On the Influence of Temperature on Infant Mortality. By Dr. Deck.

(With Illustrations.)

[*Read before the Otago Institute, 19th November,* 1872.]

Although I feel that the subject upon which I have to offer a few remarks is one especially suited to the meetings of a medical society; yet, in the absence of such in this place I have thought it might prove of some interest to the members of this Institute. I was led to collect the few data upon which my remarks are founded on hearing of the extreme heat of the weather during the past summer in England and in North America, and the consequent great increase in infantile mortality with which that hot weather was accompanied. This mortality is thus referred to in the "Lancet" for August, 1872:—

"The effect of the great heat which we have had of late is manifest in the death returns by a large increase in the mortality from diarrhœa. In London the general mortality has risen from 17 to 26 per 1,000 in the last five weeks, the rate last week, 26 per 1,000, being higher than in any previous week this year, a result almost exclusively due to the fatality of diarrhœa, which caused last week 394 deaths. The mortality from this cause was nearly all among children under five years of age, of whom 324 died in their first year. In the eighteen large towns the deaths registered from diarrhœa in the week ending July 6th were 113, during the next fortnight they were successively 226 and 370, and during the last week 604. In Leicester and Leeds the fatality is greater than in London, while in Hull it is equal, but in all the other towns considerably less fatal than in London. The Registrar-General refers in this connection 'to the importance of pure water to children who drink freely in hot weather,' and no doubt that is a most important matter, but it must be remembered that the mortality is to a large extent among infants who are hardly likely to drink freely of water."

The mortality among children from the same cause in New York is thus referred to in the "Lancet" for 10th August, 1872:—

"Heat as intolerable as that which beset the ancient mariner and his crew continues to afflict New York. Not only have cases of sunstroke reached a frightful average, but deaths from nearly every cause still swell abnormally the mortality returns; 1,056 deaths, about double the usual number, were recorded the week before last, while in Philadelphia they amounted to 885, about treble the average. But the infant mortality remains the most appalling feature. Cholera infantum, almost endemic in the Empire City, has assumed something of the proportions of an Egyptian scourge. The heat, with its insanitary sequelæ, operates disastrously on an infant population, which, owing to the premature marriages of its parents, is, as a rule, deficient in stamina and staying power. It is quite usual in New York for a beardless lad of 18

to wed a child of 16, with the inevitable result of begetting a progeny rickety, scrofulous, and (to use the indigenous phrase) hastily run up. Asiatic cholera has already numbered one victim, and New York trembles to think what ravages that pestilence will make when it fairly warms to its work."

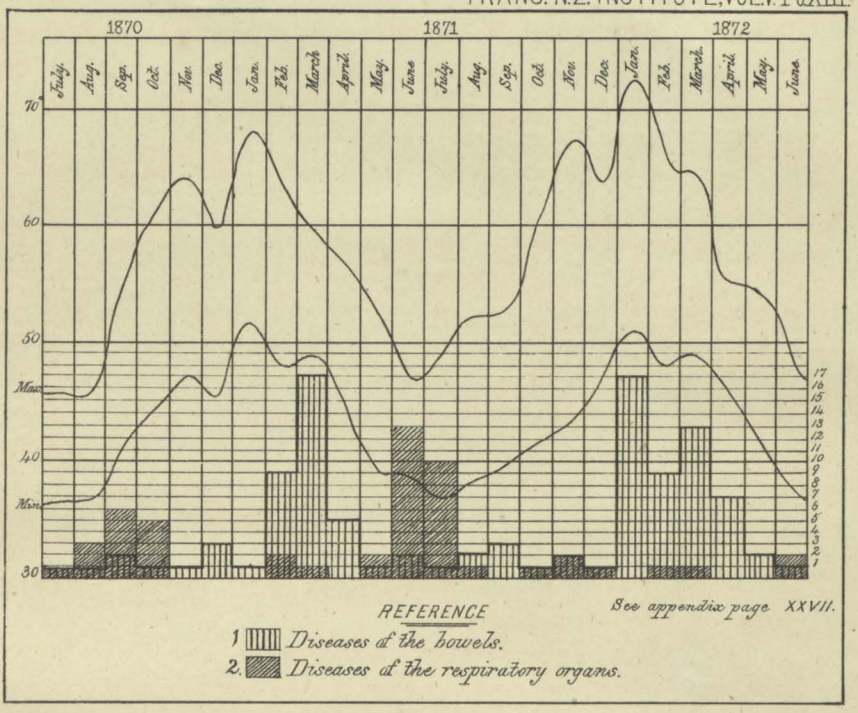
From another medical journal, published in Philadelphia, I extract the following paragraph :—

