of arteritis of the peripheral nerves in two cases. A diffuse arteritis may be the cause of the neuropathy.

The onset of peripheral neuropathy is of poor prognostic import in rheumatoid disease.

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SOME OBSERVATIONS ON THE AETIOLOGY OF BREAST ABSCESS IN THE PUERPERIUM

BY

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The purpose of this paper is to shed light on the ways in which breast abscesses arise in mothers who suckle their infants. The observations were made in a busy modern obstetric department throughout a period in which there was a rising incidence of infection with an unusually virulent type of staphylococcus (phage-type 80).

In 1957 an outbreak of breast abscesses occurred in epidemic form. Owing to the geographical position of Southampton all mothers who developed a breast abscess needing incision were seen either at the General Hospital or at the casualty department of the only other hospital in the city. These circumstances provided, therefore, an unusual opportunity to follow up infections which developed after mothers had been discharged from the maternity wards.

Much evidence has been produced of the early colonization with *Staphylococcus aureus* of babies born in maternity hospitals, and it has been shown that there is little correlation between the type of organisms found in the nares or vagina of mothers and in the nares of their infants (Barber *et al.*, 1953; Cook *et al.*, 1958). Reports have been made on the particular aspects of the mechanism of this colonization, and it was found that all full-term babies were colonized with staphylococci in the first few days of life unless protective measures were adopted (Hurst, 1957; Cook *et al.*, 1958). It appeared also that most infants acquired their staphylococci from the nursing staff or from other babies rather than from their mothers (Knott and Blaikley, 1944; Edmunds *et al.*, 1955).

Duncan and Walker (1942) noted that *Staph. aureus* of the same type was isolated both from the milk of nursing mothers and from the rectum and throat of their babies in a high percentage of cases. They suggested that staphylococci were deposited on the mothers' breasts by the babies' noses. Sensitivity tests showed that in most cases babies' noses and mothers' breasts bore like staphylococci.

Further evidence supporting this theory was provided by Cook *et al.* (1958). They investigated the acquisition of *Staph. aureus* by newborn babies and acquitted the mothers as a possible source of infection.

Duncan and Walker postulated a continuous process of infection from baby to baby via the ward environment and thence transference, through suckling, to the breasts of mothers. The staphylococcus then multiplied in the breast milk and was returned again to the baby, sometimes in massive doses though apparently of low pathogenicity. They also found that breast milk was infected after 24 hours of the puerperium but not before delivery. In the milk of the mothers of 28 stillborn infants who did not suckle there was a much smaller incidence of staphylococci. Thus there seemed to be a definite correlation between suckling and milk infection.

More evidence of the importance of the babies themselves as carriers was provided by Colbeck (1949), who investigated 160 cases of breast abscess in Winnipeg hospitals in 1949, taking nose and throat swabs from the babies. He stated that it is possible that infected nasal secretions may pass to the back of the throat and into the baby's mouth and so be regurgitated into the terminal mammary ducts during suckling. Infection of the mothers' nipples by babies' nasopharyngeal organisms is inevitable if breast-feeding is practised. No "breast toilet" can prevent this, and the customary nipple treatment is more likely to introduce a further infection to the mother and infant than to eliminate it. Colbeck thought that if a mother developed a breast abscess, breast-feeding should be stopped. He raised the possibility of lung abscess occurring in the infant through aspiration of infected milk.

Wysham *et al.* (1957) showed that the infants themselves were the major source and reservoir of pathogenic staphylococci. They reported their investigations on 117 mothers and their babies and postulated that staphylococci from babies' mouths may be aspirated into the mammary ducts during feeding when the negative pressure which is created within the ducts at suckling is released. They showed that staphylococci in the throats of babies could pass through the hole in a rubber teat and contaminate the contents of a bottle during normal feeding.

Present Investigation

This survey includes all cases of breast abscess known to have occurred after confinements in the maternity wards of one hospital during 1957. The term "breast abscess" is used to signify definite abscess formation which required surgical incision or discharged spontaneously.

