Observations

ON

OPHTHALMIA NEONATORUM*

BY

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In this subject my experience has been gained entirely within the London area. I shall therefore confine my remarks to my observations there and to the work carried out at St. Margaret's Hospital, a special institution set apart by the London County Council for the treatment of ophthalmia neonatorum.

LONDON COUNTY COUNCIL

Year.	Notifications of Ophthalmia Neonatorum for London.	Numbers Admitted to St. Margaret's Hospital.	Children Discharged Blind in Both Eyes from St. Margaret's Hospital.	Blindness Due to Ophthalmia Neonatorum.	
				Year of Birth.	Children Admitted to L.C.C. Blind Schools.
1915	760	—	—	1915	6
1916	773	—	—	1916	5
1917	641	—	—	1917	5
1918	613	58 (from Sept.)	—	1918	4
1919	870	231	4	1919	6
1920	1,186	252	4	1920	5
1921	1,076	213	4	1921	6*
1922	867	213	0	1922	3
1923	761	225	0	1923	2
1924	724	179	1	1924	1
1925	705	186	0	1925	2*
1926	705	198	0		
1927	812	211	0		
1928	733	204	0		
1929	728	224	1		
1930	617	196	1		

* Including one doubtful case.

The number of cases notified in London has not diminished during the last fifteen years. There was a considerable increase after the war, with a corresponding increase of patients seeking admission to St. Margaret's Hospital. The number of admissions of recent years has become a fairly constant factor. The most striking point in the statistics is the amount of blindness, which has decreased by more than half as St. Margaret's Hospital has become known and utilized.

There are at present 218 children under 18 years of age on the roll of the L.C.C. blind schools; of these, 45, a percentage of 20.6, are blind from ophthalmia neonatorum. Although this is an enormous improvement on old statistics of blind institutions, it is probably still unduly high. I believe that further improvement is possible by the proper teaching and training of midwives and medical students. At the present time midwives receive a far better education on the subject than the medical student. Classes are given at St. Margaret's to midwives from Queen Charlotte's Hospital, the L.C.C., and other bodies. The medical student receives no education in the subject, and probably never sees a case during his training. I hope that this meeting will pass some sort of resolution which can be sent to the General Medical Council, drawing its attention to this fact, as was done some years ago by the Council of British Ophthalmologists.

THE EYES AT BIRTH

When a child is born the eyelids are tightly closed, the skin being thrown into numerous wrinkles and covered with a fatty material. The margins of the lids are usually in contact with each other, but occasionally the upper lid is found overlapping the lower. As compared with the adult, the length of the palpebral aperture is small in

comparison with the size of the conjunctival sac. The lining membrane is thrown into numerous folds in the fornices and over the surface of the globe. The margins of the lids are covered with fatty secretion from the Meibomian glands and with epithelial debris. I have often found the Meibomian secretion containing the xerosis bacillus on the third day; and it is almost constantly present soon after birth. It is probably derived from the vagina, and is almost certainly identical with the pseudodiphtheritic bacillus found there. No doubt the greasy secretion of the lid margins helps to prevent the infected vaginal discharge getting into the conjunctival sac, but probably more important is the rapid passage of the foetus through the vagina. In one instance, in a case of twins, the first child was infected, whereas the second child escaped. It is also possible that in this case the stretching of the perineum by the first child may have saved the second one.

The epithelium of the ocular conjunctiva is not so thick as that of the adult, but next to the epithelium covering the tarsus it is the thickest part of the epithelium of the conjunctiva at birth. In the fornices at the bottom of the folds, the cells show signs of mucoid change to such an extent that the basement membrane is completely bare in places, and it would allow a ready entrance of organisms to the sub-conjunctival tissues. The corneal epithelium is only about three cells in thickness, but to compensate for this there is a greater thickness of the substantia propria, in comparison both with the thickness of the sclera and with that of the adult cornea; this no doubt allows a freer circulation of lymph between the lamellae. The conjunctiva and the corneal epithelium in the infant, therefore, do not offer the same resistance to infection as in the adult.

