

NEONATAL UMBILICUS AS A SOURCE OF STREPTOCOCCAL INFECTIONS IN A MATERNITY UNIT

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This is an account of an outbreak of streptococcal infection in a maternity ward where the immediate source of infection of a case of puerperal sepsis was in the ward nursery. While this does not seem to be uncommon, it has not received the attention which it perhaps deserves.

The Outbreak

The first incident was the development of pyrexia in a woman on the sixth day of her puerperium. This patient, Mrs. N., was admitted and delivered uneventfully on October 18 (D-day). She had a small vaginal tear which was stitched with catgut. Her puerperium was normal until D + 6, when she had a sudden rise of temperature to 103.2° F. (39.6° C.). Mother and infant were removed to the isolation ward and routine investigation and treatment begun. Culture of the mother's vaginal swab yielded a heavy growth of *Streptococcus pyogenes* type 9, and, in consequence, on D + 7 Mrs. N. and her baby were transferred to the isolation hospital, and the lying-in ward was closed. Nose and throat swabs were cultured from the ward staff, and vaginal, nose, and throat swabs from all patients, including a woman, Mrs. M., who had been delivered by forceps some ten hours previously. None showed *Str. pyogenes*.

There the matter might have rested but for two additional pieces of information. A midwife, who had been working on the ward for only a week, went on leave two days before Mrs. N. developed pyrexia, and was herself, while still at home, taken ill on D + 6 with acute tonsillitis, later shown to be due to *Str. pyogenes* type 9. Mrs. N.'s infant, swabbed at the isolation hospital on D + 8, showed the same organism in cultures from the throat and umbilicus. The infections in the mother and midwife, which both manifested themselves on the same day, suggested a common source, rather than one having been derived from the other, and the findings in the infant prompted investigation of the nursery from this point of view. Umbilical swabs were taken from all the 20 infants still in the nursery on D+9, and it was noted at the time that none showed any abnormality suggestive of infection. Nevertheless, five infants showed positive umbilical swabs, one being baby M., aged 3 days, who had been kept in the nursery until the third day in accordance with the hospital practice after forceps delivery. In addition, *Str. pyogenes* was isolated from the cots and cot blankets of two of four infected infants tested.

On D+10 the positive infants were segregated at one end of the nursery, where they were looked after by their mothers and by two nurses detailed for this sole duty. One of these mothers, Mrs. M., was found to have a broken-down episiotomy repair on D+13, when her stitches were removed. A swab taken the following day showed *Str. pyogenes* type 9.

In the meantime, in an effort to establish the source of N.'s infection—presumed to have occurred in the nursery—a list was made of the 24 infants discharged on and between October 14 and 27—that is, D - 4 to D + 9—and their own doctors were asked to visit the infants and swab the umbilicus, irrespective of its appearance. Of eight infants discharged before N. was born, seven were traced and swabbed, and one (G.) showed an umbilical infection with *Str. pyogenes* type 9. Of the 16 infants discharged on or after D-day all were traced and swabbed, and three (S., H., and J.) showed umbilical infections with the same streptococcus. It seems beyond reasonable doubt that these four infants, widely dispersed at the time of investigation, acquired their umbilical infection in the ward nursery—the one environment originally common to all.

Discussion

This investigation was shaped by two facts: the late onset of Mrs. N.'s symptoms, suggesting infection at some time after delivery; and the absence of *Str. pyogenes* in any attendant or contact other than her own infant.

The results of assuming that the source of infection must be looked for in the nursery have already been detailed. It remains to see what sequence of events can be deduced from them, and, in particular, whether answers can be found to questions about how and when infection entered the nursery, how it spread there, and how mothers and attendants became infected.

It can be seen from the diagram that the adult infections were accidents in what was primarily a series of infections in infants. There was never a time from the beginning of the earliest-known infection (G.) until the closure of the ward when the nursery was free from infection.

Nothing is known about how or when infection entered the nursery, but it seems reasonable to suppose that the most likely route was via an attendant who was in the early stages of an unrecognized infection. At its first toilet after birth the infant is given a bath, the cord is trimmed, if necessary, and retied, and is left without dressing to hang free over the top edge of the napkin. Thereafter it is cleaned only once daily, with spirit, but it must be fingered to some extent every time the napkin is changed, to ensure that it hangs out over the top edge of this garment. It is postulated that infection of the cord probably occurs from the infected hands of an attendant, in the first instance the source of infection being the attendant herself, and that once such infection has been established in one infant it is spread from infant to infant via the attendants' hands.