The obstetric unit is situated in a separate building from the main hospital and was staffed solely by trained and student midwives, so that there was little possibility of cross-infection from general medical and surgical wards.

It was the practice in the maternity wards for normal babies to be nursed alongside their mothers. Premature babies and those born by abnormal delivery were removed from the labour ward or theatre straight to the nursery until they were considered fit to join their mothers. No babies were bathed during their time in hospital. There was an isolation department which was self-contained and was staffed by midwives who did not work either in the labour or the post-natal wards.

As soon as the presence of *Staph. aureus* phage-type 80 was discovered, whether it was being merely "carried" or whether it was causing frank infection, both mother and child were transferred to the isolation unit and barrier-nursed in cubicles.

Nose and throat swabs were taken from all midwives at least once weekly. Those who were found to be carriers of phage-type 80 organisms were excluded from the labour and post-natal wards. Chlorhexidine diacetate ("hibitane") cream was introduced into the hand-washing routine in all wards.

Incidence of Breast Abscess.—During the year 1957 there were 1,732 admissions to the maternity wards. As there was no other obstetric department in the area, which served a population of 200,000, beds were in constant demand both for booked cases and for the unduly large number of emergency admissions—240 (13.9% of total). During the year 37 mothers (2.1% of total admissions) developed breast abscess. Two of these were emergency admissions. Towards the end of 1956 there was an outbreak of salmonella infection in the obstetric department, and no admissions were permitted for seven weeks while thorough cleansing of the wards was undertaken. Patients were admitted again at the end of December, 1956. At first there was a low incidence of infection of mothers and babies, which increased steadily throughout the first six months of 1957. The number of abscesses developing in each month rose to a peak in July and then diminished.

Obstetric History.—Of the 37 patients in the series, 26 were primiparae and 11 multiparae. The average age of the mothers was 26.0 years (range 18–46 years). 90% of the mothers were delivered within 24 hours of admission, and the admission-delivery interval ranged from less than one day to three days. 29 patients had normal deliveries, three were delivered by caesarean section and one by forceps, and there were two sets of twins and two breech deliveries. One macerated foetus was born. There were five cases of post-partum haemorrhage, including two which needed manual removal of the placenta.

Suckling.—35 mothers suckled 37 babies. In only two patients who developed a breast abscess in this series was the baby not put to the breast. Of these, one patient developed a superficial breast abscess before delivery

and one was delivered of a macerated foetus and lactation was suppressed.

Type of Feeding on Discharge from Hospital.—19 mothers went home from hospital breast-feeding their babies, 2 used breast and complement, and 15 used artificial feeding. There is evidence, however (Tytten *et al.*, 1958), to show that many mothers who breast-feed infants in hospital change to artificial feeding soon after reaching home. Bottle-feeding was officially encouraged in approximately half of the patients in the last three months of 1957 because of the concern caused by the frequency of breast abscess in mothers who breast-fed their babies.

Length of Stay in Hospital After Delivery.—This varied from 2 to 32 days (Table I). The policy of early discharge from the hospital was determined by the great demand for the limited number of beds.

TABLE I

Days:	0-5	6-10	11-15	16-20	21-26	27-32
No. of mothers	1	22	9	3	0	2

Previous Feeding History.—The 11 multiparae had borne 13 children previously: nine of these had been satisfactorily breast-fed and four artificially fed. None had had previous breast abscesses.

Breast Disorders While in Hospital.—The great majority of patients (25) had developed no symptoms or signs of breast disorders before they were discharged home (apart from some transient engorgement in the early stages of lactation). Nine patients had cracked nipples (unilateral in six), three had acute mastitis with a cracked nipple, and three had acute mastitis without a cracked nipple. In all except three cases the mastitis resolved before the patient left hospital. Antibiotics were used in four cases (tetracycline or chloramphenicol). Breast abscess subsequently developed on the same side as that on which these earlier abnormalities had occurred. In 18 patients an abscess developed in the right breast, in 12 in the left breast, and 7 had bilateral breast abscesses.