At birth there is no lymphoid tissue in the conjunctiva. After the first few days the lymphoid cells begin to appear generally around the vessels of the superficial layers in the superior fornices. These cells gradually increase up to the fourth week of life, when the lymphoid layer seems to be fully formed. The rapidity with which it forms depends on the amount of irritation the conjunctiva receives; thus if nitrate of silver be applied at birth, the lymphoid cells appear in large numbers in forty-eight hours.

HISTOLOGY OF THE CONJUNCTIVA IN OPHTHALMIA NEONATORUM

The following observations were made on three cases of ophthalmia neonatorum. They were all extremely severe cases; one had ended in complete destruction of both eyes, and the other two of one eye each. The tissue was removed from the lower fornix in two of the cases, and from the upper fornix in one during the third week of the disease.

The epithelium on the surface is somewhat irregular in thickness, and is desquamating, some of the superficial cells containing the gonococcus. The conjunctiva becomes papillated in consequence of the swelling beneath. This is best seen in sections cut parallel to the surface, when papillae containing numerous blood-vessels, and completely surrounded by epithelium, are observed. The epithelial cells show evidence of mitosis, and are much separated from each other, chiefly, no doubt, by the passage through them of enormous numbers of polynuclear leucocytes, since the conjunctival sac often becomes filled with pus in less than five minutes after cleansing. Between the epithelial cells are found numbers of mononuclear and polynuclear leucocytes. The gonococci are found adherent to the cells. With regard to the sub-epithelial tissue, there is an extensive exudation into the superficial layer of the connective tissue; the vessels in the deeper layer of connective tissue are dilated, and in and around the papillae there are quantities of small vessels of new formation with proliferating endothelium; these vessels contain large numbers of poly-

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nuclear leucocytes, and show many beautiful examples of **diapedesis**. The connective-tissue cells of the superficial **layer** are found to be proliferating, but not to any marked **extent**. The cells in the deeper layer of connective tissue show practically no changes.

The cells of the exudation (polynuclear leucocytes), although they are found in large numbers in the sub-epithelial tissue, are not nearly so numerous as the mononuclear cells; their relative proportion becomes increased in the epithelium; in the discharge they make up about 94 per cent. of the cells. Hence it is seen that, although they constitute the greater proportion of the cells of the discharge, they are not seen in such enormous numbers in the sub-epithelial tissue as compared with the mononuclear cells—a fact which can easily be accounted for by their more active amoeboid movements. Mononuclear leucocytes, both large and small, are found in great numbers scattered throughout the exudation, and are seen best in the papillae, which contain little else but these cells, many of which are degenerating. Of great interest is the distribution of the plasma-cells in this disease. They are found in great numbers in the connective tissue beneath the papillae, but where they approach the epithelium they become rapidly broken up, the cells staining more faintly and losing their protoplasm; hence they are practically absent from the papillae, no doubt owing to the presence of the toxin produced by the gonococcus growing in the epithelium.

BACTERIOLOGY AND IMMUNITY

In St. Margaret's Hospital there have been no unusual organisms to record nor any variation in the usual percentage already described. The gonococcus occurs in between 60 and 65 per cent. of the cases. In the non-gonorrhoeal cases, the streptococcus is the only one of serious importance, in that it causes more severe inflammation than the gonococcus and frequently leads to perforation and panophthalmitis. Staphylococci, the Morax-Axenfeld bacillus, pneumococci, the Koch-Weeks bacillus, the Klebs-Loeffler bacillus, *Bacillus coli*, *Bacillus pyocyaneus*, have all been found. In about 10 per cent. of the cases no organism can be found in the discharge except, perhaps, the xerosis bacillus or the *Staphylococcus albus*. The former is present fairly constantly in all discharges, and the latter is frequently present, especially in association with the gonorrhoeal form.

