

A survey of nasal *Streptococcus pneumoniae* in children

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SUMMARY

Nasal swabs were taken from 369 four-year-old children in two South Wales towns and cultured for *Streptococcus pneumoniae*. The organism was isolated in 34 % of the specimens, similar rates being found in boys and girls in the two towns. The children were swabbed again a year later, when the prevalence of nasal pneumococci had fallen to 25 %. There was no association between the presence of the organism on the two occasions. Types 6 and 23 were most often isolated. After excluding children who had received an antibiotic, the proportion carrying a pneumococcus was higher in those who had recently had a respiratory infection than in the rest, although the difference was not quite statistically significant. There was a significant negative association between the presence of *Staphylococcus aureus* and *Strep. pneumoniae*.

INTRODUCTION

In several studies it has been shown that it is common for healthy children to harbour *Streptococcus pneumoniae* in their anterior nares. However, such studies (mainly in the United States) have been conducted in children attending out-patient departments and day-care centres, in children admitted to hospital, and in other special groups (Straker, Hill & Lovell, 1939; Dunlap & Harvey, 1956; Masters *et al.* 1958; Laurell, Tunevall & Wallmark, 1958; Box, Cleveland & Willard, 1961; Loda *et al.* 1975; Gray, Converse & Dillon, 1980). It is not known how the findings of these studies were affected by the ways in which the subjects were selected. There have been no surveys to date in Wales. A survey was therefore conducted to determine the carriage-rate in a cohort of four- to five-year-old children among the general population in two South Wales towns.

SUBJECTS

The participants comprised all children born in hospital between October 1975 and April 1976 to mothers resident in Barry and Caerphilly. Nasal swabs were taken on discharge from hospital and at intervals thereafter in order to study

Table 1. *Pneumococci isolated in two areas in successive years*

	Caerphilly	Barry	Totals
Aged four years			
No. swabbed	187	182	369
Pneumococcus present	64	60	124
Percentage	34	33	34
Aged five years			
No. swabbed	182	176	358
Pneumococcus present	45	43	88
Percentage	25	24	25

changes in the nasal carriage of *Staph. aureus*. Details of this survey have already been published (Burr, Howells & Rees, 1978). Laboratory examination of the relevant culture plates revealed the presence of *Strep. pneumoniae* in many of them.

The study reported here refers to the swabs obtained around the time of the fourth and the fifth birthday of each child. A nurse visited the children at home and took a swab from both nostrils of the subjects, using sterile broth-moistened swabs. At the fifth birthday visit a history was obtained of all illnesses affecting members of the household during the previous month and of the medical treatment (if any) that had been received.

METHODS AND MATERIALS

The sterile broth-moistened swabs were cultured aerobically and anaerobically on blood agar plates and incubated at 37 °C.

Colonies suspected of being *Strep. pneumoniae* were subcultured onto blood agar purity plates and streaked out. A 5 µg optochin disk (Mast Laboratories) was placed on the second quadrant of the streak, and incubated aerobically at 37 °C overnight.

Isolates which were sensitive to optochin (zone \geq 5 mm) were then tested for their solubility in bile. One drop of the 10% solution of sodium desoxycholate was dropped onto the suspect colonies. The plate was then incubated in an inverted position for 30 min at 37 °C before examination. The pneumococci were sent to the Streptococcus Reference Unit, Central Public Health Laboratory, Colindale, where the organisms were typed using sera obtained from the State Serum Institute, Copenhagen. Slide agglutination tests were employed first with the pooled sera and then with the individual sera composing the relevant pool. The Danish system of type numbers is used throughout the paper.

RESULTS

The carriage-rates in boys and girls were very similar, so the data are shown combined. In fact the figures were 59 of 184 boys (32%) and 65 of 185 girls (35%) on the first occasion, and 48 of 180 boys (27%) and 40 of 178 girls (22%) on the second occasion.

Table 2. Persistence of pneumococci in 358 subjects swabbed twice

Aged five years	Aged four years		Totals
	Pneumococcus present	Pneumococcus absent	
Pneumococcus present			
Observed	28*	60	88
(Expected)	(28.5)	(59.5)	
Pneumococcus absent			
Observed	88	182	270
(Expected)	(87.5)	(182.5)	
Totals	116	242	358

* Two of these had the same serotype on both occasions.

Table 1 shows the carriage-rates in the two areas on each occasion. The two towns have remarkably similar rates each time, with a lower prevalence in the second year.

Table 2 presents the results from those children who were swabbed both times, showing the relationship between the findings on the two occasions. The observed and expected figures are virtually identical, demonstrating that there was no tendency for a pneumococcus to occur twice in the same child beyond what would be expected by chance. In only two children was the same serotype isolated on both occasions, so that the organisms do not seem to persist for as long as twelve months.

The distribution of the serotypes found is listed in Table 3. Results from the two areas were similar, so they are shown combined. The commonest serotype was type 6 followed by type 23, and those two accounted for about half the organisms recovered on each occasion.

Table 4 was constructed to test the hypothesis that the presence of a pneumococcus would be associated with a recent history of respiratory infection in the subjects or their families. In fact there is little difference between carriage rates in those with and those without such a history.

The possibility was considered that antibiotic treatment could have eliminated pneumococci from the noses of patients who were treated for a respiratory infection. Table 5 shows the subjects who gave a history of a respiratory infection after removing those who had received an antibiotic for any reason. Those who had received an antibiotic had the lowest carriage-rate, and among the rest the children with a history of a respiratory infection had a higher carriage-rate than those without such a history: this difference just failed to achieve statistical significance. There was no association between serotype and a history of respiratory infection.

