The period of infection in epidemic disease / by William Squire.

THE

PERIOD OF INFECTION

IN

EPIDEMIC DISEASE.

BY

WILLIAM SQUIRE, M.D.,

AUTHOR OF THE ARTICLES "CROUP" AND "DIPHTHERIA" IN REYNOLDS' SYSTEM OF MEDICINE.

"Hinc itaque cernere est variam admodum et accuratam Naturæ methodum, quam ad morborum generationem adhibet; quam nemo hominum (arbitror,) hactenus pro rei dignitate satis observando est assecutus."—SYDENHAM, *De Morbis Epidemicis.*

Republished, with an Introduction, from the

"TRANSACTIONS OF THE EPIDEMIOLOGICAL SOCIETY OF LONDON,"

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THE PERIOD OF INFECTION IN EPIDEMIC DISEASE.

By WILLIAM SQUIRE, M.D., M.R.C.P.

SECRETARY TO THE EPIDEMIOLOGICAL SOCIETY.

Introduction.

The first object in collecting the following observations was to define with all possible accuracy the interval between the reception of infection and the appearance of symptoms in some of the more common epidemic diseases. This interval, the incubation period, instead of being uncertain, unimportant, and almost without symptoms, has been found to have definite symptoms, a great influence on the spread of measles, hooping-cough, and diphtheria, and a duration sufficiently constant to be of generic value in the classification of disease.

The study of all that pertains to the ingress of disease can only be said to commence with the last century. Dr. Richard Mead, in his Essays on Poisons, published in 1702, calls attention to the long period of latency in rabies; in a later essay* he says "contagion is a real poison," and afterwards remarks† that the practice of inoculation "shows that the small-pox does not break forth before the eighth or ninth day from receiving infection." Till this was known, terror at the swift stroke of plague had impressed people with the idea that all illness was sudden, so that hydrophobia, small-pox, measles, as well as all ordinary ailments, were commonly thought to be owing to the last thing that seemed strange because it did or did not happen.

The shortness of the incubation period in scarlet fever affords a ready means, still serviceable, of distinguishing that disease from measles. These, carefully separated in descriptions since the time of Sydenham, are sometimes confused in practice now as they were then. Richard Morton,‡ who considered scarlet fever to differ only from measles in the appearance of the rash, and to be wholly the same disease, gives ten cases under the former heading, nine being measles, while the name of confluent

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* *A Discourse on the Plague*, London, 1720. Sudden seizures, attributed to fright, he shows to be from infection. The whole argument as to contagion is as ably stated here as in any recent discussions on cholera or typhus.

† *The Medical Works of Richard Mead, M.D.*, 4to., London, 1762, p. 317.

‡ ΠΥΡΕΤΟΛΟΓΙΑΣ, Pars altera: sive, exercitatio de Febribus Inflammatoriis Universalibus, authore Richardo Morton, Londini, 1694, p. 65.

measles is emphatically applied to an eleventh history* really relating to scarlet fever. At that time every severe and fatal case was referred to measles, scarlet fever being specially constituted, by definition only, a mild disease hardly deserving of classical nomenclature.

The epidemic increase of scarlet fever in the eighteenth century, and its association with malignant sore throat, attracted the attention of such men as Huxham, Fothergill, Cullen, and Heberden. The ill effects following upon a treatment in this fever, that had been harmless in measles, pointed to an absolute difference in their nature. Measles had always been so closely associated with small-pox that it was assumed to require a similar period for development, and it soon became evident that scarlet fever, like plague, could be quickly communicated. Dr. Withering† determined that the rash would appear on the third or fourth day after contagion; Dr. Blackburne‡ says it may occur from four to six days after; Heberden§ mentions the fifth day; and Dr. Willan‖ considers the sixth day as the latest for its occurrence. The exact period had not then been determined for the incubation of measles, nor, on turning to the latest work on medicine based on a sound pathology,¶ would precise views on this point seem to be clearly established at the present time.

The practical bearing of this part of pathology was first appreciated by Dr. Maton** at the commencement of the present century; to him is due the credit of recognising as a separate disease, on account of its length of incubation, the rubeoloid exanthem only now receiving a definite position. Dr. Mason Good††, who considered the quality of contagion in disease as "a doubtful and perhaps an inappropriate ordinal character," far from admitting this ground of distinction, classed Dr. Maton's cases as rosalia with scarlet fever, instead of referring them to the *rubeola sine catarrho* of Willan or the spurious measles of Richard Morton.

Dr. Maton had several times seen cases called either scarlatina or measles in which the symptoms were so trivial that he could not decide as to their nature. He says: "If scarlatina be mis-

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* *Op cit.*, pp. 71-87.

† *On Scarlet Fever and Sore Throat*, p. 61.

‡ *Facts and Observations concerning Scarlet Fever.*

§ *Commentorii*, p. 20. ‖ *Diseases of the Skin*, p. 255.

¶ *A Handbook of the Theory and Practice of Medicine.* By Fredk. T. Roberts, M.D., B.Sc., London, 1873, pp. 173, 175.

** "Some Account of a Rash liable to be mistaken for Scarlatina," By William George Maton, M.D., F R S., Physician Extraordinary to the Queen, *Medical Transactions*, published by the College of Physicians in London, vol. v, p. 149, London, 1815.

†† *The Study of Medicine.* By John Mason Good, M.D., F.R.S, in four volumes, London, 1822, vol. ii, p. 545; or vol. iii, p. 4, of second edition in five volumes, London, 1825.

taken for rubeola (for instance), or *vice versa*, the consequences may be fatal, since the treatment suitable to the one must commonly be quite opposite to that required by the other; their distinction must not be placed on the external characters, for though the eruption may be the same in appearance, "the shortness of its duration, and the absence of all symptoms which could deserve to be denominated those of debility, made me resolve to keep a scrutinising eye on all similar cases."*

On August 18th, 1813, Miss F. C., aged 13 years, had this rash, her face was suffused with innumerable points, but she did not feel ill; her sister, K. C., aged 20 years, with her at the time, was complaining, and next day had the rash; the state of the tongue and the obviously slight character of the illness pointed to roseola rather than to scarlet fever. Four others of this family were in the room with these two sisters, and were it a contagious disorder separation would be too late. Of these four children, two girls, of the age of 10 and 15 years, had the rash on the 4th and 5th of September; a brother, Josh. C., aged 17 years, and a visitor, Miss R. C., aged 15 years, both had it on the 7th. Mr. C., aged 24 years, the eldest of this family, was taken on Sept. 24th, when absent from home; his infant son, aged 1¼ year showed it on September 30th; fulness and induration of the small cervical glands was noticed; and two of the girls did not quite recover their health for two months.

Dr. Maton remarks: "There is only one other exanthem that I know to which these cases can be considered referable, that is, roseola; but tumours do not occur in roseola, nor is it infectious. The period intervening between the application of the infectious influence and the commencement of the disease was considerably longer than has been noticed in scarlatina. Hence it seems requisite to form a new designation, which, however, I do not venture to propose at present, being satisfied with calling the attention of my colleagues to the subject."†

This class of exanthem is best contrasted with the totally different nature of scarlet fever by the following history:—

On Tuesday, December 3rd, 1861, the eldest son in a family of nine children, returned from school before the usual holidays; the school had been broken up in consequence of the appearance of scarlet fever there. Three days after this, Friday, December 6th, the mother, in delicate health, was taken ill at night, and next day had the rash of scarlet fever. On this day, December 7th, the three eldest girls, 12, 11, and nearly 10 years of age, were removed at once to the house of an aunt, and the eldest boy leaves home. On Sunday and Monday, December 8th and 9th, the two next brothers were taken ill, first the younger, aged 5 years, and then the other aged 7 years. On the following Thursday, December 12th, five days after the separation, the second daughter aged 11 years, returns home with scarlet fever. On December 14th one of the women servants is seized, and on Sunday, December 15th, a little boy not quite 3 years old is ill, next day he suffered frequent convulsions, seemed better the day after, but died on December 20th. At this time the mother, daughter, and servant were doing well, but the two boys continued in a precarious state. On the recommendation of Sir Thomas Watson my services were sought. On the 25th the elder boy began to

* *Op. cit.*, p. 151. † *Loc. cit.*, p. 165.

improve, but the younger, seized on December 8th, had throat symptoms that threatened to end fatally; he could swallow nothing on the 26th, rallied a little on the 27th, but died on the 28th of December. The two youngest children left the house with their nurse and escaped; also two of the girls, who were sent away in the first instance; one of these joined the eldest brother on December 21st, and did not suffer. All joined the three convalescents at the sea-side on January 25th without injury. This was within a month of the recovery of the boy, and six weeks after the commencement of the girl's illness.

The old *Quarantaine*, *i.e.*, forty days', or six weeks' isolation, considered necessary for those who have suffered from an infectious illness to guard against their carrying it to others, is one of those rough guesses at truth which has a singularly near approximation to the conclusions of general experience. If, on further inquiry, this should not be found always sufficient, as in severe cases of scarlet fever, or to be in excess of what is necessary for some other ailments, it yet represents as fairly the deductions to be drawn from the facts hereafter brought together as any new conclusion that can be drawn from them; so that if the premonitory symptoms are included, as they ought to be, we may generally allow three weeks for the course of the disease, and three weeks for the precautions requisite during convalescence, always remembering that it is only the sick person who requires forty days of observation; it will appear further on, that for those who have only incurred the possibility of infection a much more restricted period is sufficient, varying from three days to twelve in some of the more severe diseases, and extending in others only trivial, to as long as three weeks.

The leading facts relating to infection from snake bites and from the poison of the mad dog, though not strictly within the limits assigned to the present inquiry, cannot be altogether passed over. From the latter cause the number of deaths in our own country is happily small; there are none from the former. In our Indian empire 12,000 deaths annually occur from bites of wild animals, the greater proportion being from snake poison,* and perhaps one-tenth from rabies. The venom of the snake is the most rapid in its action of all the animal poisons; that of the mad dog has always furnished the most striking instance of the long period of latency possible after in-

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* *Ninth Annual Sanitary Report, Government of India*, p. 204. In the Punjab, of 946 deaths from these causes, 44 were from wild beasts, 84 from hydrophobia, and 805 from snake bites. Injecting ammonia, 1 to 10, into the veins rapidly counteracts the poison of snakes. Not only may the poison of rabies be neutralised by applying lunar caustic to the wound, but dressing with common salt is efficacious The disinfecting power of this domestic agent has attracted notice lately. The vapour of acetic acid or strong vinegar for disinfecting the air of rooms, is a more effective germicide than the dangerous and disagreeable carbolic acid. Quinine also has great power in destroying germs. A solution of it carried into the nostrils will cure hay fever by killing bacteria.

fection. Galen* himself saw a case after a year. There is a recent instance of this long interval. Professor Gamgee† refers to a still longer period. Dr. Mead‡ says: "I remember one after eleven months; but the attack is generally within thirty or forty days,§ though possibly sooner in young subjects." "Nothing seems more wonderful in this whole affair than that the venom should, as it were, lie latent in the body so long a time before it discovers itself. This in different constitutions will be done in a different space of time: nay it may so happen that this ferment being weak, and the constitution strong, no visible mischief may ensue, till some accidental alteration in the body unluckily gives it an additional force." He gives the case of a lady who had pain from the bitten part every month, until on the fifteenth recurrence it became fatal rabies. Dr. Marsh‖ relates the case of a boy twelve years old bitten by a dog with incipient rabies. "Four weeks afterwards, whilst playing, he was thrown by his companions into a ditch; he went home wet, chilled, and complaining that he felt ill: that very night the fatal symptoms showed themselves." It is hardly to be supposed that the poison is actually not absorbed as well as dormant during the longer intervals noticed in this disease; the bitten part may possibly become a centre of reinfection after the elimination of the first inserted virus.

A remarkable analogy is observable between the action of the animal poison of rabies, which is only communicable by inoculation, and the infectious poisons of fevers. Dr. Marsh extends this analogy to cholera, and also to common cold and to gout; but in these latter ailments he seems to ignore, as do some of our contemporaries, the presence of uric acid in the blood, or of germs in the air, as necessary factors in these two diseases, and to forget that the injury or fright determining an attack of gout, or the chill or depression that subjects to an attack of influenza, would be inoperative without the presence of these special poisons. The action of one of these poisons is limited to the blood of cer-

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* Comment. ii, in Prorrhet. Hippocrat. (Mead's *Works*, p. 77.)

† Reynolds' *System of Medicine*, first edition, vol. i, p. 720. Cœlius Aurelianus, lib. iii, cap. ix, is quoted, as giving the incubation period most accurately.

‡ Mead on the "Poison of the Mad Dog." *Op. cit.*, pp. 77-84.

§ Of 31 cases, all fatal, collected by Dr. Gregory, 12 were seized from 20 to 43 days after; 1 in 3 weeks; 11, from 40 to 77 days; 4, from 3 to 4 months; and 3, at 8 and 9 months. He says, "from this we may learn to distrust those alleged cases of hydrophobia occurring *within* three weeks from the infliction of the wound, and which ended favourably". It is noteworthy that the shortest known period in this disease should correspond with the longest interval for mumps and rubeola, just as the shortest interval possible for measles correspond with the longest limit for scarlet fever.

‖ "Observations upon the Origin and Latent Period of Fevers." By Henry Marsh, B.A., M.D. *Dublin Hospital Reports*, vol. iv, p. 494.

tain individuals, the germ of cancer is still more limited; but some blood diseases, as pyæmia, are able to affect others through the medium of the air; its congener, purulent ophthalmia, acts chiefly in this way. They are poisons of animal origin; so are most of the paludal poisons—

> "All the infection that the sun sucks up
> From bogs, fens, flats,"

must first have been conveyed and condensed there before they were again called into activity. When, with Sydenham,* we consider the sources of all the air-borne poisons, we find this secret condition of the air is conferred by no chemical vapour whether mineral or vegetable, but by the presence of living organisms.†

Sydenham, though apparently unaware that small-pox was contagious, justly attributed epidemic diseases "to a latent and unexplained alteration of the air infecting the bodies of men." Only so long as the air contains this secret cause can the epidemic rage. Hence this "state of the air," which has been translated back to us from the Latin into "atmospheric constitution" means only the presence of the germs of disease. He further says‡ that the various epidemic states or constitutions of different years "owe their origin neither to heat, cold, dryness, nor moisture; but rather depend upon some unknown change from the very bowels of the earth, contaminating the air with such special effluvia as force the human body into this or that disease." Upon the conveyance of such infecting germs from the sick to the healthy the extension of every epidemic depends; details of the successive infection of each individual would be the full history of the epidemic. The prevention of disease requires us to know the conditions under which the different infections act.

