STAPHYLOCOCCUS AUREUS IN THE INFANT UPPER RESPIRATORY TRACT

I. OBSERVATIONS ON HOSPITAL-BORN BABIES

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(With 3 Figures in the Text)

INTRODUCTION

The upper respiratory mucosa of the newborn infant is highly susceptible to colonization by coagulase positive *Staphylococcus aureus*. Reports reviewed by Rountree & Barbour (1950) indicate that 90% or more of babies born in various hospitals of the world acquire large numbers of these organisms in their noses while they are in the nursery. In recent years these strains often have been found to be penicillin-resistant. This is not surprising in view of the frequency with which penicillin-resistant strains are now encountered in neonatal and maternity infections. Hospital nurseries are often heavily contaminated with them, as indicated by their presence in nursery air, dust, and bedding, as well as by their frequent carriage by nursery personnel (Rountree & Barbour, 1950; Barber, Wilson, Rippon & Williams, 1953).

It is not known how long newborn babies retain the hospital strains after discharge from hospital. Obviously, if they carry them very long they may contribute greatly to the reservoir of penicillin-resistant strains in the general non-hospital population. The studies of Cunliffe (1949) and Ludlam (1953) indicate that the hospital strains often are eventually lost, for they found that babies aged 6 months to 2 years have low nasal carrier rates. However, Ludlam found that six of thirteen strains isolated from hospital-born babies at the age of 5–12 months were penicillin-resistant, suggesting that nursery-acquired staphylococci sometimes persist. Colbeck (1949) reported that staphylococcal infection of the nursery phage type developed in families 10–15 months after the arrival of a new baby.

Consideration of the possible epidemiological importance of the newborn carrier suggested that this problem should be investigated more thoroughly, using phage typing as an aid to observing the carrier behaviour of individual babies.

METHODS

Clinical material. The newborn group observed consisted of 106 babies born in Paddington General Hospital between December 1952 and June 1953. Two to three nose and throat swabs were obtained from each baby, usually between the third

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and tenth day of life. No serious staphylococcal infections were noted among them although mild conjunctivitis, from which *Staph. aureus* could be cultivated, was common.

Seventy-two of these babies were not available for observation after they left hospital, but thirty-four were observed until they were 6 months to 1 year old. An additional three, born at St Mary's Hospital, were also placed under observation beginning with their third to fourth week of age. Nose and throat swabs were collected from these thirty-seven babies each time they reported to their local Child Welfare Centre, either at Marylebone Town Hall, or Lisson Grove. Usually they were first brought to the centres at about 1 month of age, then weekly for the first several months, fortnightly after the first 6 months, and once a month by the end of the year. Many of them discontinued regular visits after the first 6 months, so that the number of observations which could be made during the second 6 months of life was rather small.

Cultural technique. Pernasal swabs were taken by the insertion of a fine cotton-wool swab, wound on flexible wire, as far back as possible into the postnasal space. Ordinary swabs were used for the throat where, aided by a sterile tongue depressor and an electric torch, an effort was made to sample the entire faucial area. All swabs were inoculated immediately on to blood agar plates which were sent to the laboratory within a few hours.

The plates were incubated at 37° C. overnight, and then left at room temperature for 2–3 days before being examined. From each positive culture, one colony was transferred to Robertson's chopped meat medium and incubated overnight. Coagulase tests were performed by the Fisk tube method, using the supernatant broth of the Robertson medium. Strains which clotted the plasma within 2 hours incubation at 36° C. were defined as *Staphylococcus aureus*. They were stored in the Robertson medium at room temperature for several months until they could be phage typed and tested for penicillin sensitivity (May & Morely, 1952). Strains partially or completely inhibited by 0·25 units per millilitre of penicillin were recorded as sensitive.