The question of immunity to the gonococcus is of great interest and requires considerably more study than has been given to it. There seems little doubt that a general immunity to the gonococcus is extremely difficult to produce either clinically as the result of an attack of gonorrhoea, or artificially by vaccines. Patients who have an attack of gonorrhoea are by no means rendered immune to a second attack, or to local infection elsewhere in the body. For instance, a patient who has a gleet can infect his conjunctiva and produce a severe gonorrhoeal ophthalmia. Further, vaccines given in large doses seem to have no effect on ophthalmia neonatorum, although, perhaps, if continued over a long period they produce improvement in some chronic lesions such as iritis. At the same time, ophthalmia neonatorum clears up fairly rapidly and completely under local treatment except in a few instances. I do not think that this is entirely due to the application of antiseptics to the conjunctiva killing the organism, since it is found in large quantities even in the slight sticky discharge at the end of an attack. It may be that these organisms are of much lower virulence than the original organism found in the acute stage of the disease and hence gradually die out, but I think it is more probable that the disease clears up as the result of the local immunity which is produced in the conjunctiva. This question of local immunity has been very little in-

vestigated. Personally I think it is intimately bound up with the monocellular exudation which takes place after the acute stage of the inflammation begins to subside. The cell with which it is particularly associated is the plasma-cell, which always makes its appearance in enormous numbers as the acute inflammatory symptoms begin to resolve. Plasma-cells are broken up locally by the toxic products which are present at the seat of inflammation. It is possible by the breaking up of these cells that some antibodies may be liberated and so produce the local immunity.

We frequently see very severe attacks of gonorrhoeal ophthalmia in one eye and only a slight discharge in the other eye, yet the organism is found in both. I have also seen an acute recurrence in one eye after an interval of sixteen days, while the other eye was perfectly free from discharge, and yet the epithelial scraping in the sound eye showed the presence of the gonococcus. I suggest that this is due to the local immunity being greater in one eye than in the other. In some cases the local immunity in the conjunctiva is very slow to develop. Although there is nothing which is exactly comparable to gleet in the conjunctiva, we occasionally meet with cases which will not get well in spite of vigorous treatment, there being a little discharge which is full of organisms. We have had several cases in the hospital from three to five months; if sent out too soon these patients are very apt to relapse.

INSTITUTIONAL TREATMENT

In September, 1918, the Metropolitan Asylums Board opened St. Margaret's Hospital, Leighton Road, Kentish Town, consisting of 60 beds for women and infants, for the treatment of ophthalmia neonatorum. A theatre for the treatment of infants is provided; also a sterilizing room for disinfecting bowls, dressings, and feeding-bottles. There is a room and table for the treatment of mothers with vaginal discharge. A small bacteriological laboratory is attached, as every patient is bacteriologically examined immediately on admission. A day-room is provided where sewing can be done by the mothers when they get up; there are open-air wards for the babies whose mothers are not in hospital. A courtyard and a small garden, which are also very necessary adjuncts, are provided. In an institution of this kind it is essential to have separate lavatory accommodation for the gonorrhoeal and non-gonorrhoeal cases. A relatively large nursing staff is necessary, as the infants constantly want attention, and in addition to having their eyes washed out, they have to be washed, fed, kept clean, weighed, etc. The presence of the mother in the hospital is not such a great help in this respect, as they themselves require treatment; the infant is kept away from the mother in a separate cot, except when it is actually being fed, therefore it requires almost the same amount of attention. Roughly, one nurse is needed for every two patients. Cots or cradles are provided for the infants. On the whole, perhaps, cradles are the most satisfactory, as plenty of fresh air is desirable to prevent the spread of infectious diseases, and the high sides of the cots are apt to offer too much protection. The infant is always wrapped in a blanket, so that it is not exposed when it is moved from its bed to the treatment-room to be irrigated. Hot bottles are usually kept in the cot in the winter time or when the child is ill. Fly-nets to cover the cots are very necessary in the summer. Tapes with the names of the children are fixed round their ankles so as to prevent any possibility of a mistake being made as to their identity.