It is by careful study of each of the special poisons that a nearer approach is made to the successful investigation of epidemics. Emanations from scarlatina chiefly cling to everything they touch, and are restricted to small distances; those of hooping-cough and influenza can be widely diffused through the air. Much that is attributed to a remote or indefinite cause, such as season, will be found dependent upon some intermediate condi-

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* Thomæ Sydenham, M.D., Opera Omnia, Londini, 1844, Sydenham Society edition, p. 28, cap. 1, § 6.

† He noticed how, in obedience to laws regulating all organic growth, "some vernal epidemics appear early, as in January, and thence gradually increasing, come to this state about the vernal equinox; after which they gradually decrease, and at length disappear about the summer solstice. Others, rising in the spring, and daily increasing, come not to their state till about the autumnal equinox, after which they gradually decrease and vanish at the approach of winter," The entire works of Dr. Thos. Sydenham, newly made into English, from the originals, by John Swan, M.D., 3rd edit., London, 1753, pp. 6, 7.

‡ *Op. cit*, p. 30. Observationes Medicæ circa Morborum Acutorum Historiam et Curationem. Authore Tho. Sydenham, Londini, 1665, cap. i, § 6; cap. ii, § 5.

tion with which season, for instance, may have only an indirect connection. Low temperature, harmless in typhus is prejudicial in measles, directly and indirectly. Measles is more common in winter and spring, because the pulmonary mucous membrane is then more susceptible; the greater fatality of measles with us in cold weather is less an effect of temperature than of the tainted air pent up for the sake of warmth.

Some of the epidemic poisons, notably that of yellow fever, have limitations of elevation and of temperature above and below which they cannot exist. Small-pox, increasing in winter, is replaced by cholera in summer, both may be very fatal at the same time and place, and are utterly distinct. Some others are modified greatly by temperature; little doubt can remain, after seeing how exactly the diarrhœa of our later summer months is replaced in the winter by cough and catarrh, and noticing how, by almost imperceptible gradations, they pass into each other, but that the same poison is operative in both cases; allotropic it may be from alteration of temperature, dimorphic from something analogous to alternate generation, or, the alteration may be in the susceptibility, or the different balance of health of the individual attacked.

The epidemic constitution of any place or period, to use the phrase of Sydenham, not only comprehends the result of the preceding influences and takes into consideration the varying circumstances, social and physical, affecting the individual, but specially includes the full estimate of the extraneous elements of contagion existing around him. The phrase is rather the expression of the general state of the health of a locality prevailing at the time of observation than of a separate condition, and the existence of contagion is of the very essence of the idea to be conveyed. In this term are summed up the vestiges of an infection that is disappearing, and the first evidences of an invading disease is recorded; in the absence of all traces of contagious maladies it is sometimes said that "no epidemic constitution" prevails.

To bring about and perpetuate so desirable a condition, next to the supply of fresh air and pure water, and, indeed, one of the conditions for preserving the purity of these first requisites, it is of primary importance to reduce infection to its smallest possible limits. Not only must disinfection begin at the body of the sick, but it must commence with the first elimination of disease-germs, and be continued until they cease to be given off. This course is the way to the safety of the individual, the protection of those immediately surrounding, and the incalculable amelioration of the public health. For this we must know how soon infection begins, and how long it lasts; otherwise our efforts to check the spread of epidemic disease will often fail, even where our knowledge of the laws governing the course of the special infection is full enough to place it almost under our control.

THE PERIOD OF INFECTION IN EPIDEMIC DISEASE.

How soon does infection begin? how long does it last? Of the two questions proposed, the former might be dismissed with an obvious answer as of little importance, while the importance of the latter is as clear as the difficulty of answering it is great; this difficulty may be simplified, and, it is hoped, be made to yield some rules of practical service before the conclusion of the paper. Practical considerations of no slight interest also depend upon the first part of the question, the answer to which is not quite so simple as it may seem, but in reality involves some intricate pathological problems, as well as hygienic deductions of the greatest importance.

Effective limitation of disease, in epidemics having a most marked influence on mortality, especially among the young, must greatly depend on the recognition of the fact that *infection begins as soon as the disease*, so that our first question is pushed back to "when does the disease begin?" If the answer be, upon the development of the more prominent or characteristic sign by which the disease is known, be it rash, hoop, cough, or diarrhœa (and this will always be the popular response), then, in order to meet the popular notions of disease with warning and direction that shall be generally useful and intelligible, we must let it be generally known and understood that infection is to be guarded against while a person is only sickening for diseases, such as small-pox, measles, mumps, hooping-cough, diarrhœa, cholera, and diphtheria, and be prepared to give authority to the somewhat startling announcement that "diseases are infectious before they are developed." The incubation period, as it is called, of epidemic diseases, affords us the means of translating this paradox into a scientific position; a correct and definite idea of the first steps, the ingress, of these diseases lies at the very root of this inquiry, and merits a full investigation.

The incubation period is to be divided into the two distinct and separate stages of latency and invasion; a division admitted indeed and applied vaguely to the beginnings of

these diseases, but not with that definite and scientific precision which is to be sought for in each special disease of the class, and which must be reached before such general conviction as is alone conducive to useful action can result. Excepting mere conveyance, diseases are not communicable by personal infection until they have themselves been received by the infecting person; nor when received are they immediately communicable, unless certain local effects from contagia, coming before any general illness and even without being followed by any, may give rise to infection; for it may be stated generally that an interval must elapse before infection received can be again propagated.

This period, of longer or shorter duration for different diseases, nearly without symptoms and probably non-infectious, is the stage of latency; then, with the earliest symptoms, commences the stage of invasion. Febrile movement is now progressive and continuous so that it cannot be stopped or averted; products of the diseased action are formed, and infection begins. This point is marked by elevation of temperature, easily recognised by the thermometer; it is often preceded by an equally recognisable thermometric depression, analogous to the shock after injuries, marking the first effects of the poison.*

The latent period, nearly without symptoms and probably non-infectious, may either be absent or be prolonged within certain limits varying for each special disease; to ascertain these limits is necessary to an effective quarantine. The characteristic of this period is its variability, and it is to this that the wide divergence observed in the time of incubation of certain diseases is owing.

The period of invasion is more fixed, and nearly constant for each special disease; to recognise the commencement of this stage is necessary to the successful isolation of persons already affected by disease, so as to prevent its extension to others.

The incubation period, though divided in this way, may

* Until now the attack might have aborted; this is one mode of escape from the diseases we most frequently encounter. It is observed sometimes after slight exposure to infection, when premonitory symptoms appear and clear away again without giving rise to illness, or, when, by gradual exposure reducing susceptibility, a temporary immunity is procured affording no protection against the liability to subsequent infection. The disease once set up is, from first to last, an elimination of itself *in its own form and manner*; which self-elimination, the sign of the disease, is the very source of infection, and the basis of the axiom that infection begins as soon as the disease.

still be usefully spoken of as covering all the interval from the beginning of infection to the full development of the disease. A fixed time can more readily be assigned to it as a whole, not without some of the uncertainty that still attaches to its essential divisions; for, what is spoken of as the stage of invasion in a particular disease by one writer, might by another be included in the course of the disease, or, more frequently, be overlooked or lost sight of in the period assigned to incubation.

This stage of invasion, then, differing in each different disease, but uniform within moderate and ascertainable limits for the same disease, may be termed *the constant quantity* of the period of incubation. It seldom commences immediately or directly upon exposure to its exciting cause, and often at a surprisingly long, though at a remarkably uniform interval; this is the period of latency. The latent stage not only varies for each different disease, but according to the different modes by which the poison of each is conveyed into the blood, possibly also as to the amount and intensity of the poison introduced.

Direct inoculation of the virus of any special disease affords us an opportunity of observing with exactitude the time occupied from the initial processes to the fully developed disease; a slight difference even here is observable in the first stage, and a question arises as to how far the local multiplication of the inserted germ may go on before such general disturbance of the system is set up as enables us to say that the disease in question is produced. This process, once largely practised in the inoculation of small-pox, the typical disease of the class, and everyday observable in vaccinia, furnishes us with the best analogue to what must take place in allied diseases; the result is a short period of latency and a definite stage of invasion, so that the incubation period necessarily occupies many days.

The same thing is observable in measles; though the exact time when the poison was introduced may be uncertain; it must be certain that it was received days before the full characters of the disease became obvious, for those days are necessary to the development of the initial processes of the disease.

It may be affirmed, therefore, of some diseases, that they cannot show themselves except after a certain interval, the stage of invasion, following upon the uncertain period of latency, and that consequently their incubation period must be a long one. On the other hand, without assuming that

some diseases arise at once with full malignity, it is seen that the different processes by which their virulence is acquired may be gone through with extreme rapidity, and of these, it may be affirmed that the period of incubation may be short.

Small-pox, vaccina, measles, rubeola, mumps, varicella, typhoid, typhus, and from one point of view, hooping-cough, represent diseases having a long incubation period. Relapsing fever forms the connecting link with the division having a short incubation period, where we find besides, scarlet fever, diphtheria, plague, cholera, yellow fever, diarrhœa, influenza, dengue, erysipelas, and, if strictly investigated, hooping-cough, which combines some of the leading features of both classes.

A long incubation period is generally followed by a very definite illness terminating in a crisis, and, excepting debility, with sequelæ neither very prolonged nor very definite; the infection ceasing at a comparatively early period of convalescence. A short incubation period commences a sudden morbid disturbance, having either a long or a short process, very liable to relapses, and to prolonged or definite sequelæ, infection persisting far into convalescence. It follows that infection is spread most at the end of these diseases, with a short incubation, generally from impatience of their last lingering effects; and at the earlier, or even the earliest part of those, from disregard of their premonitory symptoms.

The duration of this period for the more frequent diseases should be widely and generally known, so that instead of referring an attack of small-pox or measles to an imaginary fright, chill, or other circumstance of the day or two before, the true source may at once be sought in the occurrences that preceded the illness by exactly twelve days.

Exact data as to the origin of fifty cases of measles have been collected, showing to what extent the time of incubation may vary; many of these instances illustrate in a striking manner how constantly this disease is propagated before the rash appears, aud consequently how hopeless is the effort to prevent its spread among those who have been in close contact up to the time of the eruption.

Where no such previous communication occurred an effectual quarantine has been maintained, as shown by cases 24 and 23, who were brought home at the height of the rash of measles, but kept apart from the other children of the family; none of them took the complaint. Case 45 (p. 20) affords another instance of measles being communicable before the rash; measles appeared a fortnight afterwards in the family of a friend who was with this gentleman on February 27th. The previous attack

proved to have been one of rubeola; so that in no case has the rash of second measles come under my notice. Rubeola occurred subsequently to measles in cases 46-48; an elder sister, who was not ill with these children, having previously had measles, comes home from school on May 7th with the rash of rubeola, some fulness of the cervical glands, but no elevation of temperature. On May 26th, the under nurse and little girl, case 46, have the rash; on May 28th the little boy; he had looked pale for several days, but except debility and some fulness of the lips and tonsils, had no febrile disturbance after the rash appeared. On June 11th, case 47, the other little girl has the rash; exactly a fortnight after the last case. On June 14th and 16th other cases occurred in this family.

Of the forty cases of rubeola now for the first time brought together, twenty-eight afford data for fixing the incubation period. This is found more frequently to exceed a fortnight than to fall far short of it; of the cases referred to (p. 28), two of them, cases 4 and 5 (p. 25), may have extended from ten days to twenty-one. Case 3 alone serves to fix the shortest limit at ten days; twenty cases have fourteen days as their shortest limit; in fifteen cases, the longest limit may have reached to sixteen or eighteen days; and, in three or four, this seems to have been twenty-one days, thus equalling mumps in the length of interval possible.

This disease, unlike measles, may recur, though rarely; as with measles and chicken-pox it can probably be conveyed by fomites. A clear instance of mumps being thus conveyed has come under notice; a boy returning from school where mumps prevailed, his family take the disease three weeks after, while he escaped.

The youngest children are not exempt from these diseases. Small-pox has been gone through *in utero;* vaccination may be effectively performed on the day of birth. The rash of measles may appear as early as the third week after birth; in an infant born while three other children were ill with measles, the first symptoms were noticed a fortnight after birth, and the rash on the third day, the attack being less severe than it usually is in the first two years of infancy. The youngest infants often go through scarlet fever favourably. Hooping cough may be fully developed in a child a fortnight old; at p. 35 is seen with what result.

Hooping-cough is brought into the first group more because of the frequency with which it is communicated in its early stages, than from any valid claim it may have to a long period of incubation. The stage of invasion is often considerably prolonged, nor need we dispute as to the right this stage has to be considered, in the absence of the hoop,

an essential part of the disease itself, so long as we recognise that it is a serious and highly infectious part of it. The remarkable association of hooping-cough with measles also gives it a right to some notice here; statistics on a large scale show this connection to be the reality that partial observation has frequently remarked; a close parallelism is also observable in their ingress, so that sometimes a doubt may remain whether, in a particular instance of impending illness, the one or the other is to result.

Measles and hooping cough may be regarded as the two members of totally distinct groups or circles that approximate the nearest to each other, but as individually separated by a wider divergence than exists between the different members of the same group; they exhibit a mutual interference in their development, so that if contracted together the one or the other is delayed; a mutually intercepting influence is also noticed with regard to hooping cough and varicella; while with the more nearly allied diseases of the first group it would seem that some of their initial stages, instead of intercepting each other, could be accomplished together. When a child has been exposed to the infection of both mumps and measles, the measles having the shorter incubation period, is the first to appear, mumps showing itself about ten days after the subsidence of the measles, or in a time but slightly, if at all, in excess of that sometimes occupied in the development of mumps when there has been no intervening illness.

These diseases are frequently separated for us by a process of clinical analysis, and shown to be distinct, whatever be the degree of affinity between them. Where, as in cases 18 to 21, a child who has previously had hooping-cough takes the infection of measles from another suffering from the mixed complaint, the former communicates measles only to one who has never had hooping-cough; even those susceptible to hooping-cough, as cases 27, 28, may contract measles only, from one suffering from this complication, if a moderately careful separation be maintained after the termination of the eruptive disease. During the earlier part of the concurrence of mumps with measles, even where some symptoms indicative of mumps are already present, up to the completion of the eruptive process, measles alone is communicated to children susceptible of both; a child having received the infection in this way will propagate measles only. Persons who have previously had mumps, when exposed to the mixed complaint after, or at the time the mumps is most prominent, will take and give measles only. Where the exposure is the same, but the susceptibility reversed, mumps only will be communicated.