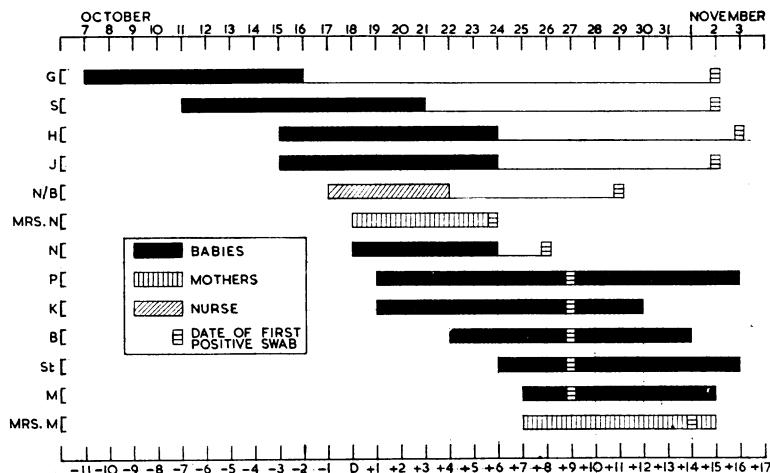


Diagram showing details of outbreak. The extent of the rectangle for any given person indicates the length of stay in the unit. For the babies and the nurse who were swabbed after leaving the unit the date of the first positive swab is joined to the appropriate rectangle by a baseline.

Proof of this hypothesis can only come by careful examination of all attendants with the most trifling "cold," and, if *Str. pyogenes* is found, of the infants who have been handled by such a person. The frequency of infant-to-infant infection must depend, initially, on the disinfection routine and the time available for its practice, and, secondly, on the number of infected infants. Details of the nursery routine are given below, but a point worth making here is that Colebrook and Maxted (1933) showed that fingers lightly infected with streptococci might sometimes be freed from infection by very thorough washing; that heavy infections might be greatly reduced but not abolished; but that with perfunctory washing for "20-30 seconds, followed by insertion in perchloride of mercury (1-1,000) or 'lysol' (1 in 320) for a similar period, more than 4,000 colonies of haemolytic streptococci could be grown from a single infected finger."

In this nursery masks, gloves, and antiseptics were not used, and it can be assumed that anything beyond a social wash would be quite impracticable at the times of greatest rush, when infants are being changed, two at a time on a slab, before being taken to their mothers for feeds. As the number of infected infants increases, the chances of further spread become increasingly great. Moreover, another source of infection becomes of increasing importance. *Str. pyogenes* can be recovered from the cots and cot-clothes of infected infants (and were found in this outbreak). These organisms become suspended in the air when blankets are shaken out while a cot is being made up, and inhalation of such infected dust is a possible source of respiratory infection in the attendant. This is the probable source of midwife B.'s infection, although hand-to-mouth infection cannot be ruled out.

Where such a focus exists a mother may acquire a vaginal infection in one of two ways; from the infected hands of an attendant coming to her straight from the nursery—especially apt to occur perhaps at night and at, or just after, delivery—or from her own hands infected from her own infant. Officially, mothers first dress their babies on the fifth day, but it has been found that they commonly unwrap their babies, more or less, when feeding them, and that they sometimes undress them more extensively to "see that everything is all right." Self-infection is thus possible virtually at any time after the infant becomes infected and the mother begins attending to her own toilet (second day).

Both the mothers infected in this outbreak are examples, we think, of self-infection. The case of Mrs. M. is of particular interest from this point of view because she was known to be negative 10 hours after delivery, and her infant was known to be infected when she first saw it on the third day. As she was then allowed to help in attending her baby, no doubt about the state of her episiotomy repair can have been entertained at that time.

