

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

from the vagina. On the next day nose and throat swabs were collected from all the staff, and nose, throat, and vaginal swabs from the adult patients, in order to ascertain the source of infection. The infants were not swabbed. One patient was found to have a few *Str. pyogenes* organisms in her throat and she was isolated.

On September 27 one of the nurses went off sick with a severe streptococcal tonsillitis, and on the 30th the resident obstetrician to the maternity unit became acutely ill with pneumonia. The latter was treated with penicillin before bacteriological investigation could be carried out. On October 1 a second nurse developed tonsillitis and was treated with penicillin, and on October 3 one infant became severely ill and was treated with chlortetracycline.

On the evening of October 3 one of us (J. R. E. J.) discussed with a bacteriologist on holiday an outbreak of streptococcal puerperal infection in another part of the British Isles. It was learnt that during this outbreak two infants had died of streptococcal peritonitis. On the following morning the nursery in the Carmarthen Unit was given more than the usual attention; in addition to the infant on chlortetracycline treatment, two other infants had a mild pyrexia and yet another infant was vaguely "off colour." Umbilical swabs were collected from these four infants as well as nose and throat swabs. The notion of taking umbilical swabs was a direct result of hearing of the fatal cases of streptococcal peritonitis the previous evening. The inference was that streptococcal peritonitis might follow infection of the cord stump.

Bacteriological examination of the umbilical swabs yielded rather alarming results: three swabs grew a mixed growth of *Staph. aureus* and *Str. pyogenes*. The remaining swab taken from the infant on chlortetracycline grew a pure growth of *Proteus*. The nose and throat swabs were all found to be negative for haemolytic streptococci. On October 5 nose, throat, and umbilical swabs were collected from the remaining nine infants in the nursery, and three of the umbilical swabs were found to contain haemolytic streptococci; the nose and throat swabs were again all negative. The strains of *Str. pyogenes* isolated during this outbreak were not typed.

In order to eliminate infection from the maternity unit, it was closed for two weeks. The patients and infants were discharged after eight to ten days in hospital. All the six infants carrying *Str. pyogenes* on the umbilicus were treated with systemic penicillin for five days, but in spite of this treatment three were still carrying *Str. pyogenes* on the day of their discharge home.

The outbreak showed that *Str. pyogenes* could be carried on the umbilicus of infants without causing any clinical illness.

Second Outbreak

On November 23, 1954, a patient in Glasfryn Maternity Home, Llanelly, ran a slight temperature on the third day of her puerperium, and nose, throat, and vaginal swabs were examined. The last yielded a pure growth of *Str. pyogenes* type 12. As a special request umbilical swabs were obtained from all the nine infants in the nursery, in addition to the nose and throat swabs from staff and infants and the nose, throat, and vaginal swabs from the patients. The swabs were collected on November 24 and 25. In this unit the infants were in their nursery day and night, whereas in the Carmarthen Unit each healthy infant was placed in a cot at its mother's bedside during the day.

Rather surprisingly all nine infants in the nursery were carrying *Str. pyogenes* type 12 on the umbilicus, whereas all the nose, throat, and vaginal swabs from the adult patients failed to reveal the presence of *Str. pyogenes*.

As it was possible that some infants might have been discharged home carrying haemolytic streptococci, special arrangements were made for health visitors to collect umbilical swabs from those infants who had left the unit during the previous week. In this way a further five infants carrying *Str. pyogenes* type 12 on the umbilicus were found.

Duration of Carriage of Haemolytic Streptococci

It was considered important to find out how long haemolytic streptococci would survive on an infant's umbilicus. If carriage persisted for some time after discharge home there was a risk of infection to other members of the household and also to the midwife and health visitor in attendance.

In considering this, one of us (W. K.) made arrangements with the county health authorities for umbilical swabs to be taken at weekly intervals after the infants had been discharged home. In order to avoid clearance by antibiotic therapy, the infants were not given any treatment. Repeat swabs were collected until a single negative swab was obtained. The numbers still carrying haemolytic streptococci after specific numbers of weeks were:

No. of weeks post partum ..	0	1	2	3	4	5	6	7	8	9
No. of infants carrying H.S. ..	14	12	8	8	6	5	4	3	1	0

It will be seen that half the infants carried streptococci for three to five weeks but that carriage could continue for as long as eight weeks. Cullen (1916) has mentioned the persistence of granulation tissue after separation of the cord in the newborn. It is not surprising that a granulating surface like the umbilical stump has been shown to be yet another "chosen lair" (Phillips, 1938) of the haemolytic streptococcus.

The fact that an infant may harbour *Str. pyogenes* for as long as eight weeks after delivery is of public health importance. Anyone handling such an infant might easily become infected themselves.

Bacteriology of the Infant's Umbilicus

The bacteriology of the infant's umbilicus was investigated many years ago. Cullen (1916) stated that "the organisms most commonly found are the streptococcus, *Staphylococcus aureus* and *albus*, and *Bacillus coli*. Occasionally *Bacillus pyocyanea* has been noted." The presence of pathogenic staphylococci has been discussed recently (Edmunds *et al.*, 1955).

It has already been shown by us that haemolytic streptococci may be present on the umbilicus of an infant born in hospital. The next step was an investigation of infants born at home. This was carried out with the co-operation of the midwives of the Carmarthen County Council. Each midwife was asked to swab the umbilicus of the next infant she delivered when it was 4 days old. Each swab was taken by a different midwife in a different private home and cross-infection was practically impossible. The examination of 44 swabs revealed one with group B haemolytic streptococci, one with group C, and three with group D. In addition coagulase-positive *Staph. aureus* was found in a number of swabs and coliforms were not uncommon.