Phage typing. Phage typing was performed only on the cultures obtained from the group reporting to the Child Welfare Centres. Their hospital cultures and about half of their later cultures, selected at random, were phage typed. Subsequently, additional cultures were typed if necessary to portray more completely the behaviour of babies carrying more than one type. Phage typing was done at the Staphylococcus Reference Laboratory (Colindale) according to the method of Williams & Rippon (1952). The phages used included: 3A, 3B, 3C, 6, 7, 29, 42D, 42E, 44, 47, 52, 52A, 53, 54, 55, 70, 73, 75, 77, 79. Staphylococci failing to lyse with the routine test dilution of these phases were then retested with the undiluted phages, and also with the following phage pools:

Routine test dilution		Undiluted
Pool *A*	31B, 52B, 42F, 47A	Pool *X*
Pool *B*	31, 44A, 51, 69, 71	
Pool *C*	57, 58, 75A, 75B, 78	Pool *Y*
Pool *D*	42B, 42C, 47B, 47C, 76	

For convenience in handling the large number of phage patterns encountered, a system of coding was adopted. Strains having phage patterns of the major groups I, II and III proposed by Williams & Rippon (1952) were divided into subgroups to which letters were assigned. Patterns which could not be assigned to any of the three groups, and which Williams & Rippon would call 'unclassifiable', were coded with the upper case letter N followed by a lower case letter. A few strains lysed by several phages of both I and III, and thus possibly intermediately related, were designated NX. The complete code system adopted was:

Ia	52A/79
Ib	52/52A
Ic	29/52
Id	29/52/52A/53/79
II	3C/55
IIIa	42D/42E/54/70
IIIb	7
IIIc	47/53/75/77
IIId	7/42D/70
IIIe	42C/47/57/75A
IIIf	42E/47/53/54/77
IIIg	7/47/53/54/73/75/77
IIIh	53/77/79 (usually undiluted phages only)
IIIi	42E/53/79
Na	31
Nb	44/52/52A/70 (undiluted)
Nc	29/77 (undiluted)
Nd	29/42D/44/54 (undiluted)
Ne	7/29/53/54/77, sometimes plus 42C, 42E, 52, 52A, or 79
Nf	47B/47C/57, sometimes plus 42B, 42E, 58 or 75
NX	multiple reactions suggesting relationship to both groups I and III, e.g. 29/42E/52/52A/53/54/79; 29/42D/42E/52A/53/79
UT	Untypable

RESULTS

Carrier rate of the newborns observed in hospital. Of the 106 newborn babies 99% acquired *Staph. aureus* by the time of discharge from hospital. The nose cultures contained large numbers of *Staph. aureus*, while the throat cultures often contained somewhat smaller numbers and were sometimes negative.

Carrier rate of the group observed at the welfare centres. The incidence of *Staph. aureus* among the thirty-seven babies followed at the centres is shown in Table 1. The increase in the nasal and throat carrier rate during the first 2 weeks was followed by a gradual decline (Fig. 1). Positive pernasal swabs fell to an average of 15% by the end of the year, while the percentage of positive throat swabs declined more slowly to an average of 55% (Fig. 2). Many of the babies continued to have positive throat cultures long after their nasal cultures had become negative.

Phage types. There were fourteen distinctly different phage types, in addition to untypable strains, among the hospital cultures obtained from the thirty-four babies born at Paddington Hospital. Their distribution is shown in Table 2. Members of Group I (74%), Group III (50%), and untypable strains (47%) were most common. The total percentage exceeds 100 because the hospital cultures obtained from an individual baby often contained more than one strain. For example, it was found that the nasal cultures obtained from a baby on its third day of life might contain a type Ia strain, the culture obtained on its seventh day might yield a IIIa strain, and the Ia strain might again be recovered from its culture taken on the tenth day. This implied either that the baby was carrying two strains simultaneously, only one of which was represented by the single colony

Table 1. *Age distribution of* Staphylococcus aureus *among thirty-seven babies*

Age in weeks	No. of swabs	Nose cultures		Throat cultures	
		Positive	%	Positive	%
½	21	17	81	9	43
1	31	30	97	26	84
1½	20	20	100	16	80
2	20	20	100	17	85
3	19	18	95	17	90
4	28	25	90	19	68
5	27	22	82	21	78
6	26	20	78	18	70
7	27	18	67	18	67
8	19	13	69	14	74
9	25	16	64	16	64
10	15	7	47	10	67
11	17	13	77	11	65
12	16	12	75	9	56
13	16	9	56	8	50
14	17	8	47	10	59
15	14	6	43	11	79
16	16	3	19	9	56
17	11	4	37	7	63
18	8	3	38	4	50
19	13	5	38	5	38
20	12	5		7	
21	7	2	24	4	60
22	10	1		5	
23	8	1		6	
24	7	2		2	
25	7	3	20	7	60
26	6	0		3	
27	5	0		3	
28	5	1		2	
29	3	0	7	2	53
30	5	0		4	
31	2	0		0	
32	3	0		2	
33	3	1	23	2	78
34	4	2		3	
35	3	0		3	
36	2	0		2	
37	2	0	13	1	75
38	2	1		1	
39	2	0		2	
40	0	0		0	
41	2	0		1	
42	2	0		1	
43	3	0		1	
44	2	0	0	1	50
45	0	0		0	
46	0	0		0	
47	0	0		0	
48	0	0		0	
49	1	0		1	