Infections of the respiratory tract with or without symptoms, though not seen in patients in this outbreak, can, of course, arise in them as in the nursery staff, and such infections have been seen in other outbreaks. It must not be lost sight of that, if the conditions are such as to give rise to infections of the respiratory tract in adults, the infants may be exposed to a similar risk. This is mentioned because most umbilical infections are associated with little in the way of overt illness, and it may be that the graver manifestations of streptococcal infection, notably peritonitis, may follow infection at some site other than the umbilicus. We would like to suggest the possibility that infections of the upper respiratory tract may sometimes spread, via a tracheitis and mediastinitis, to the peritoneum. The most interesting problem remains that these umbilical infections with *Str. pyogenes* are probably almost as common as the cases of streptococcal puerperal sepsis, but in the past the infant's infection has gone unsuspected and untreated, and in only a very small number have serious infections developed. It seems that some other factors, not yet clearly established, are required to enable the organism to invade the body. At

all events, in the majority of cases, the organism seems to settle down at the umbilical site, its invasive properties being impeded by the normal physiological obliteration of the blood vessels in this area.

If this account represents an event of fairly common occurrence, what steps can be taken to prevent it? The paramount importance of excluding attendants in the infectious stages of a streptococcal infection is obvious, but the difficulty of doing this is not so widely appreciated. Firstly, it is not sufficiently recognized that a streptococcal infection may manifest itself as no more than "a touch of catarrh" or "just a slight cold." Secondly, the nursery is visited by an extraordinary diversity of persons who never come into contact with the adult patients, never appear on any official list of "contacts," and are seldom included in the search for a source of infection. As they may be non-resident and may come to the nursery from an out-patient clinic, for the express purpose of changing or bathing the babies, their importance as possible introducers of infection is obvious.

If exclusion of infection is difficult, so also is the problem of limiting its spread. In the nursery this is bound up with the limits imposed by time, and by the sensitivity of the skin of the hands to effective methods of disinfection. One point of considerable interest has arisen from a review of all the outbreaks of streptococcal umbilical infection known to us. Five separate nurseries widely dispersed over England and Wales have been involved, and in all of them a "no dressing" technique for the umbilical cord is at present in vogue. Also of interest is the observation that "sore groins" were commoner in babies with streptococcal infections than in those without. The numbers are far too small for us to do more than draw attention to this as a possible pointer to the existence of such infections when they are not suspected on other grounds.

Lastly, when a *Str. pyogenes* infection has arisen in a patient or a member of the staff, the nursery should be included in the routine examination for sources of infection. If it is not, as in the present outbreak, the reservoir of infection, the first spread of infection to it may be unmasked and further trouble avoided. How much, is perhaps exemplified in the outbreak at Queen Charlotte's Hospital described by Gibson and Calman (1953), and in that at the Central Middlesex Hospital described by Gray (1956).

Nursery Routine at the Time of the Outbreak

The nursery is very roomy and accommodates 20 cots. A sister is in charge of the nursery and of the adjacent premature-baby unit.

Masks and gloves are not worn in the nursery. Four pupil midwives carry out the daily toilet for the babies. This is done on two slabs covered by a mackintosh which is mopped with "ipcol" between babies. Before attending to the next baby the nurse washes her hands, but does not use antiseptics. When many babies require to be changed, two are placed on one slab at a time. Once daily their eyes and faces are cleaned with sterile cotton-wool soaked in running tap-water. The hair is rinsed in warm water. The ano-genital region is washed with soap and water. A fresh piece of lint with petroleum jelly and a clean napkin are applied.

After the cord has been ligated no dressing is applied to it. The cord is kept bare above the napkin and is treated daily with spirit.

Infants are bathed on the first, fifth, and tenth days. A bowl is used for the purpose which, at the time of the outbreak, was mopped out with 5% "ipcol." The infant is dried with a clean towel, a square of lint with petroleum jelly is applied to the buttocks, and then the baby is dressed with a clean napkin and clean garments.

On the fifth day the mother watches her baby being bathed, but dresses it herself. She bathes her baby under supervision on the tenth day.

Treatment

A note regarding treatment may be added. None of the babies swabbed on D + 9 showed signs of umbilical infection. Yet a few days later, when five of them were known to be infected, the umbilicus did not seem to be absolutely normal in four, and three of them had sore groins.

The umbilical infection was treated with sulphanilamide and proflavine locally and systemic penicillin therapy was instituted. In spite of this one baby (P.) did not feed well, vomited, had loose stools and sore buttocks, and failed to gain weight for eight days. Only when the umbilicus became dry and normal and the umbilical swab became negative (D + 15) did the child's condition improve. There is little doubt that this baby had a more widespread infection which eventually responded to sulphanilamide and high doses of penicillin. Such a baby might have died had the presence of the infection not been known and treated.