Antibiotics Given After Discharge from Hospital (by general practitioners or casualty officers by way of treatment for breast abscesses before incision).—At least 32 of the 37 patients were given one form of antibiotic treatment. Penicillin was most commonly administered (in 13 cases), chloramphenicol in 8, tetracycline in 5, erythromycin in 4, streptomycin in 4, oxytetracycline in 2, and spiramycin in 1. Some patients were treated with various combinations of these drugs.

Interval Between Delivery of Mother and First Incision of Breast Abscess.—Table II shows that few abscesses developed while the mother was still in hos-

TABLE II.—Interval in Days Between Delivery and Incision of Abscess

Days:	0-7	8-14	15-21	22-28	29-35	36-42	>42
No. of abscesses	—	3	8	14	9	2	1

pital. 31 (85%) of the abscesses were incised between 15 and 35 days after delivery. One abscess was incised 60 days after delivery. The principles which governed treatment were simple. Nearly all patients had been treated with antibiotics before they were seen by the obstetric staff. The practice of early and adequate

incision and drainage was adopted without waiting for the signs of fluctuation. Some abscesses were multiple and loculated, and a few needed repeated incisions. Huntingford (1958) reports similar difficulties in dealing with breast abscesses caused by staph. phage-type 80 at Perivale Maternity Hospital.

Bacteriology

The organisms responsible for the breast abscesses in this series were all coagulase-positive staphylococci. The strains were as follows:

<i>Staph. aureus</i> penicillin-sensitive, not phage-type 80 ..	6 cases
" " penicillin-resistant, " " " " " " ..	3 cases
" " phage-type 80 " " " " " " ..	27 cases
" " sensitivity unknown " " " " " " ..	1 case

It became clear that there was an increasing incidence of infection with staph. 80 type organisms *pari passu* with the rising numbers of abscesses occurring in 1957 (see Fig.).

Chart showing increasing incidence of infection with the rising number of abscesses.

Staph. aureus phage-type 80 is an organism which first appeared in this country at some of the larger ports about six years ago, after severe outbreaks in Australasia and North America. It is a virulent strain which produces infection, often in the deeper tissues, giving rise to a protracted clinical course. It is characteristically resistant to penicillin and also to the tetracyclines, but is usually sensitive to chloramphenicol and erythromycin.

Bacteriology of Mothers' Nasal and Vaginal Swabs.—Swabs were taken from the nares and vagina of nearly all mothers on admission to the maternity department. None of the 37 mothers in this series was found to have coagulase-positive staphylococci in the vagina. In only one mother was the organism from a nasal swab of the same type as that grown from her breast abscess. This was a penicillin-sensitive *Staph. aureus*, and a similar organism was grown from a septic spot on the neck of her baby. Thus in only one case was there any correlation between the type of staphylococcus grown from the mother's nares and that isolated subsequently from her breast abscess.

Infants Admitted to the Nursery

Seven babies were admitted for a varying length of time to the nursery, for reasons given elsewhere. The

mothers of six of these babies developed breast abscesses of staph. 80 type. 29 babies were not admitted to the nursery, and were nursed in the post-natal wards alongside their mothers. The mothers of 21 of these babies developed breast abscesses of staph. 80 type.

Bacteriology of Mother's Abscess	Baby in Nursery	Baby Not in Nursery
Staph. 80	6	21
Not staph. 80	1	8

These figures are not of sufficient significance to suggest that there was an increase in the likelihood of a mother developing a staph. 80 breast abscess if her child was admitted to the nursery—that is, it was not thought that the nursery acted as a depot for staphylococcal infection.