"The harvest of death. The protracted and unprecedented heat of the first and second weeks of July were accompanied by a mortality in this city of a most startling character. The whole number of deaths for the week ending 6th July was 764, an increase of 350 over the week previous. Of these 274 were from cholera infantum. High as these figures are, they were exceeded by those of the following week, when they reached 852 ; of this number 497 were children under two years of age, and 383 under one year. Of cholera infantum there were reported 310 cases, and of sunstroke 68."

Recollecting that we had passed through a summer hotter than usual, I determined to compare the mortality among children under two years of age during that season with the mortality during the previous summer, and during other periods of the year.

I examined in the Registration Office for the Dunedin district the records of all deaths among children under two years of age during the period of the two years, from 1st July, 1870, to 30th June, 1872. During that time 232 deaths took place. I divided the causes of death into three classes: deaths from affections of the brain, deaths from affections of the respiratory organs, and deaths from intestinal affections. Of the 232 deaths, eight occurred in children that had not reached the age of one week, and the circumstances of their birth had probably more to do with their death than any external cause acting upon them ; thirty-three died from affections of the brain, fifty-eight from affections of the respiratory organs, 103 from intestinal disorders, twenty-six deaths were recorded as having occurred from debility or atrophy, two from tubercular disease, without specifying the locus of that disease, one from jaundice, and one from heart-disease. It is to be regretted that the causes of so many deaths are recorded in such an indefinite manner, it takes somewhat from the little value that statistics have, when twenty-six deaths are set down as having occurred from debility or weakness, without specifying the cause of that weakness, or what organs were especially affected.

On examining the periods of the year during which the deaths occurred from these three classes of disease. I found that there was no particular time during which deaths from brain affections were especially prevalent. The summer heat is not intense enough here to produce sunstroke, with ordinary precautions ; at least that disease is not of frequent occurrence, and no deaths among infants are attributed to it. The thirty-three deaths that occurred



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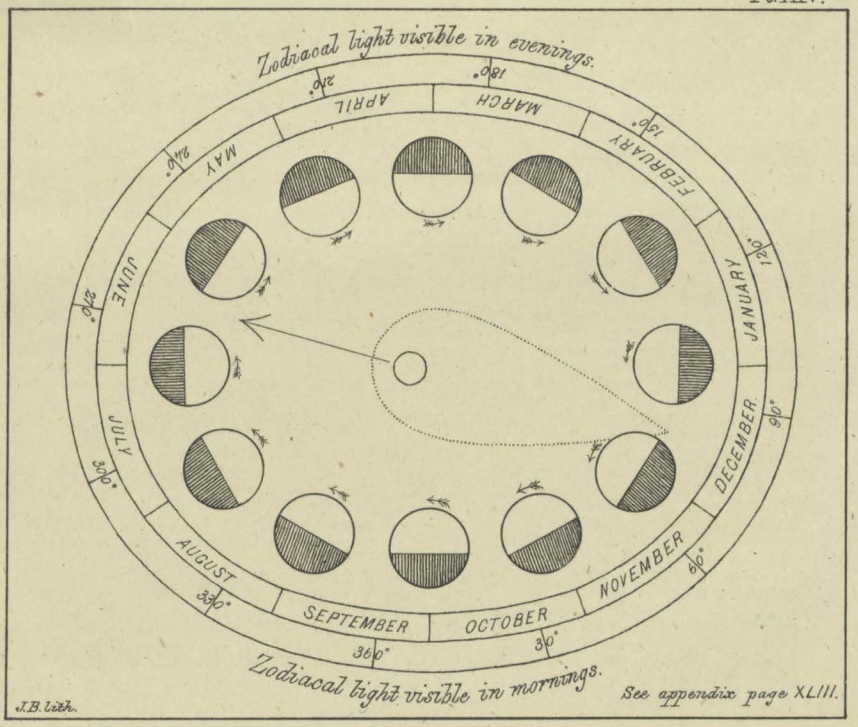
Pl. XIV.