Infection, commencing at the very beginning of diseases of the first class, and probably most intense at their height, continues with great intensity during the earlier convalescence. In small-pox, measles, mumps, and varicella, for a fortnight after the eruption the greatest care is requisite to guard against their spread; but many instances point to the infection of those diseases of slow ingress disappearing in a comparatively short time afterwards, so that three weeks may often suffice to terminate the persistence of personal infection, this in small-pox, corresponding to the disappearance of the last pustular crusts. No such limited time can

be assigned to some diseases of the other class. Hooping-cough, contagious before its characteristic sign is developed, probably ceases to be infectious before all traces of spasmodic cough are lost; but scarlet fever continues to be infectious long after all remnants of local morbid action are removed, so that personal contagion may persist for nine or ten weeks from the commencement of an attack. The shortness of the incubation period, and the suddenness of ingress, in scarlet fever, diminishes the chances of its being unexpectedly conveyed, and enables its progress to be checked by a timely separation of the sick. The long incubation period of other diseases favour their unexpected dissemination. In one of them, measles, it would not be too much to say that one-half of all the cases met with are contracted during the premonitory or catarrhal stage.

To limit the extension of most infectious diseases it is necessary to recognise the first signs of ingress. A close parallelism is presented in the earlier stages of most of them; this can be well studied during the course of vaccination; by careful observation of the one we learn to appreciate the slighter symptoms of the others, nor till we recognise these shall we be able to stop the spread of many of the most fatal among them, for it is while sickening for small-pox, as well as measles, that infection commences. On this account the invasion of the more readily inoculable diseases should receive careful study.

In vaccination the earliest vesicle of vaccinia will reproduce the disease, while from vesicles of the sixth and seventh days it may be so certainly propagated that the smaller quantity of lymph then procurable is the chief obstacle to the practice. Inoculated small-pox corresponds to what is observed in vaccinia, with less tendency to variation from the greater intensity of the poison; it is only latent till the third day, then a papule appears, this on the fourth day is vesicular; there is local irritation on the fifth, glandular sympathy on the sixth, rigors and nausea on the seventh and eighth days, soon after which the eruption shows itself. These two last days are identical with the two days sickening for small-pox, and they are infectious. At the end of the last century, when inoculation was the common practice among children, they were removed to a house provided for the purpose as soon as the sickness began, and before the eruption appeared, so as to prevent small-pox being set up in their own houses.

Small-pox is communicable from the moment the initiatory fever begins. It may be given by the breath of the patient before the eruption has appeared on the body.—Marson.

Dr. Thomas Jones in the *St. George's Hospital Reports* for 1872, pp. 235-40, gives a most instructive account of how the linen used by a small-pox patient propagated the disease in that hospital through the medium of the laundry on more than one occasion before the mode of conveyance

was detected, and the further spread of the outbreak stopped. In all these occasions the cause was traced, by counting fourteen days backward from the eruption in the different cases, to the removal of linen from those suffering from an attack; its redistribution to the wards showed how, in ordinary washing, heat is seldom applied at a sufficient height, or for a sufficient time, to destroy infection. The original source of infection was a woman who had been out of the hospital (and so possibly exposed to contagion) exactly twelve days before she was taken ill, and fourteen before the rash.

These cases, however illustrative of the axiom that "the time for taking the disease to its appearance on the skin is never longer than fourteen days," do not afford precise data for its confirmation; our conviction is based more upon common experience, and the rarity of any valid instance to the contrary being brought to notice, than upon the recorded facts of cases that had originated from a definite source of infection where the limits of the exposure were accurately known: it would be satisfactory to receive the particulars of such cases from our small-pox hospitals; any illustration of variation thus collected would not be without both scientific interest and practical utility. Dr. Gregory* has published an instance of twenty-one days' incubation of small-pox from a definite exposure; for the short period of ten days he gives very exact details of a young medical friend accompanying him to the Small-Pox Hospital on a Thursday. He soon after became languid, and his appetite fell off. On Saturday, in the ensuing week, rigors supervened, and, two days afterwards, the eruption of small-pox." These and seven other cases present a striking analogy to what will presently be seen in measles.

We may conclude that small-pox begins in most cases twelve days after infection, and seven or eight days after inoculation; so that it would seem to be almost an impossibility for small-pox to appear in less than twelve days from exposure to infection, or in less than eight days after the reception of the virus in the most direct manner, the

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* "An Essay on the Periods of Incubation of the Various Morbific Germs: addressed to the Central Board of Health, by George Gregory, M.D., Physician to the Small-Pox Hospital." The *Cholera Gazette*, Jan. 28th, 1832, No. ii, p. 60. This has only come under notice while revising the present article for the press.

latter being the shortest time in which the disease can be developed, even when the period of latency is reduced to a minimum. The latent period being, in all ordinary circumstances, four days, we have four days for incubation, properly so called, and four for the initial phenomena of the disease.

The infecting poison of small-pox so abundantly produced during the height of the disease, and of such intense activity then, does not seem to attach itself to the individual for long after the pustular incrustations clear off at the end of the third week, though the infection will cling to the clothes and furniture for a long time; it may lurk in some parts of the chamber for two years, as one case that came under my own observation seemed to show, and might be preserved in the dried crust indefinitely.

Small-pox also presents the typical example of what is seen in some other diseases, for instance, scarlet fever and hooping cough, viz.: that persons suffering from a second attack, however mild or however modified, may communicate the disease, in all its virulence, to others who are susceptible. A most significant illustration of this is given by Mr. Marson, in the case of a lady who, twelve days after meeting with a person infected with small-pox, has an illness, with delirium, but no eruption; a sister confined to the house with her, is taken ill twelve days afterwards, and has confluent small-pox. Something analogous happens sometimes in measles, when convulsions and lung complication have prevented the appearance of the rash, yet infection is propagated; in such a case protective effect is produced if the patient recovers.

Measles has a shorter time of incubation than small-pox: the rash will never appear until a week after infection, it will often be deferred until a fortnight; the usual interval is ten or twelve days. Measles has been inoculated, then the interval was seven days; now the initial processes of the disease occupy six days, of which the last four constitute the well-known catarrhal stage of measles, so that we have here but three days of incubation, even if we include the initial fever, which terminates the incubation stage. This period of incubation is prolonged for a day or two, not without symptoms, when the disease is taken by infection, and then from two to four days of latency must often be added, so that a child cannot be said to be free from the fear of taking measles, and consequently of giving it to others, for a fortnight after being exposed to infection. The longest interval met with has been eighteen days.

The first of the following cases, affords the shortest interval from infection of measles.

Case 1.—A girl, 12 years old, who had been away from her family since Christmas (certainly for three weeks), is brought home on January 24th, 1865, when her next sister and a younger brother are both ill with the measles, and have the rash upon them; two days after her return this girl has headache, and the initial feverish disturbance, with quickened pulse on the 27th; catarrhal symptoms on the 28th, the full rash on the 31st; seven days only after coming to the infected house.

Case 2.—A girl, aged 11 years, sister to the above, was slightly febrile on January 17th, she attended an evening party on the 18th, had coryza on the 19th, rash on the 22nd; the illness was at its height on the 23rd and 24th, with serious short complication; time uncertain.

Case 3.—A boy, aged 7, constantly with his sister, case 2, is not noticeably ill till the 22nd, with rash on the 24th, at its acme on the 25th; time uncertain.

Case 4.—A girl, aged 9, sister to the above, at home throughout the illness of the others and frequently in the sick room; slightly febrile on January 27th, pulse not quickened till the 29th, full rash on Feb. 1st; ten days.

So that this child, Case 4, who was with the others throughout the illness, does not take it so rapidly as her elder sister, who is brought fresh into the infection when at its height.

Cases 2 and 3 probably contracted the disease at the same time from an unknown source of contagion.

Case 5.—A boy, aged 7½ years, attends a school daily, when on Oct. 24th, 1868, a boarder is complaining of illness, which is known to be measles on the 26th. The boy, case 5, was not at school on the 25th and 26th; he went for his books only on the 27th, and then stayed away; on the 31st he vomits, seems pretty well next day, but is ailing on November 2nd, and has the full rash on the 6th; consequently, six days before any symptoms, and twelve to the rash.

Case 6.—A brother, aged 5 years, with exactly the same exposure on October 24th, had the initial fever on November 2nd, high fever on the 6th, full rash on the 7th and 8th; time, thirteen to fourteen days.

Case 7.—A girl, aged 6 years, sister of these last two boys, was removed from the house in which they were nursed on November 5th, and was not in the room with her brothers after November 4th. She has the rash on November 15th and 16th, or, after twelve days.

Case 8.—A boy, aged 1¾ years, brother of the above, removed on the same day as his sister, November 5th, and slept in the same room with her; is not noticed to have any symptoms of illness till November 15th, when the pulse was 116 and the temperature 99 degs. at night. He has the rash with convulsions on the 18th; this is on the fourteenth day after separation.

Case 10.—A boy, aged 12 years, leaves school, where cases both of mumps and measles had recently occurred, for the Easter holidays on March 20th, 1869, and goes to Brighton. He seemed dull on the 27th, returns home on the 29th, and has the rash of measles on the 30th, on which day by noon he is removed to another house; ten to twelve days; ten days after this he had mumps.

Case 11.—A boy, aged 6¼ years, who was with the last case from March 26th to the 29th, and is watched rather closely lest he should have the measles, has the initial fever on the night of April the 4th,

and, after a slight subsidence, the usual symptoms on the 7th and 8th, with full rash on the 9th and 10th; again twelve days from greatest exposure.

Case 12.—A girl, aged 5 years, sister of the above, is one of three children, whose chief exposure to infection arose from the boy, case 10, having spent one night in their house while throwing out the rash of measles, March 29th and 30th; she has premonitory symptoms on April 4th, some cough came before that, and the not unusual temporary lull in the symptoms on the two following days of incubation, coryza on April 8th, and the full rash on the 11th and 12th; twelve days' interval.

Case 13.—A boy, aged 4 years, brother to the above, exposure the same, has cough on April 9th, and the full rash on the 13th; fourteen days' interval.

None of these children took mumps on this occasion, though the boy from school, who brought measles into the house, also suffered with the mumps ten days afterwards, Case 1 of mumps.—The eldest boy in this family was much with him during the incubation, but not after the eruption of measles. They all (Cases 6 to 12 of mumps) passed through that ailment in the following year.

Case 14.—A younger sister in the above family, at first not much with the other children, sleeps with them on the nights of April 9th and 10th; she begins to cough on the 22nd, and has the rash of measles on the 24th and 25th; probable interval fourteen days.

Case 15.—A girl, aged 6 years, much with a companion until May 10th, who, a few days after is ill with measles, complains of fatigue on the 15th, and from that time remains at home; she becomes febrile on the 19th, with sore throat, fulness of the gland at the angle of the jaw, stiff neck; next day there is less fever, but the glandulæ concatenatæ are enlarged; there is cough on the 21st and 22nd, coryza on the 23rd, with less cough, and the first signs of the rash. This is fullest on the 25th; on the 26th there are severe pulmonary symptoms, relieved by stimulants, but persistent with complete defervescence on the 27th; fourteen days' interval.

The following cases not only illustrate how measles is propagated during its catarrhal stage, but how a sort of clinical analysis is often performed for us, separating hooping cough from measles, just as in some other cases we shall find mumps separated from measles.

Case 16.—A girl, aged 4 years, is taken to see a brother who is ill at another part of London, on February 19th, 1872. She only stays half an hour, as her brother is found to have measles, with the rash fully out. On March 1st, ten days afterwards, for it is leap year, the little girl sneezes; on the 2nd she has headache, and feels ill; is quite ill on the 3rd, and has the full rash of measles on March 4th; fourteen days afterwards.

Case 17.—A boy, aged 8 years, brother of the above, exactly the same exposure, does not complain of illness until March 4th, next day he seemed better till evening, when spots of measles were perceived; on the 6th and 7th the rash was full; here a whole fortnight intervened, or sixteen days from exposure till the rash.

Case 18.—A girl, aged 6 years, ceases to attend school on November 25th, 1871, because she seemed to be unwell. On November 28th or 29th she begins to have a cough, suspiciously like hooping-cough. On

December 4th she has the first sign of measles, and the full rash on the 6th and 7th; twelve days after her last attendance at school. The subsequent course of her illness makes it probable that she contracted hooping-cough at the same time.

Case 19.—A girl, aged 6 years, visited the above girl on Sunday, Dec. 3rd, 1871, the cough was then the only symptom, and no signs of measles were visible till the next day, after which no communication was continued between the two houses, as the children of this family, though they had had hooping-cough had not had measles. On December 14th she was seriously ill, but had not the full rash of measles till December 17th or 18th; fourteen to fifteen days after.

Case 20.—A boy, aged 4 years, brother of the above, exposure the same, had rash of measles on December 14th and 15th, twelve days from exposure; neither of these children had any subsequent cough.

Case 21.—A boy, aged 1 year, who had been kept in-doors with these children for two or three weeks, after a day or two's illness, has the rash of measles on December 26th and 27th, ten days after his brother and sister. This child, not having had hooping-cough, has no subsequent cough.

The next case presents a very clear example of measles being infectious during the earlier stages of invasion, and before the rash appears.

Case 22.—A girl, aged 10 years, coughs and is febrile on February 20th; she has coryza and epistaxis on the 23rd, with the rash of measles on the 24th, attaining its height on the 25th, and subsiding, with complete defervescence, on the following day. A little boy had come on a visit to the girl's home on February 5th; these children occupied the same room at night from the 9th to the 12th; the boy is first noticed to be ailing on the 13th, and returns at once to his own home; he has signs of measles on the 15th, and the full rash on the 16th and 17th. He must have communicated the disease to the girl two or three days before himself throwing out the eruption. The interval from his leaving to the height of the girl's attack of measles is twelve days; had they not been separated on February 12th the interval from rash to rash would have been set down as eight days only.

The highly infectious nature of the catarrhal stage of measles is doubtless the cause of this disease so frequently spreading through schools and families. With every desire to prevent extension of the disease the separation is effected too late; the next case is an instance of this.

Case 23.—On March 2nd, 1868, a boy at a day school is confined to his class-room because he was dull at his lessons; next day he is too ill to come at all, and the day after has measles. On March 12th, several boys who met in this class-room were away from school ill; they had the rash of measles from the 14th to the 16th of March.