Babies' Nasal Swabs

Swabs were taken from the babies' noses on delivery and twice weekly afterwards. It was decided not to take throat or umbilical swabs routinely. (Colbeck had frequently isolated staphylococci from nasal swabs when throat swabs taken at the same time were negative.)

In no cases were any pathogens present at birth. The vast majority of babies, however, were carrying staph. 80 in their nares by the fourth to fifth day. Some babies' nasal swabs were persistently negative despite their having pyoderma of staphylococcal origin.

Comparison of the type of organism grown from any one baby's nares with that cultured from his mother's breast abscess shows a striking correlation. This is readily seen in Table III, in which are recorded details of the organisms found in the mother's nose, the baby's nose or other septic focus, and the mother's abscess.

In Case 14 no nasal swab was taken from the baby, but the mother's breast abscess was of staph. 80 type and the baby was subsequently seriously ill with systemic staph. 80 infection (see below).

In Case 15 staph. 80 was not present in the baby's nose, but was isolated from a septic spot on its neck and subsequently from the mother's breast abscess.

In Cases 29 and 30 no nasal swabs were taken because of the laboratory holidays. Both mothers developed breast abscesses from which staph. 80 was cultured.

The total number of babies with *Staph. aureus* phage-type 80 in at least one nasal swab during 1957 was 334.

Neonatal Pyoderma

This includes septic spots caused by staphylococci; umbilical swabs from which staphylococci were cultured are excluded. Of the 14 babies who developed skin infections while they were still in hospital, 12 were shown to be due to staphylococci (all but one were staph. 80 type), including two cases of neonatal suppurative mastitis and one case of staphylococcal ophthalmia.

Sepsis in the Infants after Discharge from Hospital

Any serious illness in the babies in this series would have become known as a result of inquiries made at the post-natal clinics and at the Children's Hospital in the city. Only three cases were discovered—one trivial, one serious, and one fatal.

Case 36.—The baby developed an abscess on the buttock which was incised when the child was 4 weeks old. The mother's breast abscess was incised on the same day. Staph. 80 was grown from both abscesses.

TABLE III

Case No.	Onset of Abscess	Mother's Nasal Swab	Mother's Abscess	Baby's Nasal Swab	Other Septic Foci in Babies
1	January	Negative	Staph. not type 80 (S)	Negative	Nil
2	"	"	Staph. not type 80 (R)	"	"
3	March	"	Staph. not type 80 (S)	Staph. not type 80	"
4	April	"	" "	Staph. not type 80 (R)	"
5	"	"	" "	Negative	"
6	May	"	Staph. type 80	Staph. type 80	"
7	"	"	" "	" "	"
8	"	"	" "	" "	"
9	"	"	" "	" "	"
10	June	"	" "	" "	Spots staph. type 80
11	"	"	" "	" "	Nil
12	"	"	" "	Negative	" "
13	"	"	" "	Staph. type 80	"
14	"	Staph. not type 80	" "	Not done	Empyema staph. type 80
15	"	Negative	" "	Staph. not type 80	Spots staph. type 80
16	"	Staph. not type 80	Staph. not type 80 (S)	Negative	Spots not staph. type 80 (S)
17	"	Negative	Staph. not type 80	Nil	Nil. Stillborn
18	July	Staph. not type 80	Staph. type 80	Staph. type 80	Nil
19	"	"	" "	" "	"
20	"	Negative	" "	" "	"
21	"	"	" "	" "	"
22	"	"	" "	" "	"
23	"	"	" "	" "	Eye and breast staph. 80
24	"	"	" "	" "	Boil staph. type 80
25	"	Staph. not type 80	" "	" "	Nil
26	"	Negative	" "	" "	Spots staph. type 80
27	August	"	Staph. not type 80 (R)	Staph. not type 80	Nil
28	"	"	Staph. type 80	Staph. type 80	Spots staph. type 80
29	"	Not done	" "	Not done	Nil
30	"	"	" "	" "	"
31	"	Negative	" "	Staph. type 80	"
32	"	Not done	Staph. not type 80 (R)	Not done	Spots staph. type 80
33	September	Negative	Staph. type 80	Staph. type 80	Spots and breast type 80
34	October	"	" "	" "	Baby died aged 10 weeks of staphylococcal pneumonia
35	"	"	" "	" "	Nil
36	November	"	" "	" "	Spots staph. type 80
37	"	"	Staph. not type 80	Negative	Nil

(R) Resistant to penicillin. (S) Sensitive to penicillin.