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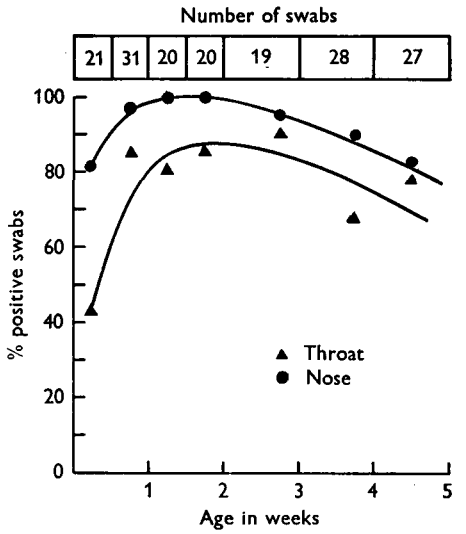

Fig. 1. Incidence of *Staphylococcus aureus* during the neonatal period.

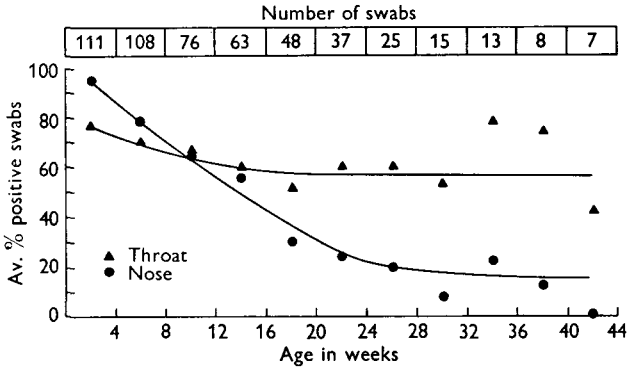

Fig. 2. Incidence of *Staphylococcus aureus* during the first year of life.

Table 2. *Distribution of phage types among thirty-four newborns*

Phage type	Number of carriers	%*
Ia	18	53
Ib	3	9
Ic	4	12
II	2	6
IIIa	9	27
IIIb	1	3
IIIc	1	3
IIId	1	3
IIIe	2	6
IIIf	1	3
IIIh	1	3
IIIi	1	3
Nb	1	3
NX	3	9
UT	16	47

* The total percentage exceeds 100 because many babies carried more than one type.

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selected from each culture, or that its staphylococcal population changed from day to day. To determine which was the case, five to nine colonies from each of two or three successive nasal cultures obtained from five babies were phage typed. The results (Table 3) indicated that a single culture could contain two strains in nearly equal ratio. In an additional culture from the same baby one of these strains might predominate.

Table 3. *Results of phage typing multiple colonies from nasal cultures obtained on different days*

Baby no.	Age in days	Number of colonies	Phage Type
121	7	3	Ia
		2	Ic
	10	3	Ia
		3	Ic
127	3	6	UT
	7	2	UT
		3	Ib
	13	5	Ib
129	5	5	Ic
	8	6	Ic
130	2	6	Ia
	5	5	Ia
		4	IIIh
133	3	5	UT
	6	2	UT
		4	Ia

To determine accurately the number of strains carried by a baby, a very large number of colonies would need to be typed from each culture. Unfortunately, this was impractical. However, it was found that when the single colonies selected from half or more of the sequential cultures of each baby were phage typed, a general index of its strains was obtained. An example of the manner in which an individual baby's carrier behaviour could be interpreted by this procedure is illustrated in Table 4. This baby acquired three penicillin-resistant strains, Ia, IIIe, and Nb while it was in hospital. Strain Ia is known to have persisted at least until the twenty-third week, IIIe until the seventeenth week, and Nb until the fourth week.