On the other hand, where children have been kept apart during the earlier stages of measles the limitation of the infection is possible, even where, as in the next cases, it is brought into a dwelling at its acme.

Cases 24 and 25.—Two girls of 14 and 11 years old, are sent to school, January 13th, 1872; they have coryza on the 27th, and are brought home with the rash of measles fully out on the 30th. There are five younger children in the family, three of whom remain at home from the

time the sisters arrive, the other two being sent away that a fair quarantine may be established; none of these children take the disease, and three weeks after it is over they mix freely with their convalescent sisters.

Instances of infection from a short exposure, both the limits of which are known, can never be so numerous as those from a longer exposure of uncertain duration; nor are they of such crucial value in determining the period of incubation as might have been expected, the rule being that the interval is longer after a single definite exposure of short duration, than where the exposure has been more continuous. The example of shortest interval (Case 1) resulted from a continuous exposure, the earliest limit of which was fixed. The instance of longest interval, presented by a case where the latter limit only of a continuous exposure is known, is the following:—

Case 26.—A boy, aged 6 years, one of a family of three children, attends a day school until November 17th, 1871, when he is removed from fear of measles and hooping cough, both prevailing among the scholars. He remains at home for some days as he seems to require rest; there is no other family in the house and no visitors. On November 26th he walks to the park, a very short distance, and is obliged to return, he is so soon tired; next day he seems rather better, but is chilly on the 28th; he coughs and is sick on the 29th, and continues ill with fever and loss of appetite till December 4th, when he is delirious at night; next day he has the first signs of measles, and the full rash on the 6th and 7th. The interval from exposure to the rash was here eighteen days, but there was reason to suspect a complication with hooping cough.

Case 27.—A boy, aged 4 years, brother of the last and much with him until December 4th, sickens on the 10th, and has the rash of measles on the 14th, but does not take hooping-cough.

Case 28.—An infant, aged 8 months, of this family, not much with the other children, also sickens on the 10th, and has the rash on Dec. 14th.

The two younger children have hooping-cough two years afterwards, when the elder boy escapes.

Case 29.—A boy, aged 6 years, at a large day school, where are both measles and hooping-cough, is feverish on the night of March 26th, 1872, and remains at home; he coughs on the 28th, and has the rash of measles on March 31st.

Case. 30.—A boy, aged 4½ years, not at school, brother of the last and with him from March 26th, has the rash of measles on April 7th, with rapid defervescence on the 8th, and no subsequent cough; probably having taken the infection of measles from his brother while he was sickening. The elder boy was seriously ill for the four days preceding the rash, with delirium and convulsive dyspnœa: again, after the rash, he was dangerously ill with extreme dyspnœa and spasmodic suffocative cough until 12th, with clubbing of the fingers and dusky face and lips; the lung complication not being proportionate to the distress suffered. On recovery at the end of the month, the finger ends became flattened at the sides, and the nails for a time arched. This boy had previously had hooping-cough. His father suffers from asthma.

The following cases were complicated with subsequent hooping cough.

Case 31.—A boy, aged 6 years nearly, the eldest of four children in a poor family, commences, by school-board authority, to attend day school on March 11th, 1872; several children in his class have coughs; he begins to cough about ten days afterwards, and had slight symptoms of cold, but continued his attendance at school up to March 28th, when the cough, already spasmodic, almost amounted to a hoop. He was quite ill on March 31st, and had the full rash of measles on April 2nd and 3rd; he was rather slow in recovering his appetite and strength, but seemed pretty well on April 20th, soon after which his cough became more noticeably spasmodic, and he suffered the extreme effects of hooping-cough, from which he died on June 2nd.

Case 32.—A girl, aged 5 years, sister of the above, at the same school, in a different class, discontinued attendance at school on March 28th, when she has coryza, but less cough than her brother; on April 2nd she appeared lively and well, but had a quickened pulse and a temperature of 102½ degs.; this exceeded 103 degs. by morning, and was more than 104 degs. in the evening, exactly 104 degs. next morning, April 4th, by evening it slightly diminished as the rash of measles appeared. There was a full rash on the 5th and 6th, with complete defervescence on the 7th.

Case 33.—A girl, aged 3 years, another sister, has the first febrile disturbance, and some redness of the conjunctiva, on April 5th, with slight subsidence on the 7th and 8th, coryza on the 9th and 10th, full rash on the 11th, and defervescence on the 12th. This child probably took the infection from the others between March 28th and April 2nd.

An infant in this family, a boy, has slight cough, with sickness, on the 5th of April, disappearing after two or three days without rash. He begins with hooping cough on the 4th of May. The two girls showed the first symptoms of hooping cough on April 28th, a week later than the elder brother. Supposing that the elder boy took the infection of hooping-cough with that of measles, at school, and that his elder sister did not, which seems to be the necessary conclusion to be drawn, an illustration is afforded of how a certain proximity is necessary to the conveyance of infection; it is probable that effective ventilation, both in bedrooms and schools, would limit in a great measure, if it did not prevent, the spread of the disease.

The order of infection with hooping-cough shows it to be no necessary consequence of measles, appearing at a definite time afterwards, for here two girls take the hooping cough together, while the one child had measles a week later than the other. Both these inferences are supported by the following cases:—

Case 34.—A girl, aged 3 years, supposed exposure to infection December 24th, is ill on January 5th, 1872, and has the full rash of measles on the 6th. She begins with hooping-cough on February 3rd.

Cases 35 and 36.—Two girls, aged 5 and 4 years, sisters of the above, became ill January 13th, and have the rash of measles on the 15th and 16th, followed by some spasmodic cough. They have hooping-cough, the elder in March, the younger in May.

The order in which they were exposed to infection

requires to be further noticed here. The youngest girl, the first to begin with measles, seemed to be making a good recovery, when on February 2nd she was taken on to the roof of the house, where there was a garden (the first and only time of her going out during her convalescence); next day she had a more marked cough, and again became febrile, with well-marked symptoms of hooping-cough of some severity, from the 6th to the 19th of February. During this time the little girl was nursed apart in her mother's room, on the birth of a baby she had to go to another room, at first with the nurse and afterwards with the elder sister; this sister has hooping-cough in March. The little girl again goes to sleep at night in her mother's room in April, and before the end of the month the infant, now two months old, gets the cough. The other girl, aged four years, who had been more alone, and slept in a separate room, does not take hooping-cough until May 4th, has high febrile disturbance all the month of May, and dies with symptoms of cerebral disease in the middle of June: so that the hooping-cough was contracted the one from the other, and had no definite relation to the measles, for the infant, who had not measles, took it sooner than the little girl who, having had that complaint, was kept longer separate from the others.

This part of the subject will be concluded with cases of uncomplicated measles in two other families, and two instances of second attacks.

Case 37.—A boy, aged 10 years, at home from school for the Christmas holidays, sickens for measles on January 17th, and has the full rash on 21st. A younger brother sickens on the 26th, and has the rash of measles on the 30th, ten to twelve days after exposure.

Cases 38 and 39.—Two girls, aged 8 and 4 years, sisters of the above, show symptoms of measles on the 27th, and have the rash on the 31st of January, ten to thirteen days after exposure.

Cases 40 to 44.—A boy, aged 7 years, second child in a family of four, was noticed to be ill on July 18th, has coryza on the 20th, and the full rash of measles on the 22nd. An elder sister sickens on August 2nd, and has the rash of measles on the 6th. Two younger children, ill on August 4th and 5th, have the rash on the 8th or 9th. The mother who was in constant attendance upon the children, but had had measles herself when eight years old, felt sick and giddy, with aching of limbs at night, on August 9th, seemed ill as with a cold from the 10th to 12th, and, on the morning of the 11th, found herself covered with rash; this began to fade by night, leaving some irritation of skin, and a feeling of weakness, but no further illness.

Case 45.—A young man, aged 23 years, had measles fifteen years ago, felt giddy on the evening of February 27th; next day he was ill with signs of catarrh, there is rash at night with cough, and every characteristic of measles. On tracing back fourteen days, it was found that he passed the night of February 14th shut up in a close cabin in crossing from Liverpool to Dublin; he returned on deck, and thought he had taken cold in his journey home, where he had but just arrived in time

to take to his bed on the evening of the 28th. The account of the previous attack is quite clear and substantiated by family memoranda written at the time. This attack is in no way shortened, for the rash and restlessness continued till March 3rd, and the fulness of throat and of the glands of the neck till the 6th; moreover, three weeks afterwards, going out in the cold, he suffered smart fever and herpetic catarrh on March 21st to the 23rd.

Most important of the inferences from these are, first, that in second measles whether highly or slightly modified, the period of incubation is unaffected; second, that the stage of invasion is more abrupt, in each of these two instances it is shortened to two days.

Sometimes the ingress of measles is so sudden as to be unnoticed, this will seldom happen in more than one of several children affected at the same time, and probably in none of those infected from the exceptional case, so that all doubt as to the true nature of the disease soon vanishes. The following three cases bearing upon this point occurred in the family of our most accurately observant member.

Case 46.—A florid healthy girl, aged 6 years, has the rash of measles on February 4th, with no obvious evidence of previous sickness, not even for an hour; there are two other children at home with her who have not hitherto been segregated by day. On looking back a fortnight it was found that these children, a sister one year older and a brother one year younger than this little girl, all carefully withheld from Christmas parties, had been taken to the pantomime on January 21st and to a circus on the 20th. It soon became evident that, with the same exposure, the sister and brother had not taken the infection at that time; they were now carefully watched. The elder girl has headache on February 12th, at night the temperature is high, next day this is normal, but is raised on the night of the following day to 101 degs.; it continues to be high for the next two days with cough; the rash appears on the evening of the 15th, and is full on the 17th, defervescence is sudden and complete on the 18th. The little boy is placed under observation at the same time. A slight elevation of temperature is found on the night of February 12th, next day there is cough; some spots of measles appear at noon on the 15th, and there is copious rash with temperature of 103 degs. at night; on the 16th the rash and all the symptoms are very intense; on the 17th the temperature is reduced to 99½ degs. in the morning after diarrhœa, in the evening it is raised to 102½, with a trace of bronchitis; next day this disappears, and the defervescence is complete: the interval for the last two cases is twelve days.

The two succeeding cases have some features both of resemblance and of contrast to the last; they show that a long interval may be looked for after a limited exposure, and that a continuous exposure tends to shorten the interval.

Cases 49 and 50.—Two little girls, the youngest, aged 4½ years, has the rash of measles on Saturday, March 8th; she had been ailing all the week, and had seemed dull and easily tired in the preceding week; she had been with her sister to a morning performance at a circus much frequented by children on February 22nd. The elder girl, aged 10

years, when seen at noon on March 8th, seemed to be quite well, except for a slight excitability of manner, a quick pulse of 100, and an elevation of temperature to 99½ under the tongue—this probably normal for midday, at night it was 98 degs. only. Next day both pulse and temperature were normal. It was evident that this child had not taken the infection when with her sister at the circus. She had slept in the room with her sister during the two nights of fever, and besides having been with her much during the few preceding days, was now entirely confined to the same room; she was without any sign of illness on March 10th and 11th; on the 12th she was lively, but again had a slight rise of pulse and temperature; on the 13th she was sick in the morning; next day the pulse was 116, the temperature 101 degs.; her appetite continued good until the 16th, when the temperature rose to 102.5 degs., and the spots appeared in the evening; on the 17th there was full rash after a temperature of 103.9 degs. had been reached; next day there was the usual subsidence of temperature, with complete defervescence on the following day.

From the care those children always receive, from the limited number of their visitors, from the fact that the elder only of the two goes to school, and that the younger is always with her mother, who even takes her for her walks, no doubt remains as to other sources of infection; tracing back a fortnight from the appearance of the rash of measles brings us to this visit to the circus, the one amusement with which these children had been indulged. An illustration of what is noticeable in the previous cases and must frequently happen, is seen in only one of these children taking the disease, though they both had the same or nearly the same exposure; fortunately, many risks of this kind are escaped. How soon the symptoms developed by the younger child could have imparted infection to the elder is uncertain; allowing four days for the period of infection before the rash appears as the limit, then, in the second case, the rash came on the twelfth day, but as the exposure was much greater at the height of the rash, namely, on March 8th, and the two subsequent days, it is more probable that in this second case eight days only sufficed to develope the disease, and of these it is clear that the first four days were without signs of illness.

Guided by the law that a short limited exposure to the infection of measles is followed by a longer interval before the disease appears than when the exposure has been continuous, we infer that when the disease is of unknown origin, by looking back a fortnight the illness can be traced to its source, but that where there is free communication with those already ill, the malady will probably be developed in less than a fortnight, and not sooner than the eighth day from the commencement of the exposure. The next cases are confirmatory of these inferences.

Cases 51 and 52.—Two children, a girl and a boy, aged 6 years and 4 years respectively, who, with one exception, had certainly not met, or mixed with, or spoken to, any other children, are seized with measles on March 25th, and have the full rash of measles on the 26th; they had some catarrhal symptoms for two or three days, attributed to change of weather. On inquiry as to the events of the previous fortnight, it appeared that these children were taken to a friend's house in London to see the processional entry of the Duchess of Edinburgh on March 12th; a person had been ill with measles in this house a fortnight before, and two days after, some children resident in the house, who were in close communication with these two during the two or three hours of their stay, became seriously ill with this prevalent complaint. A half-sister, aged 18 years, comes home to the house where the two younger children are convalescent, on Wednesday, April 1st, associating freely with them during the day; she sickens, and is chilly, with loss of appetite on the evening of Wednesday the 8th; feels ill the next day; has some spots of measles on the 10th, but does not keep her bed till the 11th; the rash was at its height on the 12th.

The duration of personal infection after measles, is probably limited to three weeks from the time of the eruption. Infection is evidently as intense in the first week of convalescence as at any part of the illness, it is likely to be considerable in the second, and may persist into the third week. How completely this danger is over in the fourth week is shown by cases 24 and 25, where they not only mixed closely with young and susceptible children of their own family, but were also taken among others to a large establishment on the Day of Thanksgiving at St. Paul's, without being the cause of illness. The following case gives a further reason for believing infection to be over by the end of the third week.

Case 54.—A boy, aged 9 years, son of a clergyman in the country; while at school, sickens for measles, on Sunday, December 7th, 1873. He remains away from home at Christmas, as his eight brothers and sisters, four older and four younger than himself, who have none of them had measles, are all at home for the holidays. On December 30th, exactly three weeks from the height of the rash, he returns to his family, mixing with the other children freely all day. He has a separate bed-room; his clothes were efficiently exposed to the fumes of burning sulphur, and he himself had a wash with carbolic soap; no one took infection from him.

