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Staphylococcal infections following childbirth

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INTRODUCTION

A growing body of medical literature has been concerned with staphylococcal infection of mothers and their newly born infants. Much of this work has been done under the shadow of outbreaks of hospital infection due to *Staphylococcus aureus* phage-type 80, or other strains of more than usual virulence to mothers and infants. It is the purpose of this paper to report the state of affairs in a provincial hospital in the absence of an epidemic situation, to compare *Staph. aureus* infections in hospital with those in domiciliary midwifery practice in the same town, to assess the efficacy of hexachlorophane powder as a prophylactic, to investigate the public health importance of *Staph. aureus* strains carried from the hospital into the homes of newly born babies, and to see what epidemiological conclusions can be drawn from the facts observed.

MATERIALS AND METHODS

The maternity unit studied is part of the Royal Hampshire County Hospital, Winchester and consists of two separate maternity wards each with its own nursery and labour room; when need arises the labour rooms and a number of single-bedded rooms are used by either ward. Each ward is run by a separate medical staff headed by a consultant obstetrician; the day nursing staffs are entirely separate but there is a common night staff.

Both wards were observed for an initial period of nine months during which no changes in routine were made. During the next 6 months the routine in Ward 1 remained unchanged but every infant in Ward 2 was powdered all over with hexachlorophane powder as soon as possible after birth and each time the napkin was changed. The powder was used in the form of 'Ster-Zac' (Hough, Hoseason and Co.) which contains 0·33 % of hexachlorophane. This method was described by Gillespie, Simpson & Tozer (1958).

During the first 12 months of the hospital survey records of sepsis were also obtained from all cases of home delivery conducted by midwives within the Winchester municipal boundary.

Nose, throat and high vaginal swabs from all mothers were submitted on each admission to the wards. Umbilical swabs were taken from infants before discharge or on the day the cord separated. Septic lesions of mothers or infants were swabbed. Weekly nose and throat swabs were taken from all members of the staff.

In the cases delivered at home only swabs from septic lesions were submitted.

Dry cotton-wool swabs on wooden applicators were used in all cases and were cultured on horse-blood digest agar. Swabs from babies in Ward 2 during the hexachlorophane period were cultured on Tween-80 digest agar. Colonies of *Staph. aureus* were recognized by their appearance and the production of bound coagulase. Strains from lesions, mothers and staff were checked for free coagulase production and subsequently phage-typed by Dr G. J. G. King of the Bournemouth Public Health Laboratory. Umbilical strains were stored and many of them were subsequently phage-typed by me. The inclusion of some strains typed by Dr King among those I typed myself enabled me to ensure that my own typing results tallied with his.

Because it is known (Forfar, Balf, Elias-Jones & Edmunds, 1953) that many lesions due to hospital staphylococci do not appear until the patient has left the hospital an attempt was made to follow-up all mothers and infants for 28 days after delivery. This follow-up was planned by Dr Randall Martin, of the Hampshire County Health Department; each mother and infant was visited by a health visitor who reported on the occurrence or absence of sepsis in mother and baby and in other members of the household, and sent swabs to the laboratory from any lesions encountered. In 13 % of all live deliveries no sepsis had occurred in hospital but there was no follow-up after discharge. In a further 2·5 % there was a record of sepsis in hospital but no follow-up. A few cases of sepsis may have been missed, therefore, usually due to inability to trace the patients.

RESULTS

Sepsis during nine months control period in hospital

Details of septic lesions occurring in hospital patients are shown in Table 1.

It will be noted that 62·5 % of maternal sepsis, and 37·6 % of infant sepsis other than sticky eyes, became manifest only after mother and child had left the hospital, which was normally 10 days after delivery. Some mothers and premature babies stayed longer in hospital whilst others with no complications were transferred to peripheral hospitals a few days after delivery. It is evident that surveys of maternity hospital sepsis which include only lesions arising in the hospital seriously underestimate the amount of sepsis that occurs, and that a true estimate of sepsis can only be reached with the co-operation of the local health services.

Sepsis in domiciliary midwifery

During 12 months, 128 mothers were delivered of 128 live infants by midwives within the Winchester municipal boundary. In many cases the midwife was accompanied by a pupil midwife who had just completed three months work in the hospital maternity unit. These cases of home delivery were followed up for 28 days by Health Visitors in the same way as the hospital cases. The occurrence of sepsis after home delivery is set out in Table 1.