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from cerebral affections, such as convulsions, congestion of the brain, and tubercular meningitis, took place, as far as the records of this small number show, with about equal frequency at all periods of the year.

The fifty-eight deaths that took place from affections of the respiratory organs, such as croup, bronchitis, and broncho-pneumonia, occurred with decidedly greater frequency during the winter months. I have laid before you a diagram (Pl. XIII., 2.) which I have drawn up with the desire to show the variations in the mean, maximum, and minimum temperature for each month during the years above mentioned, and the shaded spaces below show the number of deaths that occurred from diseases of the respiratory organs during those several months. It will be noticed that they occurred principally during, or just after, the depression of the line of temperature in the winter months, during August, September, and October, in 1870, and during June and July in the year 1871.

The 103 deaths that took place from intestinal disorders, such as diarrhœa, dysentery, and cholera infantum, being nearly twice as many as the deaths from respiratory diseases, and three times as numerous as those from brain affections, show that this class of disorders is the one the most serious to infant life. They occurred, as may be seen from Pl. XIII., 1, during the hot summer weather, or they followed it very closely. They occurred principally during February and March in the year 1871, and during January, February, March, and April in the year 1872; the number of cases in each month respectively being indicated by the shaded spaces in the lower part of the diagram.

It will at once be noticed on looking at the curves of temperature in that diagram that the summer of 1871–72 was much hotter than the summer of 1870–71, and the greater rate of infant mortality is visible at once on comparing the shaded spaces referring to those summers. It is to the influence of high temperature in increasing the rate of infant mortality from these affections that I wish especially to draw your attention. The same rule holds good here which has been found to apply in London, New York, and other places, that the higher the rate of the summer temperature the greater the rate of infant mortality that is observed from intestinal affections.

And I would observe that the increased temperature itself, rather than the insanitary sequelæ to which it gives rise (although, no doubt, they are in some measure accountable for the result) seems to be the chief factor at work among the causes that combine together to produce this increased mortality. The case is different when we consider the increased rate of mortality from disease of the respiratory organs during the winter months. Cold weather is often most healthy weather. There may be seyere cold, cold weather such as that we experienced during the past winter, when the snow lay upon the ground

for days, and it may be that no time of year is more healthy. I am quite aware that intense cold does produce very dangerous attacks of capillary bronchitis, especially in old people, but I do not think that many bronchitic attacks among infants are thus originated. The epidemics of influenza and bronchitis, to which such attacks are generally due, that occur so frequently during the winter and spring months, seem to be produced by some other agency than the cold itself. Sudden changes of temperature in themselves are scarcely sufficient to bring about such results. There seems to be some other factor at work in these catarrhal disorders that are at times epidemic over such a large area of country. They may be due to some peculiar state of electrical tension in the atmosphere, that is produced at times in cold weather, or rather during sudden changes of temperature; or they may be allied to those zymotic disorders that seem to be dependant on the influence of some germs of which we know little, either as to their mode of production or their character, but I think we may safely come to the conclusion that cold itself is not by any means a chief factor in their production.

But a careful consideration of the circumstances under which intestinal disorders are most prevalent, leads to the conclusion that high temperature, or rather *continued* high temperature, is one of the most important factors at work. It seems to act, if I may use the expression, in a *cumulative* manner. The high mortality takes place only after a certain quantum of heat has been allowed to expend its influence. Suddenly occurring high temperature, which lasts only for a short time, is not followed by these pernicious effects. The high temperature seems to act in the first place as a predisposing, and in the second place as an exciting cause. After the system has been weakened by continued exposure to excessive heat, a further exposure is found to produce these intestinal affections.

It is on this account that in the summer of 1870–71, which was comparatively cool, the chief mortality was at the end of the summer, even with a declining average temperature for the month of March in which it occurred; but in the summer of 1871–72, after a hot November and December, the sudden high increase of temperature in January is accompanied by a sudden and great increase in mortality. The gradual decrease in the mortality after that date is in accordance with the laws that are found to obtain in all epidemics, a certain number of those exposed to any morbid influence, on account of some previous constitutional state are especially susceptible, and are first and chiefly affected, and the rest suffer in a minor degree. Thus the continuation of the high temperature in February and March, 1872, might produce a less result than a lower temperature in February and March, 1871, because those most susceptible to the morbid influence of heat had been already attacked in January of that year.

