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Comparison of Nasal Swabs with Nose Blowing for Community-Based Pneumococcal Surveillance of Healthy Children▽

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The nasopharynx (NP) is the preferred site for detection of *Streptococcus pneumoniae* in young children, but NP sampling is not well tolerated. We compared nose blowing with paired nasal swabs. The sensitivity of nose blowing was 46% (95% confidence interval [CI] 38 to 56%), which increased to 94% (95% CI, 85 to 98%) for children with visible secretions.

In order to improve the comparability of pneumococcal carriage studies during the era of pneumococcal conjugate vaccine introduction, the World Health Organization (WHO) established a working group to define standardized methods (3). Wherever possible, evidence-based recommendations were made; however, explicit links to published data were not always possible. Comparisons of alternative methods for use in respiratory bacterial carriage studies are needed to improve the feasibility of such studies, particularly with children. The nasopharynx (NP) is the preferred site for detection of *Streptococcus pneumoniae* (1, 2) and is similar to the oropharynx for detection of *Haemophilus influenzae* in swabs from infants (1) or sick children (2). Some studies report increased detection of *H. influenzae* in the oropharynx compared to the NP of healthy children less than 24 months of age (2). NP aspiration is useful if detection of viral and bacterial pathogens is to be maximized (6) and is superior to a swab for *H. influenzae* (4), but these are not necessarily well tolerated by well children. We aimed to assess the feasibility of collecting nasal secretions from children who refused a nasal swab (NS) but agreed to blow their nose into a tissue. Results for pneumococci are reported.

Paired samples were collected at baseline during two community-based studies of respiratory bacterial pathogens: (i) a study of Aboriginal children 3 to 7 years of age and living in remote Aboriginal communities and (ii) a study of children less than 4 years of age attending urban child care centers in Darwin, Northern Territory, Australia. Eligibility criteria have been reported elsewhere (5). All children were well at the time of sampling. The NS method has been described previously (5). Briefly, swabs (cotton-tipped, aluminum-shafted swabs; Disposable Products) were inserted into the nose, preferably to a depth of about 3 cm for 5 seconds. Swabs that did not achieve this depth or duration were classified as poor quality. Swabs were transported, stored, and processed as previously described (5). Respiratory secretions were then collected by asking children to blow their nose, or by wiping the nose if the child could not blow, with a tissue held by the researcher (nose blowing [NB] method). The researcher removed two tissues from the box by holding the top two corners of the tissue and then folding the two in half together (for four layers of tissue) without touching any area but the corners or the back layer. The researcher then held the folded tissue over the child's nose and asked the child to blow. The tissue was examined, and dry tissues were discarded; otherwise, a cotton-tipped aluminum-shafted swab was used to collect material from the tissue and processed as for the NS. Between sampling the researchers' hands were washed with Hibitane (ICI Pharmaceuticals, Australia) and dried. Proportions were compared (by risk differences [RD] and 95% confidence intervals [CI]) using Intercooled Stata version 9.

Baseline NSs were collected from 89 healthy Aboriginal children who were being assessed for eligibility to be randomized into a clinical trial. Pneumococci were recovered from 93% (83/89) NSs. When NB was used 87% (77/89) of the children were positive (RD = −6.7% [95% CI, −16 to 2]; P = 0.213 compared to NS). The combined methods identified 94% (84/89) carriage-positive children (Table 1). Almost all children were able to blow their noses or produce visible secretions on the tissue; of these, 95% (77/81) of the children were positive (Table 2). For the primary analysis we used an intention-to-treat approach and assumed that children unable to blow their noses were carriage negative. Of the children unable to blow their noses or produce secretions, and thus giving a negative result for the NB method, 63% (5/8) were NS culture positive.

Baseline NSs were collected from 296 children (approximately 90% non-Aboriginal) attending child care centers in the

TABLE 1. Pneumococcal culture comparison of paired NS and NB collection methods for Aboriginal children aged 3 to 7 years living in remote Aboriginal communities

NB result	No. (%) with the following NS result[a]:		
	Positive	Negative	Total
Positive	76	1	77 (87)
Negative	7	5	12
Total	83 (93)	6	89

[a] Sensitivity, 76/83 = 92% (95% CI, 83 to 97%); specificity, 5/6 = 83% (95% CI, 36 to 100%).