Subsequent to this investigation group A haemolytic streptococci were found on the umbilicus of an infant who was delivered at home. The infant was swabbed because its mother developed a puerperal pyrexia and was sent to hospital. Swabs from the mother were taken while she was in hospital and revealed haemolytic streptococci in the throat but not in the nose or vagina. These findings show clearly that the infant's umbilicus must be considered a potential site for the presence of pathogens both in hospital and in domiciliary practice.

Epidemiology

Several outbreaks of puerperal infection due to *Str. pyogenes* have been described in the literature in which there was some doubt about either the source or the exact method of spread of the infection (Cruickshank and Godber, 1939; Kenny and Barber, 1944; Knox and Marmion, 1945; Gibson and Calman, 1953). In such outbreaks the infant's umbilicus might have been a reservoir of infection.

In the Carmarthen and Llanelly Maternity Units the midwives carry out the infants' and mothers' toilet. A midwife who handles an infant with an infected umbilicus could

easily transfer *Str. pyogenes* to her hands and clothing. Herein lies the danger of transfer of infection either to a mother or to another infant.

Enough evidence was found in the outbreaks described above for a plea to be made to include swabbing of the umbilicus of the infant in any routine investigation of puerperal infection.

It cannot be stressed too often that swabbing should always precede treatment. In the first paper on the use of antibiotics in haemolytic streptococcal puerperal infection, James (1945) showed how quickly a vaginal swab became free from haemolytic streptococci when an infected patient was treated with penicillin. The whole pattern of an outbreak may be obscured by treatment. Antibiotic therapy need not be delayed more than the few minutes needed to carry out the swabbing. When the results are presented by the bacteriologist, the clinician may either confirm or modify his treatment. These same principles certainly apply to the swabbing of the neonatal umbilicus.

Neonatal Infection

The possibility of haemolytic streptococci playing a pathogenic role in the infant has not so far been considered. In our experience these organisms did not appear to give rise to any signs on the cord stump itself. Indeed, there is very little in contemporary obstetric literature describing clinical signs of any sort of infection of the cord stump. Older writers, however, made some comment on inflammation of the navel. Mauriceau (1683) mentioned inflammation and ulceration of the navel, and so does Jane Sharp (1725). James Hamilton (1813), in a section on diseases of infants in his father's textbook of obstetrics, described an "erysipelatous inflammation" which sometimes "begins at the belly." Trousseau (1844) described a disastrous outbreak of fatal erysipelas of the abdominal wall in newborn infants. In nearly every case the umbilical area was involved. Meynet (1857) described similar epidemics of both erysipelas and gangrene of the umbilicus in newborn infants. The last two disasters occurred in or near the decade 1850-60 which Colebrook (1955) has described as "perhaps the blackest period in all the story of hospital infection." Nowadays manifest umbilical sepsis in the newborn appears to be a rarity.

It seems possible that the haemolytic streptococci could gain access to the peritoneum via the umbilical cord and cause streptococcal peritonitis. This presumably does not often occur, because none of the 14 infants followed up during the second outbreak was clinically ill. However, one infant in the first outbreak who was acutely ill recovered after treatment with chlortetracycline. Swabs from this infant were unfortunately not taken before treatment was started. This infant may have been suffering from streptococcal peritonitis, but in the absence of laboratory examination it would have been very difficult to establish the diagnosis.

In a comprehensive review of peritonitis in the neonatal period Rickham (1955) states that peritonitis is a "not uncommon cause of disease and death in the neonatal period." He mentions streptococcal peritonitis as a blood-stream infection. Gubern Salisachs (1951), in discussing two cases of streptococcal peritonitis in the newborn, suggests the umbilicus as a portal of entry for the haemolytic streptococcus.

Cullen wrote in 1916 "that in every instance of illness in a newborn infant it should always be the rule to inspect and if necessary reinspect the navel." One might add that this inspection should include a bacteriological examination.

Summary and Conclusions

Two outbreaks of group A streptococcal infection in maternity units are described.

In each outbreak infants in the nursery were found to be carrying *Str. pyogenes* on the umbilicus.

Carriage of *Str. pyogenes* was found to continue up to eight weeks.

A general investigation into the bacteriology of the infant's umbilicus is described.

The umbilicus of the newborn infant might provide the means of spread of streptococcal infection to its own mother, to other mothers and infants in the same maternity unit, to midwives, and in domiciliary practice to members of the household.

Bacteriological examination of the umbilical swab may help to solve some epidemiological problems in puerperal sepsis.

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SURGERY OF PERSISTENT DUCTUS ARTERIOSUS*

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Since the first successful ligation of a persistent ductus arteriosus by Gross and Hubbard (1939) fired the imagination of surgeons to explore the new world of civilian cardiac surgery, there have been reservations and difference of medical opinion in regard to the treatment of individual cases. With the rapid development of safe surgery the practical issue became defined, for the hazard of conservative management was generally conceded to be greater than the risk of ligation or suture, and the frequent occurrence of the malformation required the formulation of a basic policy which need be altered only under special circumstances.

Present Series

The series surveyed, referred from all parts of New Zealand, with a population of two million people and catered for by a free medical specialist service, represents the experience of those entrusted with the major part of this work in the period under consideration. Of 155 cases of persistent ductus arteriosus examined at the Cardiosurgical Clinic in Auckland between 1948 and February, 1955, 138 received surgical treatment, the policy being to advise operation, when

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