I have not made any distinction in this diagram between the different kinds of intestinal disorders to which children are susceptible. The manner in which the deaths were registered seemed not to be sufficiently accurate to enable me to do so with any degree of satisfaction. Until some uniform system of nomenclature of disease is adopted by medical men this will be the case. On this account I have preferred to group them all together, but if I could have made a distinction between them we should probably have found that dysenteric diarrhœa was especially prevalent towards the end of the summer, during the prevalence of hot days and cold nights, and that it was that form of intestinal disorder termed cholera infantum which was developed during very hot weather, and was the chief cause of fatality at that time.

These conclusions, which I think may be fairly deduced from the examination which I have made into the causes of the infant mortality during the past two years in the Dunedin district, are more clearly demonstrated by diagrams, showing in an accurate manner, day by day, the connection between high temperature and infant mortality, which have been compiled by Dr. Pemberton Dudley, of Philadelphia. These diagrams show for the summers of the years 1869 and 1870, both the daily maximum temperature from the 15th June to the end of August, and the daily death-rate among infants under two years of age from cholera infantum in the city of Philadelphia, and from them Dr. Dudley arrives at the following conclusions:—

1. That there are marked and sudden fluctuations in the number of deaths from cholera infantum from day to day.

2. That these fluctuations correspond very frequently with fluctuations of temperature, the increase of mortality occurring either on the same day as the increase of temperature, or on the day following.

3. That these fluctuations are more marked about the time that the epidemic is at its height, than at any other period before or afterwards.

4. That there is a gradual rise in the daily mortality from the beginning of the epidemic, and a gradual falling off towards its close, which are not attended with a gradual increase and diminution of temperature.

He adds, "The correspondence between the increase of mortality and the rise of temperature does not entirely disappear at any time during the continuance of the epidemic. It will be perceived, however, that slight changes of temperature are not always attended by any noteworthy increase in the death-rate, and there are times when the temperature on a given day rises to a very high point without being attended by any marked increase in the mortality; but it will be also observed that such days have been preceded by a period of comparatively cool weather. This fact, taken in connection with what was advanced in the fourth conclusion, appears to indicate that a certain amount of hot weather is necessary to create a predisposition to the disease,

and that when the predisposition is once developed, the high temperature of a single day acts as an exciting cause, or at least as an aggravating influence."

He also adds, "Reasoning from these facts alone, we must not conclude that the predisposition induced by hot weather is a mere debility, since if such were the case we should find the greatest mortality towards the end of the hot weather, when this debility is the greatest in degree, and most extensively prevalent; which is not the fact, the records showing a steady decrease in the daily list of deaths, even though the temperature should remain above ninety degrees. Looking at all the facts, is it illogical to infer that cholera infantum requires for its development generally a certain occult condition of the system, which, when acted upon by a certain atmospheric temperature continued for a longer or shorter period, induces a predisposition to the disease; and that children who are not previously in this occult state are not liable to the disease at all, no matter what the temperature and its resulting debility might be?"

These remarks coincide with what I have stated as obtaining in all epidemics. In order to obtain some idea as to what the occult state may be, we ask the following question: At what ages are infants most liable to these disorders? The general idea is that the process of dentition has much to do with these affections, and teething time is looked upon by the public at large with anxiety as the period of infant life most fraught with danger.

The following statement of the ages at which the 103 deaths from intestinal disorders took place, leads to a rather different conclusion:—Out of the 103 deaths, two occurred during the first month, five during the second month, ten during the third month, nine during the fourth month, thirteen during the fifth month, eleven during the sixth month, eleven during the seventh month, fifteen during the eighth month, two during the ninth month, three during the tenth month, eight during the eleventh month, and four during the twelfth month. Ten deaths took place during the second year, and one just over two years old. Seventy-five deaths out of the 103 occurred during the first eight months, and the eighth month was the most prominently fatal.

Dr. Dudley arrives at somewhat similar results from the records of a much greater number. Out of 4,013 deaths that took place in Philadelphia in children under two years of age, during a period of five years, from cholera infantum, he found that 2,073, or more than half, perished before the end of the eighth month, and three-fourths of the number perished before the end of the first year. He found the fifth and the seventh months to be the most prominently fatal of all.