Case 14.—This child was admitted to the Children's Hospital when 8 weeks old with a history of respiratory infection for three days. He had been breast-fed for two weeks. His mother had then developed a breast abscess from which staph. 80 was isolated. The child was found to have a right-lower-lobe pneumonia and subsequently developed a right-sided empyema from which staph. 80 was cultured. After treatment with tetracycline, erythromycin, streptomycin, and chloramphenicol the child made a slow but complete recovery during 10 weeks in hospital.

Case 34.—The baby was admitted in a moribund condition to the Children's Hospital when 10 weeks old with a history of chest infection for five days. She had been breast-fed for three weeks until her mother developed a breast abscess. The baby died within three hours of admission to hospital. Post-mortem examination showed extensive consolidation of the right lung with abscess formation. The lung was not cultured, but the histologist reported that the lung section showed large clumps of organisms resembling staphylococci. He concluded that the child died from a fulminating staphylococcal pneumonia, as would be compatible with staph. 80 infection.

Staph. 80 was isolated from the mother's abscess which had been incised on two occasions before the baby's illness began. The abscess needed prolonged treatment, and the mother was not discharged from hospital care until five months after the date of her confinement.

Nasal Carriage of *Staph. aureus* Among Staff of the Maternity Unit

During 1957, 25 members of the nursing staff and four of the domestic staff were found to be nasal carriers of *Staph. aureus* phage-type 80 on one or more occasions. 13 of these had only one positive swab, but one nursing sister had consistently positive swabs for 10 months and one staff midwife for 12 months. Known carriers were excluded from the labour wards, nurseries, and lying-in wards, but some were employed in the isolation ward.

Discussion

Several fortuitous circumstances were favourable to this investigation. The maternity unit had been closed for seven weeks at the end of 1956 to eliminate salmonella infection, and thorough cleansing had been carried out. The low incidence of staphylococcal infection in the early months of 1957 was followed by a rise in later months. At the same time the type of staphylococcus causing the infections changed from a less virulent strain (not phage-type 80, and in most cases penicillin-sensitive) to a high virulent strain (phage-type 80). It was possible, therefore, to follow the development of infection with these resistant organisms.

To control the epidemic staph. 80 carriers among the staff were rigidly excluded from the labour and post-natal wards: patients carrying the virulent strain and those frankly infected by it were promptly isolated. In the later months of the year breast-feeding was discouraged in a number of mothers, but the epidemic had by that time passed its peak, and the value of the introduction of artificial feeding as a means of preventing breast infection could not be assessed fully, though it was probably considerable.

In the epidemic of breast abscesses reviewed in this paper the correlation between colonization of the nares of newborn babies with a virulent strain of staphylococcus and the subsequent infection of the breasts of many of their mothers has been established.

Observations on our patients have shown once more that, whatever else is the cause of persistent staphylococcal infection in maternity wards, the mothers themselves are in no way responsible for the introduction or transmission of virulent strains of staphylococci.

Duncan and Walker (1942) considered that cracked nipples were not essential to the development of breast infection. In this series the presence of a cracked nipple had been recorded in the first week of the puerperium in nine patients who developed breast abscess (24% of the total). The cracked nipple in all cases was on the side which subsequently became infected. The significance of a cracked nipple may possibly lie in the interruption of normal feeding which it causes. Stasis of milk follows with congestion when the breast is not emptied. Attempted manual expression, if done inexpertly, may well aggravate the situation.