This closely agrees with what is observed of small-pox, and contrasts markedly with what will afterwards be noticed of scarlatina.

After exposure to the infection of measles the signs of illness cannot be expected to appear in less than a week, nor will more than a fortnight elapse before symptoms sufficiently indicative of impending danger give notice that the suspected person must not yet be allowed to mix with the susceptible. Only in those cases complicated with hooping-cough, when the general symptoms were unusually severe,

did the kind of illness remain in doubt for more than fourteen days. In the one uncomplicated case that exceeded this limit, signs of the disease on the fourteenth day, sufficient to give warning of the impending eruption, were apparent. So that a fortnight's quarantine after exposure to measles will suffice to prevent unexpected outbreaks; in scarlet fever, even a shorter quarantine might suffice, for the rule for measles may almost be reversed in this case, and we may say, that if the disease does not show itself in the first week, or by the eighth day after exposure to infection, it probably will be escaped altogether.

Fifty of the cases of measles afford more or less accurate data for fixing the incubation period; the disease appeared in only eight days in one case, ten days in twelve cases, twelve days in seventeen cases, fourteen days in sixteen cases, fifteen days in two cases; once in sixteen, and once in eighteen days.

In thirty-eight of these cases the exposure to infection was either prolonged or indefinite, and the limits of the exposure undetermined. Of these cases one appeared in eight days, twelve in ten days, ten in twelve days, twelve in fourteen days, and three in from fifteen to eighteen days.

In twelve cases the period of incubation was accurately determined; of these five occupied twelve days, six occupied fourteen days, and one occupied sixteen days. This case, No. 17, was from a single exposure of short duration; the one case (No. 1) of shortest interval was from a continuous exposure, the earliest limit of which is fixed. No instance of nine days interval was met with. There may be a doubt as to some of the cases occurring on the eleventh or thirteenth day; the two cases (16 and 17), with the same exposure, occur on the fourteenth and sixteenth days, not on the fifteenth day. It is to be remarked that all the intervals of ten days only occur among the less precisely ascertained instances. This lends support to the conclusion previously stated, that the infection of measles is most commonly communicated while in the catarrhal stage only, and that a more intimate knowledge of the ingress in these cases would transfer them to swell the already preponderating balance in favour of according a twelve or fourteen-day incubation period to measles. In the essay of Dr. Gregory, one case only of measles is referred to, where, after a single exposure, the full period of incubation is fourteen days.

Only two clear cases (44 and 45) of second attacks of measles have come under notice; most of the so-called cases

of second measles are attributable to epidemic roseola (*rötheln*, or *rubeola notha* of Babington), the rash of which, besides having some features distinct from measles, occurs without the precedent four days of catarrhal illness.

Rubeola, rosalia, or epidemic roseola, has an incubation period of from eight to ten or fourteen days, closely approximating therefore to true measles, morbilli, from which it is really distinct. That it is not second measles is well illustrated in the Cases 34, 35, and 36 of measles. At Christmas, 1869, these children, three girls, had not had measles, when two elder sisters, who had had measles in the previous year, have this rash, and communicate it to them ; they have it in as characteristic a manner as the elder girls, but without seeming to be at all more ill with it. Two years afterwards those younger girls go through measles without any modification. Case 1 : The eldest girl, a weekly boarder, where one of the school girls, usually much with her, had a rash, on November 6th, and was absent a week, from November 22nd, returns home on November 27th ; next day she seemed ill, but woke up lively and well on the morning of the 29th, covered with this rose rash, finer, brighter in colour, less raised than measles, less diffused than scarlet fever, showing clear skin between the spots ; she keeps her bed for two days, and gets up quite well on December 1st. Case 2 : Her next sister sleeps in the same room, and lies near to her ; she feels heavy and amiss on December 13th ; by evening she has the rash, and goes to bed earlier than usual that evening, but not until she had spent two or three hours with two cousins who had come on an afternoon visit. Case 3 : The elder of the cousins became ill on Dec. 24th (on which day she kept in bed) with rash on the chest and arms in the morning ; by evening this extended to the legs, body, and face, where it was very conspicuous next day, though she herself felt pretty well again. Case 4 : The younger, sleeping in the same room with the last case, felt sore throat on January 3rd, and had the rash on the 4th, just ten days after her sister was in bed with it.

To return to the first family : the youngest of those who had previously had measles, slept in the same room with the two elder sisters, but at a little distance from them ; she, Case 5, became ill on December 22nd, and had the rash on the 23rd, also ten days after the second sister's illness. These girls mix freely during the day with the three younger sisters, who sleep in a different part of the house, and who have not had measles ; each one of these, Cases 6-8, has

the rash early in January, or after another interval of ten or twelve days, without seeming to be at all more ill with it than those who had previously had measles. Three years afterwards these same children take measles, and the elder girls do not.

Cases 9 and 10.—A girl, aged 8 years, attending a day school, is very lively and well on June 5th, wakes up next morning covered with crimson spots; some remain sparsely distributed over the arms and legs on the 7th, but she is otherwise quite well. A younger sister, sleeping with her, complains of her throat on the 14th, but soon seems well again; they attend school together for a few days, and on the 22nd the second girl is noticed to have rose spots on her face in the afternoon; small, isolated, slightly raised, and not very bright spots occur on the chest and back at night. Next day the spots on the face form rose-coloured patches, not crescentic; isolated, slightly-raised pink spots occur on the arms, fewer on the legs, and very few on the feet.

These two cases are of interest as neither of these children had had measles. About three months afterwards an elder brother, aged thirteen, Case 11, who had measles some two years before, was sent home from school covered with a rash which, with apparent reason, was considered to be measles, for the eruption was very abundant, deep in colour, with very little clear skin between the spots: an elevation of temperature to 102°, and that disagreeable odour, on entering the room before ventilation had been seen to, which is so often noticeable in that disease. Neither of the sisters took any illness, though they were frequently in attendance on their brother, nor did three younger children who were kept more apart.

In a family of four children (two boys, aged nine and eight years, and two girls, of seven and five), the elder of the two girls, while absent from home, has rubeola; the others escape. Next year they all have measles, this girl equally with the others. Early in the following year the brothers return from a preparatory school with rubeola, and now the elder girl escapes, but the younger one takes it the week after the boys returned, and has sore throat and considerable hoarseness of voice.

Cases 16 to 21.—A boy at home for the Easter holidays, complains on April 2nd, 1869, of being tired, and next day has rash; he was secluded for two days, and then, on April 4th and afterwards, joined his family, seeing much of two elder sisters about his own age. On April 18th both those girls had the rash after complaining of giddiness and of feeling tired the night before the eruption. One of them had left home on the 15th, and communicated the complaint to two cousins who had previously had measles. A younger sister, not quite three years old, who associated less with the elder children, had well-marked rash on the 20th, with but little coryza and less-marked symptoms of illness than the others, though they had had measles, and she had not.

The time of incubation cannot be fixed in this series of cases, because the exposure was continuous. One of the girls leaves home ten days after the brother joins them. Had she been separated from that time, before visiting her cousins, she, in all probability, would not have carried infection to them, though less than a fortnight's quarantine would have been as uncertain against this disease as in preventing the communication of measles.

Case 22.—A young man, W. F., aged 18 years, in business in the city (source of infection unknown), while training for athletics, becomes easily tired in the evening of May 6th; next day he is better, but has headache and sickness the day after, the 8th. On the 10th he faints during a foot race, but was able to resume his duties on the 12th, and continued at the office until the 17th. The rash appears on the 18th; he has a week's rest at home; he returns to his duties on the 26th. On the evening of the 31st one of the clerks in the same office complains of fatigue, and next day has the rash. Another clerk, quite well on June 3rd, has the rash on the 4th.

There may have been some common source of infection for these cases, otherwise the two clerks may either have taken infection from W. F. on his return to them, if the incubation period can be as little as from five to seven days, or, as seems more probable, they took infection from him on May 17th, before the appearance of the rash, with an incubation period of from fourteen to seventeen days. In the next case there is no such uncertainty.

Case 24.—A sister by marriage, in the same house, but not much with W. F. till the latter part of the week that he remained at home, removes to another part of London the week after, May 31st, and has the rash on June 8th. She felt tired only the day before, but on the appearance of the eruption there was neither acceleration of pulse nor rise of temperature; nor was this the first time of her having a rash, believed to be identical, she having previously gone through both scarlet fever and measles.

Cases 25 to 30.—At a ladies' school of the highest class, with thirty boarders, a few girls from the neighbourhood are admitted to some of the classes; on Monday, March 30th, a day pupil was noticed about noon to have some spots on her face and went home; next day she was excused attendance because of a rash, nor did she return. On April 12th, one girl shows similar spots on the face; this was not thought much of until the next day, Monday, the 13th, exactly a fortnight after the day pupil left. Two other girls have also spots on the face, and the one first to show this has a decided eruption; two of these girls had slight headache with some tenderness of throat, and of some small glands on each side of the neck—one had no previous symptom. On each of the three following days one fresh case occurs, some having had similar sensations to the first two cases, also dating from Sunday the 12th; none of these had either coryza or cough; all these six girls had had measles from two to twelve years previously; in none was there any feeling of illness after the appearance of the rash. The longest period of incubation was here seventeen days. As some of the girls were sent home, a longer interval may possibly occur in other cases. Those who took the complaint were not specially in contact with the original case, and in only one could any predisponent variation of health be traced.

In half these cases of rubeola an incubation period of from ten to fourteen days is accurately determined: clearly as they all are distinguishable from second measles this similarity of development affords another sign of their near affinity. It is remarkable that, while only in our own day, by our first President, Dr. Babington, the separation of this exanthem from measles has been indicated; already the differentiation from scarlatina, by its long period of incubation, had been made by Dr. Maton in the year 1814, and published in the fifth volume of the *Transactions of the Royal College of Physicians*. Eight cases from one family are given; the latent period varied from seventeen to twenty-one days.

The two other diseases now to be noticed of the first group, varicella and mumps, correspond with measles in never appearing till after a week's interval; they probably require a longer quarantine, which, for the latter disease, must be extended to three weeks.

Varicella, or chicken pox, has an incubation period of rather less duration, subject to the same variations, as measles. The following ten cases give an interval of from ten to twelve days for incubation. This was prolonged to fifteen days in Case 5, where the infection was from a limited and not very certain source, and to sixteen days in one of the three supplementary cases, which were complicated with hooping-cough.

Case 1.—A girl, aged 7 years, who attends a day school, is noticed to have a spot on the lip on May 30th, and next day, other spots recognised as those of varicella; she remains at home, is febrile at night, with full eruption next day; the height of the disease was on June 1st and 2nd, when she remained in bed.

Case 2.—A younger brother of the above, occupying the same bedroom, is ill with chicken-pox on June 12th; ten days after his sister's illness was at its height.

Cases 3 and 4.—Two elder brothers of the above have the disease on June 13th. The interval in these cases was probably twelve days.

Case 5.—A girl, aged 3 years nearly, is visited by a nurse attending upon a child with chicken-pox on the last, or last day but one, of November. On December 14th this little girl has signs of chicken-pox, well marked on December 16th. A possible interval of sixteen days.

Case 6.—A boy, aged 7 years, brother of the above, at home with her, is taken ill on December 27th, with full eruption on the 28th.

Case 7.—A boy, aged 5 years, of the same family, absent during the illness of his brother and sister, is brought home to them on January 12th, because a child in the same room where he is staying has chicken-pox; he begins to be ill on the 21st, with the full eruption of chicken-pox on the 22nd and 23rd. Ten days' interval.

Case 8.—A boy, aged 7 years, returning home from a visit on January 6th, sickens for chicken-pox on April 13th, and is ill with it on the 14th and 15th.

Cases 9 and 10.—Two elder brothers return home from school on April

10th, and are much with their younger brother up to the time of his illness; both show slight signs of the disease on the 23rd; the younger of the two has high fever and full eruption on the 26th, and is some time before he recovers. The eldest, aged 16 years, who is known to have had this complaint in infancy, shows signs of rash on the same day, but the spots do not become vesicular; they are most numerous on the exposed parts of the body, namely the face and hands, appearing first around some recent scratches on the wrist; further rounded red spots, slightly raised, show themselves on the second day, but there is no fever, and the spots fade on the third and fourth days without any of them producing pustules or even vescicles.

Varicella with Hooping-cough.—A boy, aged 5½ years, at a day school, where there is both hooping-cough and varicella, after a slight cough, barely exciting suspicion, stays at home on March 8th with spots of varicella, which are full on the 9th and 10th; finding on the 11th he is not very ill, he is sent to school in the following week; a week afterwards (a fortnight after the eruption), on the 25th, his cough again becomes frequent, and is very severe, with illness characteristic of hooping-cough on the 31st; this continues for three weeks, when the febrile disturbance terminated with the formation of pus in an old psoas abscess, the cough continuing to be spasmodic, but not very severe, for more than another month. *Vide* case 27 of measles.

Case 12.—A younger brother, 2 years of age, has febrile disturbance attributable to the ingress of hooping-cough; during the week that the elder one is at home with varicella this febrile disturbance suddenly subsides on March 20th; there was a great diminution, both of gastric and pulmonary irritation on the 24th, and, on the 26th, the spots of varicella appeared in great numbers with the ordinary febrile disturbance, which however did not subside as quickly as usual, and, on April 1st, he had a temperature of 100° 4′, the crusted spots of the varicella still very numerous, and the hooping-cough more marked than before, accompanied with vomiting. Here the presence of hooping-cough had prolonged the incubation period of varicella to nearly its extreme limit, viz., fifteen or sixteen days; the varicella had intercepted the course of the hooping-cough for a week or more, and in all probability modified its subsequent course, for the child, though delicate, made a good recovery, and had less trouble from the cough than either of the others in this family. This boy is case 28 of measles.