Table 1. *Septic lesions in mothers and infants delivered in hospital and at home*

	Mothers of infants born alive	Infants		Total with *Staph. aureus* excluding sticky eyes
	All lesions	Sticky eyes	Other lesions	
		Ward 1		
Number at risk	285	292		
Staph. aureus isolated	6 (2·1 %)	11 (3·8 %)	30 (10·3 %)	36
Not swabbed	2 (0·7 %)	2 (0·7 %)	2 (0·7 %)	(123 per 1000
Staph. aureus negative	2 (0·7 %)	25 (8·6 %)	8 (2·7 %)	live births)
Total septic	10 (3·5 %)	38 (13·0 %)	40 (13·7 %)	—
		Ward 2		
Number at risk	374	387		
Staph. aureus isolated	14 (3·7 %)	14 (3·6 %)	31 (8·0 %)	45
Not swabbed	8 (2·1 %)	4 (1·0 %)	6 (1·6 %)	(116 per 1000
Staph. aureus negative	8 (2·1 %)	28 (7·2 %)	8 (1·8 %)	live births)
Total septic	30 (8·8 %)	46 (11·9 %)	45 (11·6 %)	—
Total septic (both wards)	40 (6·1 %)	84 (12·4 %)	85 (12·5 %)	—
Amount of total sepsis which occurred after leaving hospital — no.	25	17	32	
Amount of total sepsis which occurred after leaving hospital — %	62·5 %	20·2 %	37·6 %	
		Home deliveries		
Number at risk	128	128		
Staph. aureus isolated	2 (1·6 %)	6 (4·7 %)	3 (2·3 %)	5
Not swabbed	—	1 (0·8 %)	1 (0·8 %)	(39 per 1000
Staph. aureus negative	—	4 (3·1 %)	1 (0·8 %)	live births)
Total septic	2 (1·6 %)	11 (8·6 %)	5 (3·9 %)	—

The effect of hexachlorophane powder

For the last 6 months the babies in Ward 2 were powdered with hexachlorophane powder whilst those in Ward 1 were not. The occurrence of sepsis is shown in Table 2.

It will be seen that in Ward 2 the incidence of *Staph. aureus* infected lesions fell from 116 to 34 per 1000 live births, sticky eyes being excluded for reasons to be discussed below. These figures could be regarded as complete confirmation of the results reported in Bristol by Simpson, Tozer & Gillespie (1960), and Corner, Crowther & Eades (1960), were it not for the curious fact that a comparable, albeit slightly smaller, reduction of sepsis occurred in the untreated control ward. It is probable that the reduction of sepsis in the control ward is evidence that it was not a true control. It was noticed that the use of hexachlorophane in Ward 2 was accompanied by a reduction in the number of pupil midwives becoming carriers of *Staph. aureus* after starting duty in the unit, and this may have resulted in a decrease in the numbers of *Staph. aureus* carried from one ward to the other by the common night staff. It is probably fairer to compare the incidence of sepsis in Ward 2 after and before the use of hexachlorophane, a comparison which shows the reduction of *Staph. aureus* sepsis to one-third of its former level, reaching a point where it can no longer be said that it is safer, from the point of view of the infection risk, for babies to be born at home.

Table 2. *Effect on sepsis of powdering infants with hexachlorophane*

	Mothers of infants born alive	Infants		Total with *Staph. aureus* excluding sticky eyes
	All lesions	Sticky eyes	Other lesions	
	Ward 1			
No hexachlorophane				
Number at risk	181	187		
Staph. aureus isolated	1 (0·6 %)	15 (8·0 %)	8 (4·3 %)	9
Not swabbed	1 (0·6 %)	3 (1·6 %)	—	(48 per 1000
Staph aureus negative	—	8 (4·3 %)	1 (0·5 %)	live births)
Total septic	2 (1·1 %)	26 (13·9 %)	9 (4·8 %)	—
	Ward 2			
Hexachlorophane powder used				
Number at risk	261	267		
Staph. aureus isolated	3 (1·1 %)	18 (6·7 %)	6 (2·2 %)	9
Not swabbed	2 (0·8 %)	—	1 (0·4 %)	(34 per 1000
Staph. aureus negative	—	22 (8·2 %)	—	live births)
Total septic	5 (1·9 %)	40 (15·0 %)	7 (2·6 %)	—