Penicillin sensitivity. The majority of strains recovered from the babies' hospital cultures were penicillin-resistant. Of the thirty-four Paddington Hospital babies who later reported to the Child Welfare Centres, only seven (20%) had penicillin-sensitive strains among their hospital cultures. However, six of the seven babies also had at least one penicillin-resistant strain in addition to the penicillin-sensitive one. When these six babies are added to the twenty-seven babies who had only penicillin-resistant strains, it is apparent that 97% of the total group of thirty-four left the hospital with a penicillin-resistant strain.

Carrier behaviour. Phage typing indicated that the babies frequently maintained

Table 4. *Carriage of* Staphylococcus aureus *by baby no.* 67

Age in weeks	Nose: No. of colonies	Nose: Phage type	Throat: No of colonies	Throat: Phage type
½	+ + +	IIIe	+ + +	Ia
1	+ + +	IIIe	+ +	Ia
1½	+	Nb	+	Ia
Left hospital				
2	+ + +	IIIe	+ + +	Ia
4	+ + +	Nb	+ + +	IIIe
8	+ + +	IIIe	+ +	IIIe
12	(Overgrown with *Proteus*)		+	Ia
17	+	IIIe	+	Ia
23	0	—	+ +	Ia

+ + + More than 50; + + 10 to 50; + less than 10; 0 culture negative.

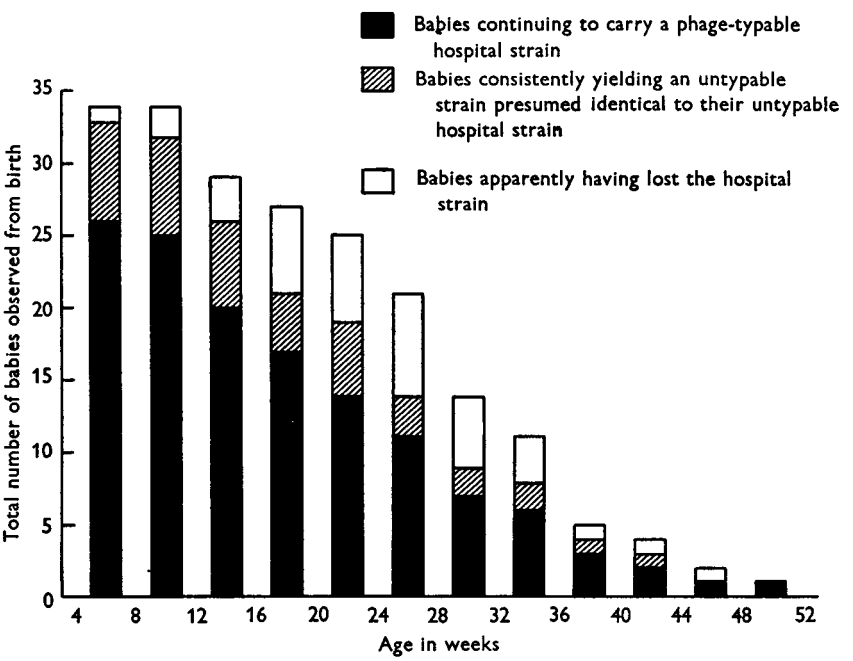

Fig. 3. Carriage of *Staphylococcus aureus* derived from the nursery.

their hospital strains of *Staph. aureus* for long periods, often throughout the observation period. The maximum length of time they were observed to carry a hospital strain is shown graphically in Fig. 3. Only one baby appeared to lose its hospital strain within the first month of age. Of the twenty-one babies remaining under observation at 24–28 weeks of age, eleven (53 %) still carried a typable hospital strain. An additional three (14 %) continued to yield an untypable strain just as they had while in hospital. If it is assumed that their untypable strain was identical throughout the successive cultures, it can be concluded that 67 % of

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the twenty-one babies were still carrying a hospital strain at approximately 6 months of age. Likewise at least one-half of the small number of babies available for observation during the last 6 months of their first year continued to harbour a hospital strain.

The record of the baby who was followed longest is shown in Table 5. This baby was observed to carry its penicillin-resistant hospital strain for 49 weeks. Only three of its cultures contained staphylococci which were not the hospital phage type. These staphylococci, in each instance, were untypable. The fact that they were penicillin-resistant suggests that they may have been derived from the hospital strain. Strains lysing with phages of the I a pattern are known sometimes to lose their phage susceptibility.