Only gonorrhoeal cases receive treatment in the treatment-room. Non-gonorrhoeal patients are provided with sets of bowls and undines, and the treatment of these cases is carried out separately. They are as far as possible

confined to one ward, but frequently this is not practicable, and isolation can be carried out in the wards as above described without risk of infection. For the irrigation and treatment of the infants' eyes a table has been made for me by Messrs. Weiss (see Fig.). It is of metal, and it consists of a solid base with a central rod which can be raised or lowered by hand. The top consists of a trough, out of which the baby cannot fall, and in one end of the trough a half-moon-shaped piece is cut out so as to receive the neck of the infant and prevent the soiling of the clothes from the lotion. Outside this is a curved adjustable head-piece on which the baby's head rests during irrigation. Beneath the head-piece is a tray to catch the

lotion, which is let off into a bucket of lysol fixed to the stand. These are all easily removed for cleaning purposes. The top of the table is slightly tilted towards the head.

Irrigation is carried out from an adjustable stand irrigator. Around the jar containing the lotion is a metal jacket, which in summer-time is packed with ice for cooling the lotion. A tap is provided to drain off the water from the jacket as the ice melts. A glass nozzle is attached to the rubber tubing from the irrigator. The nozzle is provided with a ball stopcock, which can be adjusted with one hand. When the nozzle is not in use it is kept in a solution in a small jar attached to the stand. For the examination of the cornea a focus lamp is adjusted over the face. Protargol and other solutions are applied by wool mops and glass rods. Oily solutions are kept in undines.

ADMISSION OF PATIENTS

The greatest difficulty we have to contend with is in getting the patients into hospital early enough. The commonest time at which corneal ulceration occurs is during the first stage of the disease. Although the law has drawn the attention of the practitioners and midwives to its importance, there is often delay in the notification of the disease to the medical officers of health. When the hospital was first opened the average age at which the infant was admitted was three weeks, but this has since considerably improved as the attention of the health department has been drawn to it, and now midwives are allowed to send cases direct to the hospital without a medical certificate; but there is still too large a proportion of cases admitted with corneal ulceration. It is very difficult to make doctors and midwives realize that the mother and infant

can be moved safely by means of an ambulance on the third or fourth day after the birth of the child; they do not yet seem to grasp the importance of immediate and efficient treatment.

LOCAL TREATMENT

As soon as the patient is admitted to the hospital a smear preparation is made from the conjunctival discharge and stained with pyronin and methyl green or thionin blue, and by Gram's method if necessary. It is usually possible to make a diagnosis therefrom sufficient, at any rate, to separate the gonorrhoeal from the non-gonorrhoeal cases. If the gonococcus is found, the patient is placed in the gonorrhoeal ward. The percentage of gonorrhoeal cases admitted is a little higher than the general average of 60 per cent.

In cases of doubt the patient is put in the isolation ward and a smear preparation is taken on three or four successive days; cultures are also made, but as a rule the latter do not afford much assistance in the diagnosis. If the gonococcus is not found in three smear preparations made on successive days, the patient is put in the "negative" ward. In the case of infants without their mothers it is sometimes impossible to isolate the negative cases, but the treatment of them can be quite safely carried out in the ward without fear of infection. I may say here that the word "gonorrhoea" is never mentioned in the hospital, as it is apt to get the hospital the name of a "venereal hospital" (which is extremely undesirable, as it may lead to domestic trouble among the patients); to get over this difficulty we therefore speak of the cases as being positive and negative.

There is a special case paper showing the amount of discharge present, which is recorded daily.

By comparative methods we have come to the conclusion that eusol (1 in 10) is the best lotion to use, but it must stand 24 hours after being made. The next best lotion is one of boric acid and sodium bicarbonate. The lotion is used every hour when the discharge is large in amount, every two hours when less, and every three hours when slight. After a wash out with the lotion the conjunctival sac is filled with acriflavine (1 in 1,500 of castor oil). We have found the use of this oil extremely beneficial. It prevents the sticking of the eyelid margins, and it acts as a harmless antiseptic constantly present in the conjunctival sac. Our experience of silver applications is that they seem to be of little value in the early stages of the disease and inclined to accentuate the symptoms rather than to improve them, so that they are not used, as a rule, until the swelling of the eyelids begins to subside. They are of the greatest value in clearing up the later stages of the disease. All preparations are rubbed into the conjunctiva with wool mops. The rubbing assists the removal of the surface epithelium in which the organism is growing. Nitrate of silver (10 grains to the ounce), subsequently neutralized by a salt solution, is most efficient in skilful hands. Where it is at all doubtful that the solution will be properly applied, it is far safer to use 10 per cent. protargol.

