Comparison of the Nasopharyngeal Swab and the Cough Plate in the Diagnosis of Whooping Cough and Hemophilus pertussis Carriers*

JOHN J. MILLER, JR., M.D., F.A.P.H.A., CHARLES W. LEACH, M.D., T. M. SAITO, AND J. B. HUMBER

Department of Pediatrics, Stanford University School of Medicine, San Francisco, Calif.

THE nasopharyngeal swab, which has been used in the past in the diagnosis of pneumonia and in the detection of meningococcus carriers, was adapted by Bradford, Slavin, and Brooks [1, 2] to the diagnosis of whooping cough. The value of this method has been confirmed by Anderson [3] and in a preliminary study by the present authors.[4] Recently Brooks, Bradford, and Berry [5] have reported their findings in a total of 438 nasopharyngeal cultures from 248 cases of pertussis. A somewhat smaller number of cough plate cultures were taken for comparison. Fifty-two per cent of the nasopharyngeal cultures were positive as compared to 37 per cent of the cough plate cultures. In infants under 3 years of age the difference in the results with the two procedures was most marked —32 per cent.

The following report amplifies our previous one and contains some data on the carriage of *Hemophilus pertussis* by familial contacts.

The nasopharyngeal applicator and the technic of insertion have been fully described.[1, 4] The Bordet-Gengou medium we employed was the same as previously reported [4] and differed from that of the Rochester workers in that 33 per cent horse blood was added instead of 15 per cent sheep blood. Fresh media were prepared every 2 weeks. It did not appear necessary to pour plates any more often. For both the cough plate and swab cultures, Petri dishes 3½ inches in diameter were used. At least two Petri dishes of medium were inoculated with each swab, and the cough plates were also usually taken in duplicate.

The cultures were obtained by many different physicians and nurses. In more experienced hands better results might be expected.

One or more duplicate tests with nasopharyngeal swabs and cough plates were made in 214 cases of whooping cough. A total of 342 comparative cultures were examined. The results are classified according to the duration of the disease in Table 1.

During the first week 74 cultures were taken. In 32 both plate and swab were positive, in 6 the plate only was positive, in 22 the swab only was positive, and in 14 both cultures were negative. Eighty-one per cent were thus positive by both or either means. It is therefore apparent that the cultural methods available for the diagnosis of pertussis in the catarrhal stage are relatively

TABLE 1

A Comparison of Results with Cough Plates and Nasopharyngeal Swabs in 342 Tests on 214 Cases in Which Both Cough Plate and Swab Were Used Classified According to Week of Disease

Week of Disease	Both Plate + Swab +	Plate + Swab −	Swab + Plate −	Both Plate − Swab −	Total	Per cent + by Swab	Per cent + by Plate	Per cent + by Both (or Either)
1st	32	6	22	14	74	73	51	81
2nd	30	10	22	24	86	60	47	72
3rd	14	8	14	36	72	39	31	50
4th	12	3	8	28	51	39	29	45
5th	1	1	7	19	28	29	7	32
6th	1	..	2	11	14	..	..	..
7th	..	1	..	11	12	..	..	..
8th	..	..	1	3	4	..	..	..
9th	..	..	..	1	1	..	..	..
Total	90	29	76	147	342	49	35	57

\+ Positive
− Negative

efficient. This is fortunate as of course the diagnosis can rarely be made clinically until the second or third week of coughing. As Table 1 shows, the cultural tests become less reliable as the cough persists. In every week, however, the percentage of positives obtained by swabs was higher than that obtained by cough plates. This superiority was more noticeable in the first week and after the fourth week.

The results obtained in comparative tests are classified according to the age of the patients in Table 2. As has been stressed [5] the nasopharyngeal swab was particularly useful in obtaining cultures from infants. Sixty-three per cent of tests on infants under 2 years of age were positive by swab as compared to 40 per cent positive by cough plate. Rather curiously in the group over 10 years of age the difference in the efficacy of the two procedures was also almost 20 per cent.