Influence of Caesarean section

Staph. aureus lesions of the mother were, as might be expected, more frequent after Caesarean (4·7 % of sixty-four women) than after normal delivery (1·9 % of 917 women); 14·1 % of Caesarean babies developed *Staph. aureus* lesions other than sticky eyes compared with 5·8 % of babies born normally. *Staph. aureus* was isolated from sticky eyes in 3·1 % of Caesarean babies and 5·0 % of babies born normally, this difference being insignificant. In forceps cases there was a slightly greater incidence of sepsis in both mothers and babies but the difference from the incidence after normal births was not statistically significant. The increased sepsis rate after Caesarean section makes direct comparison of hospital and domiciliary infection rates invalid, for only normal labours are conducted in the home.

Public health importance of Staph. aureus *carried out of a maternity hospital*

In 920 families which received a baby born in hospital but not treated with hexachlorophane there were five cases of suppurative infection in other members of the family during the first 28 days of the infant's life. The home deliveries were designed to be the control to this part of the investigation and they yielded two cases of suppurative infection (both in the same family) among 128 families. No infections occurred among the 267 families receiving a hexachlorophane treated baby.

Within twenty-eight days of delivery, therefore there was no significant difference between hospital and domiciliary deliveries in respect of other members of the family developing suppurative infections, and therefore no evidence that *Staph. aureus* strains carried out of hospital by newly born babies are an important public

health problem. Family infections due to this cause have been observed, however, and a longer period of observation might provide evidence leading to a different conclusion. If a hospital maternity unit suffers an epidemic due to a virulent phage-type of *Staph. aureus*, such as 80/81, family infections may become frequent as has been reported by Wentworth, Miller & Wentworth (1958).

DISCUSSION

'Sticky eye'

About half the swabs from infants with 'sticky eye' yielded no pathogenic bacteria. This observation is in accordance with previous reports of Parker & Kennedy (1949), Hutchison & Bowman (1957) and Gillespie *et al.* (1958). Hutchison & Bowman considered that there was serious doubt about the bacterial aetiology of 'sticky eye' in newly-born infants, and three observations made during the present work confirm that 'sticky eye' behaves quite differently from conditions known to be caused by bacteria.

Hexachlorophane powder had a striking effect upon *Staph. aureus* sepsis acquired by infants and transmitted to their mothers, but its use had no effect whatever upon the incidence of 'sticky eye' whether or not *Staph. aureus* was isolated from the swabs. Of course the antiseptic was not applied to the eyes, but the reduction of maternal infections (normally derived from infants) suggests that fewer *Staph. aureus* were harboured and transmitted by powdered infants and thus fewer of them infected their mothers; were 'sticky eye' a bacterial infection fewer powdered infants would have been expected to infect their own eyes, but the number of 'sticky eyes' remained unaffected by the treatment.

A second difference in behaviour between 'sticky eye' and proved bacterial infections was that *Staph. aureus* sepsis of mothers and infants was more frequent after Caesarean delivery than after normal delivery, whereas the incidence of 'sticky eye' showed no such difference. Hutchison & Bowman (1957) suggested that 'sticky eye' might result from contact with antiseptics applied to the mother's perineum before vaginal delivery; were this the case Caesarean section would be expected to protect against 'sticky eye', but in fact it does not appear to do so.

The third way in which 'sticky eye' differs from known bacterial infections is in the time of its onset. Eighty per cent of 'sticky eyes' occurred before discharge from hospital compared with 38 % of maternal sepsis and 62 % of infant sepsis.

It may be concluded that only a minority of 'sticky eyes' are of bacterial origin and that simple swabbing does not distinguish bacterial infections from other causes of the condition. Clinically 'sticky eye' is usually entirely trivial and easily treated by simple remedies, and it is probably wise not to undertake bacteriological examination unless the condition is clinically significant. The inclusion of *Staph. aureus* isolations from 'sticky eyes' in surveys of neonatal sepsis is misleading and makes the comparison of different series of published figures difficult.

Nurses as sources of infection

Since Parker & Kennedy (1949) observed that infants in maternity hospital nurseries could infect each other with *Staph. aureus* there has been a tendency to assume that the infant-to-infant route is the only important pathway of cross-infection in nurseries. Nurses are known to be the source of the infecting strains of *Staph. aureus* but are often believed only to be passive agents in their spread from infant to infant.