I think the use of silver nitrate for prophylactic treatment is strongly to be deprecated, likewise the use of mercury perchloride lotion. Every year there are admitted to St. Margaret's Hospital cases in which the cornea has been damaged by the improper use of these drugs, and personally I advise the use of acriflavine oil or protargol, both of which, I think, are efficacious.

External canthotomy is done in the early stages of the disease when the lids are greatly swollen, or when the palpebral aperture is so small that the conjunctiva cannot be properly cleansed. It prevents the retention of the pus in the conjunctival sac under the pressure of the eyelids and relieves the tissue tension by a local blood-letting.

EFFECT OF VACCINE ON THE DISEASE

We have used ordinary and detoxicated vaccines extensively, and also serum, but I do not think that they have any influence in shortening the ordinary period of the disease. Treatment by milk injection has no effect, and is very dangerous, as the rise of temperature lowers the resistance, and is often associated with the onset of corneal ulceration.

DISCHARGING OF PATIENTS

It is very difficult to know when a baby should be discharged from the hospital. Bacteriological examination has shown that the gonococcus can be found in the conjunctiva twenty-eight days after cessation of all the discharge. In our hospital we have had a relapse of the disease twenty-one days after cessation of all discharge, the eyelids during that time being not even sticky (the gonococcus was found in the recurrent discharge). It is obvious from a practical point of view that a child cannot be retained in the hospital for three weeks after the disease has apparently ceased, and it is the usual practice to discharge the patient after he has been totally free from any sign of discharge for a week. As a practical method this works fairly well. Strict injunction is given to the mothers to return if there is any sign of recurrence of the discharge. About 10 per cent. of the patients do so, and in most instances they are re-admitted. The gonococcus can always be found in considerable numbers even if the discharge is slight in amount. The relapse is hardly ever severe, and usually amounts only to stickiness of the lids. Every now and then a case may exhibit symptoms almost as acute as those of the early stages of the primary disease, but differing from it in that it only lasts for a very short time—usually about a week. I have never seen any corneal trouble as the result of recurrent attacks.

GENERAL TREATMENT

The general health of the infants is of the utmost importance, and one cannot emphasize too strongly the great care that is necessary in the feeding and management of them. There is an enormous contrast between the infants who are breast-fed and those who are admitted without their mothers. The infants who are admitted with their mothers, as a rule, do extremely well, and in spite of the constant disturbances due to treatment put on weight steadily. Infants admitted without mothers in most instances do not do nearly so well. This does not seem to be due to any variety of artificial feeding, as all the various dried milks, fresh milk direct from the country, and peptonized milk have been tried without result. It is probable that in the case of the infants who are nursed by their mothers some protection is afforded them through the breast-feeding. There is little doubt that the infants do far better in the winter than in the summer, and the ophthalmia is not so severe then. The infants who are admitted without their mothers are very largely drawn from the lowest class of patients, and are frequently illegitimate, or the mothers may be unable to come into the hospital because they are obliged to work or have a number of other children. A large number are prematurely born, and therefore the death rate is always very high amongst this class of case. Congenital syphilis in young infants, if present, usually shows no signs, although it may be very detrimental to the general nutrition of the infant, and is, I think, thereby a frequent cause of corneal ulceration. Congenital syphilis does not seem very prevalent in these infants. In a series of twelve successive cases in which the blood was examined no case was found to have a positive Wassermann reaction. On the other hand, out of two patients who developed

corneal ulceration in the hospital, from clear cornea, both had a positive Wassermann. Many of the other cases of corneal ulceration have also shown a positive reaction.

AFFECTIONS OF THE CORNEA

The cornea is affected either by becoming hazy or ulcerated.