When the total number of cases observed is tabulated, rather than the total number of tests, the results of the procedures appear in better light. In Table 3 are listed the results obtained in 225 cases. Sixty-three per cent were positive by swab at some time in their course (though some were not tested until the second month of the disease). Forty-nine per cent were positive by cough plate. Both of these percentages are of course higher than those shown in Table 1—49 per cent and 35 per cent respectively. The necessity of

TABLE 2

A Comparison of Results with Cough Plates and Nasopharyngeal Swabs in 282 Duplicate Tests Taken during the First Four Weeks of Cough Classified According to Age of Patient*

Age Years	Both Plate + Swab +	Plate + Swab −	Swab + Plate −	Both Plate − Swab −	Total Number Tests	Per cent + by Swab	Per cent + by Plate	Per cent + by Both (or Either)
Birth to 2	28	5	24	25	82	63	40	70
2 to 4	22	8	12	27	69	49	43	61
4 to 6	17	7	9	22	55	47	44	60
6 to 10	19	4	14	18	55	60	42	67
Over 10	3	3	7	8	21	48	29	62

* The figure 282 is one less than the total (283) for the first four weeks shown in Table 1, because the age of the child furnishing one duplicate culture was unknown.

TABLE 3

Results of Bacteriological Examinations in 225 Cases of Pertussis

(Many of whom were tested repeatedly though not all or always by both procedures)

Tested by Swab			Tested by Cough Plate		
Number of Cases	*Number Positive*	*Per cent Positive*	*Number of Cases*	*Number Positive*	*Per cent Positive*
220	139	63	219	107	49

214 cases tested by both procedures
6 cases tested by swab only
5 cases tested by plate only

repeating negative tests is therefore apparent.

It should be mentioned that the diagnosis of " pertussis " in the cases which yielded negative cultures was made on clinical grounds—typical paroxysms with or without hyperlymphocytosis. There is no doubt that atypical cases were missed by the bacteriologic tests as well as typical ones. About one-fourth of the bacteriologically proven attacks were not typical clinically. The epidemiological importance of atypical attacks of whooping cough was recognized more than 35 years ago by Luttinger.[6] Kristensen [7] has described the attacks in 116 children with positive cough plates as being atypical in 40 (35 per cent).

The possibility that some of the bacteriologically negative cases we observed might have been para-pertussis should be mentioned. However, this is not very likely as we are familiar with the cultural characteristics of *Bacillus para-pertussis*.[8, 9] It grows faster and more luxuriantly on Bordet-Gengou medium than does *H. pertussis* and hence is less likely to be missed if it is considered.

During the course of this study, a period of 2½ years, 5 strains of *B. para-pertussis* were isolated. (The cases are not included in Tables 1–3.) Three of these strains were recovered within a period of 1 month from widely separated parts of San Francisco. Only 2 of the 5 strains came from children with typical clinical whooping cough. In 3 instances the coughing was less severe, of short duration, and not clinically diagnosed whooping cough. Both nasopharyngeal swabs and cough plates were positive in 2 cases, swabs only were positive in 2 cases, and only the plate positive in 1 case. No positive cultures were obtained after the 14th day of the attack (3 children had stopped coughing by then).

It is our impression that whereas *B. para-pertussis* infections are probably quite common in this community—40 per cent of 50 children with negative histories were found to carry specific agglutinins,[10] this organism probably causes only a small minority of the cases of typical whooping cough. That still other organisms may be occasionally responsible for this syndrome is likely. Brown described a typical case associated with *Bacillus bronchisepticus*,[11] apparently communicated from a rabbit with snuffles. Alexander [12] has noted that occasional cases of chronic bronchitis, difficult to distinguish from whooping cough, may be due to infections with *Hemophilus influenzae*. Furthermore, we have occasionally found almost pure cultures of this organism on nasopharyngeal swabs or cough plates. It is not possible to say whether these were cultures of the etiologic agent or of a secondary invader. We did not type the cultures. However, Sinclair [13] and Alexander [14] have conclusively shown that *H. influenzae* type B is a dangerous respiratory pathogen in infancy. In any evaluation

of the diagnostic procedures under discussion or of the prophylactic effectiveness of *H. pertussis* vaccine, the possibility that apparent failures are due to infections with other organisms than *H. pertussis* must always be borne in mind.

Fifteen familial contacts, without cough or hoarseness, were cultured during the course of this study. The results of these tests are shown in Table 4. Three were contacts to cases of para-pertussis and the remainder to cases of pertussis—all bacteriologically proven. Two were infant siblings of children with pertussis and were injected with immune pertussis sera with prophylactic intent. Neither infant developed a cough and 4 repeated swabs on each child yielded negative cultures. Of the remaining 10 uninjected familial contacts to pertussis, *H. pertussis* was isolated by induced cough or by swab from 3. One of these 3 carriers was incubating the disease as he began to cough 3 days later. Kristensen [7] has described 9 similar incubatory carriers, and Blatt and his coworkers [15] first described asymptomatic contact carriers.