An infant at the breast, a girl, aged 4 months, who was about to be vaccinated, had this operation delayed until March 31st, because of varicella, which appeared on March 22nd, ten days after the elder boy's illness. The day before the varicella showed itself, the mother feared that she had either taken cold or that hooping-cough might be threatening; a similar fear was expressed on the day before vaccination, but on that day there was no indication of illness sufficient to warrant a further delay. The vaccination took readily, the vesicles were mature on the eighth day, with areola on the ninth, when the progress was somewhat checked; previously it had been slightly accelerated, the febrile action of the seventh day being rather in excess of what is usually met with, and now a cough, noticed from the day after the vaccination, became suspiciously like hooping cough. The subsidence of temperature noticed in vaccinia upon the formation of the areola was not so marked as usual; on April 10th there was still redness of the arm; this was less on the 14th, and the febrile disturbance had subsided. There were no pulmonary *râles*, and the child seemed well, except for some fits of cough, with coryza; during this week the cough became very violent. On April 24th sickness followed the cough, and the act of sucking excited it; the crusts of vaccinia had not separated. The child became thin and ill, with more than one complication, to give rise to anxiety which was

not at an end until the middle of May, when a succession of small boils appeared under and near the vaccination marks.

The eldest boy in this family who had hooping-cough with measles (case 26 of measles), now escaped.

Mumps has fourteen days of incubation, which may be extended to three weeks; twenty-two days being the longest period that has come under my observation. The boy (aged 12 years, case 10 of measles), who must have contracted both measles and mumps at school before he left on March 20th, has signs of mumps on April 9th, exactly three weeks afterwards, and ten days after the rash of measles; he was removed on March 30th to a house where there were four children who had had measles but not mumps. They all four have mumps from the 23rd to the 25th of April, the shortest interval being fourteen days. Six cases in another family give an interval of from nineteen to twenty-four days. A boy, aged 8 years, attending a day school, who had not seemed very well for a week, has stiff neck on March 20th, 1870, and next day is febrile, with parotitis. His next younger brother and the nurse have mumps on April 8th; eighteen days. Two sisters sicken on April 9th and 10th; the mother on the 12th, and an infant (whose case is published)* on April 14th.

Four cases (13 to 16), in another family, are these: a boy is sent home from school unwell on March 11th, next day he is found to have mumps; on the 14th, a brother and sister, separated from him the day before, are sent to different houses, they remain free from symptoms till the 25th, when the girl complains of stiffness in the neck while eating her dinner, and next day has obvious mumps, thirteen days after the separation. The younger boy (case 14) has no disturbance of health until April 2nd, he was sent home on April 3rd, and next day, exactly three weeks from his leaving home, the parotids are swollen and the disease established. Three weeks after this a servant in the house (case 17) is taken with the disease on April 25th.

Where children are exposed to the infection of both mumps and measles at the same time, the measles, even if delayed in its development, will always precede the mumps, though some of the initiatory stages of mumps would seem to have been accomplished in the meanwhile, for it is only nine or ten days after measles that the mumps appear, instead of after a fortnight, which is the shortest period of incubation for mumps;

* *Temperature Observations.* J. and A. Churchill. London. 1871. P. 9.

or after three weeks, at which interval hooping-cough is generally found to follow measles. In hooping-cough following measles, it frequently happens that the measles only is communicated while at its height, (for there is reason to believe that in early convalescence from measles, or especially if measles have followed hooping-cough, that both may be communicated), so where mumps and measles have been taken together, it may happen that measles only was communicated as in the following instance (cases 18 and 19) :— Two boys attended a day school last spring, where cases both of mumps and of measles had recently occurred ; the elder of these boys has to remain away for a week from illness, sufficiently severe but of no marked type; the younger continues to attend the school till at the end of the week he has the catarrhal symptoms of measles ; both boys have the rash of measles together, and a younger brother, who does not go to school, is allowed to remain in the same room with them, and indeed has been sleeping in the room with the elder all the week, the youngest boy is just beginning with the catarrhal stage of measles when the eldest shows signs of mumps, and two days afterwards the second boy has mumps ; the youngest was removed to another room as soon as he became ill, and did not afterwards take mumps.

Case 20.—A lad, aged 15 years, left school on December 17th (one of his schoolfellows with whom he associated began with mumps the day before) ; he has no feeling of illness until December 24th, when he was restless at night, next morning he vomited, and then felt better ; on the 26th he was able to skate though easily tired ; he came to London on December 28th on a visit, and was noticed not to be looking well ; he felt and looked better on the 30th, except for some swelling under the right ear ; there was increased swelling with pain and illness, next day, December 31st. The submaxillaries were swollen on January 5th, the left parotid on the 7th, and he was well again, except for almost imperceptible swelling of the parotids, on the 12th. For the latent period and the stage of invasion, each a week.

Six schoolfellows who left school on the same day had mumps about the same time—all early in the new year—between a fortnight and three weeks after exposure. In this case the disease cannot be said to have begun until the fourteenth day after leaving, viz., on the 30th of December ; the sickness on the 25th probably marks the commencement of the invasion period, occupying exactly six days, thus leaving eight days for the period of latency which other cases show may in this complaint be easily extended. Infection can hardly be said to have begun in this case until the first local signs (which in other instances are shown to follow very quickly upon the first progressive elevation of

temperature) were perceptible. Five children were at home with him from December 17th to 28th, none of whom took the disease; he returned home also after a fortnight's quarantine, and did not communicate it to others. Case 14 shows that for preventive quarantine, where it is doubtful whether the poison of mumps has been received, fully three weeks must be allowed; here, again, a short limited exposure with complete separation does not, any more than in measles, serve to mark the shortest incubation period, but may, in fact, be followed by a longer interval of freedom from all signs of the disease than when the exposure has been more complete and continuous.

The close parallelism between the ingression of the diseases hitherto considered, is worth notice; an initial fever generally marks the invasion period; this, in measles, is often to a considerable degree, sometimes nearly equal, but never quite, to what takes place at the acme just before the eruption; at others it is either less obvious, or attention is withdrawn from this part of the illness by the temporary depression of temperature that follows it. This, however, has but little practical importance, for it is not until progressive febrile disturbance, easily recognised by the thermometer, marks the real beginning of the disease that infection begins. This usually is four days before the eruptions of small-pox and of measles (probably not so long before mumps), and only one, or at most two, days before the specific indications of chicken-pox, and rubeola.

Hooping-cough may be considered at the end of this group, though many of its affinities are with disease of the other class. Facts are wanting to show what is the period of incubation; this stage being frequently prolonged or overlooked, is one great cause of the extensive spread of this disease, for it is quite as infectious in the early catarrhal stage as when the hoop is developed.

That the incubation period of hooping-cough may be a short one is shown by a case previously published,* where a girl, aged 12 years, is brought home to a family with hooping-cough on July 25th, has spasmodic cough on the 30th, with bronchial râles and the hoop on August 2nd, the eighth day after; it is rare to meet with the hoop until the second week, but not, I believe, to find evidence of the disease within a week of exposure. Where separation is effected, more than a week must be allowed for quarantine purposes;

* *Infantile Temperatures.* J. and A. Churchill. London. 1869. P. 26.

this is illustrated by the following case which also shows that hooping cough is infectious in its earliest stages before the hoop is developed. The younger children of a family in the north-west of London associate with another family in the Square Gardens, who, after an absence from home, return from the seaside at the end of August with hooping-cough; after September 2nd there is no further communication between the families, but during the week one child, a boy, aged 6 years, has a cough, which by September 7th becomes frequent. An elder sister, aged 15 years, who is a good deal with this boy, but had not been in the Square Gardens, is sent from home to escape the cough on September 9th. During the next few days all the younger children begin to cough, but letters from the elder state that she has escaped and is quite well; this is considered to be most fortunate, as the aunt at whose house she is visiting has an only daughter, 8 years old, who has always been considered delicate, and who is watched with care. On September 13th the elder girl first makes mention of a cough, she afterwards describes this as "fidgetting," and complains that she could not sleep at night. On the 19th she is seen by the doctor, who is unable to recognise any of the distinctive signs of hooping-cough; next day and the day after more violent paroxysms of cough leave him in no doubt as to its nature, though she felt better herself and was able to sleep when the paroxysm of cough was over. The cousin, who had never occupied the same room at night, was now kept more apart during the day, but it was too late; a short irritative cough commenced, and by the end of the week she becomes languid, and is soon prostrate and febrile. The character of the cough was quite pronounced by September 30th, and was afterwards very severe. A serious illness continued till October 16th.

The infection of hooping-cough can be conveyed: a stout boy, 2 years old, quite well except for cutting the two last molars, is visited by some friends on November 20th, who have a child at home with hooping cough; this boy coughs on November 24th, and is seriously ill with lobular pneumonia the last three days of November and the first two of December. On December 8th there is no pulmonary mischief, but he has short cough, worse at night, with thin loose secretion, and hoops on December 15th.

Cases of hooping-cough published at pp. 40 to 52 of my "Temperature Observations in the Diseases of Children,"*

* J. and A. Churchill. London. 1871.

and others that need not now be detailed, give generally a week for incubation, and a week or rather more for the febrile or catarrhal stage, so that the hoop is seldom developed until after a fortnight from exposure. In the course of hooping-cough an intercurrent inflammation often stops the hoop, a fact impressed into the service of various theories; such accidents certainly interrupt and probably delay the ordinary course of the disease; what often happens in the more advanced stages of the disease sometimes occurs at the commencement, as in the last case given, when pneumonia occupying five days of the ingress, the hoop instead of appearing on the first week of December, was delayed till the 20th, and this is frequently found to be the case from much slighter causes. If such prolonged intervals are to be considered as "incubation period" then is hooping-cough closely approximated to the diseases previously treated of, and it may be concluded for all lessons of practical precaution, as in those cases, so here, that if a child has been exposed to infection, a fortnight may elapse before the symptoms of illness are declared, nor can such child be considered free from the chance of conveying infection until after three weeks. On the other hand, while it is probable that small-pox could hardly be communicated for the first eight or ten days from exposure, or mumps for nearly a fortnight, hooping-cough has the dangerous prerogative of being communicable from the earliest symptoms that may appear within three days of infection, as well as by the later manifestation of the disease, that may be delayed if not indefinitely, at least for two, and perhaps even for three months.

The poison of hooping-cough, like that of scarlet-fever and others, may be intensified both by the re-infection of those in certain states of weak health, or by being concentrated where several sufferers are congregated or kept too much confined either in small rooms or else in the same room. A case is given at p. 43 of my *Temperature Observations*, where a child was in considerable danger until removed from the room where another was ill.

Fatal consequences resulted in the following case from this cause, further intensified by allowing the dead child to remain in the dwelling:—A girl, 2 years old, while teething, has a cough, at first attributed to that cause, but suspected to be hooping-cough on February 2nd, and recognised as such on the 10th of February, when a brother, 4½ years old, occupying the same room, has a similar cough. On this day the mother gives birth to an infant, who, thriving very well

for the first week, after that is noticed to pine and have difficulty in taking the breast—there is no doubt of the infant having hooping-cough, on the 24th of February, it was sick with its cough, and before the end of another week could hardly suck, as the first touch of fluid in the fauces induced violent spasm. On March 1st the infant dies; at this time the little girl's cough was improving greatly, and though the boy's cough was violent he was otherwise doing well, and had a strong well-formed chest. Instead of the infant receiving prompt burial it remained in the room, there were but two on one floor occupied by the family, until March 8th, when, in spite of chlorine and other disinfectants, an offensive atmosphere was induced. On March 10th the boy's cough had increased, the fauces became red and irritable, there was viscid phlegm in the mouth and difficulty of taking food; on the 17th he had dysuria, with marked pyrexia, afterwards convulsions, and death on the 24th of March. The girl's cough was also increased at the same time, but her health improved by the end of the month, and after April 2nd her convalescence progressed rapidly.

A frequent mode by which the poison of hooping-cough spreads, is by persons who have previously had the complaint, while much with the sick, suffering a second attack in a modified form, which, by not exciting alarm, leads to neglect of the requisite precautions against conveying infection. Fomites readily attach themselves to surfaces, whether articles used by the sick or near them, and to the clothes of attendants; these infecting particles, probably minute solids, cannot be wafted far, they may be carried by the healthy, but the most frequent mode of diffusion is by liberation from the breath of the sick.

Scarlet-fever is the typical example of my second class of infectious diseases to which these latter properties, that are also attributable to hooping-cough, belong. The incubation period is essentially short, and may be very short, even to a few hours, the more usual period is from three to five days. A necessary question arises as to how long may this period be extended; the longest interval I have met with has been eight days, and when children have been removed from a source of infection if any have taken it they will most probably sicken within the week. This also is true of diphtheria, of which several instances have come to my notice.

Scarlet fever is not so infectious during the first day or two of sore-throat as it afterwards becomes, so that an early

separation gives good hopes of immunity, especially if the exposure has not been at very close quarters, such as sleeping in the same bed; even a moderate distance, about two yards, between children's beds, is some safeguard. Persons suffering the sore-throat, so often experienced by those who, having previously gone through the disease, are attending upon scarlet fever, are not free from the fear of infecting others: an instance has lately come under notice where a nurse had such a sore-throat, with aching of limbs, and only a slight degree of fever, enough, however, to oblige her to go home for two or three days; her husband, who had never had scarlet fever, takes the complaint with great severity.

The way in which the infection of scarlet fever clings to surfaces and rooms is well known, it may thus lie dormant, as in the case of small-pox, for months, or possibly for years. By these means the disease may unexpectedly make its appearance, when by some chance a debilitated or susceptible person is confined to the infected chamber, or exposed to slight traces of infection that may linger on clothing. The latter cause is illustrated by two cases occurring on board ship, published in the *Lancet*, September 3rd, 1864, p. 279, by Dr. W. M. Saunders, R.N. A naval cadet of H.M.S. *North Star*, has symptoms of scarlet fever on February 21st, 1842; the ship left Madeira, the last land touched, on 1st of January, where the lad visited at a house wherein some children had recently had scarlatina. "The clothes which he wore at Madeira were most probably worn on each Sunday during the voyage."

A midshipman of H.M.S. *Shannon* was put on the sick list 2nd May, 1857, for a wound of the foot; on the 7th of May he was attacked with febrile symptoms which proved to be those of scarlatina. The ship anchored in Simons Bay, Cape of Good Hope, on the same day, not having communicated with the shore, or with any vessel since leaving England, on the 25th of February. The *Shannon* was at Portsmouth, in February, 1857, when some children near this young man's father's house at Southsea, had scarlatina. Here, although the infection had lain dormant for nine weeks, it becomes operative in the usual period of incubation, five days, after a susceptibility is induced by the wound.