In the early stages corneal haze is probably only due to oedema in the corneal epithelium, but when the cornea is very "hazy," especially when it is localized, it is probably the early stages of true infection of the cornea. These cases very frequently break down into corneal ulcers.

Corneal ulcers are of three types:

(a) Those which I call puncture ulcers, in which there is a tiny perforation straight through the substance of the cornea with very little infiltration, which will develop and run its course to perforation in twenty-four to forty-eight hours, subsequently leading to a very slight nebula, possibly with an anterior polar cataract or adherent iris. The infection is always gonorrhoeal and the child in good health.

(b) A fairly large ulcer with considerable infiltration of the cornea. In the early stages these may present themselves as accumulations of pus beneath the epithelium or as a breaking-down hazy cornea. They frequently perforate, leading to dense nebulae with an adherent iris.

(c) Sloughing of the whole of the cornea. This type of ulcer is usually associated with marasmic or premature children, and generally starts with very dense infiltration of the whole of the cornea, a central portion of which becomes necrotic and breaks down. Extrusion of the lens through the opening is frequent. It is these cases which lead to a staphylomatous cornea. Extrusion of the lens can only occur when the ulcer is very large and involves the central portion of the cornea. I have watched the extrusion in these cases. The umbo of the lens presents in the base of the ulcer as the result of the child's crying or straining, the lens is delivered through the ulcer, and generally remains attached by a few fibres of the suspensory ligament, which are then torn through by the closure of the eyelids, and the vitreous can be clearly seen presenting in the wound.

In every case I have examined the lens is delivered in the capsule. In all cases in which the lens has been extruded it has been followed by buphthalmos. This is probably due to the vitreous and iris being incorporated in the wound and causing complete obliteration of the anterior chamber. When there is streptococcal infection this type of ulcer frequently leads to panophthalmitis, but I have never seen a case of gonorrhoeal perforation go on to panophthalmitis, even where the lens is extruded and the vitreous is presenting in the wound.

AFTER-TREATMENT OF CORNEAL ULCERATION

After the patients leave the hospital they are directed to attend an ophthalmic hospital. Corneal nebulae, even when they are quite dense, often clear very considerably, and I do not advise any operation in the way of an optical iridectomy until the child is at least six months old, as it is impossible to say to what extent the corneal nebula will clear. The chief indication for operation is nystagmus. This develops directly the child is able to open his eyes and look round for the light, and it is in these cases that early operation is advisable. It is sometimes observed in one eye affected by severe nebula when the other eye is clear. My own experience of optical iridectomy, except in a few cases, is that the vision is not very greatly improved thereby. On the other hand, in cases of anterior polar cataract where the cataract practically fills the pupil

in its contracted condition, or in a small centrally situated nebula, the vision is often improved by a small optical iridectomy, and in some instances this may be combined with the division of an adhesion of the iris to the posterior surface of the cornea. I do not as a rule advise the simple division of anterior synechiae, as from my own experience I do not think that they often give rise to much trouble. For staphylomatous cornea and buphthalmic eyes which are protruding between the lid or which are very unsightly, a Mule's operation is advisable, using a small glass ball, and stitching the sclera together with a purse-string suture of silk, a separate stitch being made for the conjunctiva. If this method is followed, extrusion of the ball is extremely rare.

OTHER COMPLICATIONS

Gonorrhoeal arthritis, although not uncommon in the mothers, is rare in the babies. We have had only one such case in 350 children. This child had both ankles and knee-joints severely affected and subsequently died of heart failure.

Rhinitis is a frequent accompaniment of ophthalmia neonatorum. The gonococcus can be found in the nose when there is a large quantity of discharge, or when there is practically none. If there is much discharge there are always immense quantities of other organisms, and I think that the rhinitis is attributable far more to these organisms than to the gonococcus.

Purulent mucocele is often mistaken for ophthalmia neonatorum. In some of these cases the gonococcus has been found in the discharge, although the pneumococcus is more frequent.