This evidence complements the epidemiologic evidence that healthy carriers exist. Their importance in the epidemiology of pertussis, however, is uncertain. Our carriers were certainly transient carriers and, without cough, they probably disseminated but few organisms. To the writers it would seem that mild and atypical cases, particularly in adults, together with early undiagnosed cases, probably are more important.

TABLE 4

Asymptomatic Familial Contacts to Cases of Pertussis and Para-pertussis

				First Cultures		Repeated Cultures				
Name	*Age*	*Culture in Case*	*Relation to Case*	*Swab*	*Cough Plate* *	*Swab*	*Cough Plate* *	*Swab*	*Swab*	*Notes*
E.S.	4 w	H. pert.	Sibling	—	..	—	..	—	—	Received immune
K.D.	9 w	"	"	—	..	—	..	—	—	serum prophylaxis
R.L.	4 y	"	"	—	+	..	..	..	..	Dev. pertussis 3 days later
R.S.	14 y	"	"	—	+	—	—	..	..	Never coughed
B.	adult	"	mother	—	..	..	..	..	..	" "
W.	"	"	"	—	..	..	..	..	..	" "
Sa	"	"	"	—	..	..	..	..	..	" "
Mc	"	"	"	—	..	—	..	..	..	" "
K	"	"	"	+	..	—	+	—	..	" "
C	"	"	"	—	..	..	..	..	..	" "
H	"	"	"	—	..	..	..	..	..	" "
Hol	"	"	"	—	—	..	..	..	..	" "
D R	10 y	B. para.	sibling	—	..	..	..	..	..	" "
R	adult	"	mother	..	—	..	..	..	..	" "
L.S.	"	"	"	..	—	..	..	..	..	" "

* Coughs were induced by placing swab in nasopharynx
H. pert. = *H. pertussis*
B. para. = *B. para-pertussis*

Isolation of the typical cases, undiagnosed until paroxysms have appeared, is certainly of limited value. The more widespread use of bacteriologic procedures to identify early cases, atypical cases, and carriers is therefore advocated. Nasopharyngeal swab cultures, more practicable and more productive than cough plates, should be given a trial in public health laboratories.

SUMMARY

Three hundred and forty-two com-

parative tests with nasopharyngeal swab cultures and cough plates were made in 214 cases of whooping cough. In every week of the disease, and in each age group the swabs yielded a higher percentage of cultures positive for *H. pertussis* than did the cough plates. The use of both procedures however was superior to that of the swab alone. Five cases of para-pertussis were encountered during the course of the study. Three carriers of *H. pertussis* were found among 12 familial contacts to pertussis.

The nasopharyngeal swab technic can provide the publbic health officer with a relatively simple means of detecting early cases, atypical cases, and carriers of *H. pertussis*.

REFERENCES

1. Bradford, W. L., and Slavin, B. *Proc. Soc. Exper. Biol. & Med.*, 43:590, 1940.
2. Bradford, W. L., and Brooks, A. M. *Am. J. Dis. Child.*, 62:436, 1941.
3. Anderson, P. M. *M. J. Australia*, 11:224, 1941.
4. Saito, T. M., Miller, J. J., and Leach, C. W. *A.J.P.H.*, 32:471, 1942.
5. Brooks, A. M., Bradford, W. L., and Berry, G. P. *J.A.M.A.*, 120:883, 1942.
6. Luttinger, P. *Am. J. Dis. Child.*, 12:290, 1916.
7. Kristensen, B. *J.A.M.A.*, 101:204, 1933.
8. Eldering, G., and Kendrick, P. *J. Bact.*, 33:71, 1937, and 35:561, 1938.
9. Bradford, W. L., and Slavin, B. *A.J.P.H.*, 27:1277, 1937.
10. Miller, J. J., Saito, T. M., and Silverberg, R. J. *J. Pediat.*, 19:229, 1941.
11. Brown, J. H. *Bull. Johns Hopkins Hosp.*, 38:147, 1926.
12. Alexander, H. E. in Holt's *Diseases of Infancy and Childhood*, New York, 1940, p. 1115.
13. Sinclair, S. E. *J.A.M.A.*, 117:170, 1941.
14. Alexander, H. E., Ellis, C., and Leidy, G. *J. Pediat.*, 20:673, 1942.
15. Blatt, M. L., Levin, I. M., Dale, M., Mansowitz, D., and Kessler, H. *Am. J. Dis. Child.*, 46: 926, 1933.