An instructive instance of continuous exposure to the poison of scarlet fever becoming dangerous only upon the receipt of an injury is given by Mr. Henry Veasey, of Woburn, Bedfordshire, in the *British Medical Journal*,

1869, vol. i, p. 113. A servant, aged 30, in a family where scarlatina had prevailed two months previously, with desquamating convalescents in the house, but no new cases of fever for the last month, cuts the knuckle of her right middle finger against a child's broken mug, on May 27th. The wound was contused and painful, it was the girl's menstrual period. She is sent home the same evening. Next day she has rigors and erysipelatous swelling of the hand. Her illness was extreme for some days. On the fifth day, May 31st, there was sloughing at the seat of injury, vesications in the right arm, rash on the neck, chest, and left arm, with sore throat, full rash, and all the characters of scarlet fever well marked by evening. The patient recovered; a nurse in attendance upon her at the height of the illness, went home at night, and on June 3rd, the nurse's child, aged 3 years, had sore throat, and scarlatina rash well marked on the three subsequent days.

It is not likely that the poison of scarlatina was introduced only by the wound in the hand; doubtless, material had already been received sufficient to set up the disease, when the accident gave it a starting point. The first evidence of small-pox, measles, and varicella will appear at, or near a recent wound or abrasion of the skin, when the special infection must have been received days before the injury. Sir James Paget, in a clinical lecture, gives instances of scarlet fever following upon surgical operations; most of these are from the nurse having introduced the infection at the time of the operation, or soon after, the disease appearing at a time closely corresponding to the ordinary incubation period of scarlet fever. In one case of lithotomy in a boy, followed first by scarlet fever, soon after that by hooping cough, this probably taken during convalescence, there is reason to believe that the poison of scarlet fever had already been received before the operation; the first signs of scarlet fever gave way to suppuration from the wound, after that had ceased the scarlet fever symptoms returned and went through their full course after a fortnight's interruption; how long such an interruption and delay in the development of scarlatina may be prolonged is uncertain; ten or twelve days would be a short time to allow for such a possible extension of the incubation period, and consequent quarantine limit. A still longer time would seem possible in the case of typhoid fever as shown by the instance presently to be cited from the experience of my friend Mr. Adams. It may be that the complications of

intercurrent disease, by interrupting the morbid process of scarlet fever in their midst, tend to prolong the subsequent duration of infection as in this case:

Case 1.—A girl, aged 9 years, probably exposed to scarlet fever on January 13th, has the first symptoms on the 14th; on the next two days there is delirium and a full eruption, this subsides on the 19th, when articular rheumatism began. Pericarditis, with effusion, existed as a serious complication from January 24th to February 10th; there was then some otitis and paralysis of the palate, and afterwards of the abdominal muscles. Convalescence having fairly set in, after a month's quarantine, she is sent into the country, on March 20th, to join other children of the family, nine weeks and a half, or sixty-six days after the commencement of her illness. A younger brother meets her at the railway station, and, in returning home, sits opposite to her in a close carriage. On March 22nd this boy is ill, he vomits, and is very restless at night; next day has sore-throat and rash, with full rash on the 24th and 25th; the illness is severe, and continues to the end of April. Two children, one older and one younger than this one, escape.

Another instance of the length of time scarlet fever continues to be infectious, is the following, in which there is no important complication to draw attention from the fact that personal infection may linger, not only far beyond the time of desquamation, but after the clearing away of the last visible morbid product of the disease.

Case 2.—A girl, 10 years old, comes from school on July 4th with scarlet fever; the attack was severe, but uncomplicated. Throughout August one nostril is tender and obstructed, the tonsil on the same side is full; there is eczema of that ear. On August 14th, six weeks after the commencement of the illness, this girl is sent to the sea-side, where she joins her two younger brothers; the youngest, aged 5 years, has sore-throat on August 16th and the full rash of scarlet fever on the 20th.

Case 3.—The other brother, aged 9 years nearly, is separated from the younger, and returns to London with the convalescent sister, who has now no vestige of the illness, on September 4th; they stay at the house of a friend, who has one grown-up daughter, in whose room the girl sleeps, from the 4th to the 10th of September; the boy goes to his own house on September 6th, he has slight sore-throat on that day, is feverish on the 9th, and full rash on the 10th.

Case 4.—The young lady with whom the girl was staying, is taken suddenly ill on the afternoon of September 10th, with headache, lassitude, and chills; next day she vomits, and has sore throat, with intense aching of limbs and prostration; there is the full rash of scarlet fever on the 12th. These attacks either originated from the girl, again nine weeks and a half, or sixty-six days from the commencement of her illness; or the boy communicated scarlet fever four days before he is himself ill; he probably contracted the disease before leaving the infected house, as the symptoms appeared within three days of leaving it.

To give all the instances of short incubation in scarlet fever would be to exhaust a record of cases more numerous than those of measles. It sometimes happens that of children with equal exposure to either infection one escapes. In measles there is danger of attack while the children re-

main together, even after a month or more has elapsed, but if they are separated, and the room and clothes disinfected, the danger of a fresh outbreak is little or none; this is not the case with scarlet fever, when local causes of disease may remain after every means of disinfection have been practised.

Case 5.—Of two young children, one, a girl, has an illness in June, which, after some days of uncertainty, is recognised as scarlet fever; it is considered too late to separate them, and on the appearance of some slightly suspicious symptoms, the other, a boy, is placed in the same bed with the girl; he was soon better again, continued much with his sister throughout the illness and during convalescence; they both make a long visit to the sea-side, and return to their house early in October; within three days of their arrival the boy is taken ill.

Every care had been taken to disinfect the house, and special care as to the room and everything in it; the child's bed had been near the fire-place, and at the foot of a mahogany polished bedstead, with rounded end, on washing this surface with diluted Condy's fluid, the end nearest the child's bed discoloured several basinfuls; the corresponding round end of the footboard furthest from the child's bed caused hardly any discolouration; some shells used as playthings by the sick child also required repeated washings, others exactly similar not used by the child did not change the weak solution of permanganate of potash used. The local cause of infection here was caused by a neighbour having appropriated the rain water pipe, having an opening near the child's bedroom window, into a soil pipe, for a water-closet.

In another case of doubtful scarlatina occurring to a little boy, (case 6) during hot weather, on July 10th, commencing with diarrhœa, on the 7th the symptoms had so rapidly disappeared that he was allowed to mix with other children on July 16th; on the 19th two other children were ill with scarlet fever.

Cases 7 and 8.—Of two little girls living in an isolated, perfectly healthy house, the elder, 4 years of age, has a rash on February 21st, thought to be measles, and attributed to contagion from a child met with on February 17th, when she was taken to a London hospital, this being the only occasion for some time on which any communication with others could be traced. On the evening of the second day after this, February 19th, the child vomited; on the 20th she had sore-throat; the rash now appearing was evidently that of scarlet fever. The younger child, aged 2 years, was also ailing on the 21st, and seemingly had some difficulty in swallowing on the previous evening before there was any appearance of rash on the elder child. Both had rash on February 22nd, that on the eldest being most diffused and intense; next day the elder has albuminuria. They die, poisoned by scarlatina, the younger on February 26th, the elder on March 2nd, leaving their parents child-

less. The younger child took the complaint from her sister, if not while she was only sickening for it on February 19th and 20th, yet certainly before the 21st, when the rash appeared.

Terrible consequences not unfrequently result from allowing children from a house or family, infected with either scarlet fever or diphtheria to go direct to school; beyond the chance of infection being carried, is the certainty that if such child had only the first process of either disease set up in themselves, they will diffuse it widely before it is known to have commenced; quite recently a widely spread outbreak of diphtheria originated in this way: a scholar continued to attend school while a member of the family at home was ill with diphtheria, no harm resulted until soon after the first symptoms of illness were felt by this scholar, and though further attendance at the school then ceased, nineteen children in the school were attacked. The closest correspondence is found to exist between the laws of infection in scarlet fever and diphtheria, as is fully set forth in the article on the latter disease, in the first volume of Reynolds' *System of Medicine*.

Influenza is more closely connected with scarlet fever and diphtheria than is commonly known. Prevailing under two forms, the catarrhal and the herpetic, it has an incubation period closely corresponding to what is observed in those diseases; this may either be very short, or may occupy three or four days, but will not extend beyond a week. The shorter period generally obtains in the catarrhal form, the longer in the herpetic. The two forms, though most frequently propagating their own specific characters, are capable the one of giving rise to the other; instances of this are given in my *Temperature Observations*, p. 33; perhaps the catarrhal form more frequently gives rise to the herpetic, but they are really interchangeable. It would seem that the poison in a diffused state, acting on a healthy person under healthy conditions, may be rapidly thrown off with catarrhal secretion, while the same poison if concentrated and acting in different conditions of health, or under insanitary surroundings, may show itself less quickly but with more profound effect. Hence the affinities of herpetic catarrh with croup, ulcerated sore-throat, and diphtheria; those of influenza when mild, with common cold and diarrhœa. What in the winter is cough, in the summer affects the gastric mucous membrane rather than the pulmonary, resulting in diarrhœa; this may go through a household, as does catarrh: one person visiting another

with summer diarrhœa, and staying in the sick room, is liable shortly to be similarly affected. The epidemic form of influenza has some affinity with scarlet fever, both in the rapid action and in the intensity of the contagion; this, though acting on different tissues, and productive of less serious lesions, is much more readily spread by atmospheric, or other less appreciable modes of conveyance.

Typhoid or enteric fever, with an incubation period generally of ten or twelve days, which may be considerably prolonged, may also be developed in so short a time as four days. Dr. Clifford Allbutt records* the exceptionally short interval of five days in a child after sleeping one night with a nurse ill of typhoid; the evidence if not quite conclusive in this case is presumptive of the possibility of so short an incubation period. One case of typhoid from tainted milk which came under my notice, occurred on the fifth day from that on which alone the poison was imbibed. Dr. Murchison† gives a case from Knævenagel's work on the Etiology of Typhoid, of a man who falling into a latrine has typhoid fever eight days afterwards, some of the poison probably being received by inhalation at the time of the accident.

An instance of definite and short incubation of typhoid from inhalation has recently come under notice in a house near Grosvenor-square, most carefully guarded against the entrance of sewer gas, and the usual sources of water contamination, the pipe drains being well ventilated, by air tubes from below the trap of each water-closet to the roof. A change in the main sewer obliged the house drain to be carried from the back to the front of the house; for some days in May, workmen were employed in putting new pipe drains in the previously undisturbed basement; from this work no mischief could arise until the old communication with the outer drains was severed, or the new one opened. From the memorandum of the work done, supplied to me by the contractor, the period of danger appears to have been limited to three hours, on Saturday, the 24th of May. No defect was noticed in the portion of the drain removed, unless there had been slight leakage from the scullery sink at the back of the house, this was remedied on Friday, the 23rd, and lime was added to the earth surrounding the new

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* *British Medical Journal*, 1870, vol. i, p. 480.

† *A Treatise on the Continued Fevers of Great Britain*, by Charles Murchison, M.D., LL D., F.R.S. Second Edition. Longman, Green & Co., London, 1873, p. 469.

drain. The opening in the basement of the house where the old drain passed through was closed with cement.

The following is the workmen's account:—Thursday, 22nd May, putting waste to sink and preparing soil pipe; Friday, 23rd May, repairing new soil pipe, and putting in drain pipe; Saturday, 24th May, assisting putting in drains, opening front vault, shore drain for syphon, connecting servants' water-closet and soil pipe, opening old drains and making air tight, 3 hours; Monday, 26th May, making good paving and soldering in air-pipe.

Beyond a somewhat sickly smell under the sink, removed by the lime, nothing disagreeable was noticeable until during the three hours on Saturday, when one of the servants, a delicate woman of 30, complained more of it than the others, and consequently went out in the evening for fresh air, and to see the illuminations on the Queen's birthday. She made no further complaint, nor did she feel any illness until seven days after, when, on Friday, the 30th of May, she again felt nausea, and returned from a walk tired, with a fixed pain in neck, and diarrhœa; at night she was sick, the diarrhœa continued; she complained of chills, headache, night fever, and restlessness, with occasional vomiting, and persistent diarrhœa. On June 5th her evening temperature was 104.3, with nearly the same elevation for the next five days, the morning temperature ranging from 101° to 101°.8; during this time very characteristic rose spots appeared. By June 15th, the diarrhœa and febrile disturbance were moderated; there was slight nocturnal delirium and great prostration. In the last week of the illness, bronchial râles, with free expectoration, a tendency to constipation or inactivity of the bowels, and considerable emaciation; very little solid nourishment could be taken till June 30th, when she first left her bed. Some desquamation was noticed both of the feet and arms, especially near the elbow, where the skin was red and thin. No one else suffered in the house. The milk supply was unexceptionable. This servant had no friends in London, had visited no other house, nor taken either food or drink elsewhere.

The most frequent source of typhoid is the diffusion of the poison in drinking water, whether contaminated by direct admixture of sewage, or tainted by sewer gas. The outbreak at Guildford, investigated by Dr. Buchanan,* affords definite data for estimating the ordinary incu-

* *Tenth Report of the Medical Officer of the Privy Council*, 1867, p. 34.

bation period of typhoid. A new well for the supply of water by steam power to the higher parts of the town of Guildford was constructed in fissured chalk, in such proximity to the old sewer that contaminated water was pumped into the reservoirs until August the 1st; from that date to August the 17th, the high service drains were charged from the old well, when from some interruption to this source of supply, the water stored before August 1st in the new high service reservoirs was distributed to 330 houses. "It was distributed on no other day, and to no other houses, and on these 330 houses the fever almost exclusively fell." The first cases happened on the last three days of August; houses that had no cisterns, but took their supply direct from the mains, were attacked particularly early and suddenly; many houses had cisterns, or large underground tanks, in which the water received on August the 17th would be stored. Other cases of typhoid fever came under observation in the first two days in September, and on September the 3rd and 4th, a surprisingly large number of people sent for medical assistance, and were found to be suffering from the same fever. During the month, 264 cases of fever were under treatment. Dr. Buchanan fixes the occurrence of the first symptoms, in a great proportion of the cases, eleven days after the operation of the cause. A fact of interest in connection with the transitory operation of the cause is the low death rate, only three cases died in September. The total number of cases was 500, of the deaths 21; the last death was on November 22nd.