Table 5. *Carriage of* Staphylococcus aureus *by baby no.* 5

	Nose		Throat	
Age in weeks	No. of colonies	Phage type	No. of colonies	Phage type
1½	+ + +	I a	0	—
Left hospital				
3	+ + +	—	+ + +	I a
4	+ + +	—	0	—
5	0	—	+ +	I a
6	+ +	I a	0	—
7	+ + +	I a	0	—
8	+ + +	—	+	I a
9	+ + +	—	+ +	—
11	+ + +	I a	0	—
14	+ +	I a	+	I a
15	+	—	0	—
16	+	UT	+	UT
18	0	—	+	—
20	0	—	+	I a
22	0	—	+	—
23	0	—	+	I a
26	0	—	+	I a
27	0	—	+	—
28	0	—	+	—
29	0	—	+	I a
30	0	—	+	—
36	0	—	+	UT
39	0	—	+ +	I a
43	0	—	+ +	I a
49	0	—	+ + +	I a

The hospital strains were usually carried in the throat longer than in the noses of these babies. Often the hospital strain disappeared from the nose after a few months. Nasal cultures then remained negative thereafter, and no new strains were acquired in subsequent weeks. When the nasal cultures had become negative, throat cultures were often only intermittently positive and contained no more than a few colonies. However, phage typing always demonstrated these to be the original hospital strains. The record of baby no. 5, shown in Table 5, is representa-

tive of this tendency for hospital strains to persist in the throat for a longer period than in the nose.

It is conceivable that the babies whose throats alone continued to show positive cultures might have received these staphylococci from their mother's milk supply which they themselves could have infected earlier. Analysis of the feeding records, however, indicated that this could not explain the positive throat cultures which were associated with negative nasal cultures. The majority of the babies continued to be throat carriers long after they were fully weaned from the breast.

Thirteen of the babies yielded strains in their post-hospital cultures which were not found during hospitalization. However, since the new strains of nine had phage patterns similar to those common among the hospital cultures of other babies, it is probable that they were acquired in hospital, but overlooked in the random sampling of a single colony per culture. The strains which first appeared in the post-hospital cultures of the other four babies had phage patterns never found among hospital cultures, and therefore may have been derived from the home. In two of these babies the new strains seemed to replace the original hospital strains, but in the other two they were carried in addition to those of hospital origin. Transient strains, appearing in not more than one culture per baby, were relatively infrequent among the entire group. They occurred in the nasal cultures of ten babies and in the throat cultures of only two.

Individuality of the carrier state. It was striking that the babies often could be characterized by the staphylococcal strains they were carrying. There were seventeen distinct strains carried among the total of thirty-seven babies observed, and since 70 % of them carried at least two strains, the chance of more than one baby having the same set was not great. When the different phage patterns were considered together with penicillin sensitivity, it was found that twenty-five (68 %) of the babies could have been identified by the strains they carried. The single strains and strain combinations carried by the babies are shown in Table 6.

Twins, despite their intimate contact, did not entirely share the same strains. Two sets of twins (pair A and pair B) were observed; both pairs were of the same sex and believed to be single-ovum twins. The dissimilarity of their staphylococci was particularly clear in pair A (baby no. 80 and no. 81, Table 6). While one of them carried phage type I a and III a, the other carried only III a in all of its twenty-three positive cultures obtained during the 34 weeks of observation. The distinction between strains carried by pair B (baby no. 75 and no. 76, Table 6) was somewhat less clear. They seemed to share a strain lysing with the N f pattern. However, baby no. 75 carried an I a strain which lysed only with the undiluted phages of that pattern, whereas his brother's I a strain appeared dissimilar in that it always lysed with these phages in the routine test dilution. Also, baby no. 75 was characterized by frequent yielding of the N e strain in his cultures, whereas this strain seemed transient to his brother, from whom it was obtained only once. Baby no. 76 yielded untypable cultures on two occasions, while an untypable culture was isolated only once from baby no. 75.