It is important to note that in five babies the umbilicus looked normal at a time when it was infected. Obvious clinical changes in the umbilicus are more likely when there is associated infection with other organisms in addition to *Str. pyogenes*. If treatment is required in such cases it is inadvisable to confine it to local applications; one has to keep in mind that the associated organisms may be potent penicillinase producers, inactivating locally applied penicillin and enabling *Str. pyogenes* to grow and invade the body (Jackson, Lowbury, and Topley, 1951; Rountree, 1955). In these cases local treatment should be combined with systemic penicillin.

Conclusions

The outbreak demonstrates the following points:

(1) In a maternity hospital the nursery was the source of infections due to *Str. pyogenes*. (2) Without investigating the nursery it would have been impossible to find a connecting link between the infected adults or to detect the source of their infection. (3) If the nursery had not been investigated it might not have been possible to control the outbreak of streptococcal infections.

We feel that this justifies a special plea for bacteriological investigation of the nursery whenever a case of streptococcal infection is found in a mother or a member of the staff.

We wish to thank the staff of the United Cambridge Hospitals for their kind co-operation at all times, and the numerous general practitioners who visited infants in their own homes to take umbilical swabs.

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Numbers 1 and 2 of the first volume of the *International Journal of Applied Radiation and Isotopes* have recently been issued in a single volume. This new journal is to be published by the Pergamon Press, London, at a subscription of £6 per volume or at £3 10s. for individual subscribers certifying that the journal is for their private use. Sir John Cockcroft explains its aims in an editorial: "It was evident at the recent International Conference on the Peaceful Uses of Atomic Energy that, in this as in other fields, much work had been duplicated in different parts of the world, through difficulties in keeping in touch with current developments. This journal is intended to provide a forum for the publication and discussion of these techniques, for the reporting of news of general interest in the field, and for the promotion of international co-operation." The editors are drawn from the U.S.A., U.S.S.R., Holland, France, and Great Britain.

HAEMOLYTIC STREPTOCOCCI ON THE NEONATAL UMBILICUS

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Outbreaks of haemolytic streptococcal infection continue to occur in maternity units and their control "is still a major issue in obstetrics" (Colebrook, 1946). It is often difficult to find the source of infection and to determine the precise method of its spread. The control is bound up with the general investigation of puerperal pyrexia. In the two units referred to in this paper the possibility of puerperal infection is considered whenever a patient shows a sustained temperature of over 99° F. (37.2° C.) or a raised pulse rate of over 90 a minute. This criterion of puerperal morbidity has been used in the Carmarthen Maternity Unit since 1943 and in the Llanelly Maternity Unit since its opening in 1946. Any patient showing these signs has nose, throat, and vaginal swabs taken and a catheter specimen of urine collected. The patient herself is isolated until the bacteriological examination of the specimens has been completed.

In the event of a group A haemolytic streptococcal (*Str. pyogenes*) infection being found the patient is generally removed from the unit. In an attempt to find the source of infection, further bacteriological investigations are then carried out by taking nose, throat, and vaginal swabs from all the patients, and nose and throat swabs from the medical, nursing, and domestic staff. Particular care is taken in the completeness of this investigation. Staff and patients are also questioned about the existence of infective lesions. Any carriers of *Str. pyogenes* are excluded from the unit and are not allowed to return until they are bacteriologically negative.

In our experience of outbreaks of puerperal infection *Str. pyogenes* is not always found in the swabs from medical, nursing, or domestic staff. Positive findings have, however, been fairly common in the vaginal and throat swabs of clinically normal patients. Others have had this experience with vaginal swabs in normal patients during outbreaks of infection (Cruikshank and Godber, 1939).

Two outbreaks of haemolytic streptococcal infection have occurred recently in Carmarthen and Llanelly. In addition to the routine just described, nose, throat, and umbilical swabs were taken from the infants. Rather surprisingly, a large number of infants were found to be carrying haemolytic streptococci on the umbilicus without showing signs of clinical illness. In several instances this carriage persisted for several weeks, even when the cord had dropped off and the umbilicus looked perfectly clean. It was an easy matter to collect umbilical swabs because a "no dressing" cord technique was in use in both units. The following is an account of the two outbreaks.

First Outbreak

In the Carmarthen Maternity Unit on September 23, 1954, two patients on the second day of the puerperium were found to have slight pyrexia and *Str. pyogenes* were isolated