SOME OBSERVATIONS ON THE CONTROL OF MEASLES EPIDEMICS

BY

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The opinion is often expressed that measles epidemics cannot be controlled. The basis for this view seems to be that isolation is generally useless because the harm is usually done before the diagnosis is made, and that school closure is neither practicable nor effective in suppressing an epidemic. Dr. Forbes, medical officer of health for Brighton, has recently suggested that the exclusion of home contacts attending infected schools might also be abandoned. In view of advances which have been made in our knowledge of the epidemiology of measles it seems worth while to ask ourselves how far epidemics could be modified, if it were so desired, by applying the knowledge we now have.

In an article¹ entitled "The mechanism of a measles epidemic," published in April of last year, I expressed the view that "the only hope of really preventing these epidemics altogether is through the immunity factor," and that "we must hope for either a simple method of inoculation which will produce a more or less permanent immunity, or else a simple method of rendering an attack abortive and harmless, such as the proposed method of inoculating contacts with their parent's blood, whilst at the same time allowing it to produce a permanent immunity." Considerable research has been done recently on the experimental production of passive immunity in children by the use of human convalescent serum, and this was well summarized in the recent Report of the Medical Officer of Health and School Medical Officer on the Measles Epidemic of 1929-30 (London County Council, 1931), and amplified by Dr. D. N. Nabarro and Dr. A. G. Signy in their paper in the *Journal*.² In

their series of 625 children treated with human serum before the fifth day after exposure to measles infection, only twelve developed measles, as compared with an expectation of several hundreds, and all the cases were mild in form. The passive immunity produced in this way lasts, we are told, two to four weeks. If the serum is injected on the sixth to the ninth day after exposure to infection partial protection is afforded, an attenuated attack resulting, which produces permanent active immunity.

SERO-PROTECTION IN RELATION TO EPIDEMICS

Provided that the serum is available, we now have a means, therefore, of protecting all home contacts to measles cases for upwards of a month, or, better still, of rendering them permanently immune by allowing them to have an attenuated attack. Moreover, we could, if so desired, suppress an epidemic in any school by treating all unprotected children with convalescent serum, but in this case scarcely any of the treated children would receive anything but a temporary passive immunity, and since an epidemic lasts several months the school would probably be again invaded by measles when this immunity had waned and before the infectiousness had declined to the normal level. There are, of course, practical difficulties in the way of any such operations on a large scale—in particular, the difficulty of obtaining sufficient serum and of overcoming prejudice against such a procedure—but it is by no means unlikely that these difficulties may be removed. It is not, therefore, merely a matter of academic interest to estimate what effect could be produced on a measles epidemic by giving certain groups of children a passive immunity at a certain phase of the epidemic.

The first question to ask is: What groups of children should be immunized in order to produce the maximal salutary effect? Some light is thrown upon this by the figures in Table I, which were obtained from an analysis of the card records of measles notifications in the metropolitan borough of Battersea during 1925-28. (This was

TABLE I

	Age of "Secondary Case"									Total
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	
Age of "primary case" { 0-1	—	—	2	3	1	2	—	—	—	8
1-2	—	2	3	3	3	1	—	—	—	12
2-3	8	9	—	3	6	3	1	—	—	30
3-4	9	17	14	1	4	6	3	1	—	55
4-5	3	26	30	12	2	5	4	3	5	90
5-6	20	37	38	34	28	5	7	3	4	176
6-7	5	15	9	21	16	8	2	1	5	82
7-8	2	4	—	5	1	1	2	—	3	18
8-9	1	1	2	4	—	3	2	—	2	15
Total ...	48	111	98	86	61	34	21	8	19	486

made possible by the courtesy of the medical officer of health, Dr. G. Quin Lennane.) The table shows the ages of 486 children under 9 years of age who contracted measles from another child in the same house, developing the rash ten to thirteen days later than the first child. These I have termed "secondary cases," and the age of the child from whom the disease was contracted, termed the "primary case," is also shown in each instance. It is readily seen from the table that the secondary cases are, on the whole, much younger than the primary cases; actually the mean age of the primaries is 5.3 years, and 60 per cent. are aged 5 or over, compared with 3.2 years and 17 per cent. for the secondaries.