Table 6. *Combinations of* Staphylococcus aureus *strains carried*

Baby no.	Number of strains: One	Two	Three	Four to six
5	—	Ia, UT	—	—
*6	—	UT, *UT*	—	—
*8	—	—	IIIa, UT, *UT*	—
9	—	IIIa, UT	—	—
*12	—	*II*, UT	—	—
*13	—	—	*II*, *IIIa*, UT	—
14	IIIa	—	—	—
16	—	IIIa, UT	—	—
19	UT	—	—	—
*23	—	Na, UT	—	—
*25	—	—	—	Ic, IIIa, *IIIb*, UT
*29	—	—	—	Ia, *Ib*, IIIa, NX, UT, *UT*
*38	—	Ia, IIIa	—	—
*40	—	—	—	*Ia*, *Ib*, IIId, *UT*
*50	—	*Ia*, UT	—	—
55	—	Ia, IIIa†	—	—
*67	—	—	Ia, IIIe, Nb†	—
*72	—	Ia, *Nc*	—	—
*75	—	—	Ia†, Ne, *Nf*	—
*76	—	—	Ia, *Nf*, UT	—
*78	—	—	—	Ia, IIIa, IIIc, NX
80	IIIa	—	—	—
81	—	Ia, IIIa	—	—
82	Ia	—	—	—
*83	IIIf	—	—	—
*84	Ic	—	—	—
*87	—	IIIi, *UT*	—	—
*89	—	Ia, IIIe	—	—
*92	—	—	Ia, *Ib*, IIIa	—
93	—	Ia, UT	—	—
*95	—	—	Ic, IIIg, UT	—
103	Ia	—	—	—
*109	IIIh	—	—	—
*118	—	—	Ib, UT, *UT*	—
125	UT	—	—	—
*131	Ib	—	—	—
*132	Ia†	—	—	—

* Babies carrying distinctive strain combinations.
† Lysis with undiluted phages only.
Penicillin-sensitive strains in italics.

DISCUSSION

The data indicate that the Paddington Hospital babies were fairly comparable to newborns of other hospitals reported in the literature (Rountree & Barbour, 1950), both in respect to their high carrier rate and to the high incidence of penicillin-resistant strains. The predominance of Group I and III phage types, as well as untypable strains was also to be expected. Members of these groups are known to be common in nurseries and hospital wards, and untypable strains frequently are

carried in the noses of healthy adults (Williams, Rippon & Dowsett, 1953; Rountree, 1953). Strains of the III a phage pattern seem not to have been encountered elsewhere, but information on phage type distribution is still very incomplete. Colonization by multiple strains, although unanticipated because it is not often observed among adult carriers, is not surprising. Newborns in a hospital nursery are exposed to many different strains of *Staph. aureus* in large numbers (Rountree & Barbour, 1950; Barber, Wilson, Rippon & Williams, 1953). Also, the initially sterile newborn mucosa perhaps favours the simultaneous establishment of more than one strain.

The declining nasal carrier rate with increase in age is in accord with the observations of Cunliffe (1949) and Ludlam (1953), but that the throat carrier rate should remain at a high level was completely unexpected. This tendency for retention of hospital staphylococci in the throat after disappearance from the nose was especially evident in the babies' individual carrier records. It is difficult to explain this phenomenon. The nasal staphylococci did not seem to have been replaced by bacteria of any other kind, nor can their disappearance readily be explained by humoural immunity. Staphylococcal antitoxin is at a very low level at this age (Bryce & Burnet, 1932).

It is apparent that the throat culture is a more accurate index of the staphylococcal carrying state in late infancy than is the nasal culture, even though false negative throat cultures sometimes may be obtained. Whether this is also true in early childhood needs to be investigated. The literature contains little information on the incidence of *Staph. aureus* in the throats of children, but Matthews, Atkinson, Saunsbury & Clegg (1949) reported 55·7 % of mouth washings from 194 school children aged 5–12 years to contain coagulase-positive staphylococci. According to the data of Cunliffe (1949) it is during this age period that the low nasal carrier rate of infancy again rises to the adult level. Comparison of phage types present in the noses and throats of individual children during this time might prove interesting, for conceivably the throat staphylococci are strains persistent since birth and the nasal strains more recently acquired.