Table 6 shows the relationship between the presence of *Strep. pneumoniae* and *Staph. aureus* in the children's noses. On each occasion there was a significant negative association between the two organisms.

Table 3. *Numbers of pneumococcal serotypes isolated*

Serotype	Children aged four	Children aged five
1	1	1
3	4	1
6	35	29
10	2	6
11	15	2
14	13	1
15	2	5
16	0	1
17	3	2
18	1	2
19	10	8
20	0	1
21	1	2
22	4	0
23	21	15
31	0	1
33	1	2
34	0	2
35	1	2
38	1	1
CNV	10	4
Untypable	1	0
Totals	126*	88

* N.B. In two subjects two different serotypes were isolated on one occasion.

CNV, culture not viable; organisms identified as pneumococci which were non-viable on arrival at Central Public Health Laboratory.

Table 4. *Respiratory infections and presence of pneumococci*

	Pneumococcus present	Pneumococcus absent	Totals
Respiratory infection in subject	37 (24 %)	119 (76 %)	156 (100 %)
Respiratory infection in family but not subject	14 (29 %)	35 (71 %)	49 (100 %)
No respiratory infection	37 (24 %)	116 (76 %)	153 (100 %)

Table 5. *Antibiotic treatment, respiratory infections and pneumococci*

	Pneumococcus present	Pneumococcus absent	Totals
Antibiotic to subject	16 (17 %)	79 (83 %)	95 (100 %)
Respiratory infection in subject but no antibiotic	25 (36 %)	44 (44 %)	69 (100 %)
No antibiotic or respiratory infection	47 (24 %)	147 (76 %)	194 (100 %)

Table 6. Relationship between presence of pneumococci and staphylococci in children's noses

	Aged four years			Aged five years		
	Pneumo- coccus present	Pneumo- coccus absent	Totals	Pneumo- coccus present	Pneumo- coccus absent	Totals
Staphylococcus present (Expected)	34 (45)	100 (89)	134	25 (36)	121 (110)	146
Staphylococcus absent (Expected)	90 (79)	145 (156)	235	63 (52)	149 (160)	212
Totals	124	245	369	88	270	358
	$\chi^2 = 6.36$ (1 d.f.); $P < 0.05$.			$\chi^2 = 7.41$ (1 d.f.); $P < 0.01$.		

DISCUSSION

The fact that *Strep. pneumoniae* was isolated from the noses of healthy children was not in itself surprising. Studies in orphans (Straker, Hill & Lowell, 1939), new in-patients (Laurell *et al.* 1958), out-patients (Box, Cleveland & Willard, 1961), attenders at a development centre (Loda *et al.* 1975), and families selected in various ways (Dunlap & Harvey, 1956; Masters *et al.* 1958; Gray, Converse & Dillon, 1980) have shown that a high proportion of such children carry pneumococci at some time. However, all these studies were conducted in specially selected groups or volunteers, so that none of them can be assumed to represent the general population of children.

The only selective factor in the present study was that the infants were still living in the area at the age of four years. The group therefore does not include children who changed their area of residence but otherwise it can be regarded as representative of children of that age in the area. The similarity between the findings in Barry and Caerphilly is noteworthy.

It is difficult to make comparisons between these findings and those from previous studies because of differences in the age groups and the methodology. In general, the prevalence-rates of pneumococcal carriage (34% at age four, 25% at age five) were similar to figures previously reported. For example, Box *et al.* (1961) found nasal pneumococci in 28.5% of paediatric out-patients, while Harvey & Dunlap (1962) reported prevalence-rates between 30 and 40% in children aged four to five years.

The decline in prevalence from four to five years of age accords with other evidence of a fall during childhood (Masters *et al.* 1958; Harvey & Dunlap, 1962; Loda *et al.* 1975). The reason for this is unknown, and it is in contrast with the rising prevalence of nasal staphylococci during this period (Burr & Howells, 1982). There was a negative association between the two organisms in the noses of the children individually at both four and five years. There is some published evidence of a possible antagonistic action of *Staph. aureus* against other bacteria

(O'Grady & Wittstadt, 1963; Aly *et al.* 1970; Heczko *et al.* 1981). The present findings suggest that a similar action may exist against *Strep. pneumoniae*.

The serotypes most frequently isolated were types 6 and 23, accounting for about half the pneumococci. The finding is only partly in accordance with previous reports, in which type 19 has been as common as type 23 (Masters *et al.* 1958) or more common (Loda *et al.* 1975; Gray *et al.* 1980). The total lack of any association between pneumococcal carriage on the two occasions was most striking. Gray *et al.* (1980, 1981) took swabs at monthly intervals from a group of children and found the same strains to persist for several months, sometimes in association with blood antibodies. But in their subjects carriage seldom continued for as long as a year, and then mainly in early infancy. The present findings suggest that by the age of four years the organism does not persist for as long as twelve months.

No relationship was found between the presence of a pneumococcus and a recent history of respiratory infection, in contrast to the findings of Laurell *et al.* (1958). The lack of any association may have been due to eradication of the organism by antibiotics. When children who had received antibiotics were excluded, the carriage-rate of *Strep. pneumoniae* was somewhat higher amongst those with a recent respiratory infection than in the others.

It therefore seems that *Strep. pneumoniae* appears quite frequently in the noses of children, perhaps in association with respiratory tract infections. The organism does not persist for long and tends gradually to be replaced by *Staph. aureus*.

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