Were the infant-to-infant route the only important one in the spread of staphylococci in nurseries the problem should be easily solved by the abolition of nurseries and 'rooming-in' the infants with their mothers, but in practice the intensification of 'rooming-in' has little favourable effect on the sepsis rate (see Hill, Butler & Laver, 1959) despite lessened infant-to-infant contact. The importance of nurse-to-infant transmission of *Staph. aureus* was therefore examined bearing in mind that most infants are demonstrably infected within 48 hours of birth (Gillespie *et al.* 1958). The following incidents were observed:

(i) The arrival of a pupil-midwife carrying *Staph. aureus* phage-type 79 was followed by the development of septic lesions in five babies and a breast abscess in a mother due to this phage-type. The same girl was later attached to a district midwife and after two of the home deliveries which she attended the mothers developed sepsis due to *Staph. aureus* type 79.

(ii) *Staph. aureus* phage-type 42E was isolated from 'sticky eyes' in two babies born at home. A few days later the pupil midwife who had attended both deliveries reported sick with a boil due to the same organism.

(iii) On two occasions before beginning this survey the *Staph. aureus* strains isolated from a baby's eye and a mother's breast abscess were the same as those carried by the district midwives who had conducted the deliveries.

(iv) Sister A in the Winchester maternity unit was a permanent *Staph. aureus* carrier. In five months she was recorded in the unit's birth register as being concerned in thirteen deliveries and six of the babies were later found to carry her strain of *Staph. aureus*. During the same period only 6 out of 259 babies born without the recorded presence of Sister A afterwards carried her strain of *Staph. aureus*.

(v) A similar investigation was made of the activities of Sister B. Four out of twelve babies born in her recorded presence afterwards yielded the same phage-type of *Staph. aureus* as the one she carried. This type was isolated from only 7 out of 260 babies born in Sister B's absence.

It is concluded from these observations that babies are often contaminated at the time of birth by a *Staph. aureus* carrier present in the labour room. The same carrier may infect a series of infants in this way, and when they are swabbed at a later date and found all to be infected with the same phage-type of *Staph. aureus* a nursery epidemic may be wrongly suspected.

In practice it is likely that both infant-to-infant and nurse-to-infant cross-infections occur together and the importance of one route or the other depends on such circumstances as the presence of a person shedding *Staph. aureus* in the

labour room, the degree of overcrowding of the nursery, and the spreading capacity of different strains of *Staph. aureus*. The use of hexachlorophane probably cuts down infant-to-infant and infant-to-mother transmission of *Staph. aureus* to an unimportant level but it does not prevent colonization of the infant from the first source of *Staph. aureus* encountered.

Whilst agreeing with Elias-Jones, Gordon & Whittaker (1961) that communal nurseries should be abolished I do not believe that this step alone will control *Staph. aureus* infection unless the babies can be protected from *Staph. aureus* long enough to permit harmless bacteria to colonize their surfaces, umbilical stumps and noses and fill the 'bacteriological vacuum' which these carrier sites present. This protection must begin the moment the baby is born, and there is scope for further investigation as to whether the filling of the bacteriological vacuum on the newborn child should be artificially aided or left to chance contamination.

SUMMARY

An investigation is reported into sepsis due to *Staphylococcus aureus* in the maternity unit of a provincial hospital and in domiciliary midwifery in the same town.

In the hospital *Staph. aureus* infections of mother or infant occurred 123 times per 1000 live births in one ward and 116 per 1000 in another, but the use of hexachlorophane powder on the infants in one ward reduced the sepsis rate in that ward to 34 cases per 1000 live births, thus confirming the reports by two teams in Bristol hospitals. Sepsis was more frequent in both mothers and infants after Caesarean delivery than after normal labour. Reasons are given for thinking that 'sticky eyes' are usually not caused by the bacteria isolated when the eyes are swabbed.

The rate of infection in domiciliary cases was 39 per 1000 live births. As all these were normal deliveries the sepsis rate cannot be directly compared with that occurring among complicated cases in hospital.

No evidence was found that hospital *Staph. aureus* strains carried home by newly born infants were causing a significant amount of sepsis among their home contacts within 28 days of delivery.

The importance of nurses as sources of infecting strains of *Staph. aureus* in maternity work is discussed. The infant-to-infant route of transmission has been stressed in the literature but reasons are given for believing that nurse-to-infant infection in the labour room may also be important under certain circumstances.

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