Much uncertainty as to the time necessary for the development of typhoid, is owing to the difficulty of ascertaining how long, or how continuously its course has been operative. Some persons exposed to it would escape with slight symptoms of malaise, did not a continuance or a repetition of the exposure at length overcome their powers of resistance, and they fall victims to the disease, not from the effects of the last only of the exciting causes; yet if this alone were taken into consideration the period of incubation would be unduly shortened. Others, after, or during exposure, suffer from diarrhœa, and may escape with no other symptoms, unless by sudden interference with the accustomed eliminative effort, or some other change of condition the disease is set up; hence the incubation period may be unusually prolonged. Mr. Adams, of Harrington-square, was attending a gentleman for troublesome diarrhœa persisting for more than a fortnight after his return from a continental town of

bad sanitary odour; the diarrhœa aggravated an ulcer or fissure of the rectum, and the pain was so intense that the usual operation was necessitated; while the incision was suppurating freely, no diarrhœa and no discomfort occurred, but on the complete healing of the fissure a sudden rigor ushered in a rise of temperature with evening exacerbations, ochrey diarrhœa began, there were rose spots in the second week, and all the symptoms of typhoid continued their usual course.

A convalescent patient probably does not give off infection long after the symptoms cease; but for how long typhoid might in this way be carried to distant parts is conjectural; that it may become active long after it has found its way into water sources is well known. The poison of typhoid, like that of cholera, acquires increased activity after it is thrown off from the human body, under the co-operation of heat and moisture upon filth; contaminated water is the great medium of conveyance for those poisons, whether directly or by subtle particles of them diffused into the air, and condensed into water surfaces, or carried by sewer gas directly into drinking water. Personal infection, rare in both instances, is rarer in typhoid than in any other of the diseases under consideration, yet the infection, however propagated, derives its origin from persons previously affected. Certain forms of illness of irregular duration, generally shorter than that of typhoid, and often characterised by diarrhœa, are probably owing to the poison of typhoid, and may probably reproduce it: such cases are given at pp. 55-60 of my *Temperature Observations*, and Professor Jürgensen, of Tübingen, has recently called attention to numerous cases of this kind.

Typhus has been so exhaustively examined in the masterly essays of Dr. Murchison, that it becomes merely necessary to refer to the second volume of the *St. Thomas's Hospital Reports* for 1871, new series. The incubation period is twelve days; of thirty-one cases there collected seventeen occurred at this limit; one case in not less than thirteen days; one in fourteen days; one exactly fifteen days; and in one it was not less than twenty-one days. Ten cases, or nearly one-third of the whole number, fell below the limit of twelve days; of these, in two it was not more than ten days; in one not more than six days; in one exactly five days; in one between five and a-half and six days; in two not more than four days; in one not more than two days; and in two there was no latent period, or only one of a few hours. In this disease it is to be remembered that the distinctive rash does not

appear till the fourth or fifth day of illness. The remarkable way in which the infection of this most infectious of diseases is diluted and soon destroyed by free ventilation and fresh air, is forcibly stated in the great work on fevers already referred to; one statement there, however, requires correction: instead of convalescents from typhus not having the power of spreading the disease, a medical friend of my own, impatient of precaution during rapid convalescence, hastened from London to a distant part of the country, and communicated typhus in two remote villages, where nothing of the kind had previously been known.

Relapsing fever is conspicuous for the shortness of its incubation period. In numerous instances persons are attacked at once upon exposure to sources of strong infection. In the Camberwell workhouse, tramps received at night to infected quarters, were found next day to be suffering from the disease. The cases related by Dr. Marsh,* where the febrile rigor succeeded immediately to the application of the contagious effluvium, were most likely of this kind. Very clear instances of a five days incubation period have been recorded of this disease, and it has been stated to be oftener over than under five days. Of twelve accurately determined cases, three were immediate; two from two to four days; two were five days; and one each in seven, nine, twelve, thirteen, and fourteen days. The possibility of latency to the fourteenth day has, however, yet to be determined.

Yellow fever usually with a short incubation period of from two to five days, and rarely exceeding eight, has yet been stated sometimes to extend to ten days. In the thirty-eight cases reported by Inspector-General Lawson on board the *Bristol*, some began to appear two days after exposure; twenty-nine of them occurred in the first eight days; the one exceptional case was a week after the others, thus suggesting the possibility of reinfection. This case falling fourteen days after the original exposure, cannot be used to justify a quarantine of a fortnight's duration, for the possibility of this length of incubation period is not beyond doubt; if, after leaving an infected port, no case of disease have occurred by the fourth day, that is sufficient evidence that neither crew nor passengers had contracted the disease before they left, and that further quarantine is unnecessary.

Plague, now nearly extinct in Europe, is fortunately characterised by a short period of incubation. Dr. Gregory

* *Dublin Hospital Reports*, vol. iv, 1827, p. 455, case 5; see also pp. 518-20.

writes "From the concurrent testimony of numerous authors, we are warranted in saying that the period of incubation of the true pestilential germ is very short." "Two days have been stated as the minimum, and fifteen as the maximum; five days may be looked upon as a fair average. Four days suffice to set up the constitutional symptoms when the plague is received by inoculation." The shortness of the incubation period offers an additional character to those noticed by Dr. Tholozan as distinguishing plague from typhus.

Dengue, an eruptive disease, is, like influenza, a pure epidemic, first attacking a few and extending its circle till few escape; the ingress is sudden, with febrile and articular pains, followed by a scarlet rash; it passes off without danger, but leaves debility, a tendency to relapse, with pain and weakness of the joints. The stage of incubation is a short one, but may extend to three or four days; one attack is not protective against another. Infection will cling to surfaces, and may linger long on board ship, breaking out unexpectedly; in 1870 this happened among troops conveyed by sea from Bombay (where it had extended from Zanzibar) to Cannamore on the Malabar coast; in 1871 the epidemic extended to Madras and thence to Calcutta, Rangoon, and Singapore; in 1872 it had extended both to China and to the Punjab. Dr. Taylor* notes the disease first in Delhi on June 1st, 1872, attacking one member in an European family that had arrived from Calcutta three days before; subsequent seizures were observed amongst persons who had been in communication with this family. The disease prevailed as an epidemic from July to November. Almost every one exposed to the contagion caught the disease; when once it entered a house hardly a person escaped. One fatal case only is reported in the whole course of the epidemic. Common in India, where scarlet fever is rare, dengue would seem to be of African origin, and to owe its extension to the slave trade. It has not yet appeared in Europe. In the West Indies it was first described as a hybrid between urticaria and rubeola, as with us rubeola is sometimes spoken of as scarlet fever and measles conjoined, a confusion of totally different morbid conditions, possible only so long as the distinctive characters of a disease remain unrecognised.

* *Report of the Sanitary Administration of the Punjab for the year* 1872, p. 70. Other particulars of this exanthem are from the address of our President, Dr. W. R. E. Smart, C.B., Inspector-General of Hospitals, Royal Navy.

Cholera, whatever may be said of its mode of propagation, is distinguished by the shortness of its incubation stage; hence the readiness with which quarantine measures may be made effective in a country such as our own. From inquiries made by the Central Board of Health in 1831, of 171 cases at Berlin 159 were found to have occurred within five days from exposure to the infective germ. At St. Petersburgh, in the cases where single exposures to infection were best ascertained, the period of incubation ranged between one and five days. In the Austrian territory, the Genoese Medical Commission observes "that those who had absorbed the germs of the disease were generally attacked before the third, and not later than the fourth day." The difficulty experienced in the early recognition of some diseases is no obstacle to the efficiency of preventive measures against cholera. The premonitory diarrhœa generally affords an obvious symptom, and it is well known that the infection at this stage must be guarded against. One attack of cholera affords very slight, if any protection, against recurrence.

Until quite recently typhus has been often confounded in India with remittent fevers; ten times the number of deaths in British India are registered under the head of "fevers" to those from cholera during the worst epidemics.* In the report already referred to, Dr. Fairweather states, "In no instance do medical officers attribute these severe forms of fever to any but a malarious origin. The manner of distribution seemed to point more to a *specific cause* than to any general condition. In the early part of 1872 typhus fever was found mixed up with the ordinary fever of the country in a jail in the north-west of India;† it was known to have prevailed here before, but had escaped detection. How much more difficult must it be to detect the presence of a specific fever among the mass of the native population. That fevers peculiar to this country do exist few will be prepared to deny. No mere general descriptions will ever be useful in determining the nature of a disease, and it is

* *Ninth Annual Report of the Sanitary Commissioners with the Government of India*, p. 207.

† *Report on the Sanitary Administration of the Punjab for the year* 1872, p. 68. Dr. De Renzy directed an inquiry on this point; the careful clinical observations of Assistant-Surgeon Lombard proved the fever in question to be typhus; he caught it and died. The temperature observations he made leave no doubt as to the nature of the fever of which he himself fell a victim; yet on these very proofs, with the usual evening exacerbation, the local medical authority remarks, "The disease therefore was, as far as the temperature is concerned, decidedly remittent."—Appendix to Report.

only by an officer who can make minute clinical notes of cases, such as were made by Dr. Lombard, that the tangled skein of Indian fevers will ever be unravelled." No long time has passed since among ourselves typhus was called endemic, under the name of jail fever.

The London bills of mortality included many cases of typhoid or enteric fever under the name of ague; the death of James I is a probable instance. How long a new resident in a malarious district may escape, or how soon he may suffer, was seen in this country, when our old ague grounds were undrained; Irish harvest men, a month in the fens, were sometimes attacked before their work was over, many were seized on their journey home, others long after their return. Malaria, short of inducing ague, produces some ill effects not immediately noticeable, but developed on some subsequent exposure to any cause of illness, even though this be experienced long after quitting the malarious district.

Malarial fevers, having many points of resemblance to epidemics like yellow fever and cholera, though non-contagious, are found also to have an incubation period, which, though capable of being accelerated or retarded, is yet as constant as that found to obtain in so specialised a disease as typhoid. Dr. Walter Dickson, one of our secretaries for the Navy, informs me that the non-contagious malarious fevers of the west coast of Africa often show an incubation period of twelve days. At about that interval, after the return of a boat's crew from a river expedition, some cases of remittent fever would occur even among the more cautious of the men; sometimes a debauch would determine the attack before this period, or bring it on at a somewhat later time in those who otherwise in all probability would have escaped. M. Littré, of the Institute of France, has ingeniously shown how the fatal illness of Alexander the Great was brought on in this way nine days after exposure to malaria in a boat expedition near Babylon.

Since concluding this paper the Essay of Dr. Gregory, already noticed, came into my hands; he gives illustrations of the incubation period of malarial or endemic fever in Sicily, from Sir William Franklin, Principal Inspector of the Medical Department of the Army. On the 12th of July, 1810, a regiment marched from Milazzo to the neighbourhood of Messina; a detachment was subsequently sent to occupy a large mansion, the Casa del Corso, where in certain seasons no one sleeps without afterwards suffering intermittent or remittent fever. Ninety-one men were

stationed here. On the 31st of July, thirteen days after exposure to the malaria, the first case of remitting fever was sent to hospital. On the 1st August, five others were reported. The following day the detachment moved from the Casa del Corso, and encamped near the rest of the regiment, which was then healthy. Yet the men continued to drop, and the admissions into hospital from this detachment were, August 2nd to 6th, one, eight, five, six, and seven men on each day; on the 7th eleven were admitted, and twelve on the 9th, after which the number were, four, eight, two, three, on consecutive days; then comes one on the 15th, two on the 20th, and one on the 26th day. Seventy-seven men of the ninety-one exposed to the germs of the disease were attacked; after their removal the greatest number of cases fell within twelve days, and one exceptional seizure takes place twenty-five days after removal from the malarious locality. Would the fourteen who escaped have fallen with fever had the exposure been longer? Dr. Gregory thinks not. He says, "as a proof of the intensity of the poison, of the seventy-seven attacked twenty-three died, being in the exact ratio of thirty per cent., the usual rate of mortality in small-pox, and also approximates to that of epidemic cholera." The account is insufficient to reveal the causes of this great mortality, or the exact nature of the disease. Like a true malarial remittent, it did not spread to any not exposed to the local influence.

In conclusion, the great questions bearing on all that may intensify or that can mitigate the extension and severity of these diseases must pass with bare mention. How much hygienic measures, directed by a full knowledge of the natural history of each epidemic, lessen the fatality of some and defend against others is beginning to be understood and acted upon. There are scourges of the past now only matter of history; social progress has slowly and indirectly, but most effectively, obliterated many evils inseparable from imperfect knowledge of the conditions and deficiency in the means of healthy living. Plague is abolished from Christian Europe. By what means the mortality from small-pox may be annihilated is well established; even if the reactionary activity of ill-instructed intellects so far prevail as recently in Leipzig, the head-quarters of German learning, to check the employment of vaccination; the loss in one year of seven hundred children, and the death of one in every hundred of the inhabitants by small-pox, forcibly recalls the value of the disused protection, and limits for the future

any such disastrous success on the part of anti-vaccination leagues.* Where we have no direct means of preventing personal susceptibility to disease, we lessen it by all that tends to maintain intact the vital resistance of each individual, by all that conduces to general prosperity, and by such local cleanliness and public conservancy as will maintain the purity and secure the freest supply of the water we drink and the air we breathe. The least speck of the less potent poisons finds quick inlet, and stings sharply when the state of health is weak, or the air bad around. Free admission of air almost robs the poison of typhus of its power; in my own experience this fever was banished for a time from London by the first operation of the Common Lodgings House Act. An infection the most subtle and persistent, that of scarlet fever, has been limited to one patient in a room with other children living and sleeping in it, by preserving a separation of a few yards, and attention to the maxim that disinfection must begin at the body of the sick. As these poisons are diluted and destroyed by fresh air, so are they intensified by accumulating in air otherwise foul; the mortality of measles is one per cent. under good hygienic conditions for all ages beyond the first year; under ordinary circumstances this rate is doubled; the usual mortality for all ages is one in thirty or forty cases; during the siege of Paris the mortality from measles in the Hôpital de Bicêtre exceeded one in three.† All clinical experience is confirmatory of Dr. Sanderson's demonstration of the increased virulence infecting poisons may acquire in transmission from one individual to another. Essential differences are shown in the various morbid poisons by another order of facts; the mortality from typhus is far less in childhood than in age; hooping-cough, so dangerous to the infant, is merely troublesome to the adult. The regulations to keep out cholera would be powerless for the exclusion of small-pox. Thus, the best intentioned sanitary efforts often fail, wanting the precise information that can alone be afforded by the science of medicine.

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* La Variole au point de vue épidémiologique et prophylactique, par Léon Colin, Professeur à Val de Grâce, Médecin en chef de l'hôpital militaire des varioleux de Bicêtre pendant le siége de Paris, 1870-71. Baillière et fils, Paris, 1873, p. 22. The numbers here quoted, given by Professors Wunderlich and L. Thomas, are from November 1870 to February 1871.

† *Op. cit.*, p. 151.

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