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TABLE 2. Pneumococcal culture comparison of paired NS and NB collection methods for Aboriginal children aged 3 to 7 years living in remote Aboriginal communities and for whom NB or wiping produced visible secretions on a tissue

NB result	No. (%) with the following NS result[a]:		
	Positive	Negative	Total
Positive	76	1	77 (95)
Negative	2	2	4
Total	78 (96)	3	81

[a] Sensitivity, 76/78 = 97% (95% CI, 91 to 100%); specificity, 2/3 = 67% (95% CI, 9 to 99%).

TABLE 4. Pneumococcal culture comparison of paired NS and NB collection methods for children aged less than 4 years and attending urban child care centers and for whom NB or wiping produced visible secretions on a tissue

NB result	No. (%) with the following NS result[a]:		
	Positive	Negative	Total
Positive	59	3	62 (56)
Negative	4	45	49
Total	63 (57)	48	111

[a] Sensitivity, 59/63 = 94% (95% CI, 85 to 98%); specificity, 45/48 = 94% (95% CI, 83 to 99%).

city of Darwin. The pneumococcal carriage rate was 43% (127/296) according to the NS method. Swabs from 91% (269/296) of the children were good quality. When NB was used, 21% (62/296) were positive (RD = −22.0% [95%CI, −29.3 to −14.7]; $P = 0.0000$ compared to NS). The combined methods identified 44% (130/296) carriage-positive children (Table 3). Of 111 children who were able to blow their noses and produce visible secretions, 56% (62/111) were positive (Table 4). Of the 185 children unable to blow their noses, 35% (64/185) were NS culture positive.

For Aboriginal children, the sensitivity of NB was 92% (95% CI, 83 to 96%) and the specificity was 83% (95% CI, 36 to 99%). These values were 46% (95% CI, 38 to 56%) and 98% (95% CI, 95 to 100%), respectively, for children attending child care. The sensitivity of NB increased to 97% (95% CI, 91 to 100%) for Aboriginal children and to 94% (95% CI, 85 to 98%) for children attending child care if they had visible respiratory secretions.

We had previously found that children would tolerate insertion of an NS to about 3 cm for 5 seconds, whereas deeper insertion into the NP was vigorously opposed. Our study shows that collection by NB with a tissue may be an option for some children. A limitation of this study was that we chose to use NSs rather than NP swabs as the "gold standard." Inserting a swab deeper into the NP may have increased our ability to collect secretions and thus to detect pneumococci. We were unable to find any published studies that had addressed this option of specimen collection for bacterial carriage surveillance. Almost all studies fail to report swab quality, the number of children who refuse a swab, or the number of parents who refuse to enroll their child because of the swabs. If respiratory secretions could be obtained by NB into a tissue, pneumococcal recovery was almost identical to that with NSs (95% and 96%, respectively, for Aboriginal children and 56% and 57%, respectively, for children attending child care). For children from whom respiratory secretions cannot be obtained with a tissue, a proportion will be colonized with pneumococci (63% of Aboriginal children and 34% of children attending child care centers).

TABLE 3. Pneumococcal culture comparison of paired NS and NB collection methods for children aged less than 4 years and attending urban child care centers

NB result	No. (%) with the following NS result[a]:		
	Positive	Negative	Total
Positive	59	3	62 (21)
Negative	68	166	234
Total	127 (43)	169	296

[a] Sensitivity, 59/127 = 46% (95% CI, 38 to 56%); specificity, 166/169 = 98% (95% CI, 95 to 100%).

In conclusion, NB offers an alternative method of specimen collection in studies of pneumococcal carriage if nasal secretions can be detected. For children unable to produce visible secretions by NB, a proportion will be colonized and persistence with NS sampling is recommended.

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