

Nasal staphylococci in children – a follow-up study

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SUMMARY

Nasal carriage of *Staphylococcus aureus* was studied in a cohort of infants born to the residents of two towns in South Wales. The children were followed up to the age of 5 years, nasal swabs being taken annually after a more detailed survey during the first year. The carriage-rate of *S. aureus* reached a minimum of 10–15% at one year and then rose steadily to 41% at five years. From the age of two years about 90% of the organisms isolated were resistant to penicillin. There was a marked tendency for children to carry the same strains from year to year, but carriage during the first year of life did not predict carriage at the age of five.

INTRODUCTION

In 1978 we published results of a survey of nasal staphylococci in 492 babies in two South Wales towns (Burr, Howells & Rees, 1978). The majority of these babies carried *Staphylococcus aureus* on their discharge from hospital and in most cases the organism was sensitive to penicillin. By the time the infants were a year old only 12% still carried nasal staphylococci, but the majority of these organisms were resistant to antibiotics. We have now followed up these children to their fifth birthday and present the findings here.

SUBJECTS

The subjects concerned were those described in our previous paper; they comprised all infants born in hospital between October 1975 and April 1976 to mothers who lived in Caerphilly and Barry. The children were visited annually by a nurse around the time of their birthdays. A swab was taken from both nostrils and delivered the same day to the laboratory.

Table 1. *Results of successive swabs*

	Years			
	2	3	4	5
Staphylococci				
None isolated	346	287	235	212
Sensitive	9	6	17	14
Resistant to penicillin only	49	78	111	125
Resistant to other antibiotics*	3	3	6	7
Totals	407	374	369	358
Percentage positive	15	23	36	41
Percentage resistant	85	93	87	90

* There were no staphylococci sensitive to penicillin and resistant to another antibiotic.

MATERIALS AND METHODS

Specimens were submitted on sterile broth-moistened swabs which were then cultured on blood agar plates aerobically and anaerobically. After overnight incubation at 37 °C a slide coagulase test was performed on any colonies resembling *S. aureus* and confirmation obtained by tube coagulase if necessary.

Sensitivity tests and phage typing were then carried out as described in our previous paper. As before, the antibiotics used were penicillin G, erythromycin, fusidic acid, clindamycin, methicillin, tetracycline, co-trimoxazole, gentamicin and neomycin.

RESULTS

The findings in boys and girls were very similar each year so they are shown combined. Table 1 shows the staphylococci isolated on successive occasions. The total number of infants declined over the period because many had moved out of the area. There was a steady rise in the proportion from whom *S. aureus* was obtained so that by 5 years 41 % of children were carrying the organism. Only a small minority of the staphylococci were sensitive to antibiotics on each occasion. Fig. 1 shows the percentage of children carrying *S. aureus* from birth to five years. In both areas the minimum prevalence was at one year of age.

Table 2 was constructed to test the hypothesis that the presence of *S. aureus* in the first few months of life predisposes to nasal carriage later. Only those 352 subjects who were swabbed at the start, at one year and at five years are shown here, and the findings at the start and at one year compared with those at five years. There was no significant difference between the observed figures and those expected on the basis of a chance association between the different occasions. When staphylococci were recovered on two occasions, the phage types were compared to see whether the organisms seemed to be of the same strain. Only 21 % of those present at the start and at 5 years, and 39 % of those present at one and five years, were the same strain. Untypable strains of *S. aureus* were assumed to be the same strain for this purpose.

Table 3 similarly compares the findings in 357 subjects swabbed at four and five

Table 2. Comparison of results from 353 subjects swabbed at start, at 12 months and at 5 years

	First swab: staphylococci		One year: staphylococci		Totals	
	not present	present	not present	present		
Five years						
Staphylococci present						
Observed	107*	36	23†	120	143	
(expected)	(99.9)	(43.1)	(17.5)	(125.5)		
No staphylococci present	139	70	20	189	209	
Observed	(146.1)	(62.9)	(25.5)	(183.5)		
Totals	246	106	43	309	352	

$\chi^2 = 2.82$ (1 D.F.), NS $\chi^2 = 3.32$ (1 D.F.), NS

* 23 of these (21%) were the same strain on both occasions.