The possible epidemiological significance of throat carriage during infancy and early childhood should not be minimized. Although many workers believe that *Staph. aureus* is disseminated primarily by nasal carriers, Dowling, Lepper & Jackson (1953) have found that adult patients carrying antibiotic resistant strains in their throats are most likely to distribute them to their household contacts. Throat carriage during infancy may have even greater importance, for babies commonly distribute their saliva more widely than adults.

It seems that babies remain potential distributors of the hospital's penicillin-resistant staphylococci much longer than do adult patients. According to Dowling, Lepper & Jackson (1955) only 31 % of adult patients carry penicillin-resistant strains for more than 7 weeks after their hospital discharge. This is in contrast to the babies observed here, of whom over 50 % carried their penicillin-resistant strains for 6 months or more. The difference may be due to the absence of competitive upper respiratory flora at the time the babies acquired their staphylococci. Staphylococci probably have a better chance to become permanently established

on the sterile mucosa of a newborn baby than on that of an adult, where other bacteria already exist in ecological balance. The fact that each of these babies maintained its own individual strains of staphylococci so consistently suggests that strains encountered neonatally, indeed, become a part of the normal residential flora.

The neonatal establishment of the hospital strains may account for the infrequent acquisition of new strains by these babies in later life. Certain observations by other workers suggest that staphylococci which have become resident may prevent new strains from becoming established. For example, Rountree & Barbour (1951) found that student nurses who already carried nasal staphylococci when they first went on ward duty were least likely to acquire penicillin-resistant hospital strains. Gould (1955) has observed that when new phage types of staphylococci appear on the nasal mucosa during antibiotic therapy they disappear with the return of the carrier's original phage type when the therapy is withdrawn. This may be cognate to the way in which intestinal organisms that appear during antibiotic therapy disappear when the normal flora returns upon cessation of treatment. The protective action which the normal body flora may exert in preventing the establishment of foreign micro-organisms is only just becoming appreciated.

If it is assumed that hospital staphylococci which colonize the upper respiratory tract at birth can be carried indefinitely, then carriers of antibiotic-resistant strains will become progressively more numerous among the general population. As yet, there is little information on carriers of antibiotic-resistant staphylococci among the non-hospital community, but Oswald, Reedy, Randall & Welch (1953), believed the literature to indicate no appreciable increase up to 1953. However, Rountree & Rheuben (1956) observed the incidence of penicillin-resistant staphylococci among blood donors to double between 1954 and 1955. Thirteen of 200 donors (6·5 %) swabbed in 1954 carried penicillin-resistant strains in their noses, whereas twenty-six (13 %) of 200 donors carried them in 1955. Fusillo, Roerig & Ernst (1954) reported 17·8 % of sixty-two blood donors to carry penicillin-resistant staphylococci in their throats. All of these observations apply only to the adult population. It is quite possible that children born in hospitals during recent years carry antibiotic-resistant strains with frequency even greater than the present generation of adults.

SUMMARY

Pernasal and throat swabs taken on 106 newborn babies showed that 99 % harboured coagulase-positive *Staph. aureus* by the time they left the hospital nursery. When the strains isolated from thirty-four of them were phage typed and tested for penicillin sensitivity, it was found that thirty-three (97 %) carried at least one penicillin-resistant strain. Phage typing of their subsequent cultures, taken as they became older, demonstrated that they retained these strains for very long periods. Of the twenty-one still under observation at 6 months of age, eleven (53 %) were carrying one or more of their original hospital strains, and an additional three (14 %) still were consistently yielding an untypable strain believed

to be identical to that acquired in hospital. Similarly, of those remaining under observation for the last 6 months of their first year, at least 50% continued to carry their hospital strains.

These babies frequently retained the hospital strains in their throats longer than in their noses. Although their nasal cultures often became negative after the first few months of life, the original hospital strains continued to be recovered from the throats. This would indicate that the throat culture is more accurate than the nasal culture in determining staphylococcal carriers among this age group. Antibiotic-resistant staphylococci in the infant throat may have considerable epidemiological significance, since babies tend to widely distribute their saliva.

The observations suggest that the staphylococci acquired at birth become a normal component of the upper respiratory flora, and may thus prevent new strains of staphylococci from becoming established later. This may explain why newborn babies retain the antibiotic-resistant staphylococci of the hospital much longer than do adult patients. Antibiotic-resistant strains among the general non-hospital population will be increased steadily by babies born in hospitals.

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