The process of dentition, beginning at the seventh or eighth month, is not completed until the twenty-fourth or thirtieth. It therefore follows that this

disease manifests its power upon infants in whom this process, commonly speaking, has not yet commenced. By the time that the first molar teeth usually make their appearance, the susceptibility to the disease is nearly past. Whatever the process of dentition may have to do in favouring this susceptibility, it must be the development of the teeth in the bony structure of the jaws rather than their eruption through the gums that acts unfavourably.

But there are other considerations that lead to the conclusion that there are agencies at work during these early months of life in producing this susceptibility other than the process of dentition. Cholera infantum seldom attacks in a severe manner children that are *properly nourished*, and at no period of life do causes of mal-assimilation of food, and consequently of mal-nutrition, exist so frequently as during these first eight or twelve months. Suppose a child for whom the maternal supply of food is poor in quality or insufficient in quantity, and that there is a want of suitability in the nourishment that has been given to make up the deficiency, mal-nutrition must be the result. How frequently do such cases occur! How much more likely are they to present themselves during these early months of life than afterwards when the digestive organs are more fitted to act upon a variety of food, Faulty dietetics are most likely to obtain just at those months that we have found to be most fatal to infant life.

Their intimate connection is still further apparent when we consider the organ that this mal-nutrition will act upon with the greatest intensity. Dr. West says, "There is no organ in the body, with the exception of the pregnant womb, which undergoes such rapid development as the brain in early childhood. It doubles its weight during the first two years of life." The brain, then, and the medulla oblongata, the head-centres of nervous life, will be the organs upon which this mal-nutrition will be most injurious. And we can readily understand how injurious the depressing influence of high temperature must be on a system in which these important organs are in a weak, badly nourished, state. And we find in all severe cases of cholera infantum that the brain is as much affected from the onset of the disease as the intestinal canal. That which might have been only a simple diarrhœic attack from some passing irritation, is changed into a severe, perhaps fatal, intestinal disorder through this weakened state of the brain and nervous system. The intimate connection that exists between the two I need not now enlarge upon; the effect upon the intestinal canal of any sudden shock or emotion, which must act through the brain, is well known to everybody. I will only add that the recent experiments of Ranvier throw some light on the nature of this connection. He has shown that œdema of the leg may be produced by section of the vasomotor nerves which supply its vessels, and does not follow ligature of the femoral vein. He has demonstrated that venous congestion

alone is not sufficient to produce œdema, but that the increased exudation from the vessels is rather dependent on want of power in the vasomotor nerves. Supposing this want of nerve-power suddenly to obtain in the vasomotor nerves, regulating the tension and secretory powers of the vessels of the intestinal canal, how soon may this be followed by that which may be equivalent to œdema in the leg, the symptoms that obtain in cholera infantum. I only suggest a consideration of these experiments of Ranvier, as throwing some light on the essence of this disease. An account of these experiments will be found in the "British Medical Journal," 15th June, 1872.

On these accounts I look upon mal-nutrition from faulty dietetics, this mal-nutrition affecting principally the integrity of the brain and nervous system, as the occult predisposing state on which high temperature acts in such a prejudicial manner in producing these intestinal disorders. I will only add that these considerations show how important it is that great attention should be paid to the diet of young infants during hot weather, especially after any continuance of it of long duration. Weaning a child at such a time would be very unwise, and likely to render it susceptible to a severe attack of intestinal disorder, should such occur. All young infants should be protected as much as possible from the effects of high temperature, and an endeavour made during its continuance to invigorate the whole system, and the nervous system in particular, by tepid or cold bathing, and plenty of fresh air during the cool parts of the day.

I would desire also to call attention to the need that exists that some uniform system of nomenclature of disease should be used by all medical men in giving certificates of death. Some uniform system such as that adopted by Dr. William Farr, the Registrar-General of England, should be used by all. At the third conference of the Statistical Congress of the Great Powers of Europe, held in 1857, a nomenclature was agreed upon for adoption in all the States of Europe; it would be well if all the medical men in the colony were supplied with some such system of nosology, that the causes of all deaths might be registered in a methodical and uniform manner. I see by a foot-note in Dr. Aitken's "Science and Practice of Medicine," fourth edition, page 178, that a committee of the Royal College of Physicians of London was then (1864) at work upon a scheme of defining and classifying diseases, which might be an improvement upon that of Dr. Farr's. But I do not know what has been done in the matter. I call attention to this as a matter deserving the attention of all medical men, and I should be glad to learn that something was done in the matter by the authorities at Wellington.