† 9 of these (39%) were the same strain on both occasions.

Table 3. Comparison of results from 358 subjects swabbed at 4 years and 5 years

	Four years		Totals	
	Staphylococci present	No staphylococci present		
Five years				
Staphylococci present				
Observed	72*	74	146	
(expected)	(53.0)	(93.0)		
No staphylococci present	58	154	212	
Observed	(77.0)	(135.0)		
Totals	130	228	358	

$\chi^2 = 18.1$ (1 D.F.). $P < 0.001$.

* 43 of these (60%) were the same strain on each occasion.

years. Here there is a significant association between the presence or absence of *S. aureus* on the two occasions, and 60% of those recovered on both occasions were the same strain.

At five years the mothers were asked whether there had been any skin infections in the family during the previous month. No relationship was found between a history of septic skin lesions and the isolation of *S. aureus* from the subject.

DISCUSSION

Our previous paper shows that the prevalence of nasal *S. aureus* falls precipitously from 72% on discharge from maternity hospitals to 12% at one year. The present study continues these observations and shows that the prevalence at one year is

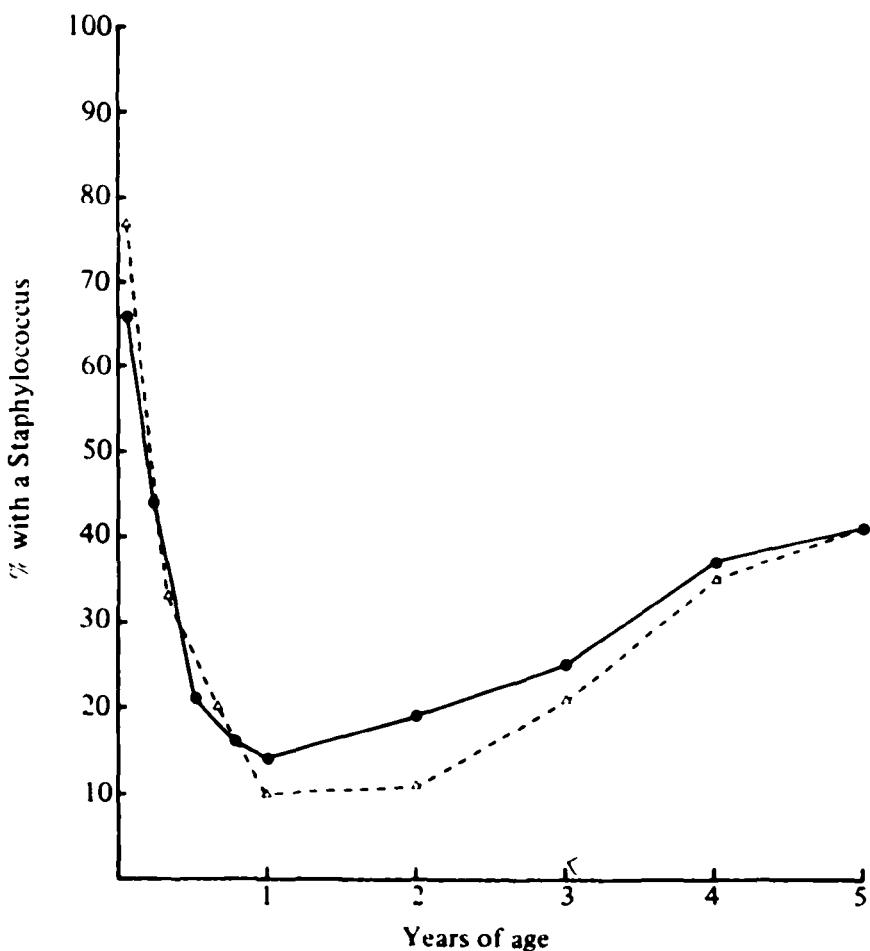


Fig. 1. Changes in carriage-rate of *S. aureus*. (●—●), Caerphilly children; (△---△), Barry children.

a minimum from which it rises slowly over the next four years, reaching 41 % in children aged five. The changes could not have been due to selective losses to follow-up in the non-carriers since the absolute numbers of carriers rose steadily as well as the proportions.

