the air, till the instant he descended into the water, into which he was suffered to sink himself slowly, with the bulb of the thermometer under his tongue. These are important circumstances. The following table exhibits the result.

Immediately

Immediately on immersion,	14 min. after, heat	$96^{\circ} \frac{1}{2}$
heat - - -	15 - - -	96
1 minute after -	16, 17, 18, 19, 20	96
2 minutes -	21, 22, 23, 24	
3 - - - - -	25 - - - - -	95
4 - - - - -	26 - - - - -	94
5 - - - - -	27 - - - - -	$93^{\circ} \frac{1}{2}$
6 - - - - -	28, 29 - - -	94
7, 8 - - -	30 - - - - -	93
9 - - - - -	31, 32 - - -	94
10 - - - - -	33, 34 - - -	$92^{\circ} \frac{1}{2}$
11, 12, 13 - - -		

He now got out into the air very slowly, and stood in it three minutes, the wind *not* blowing on him. He lost one degree of heat at first, which he recovered. He was then put into a warm bath at 90° , which at first *he felt* warm, and his feet and hands were pained: but in two minutes he fell into a very violent shiver, and his heat fell two degrees. The bath was then heated to 95 and 96° , but still he felt cold. It was heated to 99° : he continued in it five minutes and his heat was 91° . The heat was gradually raised to 106° , when the sense of coldness of which he had complained at the pit of the stomach gradually went off. Before this I had usually kept him in the warm bath till his natural heat was nearly recovered, but after being half an hour in the heat of 106° , his own heat was still 93° . He now became sick and very languid, a cold sweat covering his face, his pulse very quick and feeble. He was removed into bed, but passed a feverish night, and next day had wandering pains over his body, with great debility, resembling the beginning stage of a fever. By cordials and rest this went off.

F

This

This experiment clearly enough confirms the greater danger of being wet with fresh than salt-water ; but in itself points out nothing certain besides, except that it is not to be rashly repeated. I mean to try some of these experiments to a greater extent on the brute creation, when I have procured thermometers better suited to my views. The thermometers I employed had not a sufficient mobility for very nice experiments, and I am well aware, that in particular instances this may have misled me, though the general results, which is all that is of importance in such experiments as these, will I hope be found just and true.

Before I conclude, I must offer a few observations on the subject that led to these experiments.

1. It is, I think, already well known among seamen, that where there is only the choice of being wet with salt or fresh water, it is always safest to prefer the first. In the heavy showers of rain, hail, or snow, by which gales of wind are generally accompanied, the men that must be exposed to them, ought, like Lieutenant Bligh and his crew, to wring their clothes out of salt-water.

2 In all cases where men are reduced to such distress by shipwreck or otherwise, that they have it only in their power to chuse between keeping the limbs constantly immersed in the sea, or of exposing them to the air while it rains or snows, or of being exposed to it, where the sea is at times washing over them, it is safest to prefer a constant immersion ; because, in the northern regions, where the cold becomes dangerous to life, the sea is almost always warmer than the air, as the experiments of Sir Charles Douglas shew ; and because there is not only a danger from the increased

creased cold produced by evaporation, but also from the loss of heat by the rapid changes of the surrounding medium, as the foregoing experiments point out.

3. Whether, in high and cold winds without rain or snow, and where a situation may be chosen beyond the reach of the waves, it is safer to continue in the air, or to seek refuge in the sea, must depend upon several circumstances, and cannot perhaps be certainly determined. The motives for choosing the sea will be stronger in proportion as the wind is high and cold, and in proportion as the shore is bold.

The foregoing narrative shows that men may survive twenty-three hours immersion in the sea, of the temperature of 38° or 40° (as great a cold as it almost ever possesses) without food or water, and almost without hope of relief; but that any man ever survived an equally long exposure to the higher degrees of cold of the atmosphere, in the same circumstances, does not appear. Though in the case related, immersion in water did not prevent thirst, yet there is no doubt that it alleviated it, a circumstance of high importance towards the preservation of life.

Liverpool,
December 25, 1791.

P. S. I have purposely avoided any reasoning on the causes of the loss of vital heat on the change of media in the experiments recited. It may be supposed that during immersion, the water immediately in contact with the skin, having become heated to a certain degree, the naked body, on rising from it into the air, was in fact exposed to a colder medium, and thus the loss of heat, in this instance, produced.

My

My examination of the heat of the water during immersion, not having been made in contact with the body, I will not deny that there is some foundation for the remark; and the cases, it must be allowed, are by no means exactly parallel between immersion in an open vessel, however large, and immersion in the sea, where the constant undulation may be presumed to occasion a continual change in the surrounding fluid. But whatever allowance may be made for the circumstance mentioned, I am persuaded that the difference between the density of air and water being considered, it is not sufficient to explain the loss of heat in the instance alluded to. The changes of temperature in the living body are governed by laws peculiar to itself. I have found, in certain diseases, greater and sudden variations than any mentioned, from applications of cold very gentle in degree, and momentary in duration.

In his masterly "Experiments and Observations on Animal Heat," Mr. Hunter has objected to taking the heat of the human body by introducing the bulb of the thermometer into the mouth, because it may be affected by the cold air in breathing. The objection is well founded if the bulb be placed on the upper surface of the tongue, but if it be under it and the lips shut, the effects of respiration may be disregarded, as I have found from many hundred experiments. The heat may be observed in this way with ease and certainty, by employing thermometers curved at that end to which the bulb is affixed (the bulb being introduced at the corner of the mouth,) some of which have been made for me by Mr. Ramsden, according to a form given, as well as others on Mr. Hunter's plan. From repeated trials it appears to me, that when the usual clothing is on, the heat of the living body may be taken with

with nearly the same result and equal certainty, under the tongue with the lips shut, at the axilla with the arm close to the side, and in the hollow between the scrotum and the thigh; every other part of the surface is liable to variation and uncertainty. It is evident, that of these three methods, the first only can be employed (as far as I can discover) when the trunk of the body is immersed in water; and even when the naked body is exposed to the cold air, the first method seems the best, the heat remaining most steady under the tongue; the axilla is the next best in order, and the worst, the lower part of the groin; for the scrotum and the parts of generation lose their heat on the application of cold, more speedily perhaps than any other part of the body, the extremities not excepted.

N. B. The water employed in the experiments related, contained salt in the proportion of one to twenty-four.