The risks of feeding a baby from a breast which is infected have not been taken seriously in some quarters, though Colbeck (1949) and Ravenholt *et al.* (1957) produced striking evidence of the dangers.

In our series one child died from staphylococcal pneumonia and one was seriously ill with an empyema.

When once an outbreak of breast abscess has occurred what measures can be taken to limit its spread? The wards in which the virulent staphylococci are found could be closed temporarily, but with the present demand for maternity beds this policy is not always justified in view of the frequent persistence of infection after such measures have been adopted.

If virulent organisms are grown from the babies' noses attempts could be made to treat this infection with local and systemic antibiotic therapy. However, this treatment would inevitably begin only after contact between a baby's nose and its mother's breast had occurred, unless antibiotics were given prophylactically. The problem of developing resistant strains would then arise.

A third suggestion is that breast-feeding should be stopped, or at least greatly reduced, when virulent staphylococci are abroad in a maternity department. This would appear eminently reasonable, since in a large majority of cases infection of the breast seems to be directly related to suckling and since it has been shown that many mothers stop breast-feeding soon after they are discharged from maternity hospitals.

Summary

An epidemic of 37 cases of staphylococcal breast abscess in the puerperium is described.

Details are given of many particulars concerning pregnancy, labour, and lactation in the mothers affected.

The factors associated with an increase in the incidence of breast abscess are noted, and the relationship is established between organisms isolated from the babies' noses and those subsequently isolated from maternal breast abscesses.

The chronic course of these infections and the danger of serious infection in the infant are stressed.

Possible methods of preventing the spread of such an epidemic are discussed, together with the problem involved in preventing colonization of newborn babies with virulent strains of staphylococci.

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AN OUTBREAK OF DIPHTHERIA EPIDEMIOLOGICAL ASPECTS

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A dozen years ago, when diphtheria was still prevalent, a small outbreak affecting barely 20 individuals would have merited but passing mention. That such an outbreak occurring to-day can occasion dismay is at once a tribute to the effectiveness of the prophylactic measures introduced during the last war and perpetuated since, and a challenge to any complacency which could lead to relaxation of vigilance. Whenever diphtheria has re-emerged in epidemic form in this country in recent years it has usually erupted with dramatic suddenness, affected a few persons in a small and closed community, and in two or three weeks disappeared almost as rapidly as it began. Nevertheless the consequences can be serious to a minority of those affected.

A local epidemic occurred in Barking, Essex, during September and October, 1958. On the morning of September 30, 1958, the health department was notified by a local isolation hospital that a diagnosis of diphtheria had been arrived at in the cases of two Barking infants' school children. The following details were obtained.

The First Cases

Case 1.—A boy of 7 years, fifth in a family of eight children, was taken ill with a sore throat on return from school on September 19. For four days he was treated at home with antibiotics but did not improve, and on September 24 was admitted to Chadwell Heath (Ilford Isolation) Hospital. Routine nose and throat swabs on admission revealed no pathogens. He appeared to be making satisfactory progress during the next few days, when, on September 29, he developed the signs and symptoms of a toxic myocarditis. The diagnosis of diphtheria was now made on clinical grounds in the absence of laboratory confirmation. This boy died on September 30.

Case 2.—A girl of 6 years, a close friend and class-mate of Case 1, and fourth in a family of seven children, complained of sore throat on September 25. She was seen by a doctor on the 27th, when a diagnosis of tonsillitis was made and antibiotic treatment started. Two days later she was admitted to hospital, where she was found to be gravely ill with membranous pharyngitis, "bull-neck," and cardiac involvement. Diphtheria was diagnosed immediately and antitoxin administered. Throat swabs were examined specifically for *Corynebacterium diphtheriae*, but none were found.

The school class in which these two cases occurred was one of four in a modern single-story infants' school attended by 127 pupils between 5 and 7 years of age. The children, for the most part, kept to their own classes but mixed together during playtime, assembly,