This pattern closely resembles that reported 20 years ago by Rycroft & Williams (1960) in a cross-sectional survey. They reported that 'the total staphylococcus carrier rate fell sharply in the first year of life and was lowest between about 6 months and 2 years; it subsequently rose and by the third or fourth year it was as high as is commonly found in adults'. Similarly Masters, Brumfitt & Mendez (1958) found that schoolchildren aged 5 years and over had a higher carriage-rate of staphylococci than children aged 1 to 4 years. Perhaps the rising prevalence over these years is a reflexion of increasing contact between children as they attend nurseries, play groups and school.

The carriage-rates reported in adults vary from one survey to another, but they all suggest that the prevalence of nasal staphylococci does not fall again to the levels found in one-year-olds. Thus the carriage-rate was found to be 47 % by Miles, Williams & Clayton-Cooper (1944) in Birmingham out-patients, 42 % by McDonald *et al.* (1960) in Royal Air Force recruits, and 25 % by St Leger *et al.* (1980) in patients admitted to a general surgical ward. For some unknown reason it seems that the noses of newborn infants are particularly favourable and those of one-year-olds particularly uncongenial to staphylococci.

The pattern of antibiotic resistance differs markedly from that reported in the past. Rycroft & Williams (1960) found the highest proportion of organisms resistant to penicillin (33 %) in hospital-born infants aged 0–6 months; in subsequent age-groups up to 5 years this proportion was always below 15 %. But in the present survey the situation was reversed – of the staphylococci recovered from newborn infants only 22 % were resistant to any antibiotic, whereas from 2 to 5 years this percentage was about 90 %. The two surveys are not wholly comparable, since that of Rycroft & Williams was cross-sectional and may contain a cohort effect, whereas this was longitudinal and may reflect changes occurring with time irrespective of age. The high proportion of resistant organisms now found in 2 to 5-year-olds may be a result of liberal antibiotic usage; treatment with penicillin clearly promoted the selection of resistant organisms in the first year of life (Burr *et al.* 1978), and presumably the same factor continues to operate throughout childhood. Obviously it would be wise to assume that staphylococcal infections in children are likely to be caused by penicillin-resistant organisms and to treat them with other antibiotics.

The results obtained at 5 years were compared with those from the same children when they were swabbed the first time and also at one year, since it has been suggested (Hurst, 1957) that 'babies who do not become carriers within the first two months of life are unlikely to do so later'. In fact there was little relationship between the results of the swabs taken during the first year of life and those at five years. But there was a strong association between the presence of staphylococci at four and at five years, and a majority of organisms present on both occasions were of the same strain. Thus children may become carriers with persistence of the same organism from one year to another.

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REFERENCES

- BURR, M. L., HOWELLS, C. H. L. & REES, P. W. J. (1978). Antibiotic resistant staphylococci acquired during the first year of life. *Journal of Hygiene* **81**, 125–130.
- HURST, V. (1957). *Staphylococcus aureus* in the infant upper respiratory tract. I. Observations on hospital-born babies. *Journal of Hygiene* **55**, 299–312.
- MASTERS, P. L., BRUMFITT, W. & MENDEZ, R. L. (1958). Bacterial flora of the upper respiratory tract in Paddington families 1952–4. *British Medical Journal* **i**, 1200–1205.
- MCDONALD, J. C., MILLER, D. L., JEVONS, P. & WILLIAMS, R. E. O. (1960). Nasal carriers of penicillin resistant staphylococci in recruits to the Royal Air Force. *Proceedings of the Royal Society of Medicine* **53**, 255–258.
- MILES, A. A., WILLIAMS, R. E. O. & CLAYTON-COOPER, B. (1944). The carriage of *Staphylococcus* (pyogenes) *aureus* in man and its relation to wound infection. *Journal of Pathology and Bacteriology* **56**, 513–524.
- RYCROFT, J. A. & WILLIAMS, R. E. O. (1960). Penicillin-resistant staphylococci in normal young children. *Proceedings of the Royal Society of Medicine* **53**, 258–260.
- ST LEGER, A. S., HOWELLS, C. H. L., CROSBY, D., MAHLER, M. & REES, P. W. J. (1980). Nasal carriage of *Staphylococcus aureus* among patients on a general surgical ward. *Journal of Hospital Infection* **1**, 333–339.