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Identification of Respiratory Viruses in Adults: Nasopharyngeal versus Oropharyngeal Sampling▽

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The optimal method for identifying respiratory viruses in adults has not been established. The objective of the study was to compare the sensitivities of three sampling methods for this purpose. One thousand participants (mean age, 63.1 ± 17.8 years) were included. Of these, 550 were patients hospitalized for acute febrile lower respiratory tract infections and 450 were controls. Oropharyngeal swabs (OPS), nasopharyngeal swabs (NPS), and nasopharyngeal washings (NPW) were obtained from each participant and were tested for 12 respiratory viruses by a multiplex hydrolysis probes-based quantitative real-time reverse transcription-PCR. Patients were defined as positive for a specific virus if the virus was identified by at least one sampling method. In all, 251 viruses were identified in 244 participants. For the detection of any virus, the sensitivity rates for OPS, NPS, and NPW were 54.2%, 73.3%, and 84.9%, respectively (for OPS versus NPS and NPW, $P < 0.00001$; for NPS versus NPW, $P < 0.003$). Maximal sensitivity was obtained only with sampling by all three methods. The same gradation of sensitivity for the three sampling methods was found when influenza viruses, coronaviruses, and rhinoviruses were analyzed separately. The three sampling methods yielded equal sensitivity rates for respiratory syncytial virus. We conclude that nasopharyngeal sampling has a higher rate of sensitivity than oropharyngeal sampling and that the use of NPW has a higher rate of sensitivity than the use of NPS with a rigid cotton swab for the identification of respiratory viruses in adults. Sampling by all three methods is required for the maximal detection of respiratory viruses.

The oropharynx and the nasopharynx are the most common pathways for the introduction of airborne microorganism into the respiratory tract. For these reasons, several methods have been developed over recent decades for the identification of viruses that cause respiratory viral infections at these sites. Although these infections are common in all age groups, the vast majority of studies that have assessed and/or compared the various sampling methods have been conducted with individuals in the pediatric age group (9).

The paucity of this type of study with individuals in the adult population is striking in the light of data indicating that the same sampling methods have lower rates of sensitivity for adults than for children and adolescents (12, 13). Furthermore, different sampling methods can affect the results of laboratory testing. The prevailing view today is that the preferred laboratory technique for viral detection is the nucleic acid amplification test (9). Another important variable is the specific viruses that are compared using the different sampling methods. Most published studies have compared these methods for single viruses and only a minority have looked at all the common respiratory viruses (6, 14, 16).

To address these methodological problems, we designed a NAAT-based study with a large adult population with the aim of comparing the sensitivities of samples from the oropharynx and the nasopharynx for the identification of all respiratory viruses. We also aimed to compare the sensitivity of sampling of the nasopharynx with swabs to the sensitivity of sampling of washings for the same purpose.

MATERIALS AND METHODS

Study population. The study population comprised two groups of subjects: patients hospitalized with lower respiratory tract infections and controls. The recruitment of patients and controls was conducted over three winter periods, with the first being between 1 January 2004 and 31 March 2004, the second being between 1 November 2004 and 15 March 2005, and the third being between 1 November 2005 and 15 April 2006. The study was approved by the Helsinki Committee for Research on Human Beings of the Soroka Medical Center, and all participants gave signed informed consent to participate.

The patient groups included patients over 18 years of age who were hospitalized from the community in one of the internal medicine departments of the Soroka Medical Center and fulfilled the following three criteria over the week prior to hospitalization: (i) they had an acute febrile illness; (ii) they had a cough that appeared or worsened; and (iii) they had at least one of the following: appearance or worsening of shortness of breath, sputum production, wheezing, and chest pain or discomfort. None of the patients was recruited from a nursing home. In accordance with accepted criteria, the patients were subclassified into three groups: those with community-acquired pneumonia, those with nonpneumonic lower respiratory tract infection, and those with acute exacerbation of chronic obstructive pulmonary disease.

The control group comprised ambulatory patients over 18 years of age who came to one of the outpatient clinics of the Soroka Medical Center, agreed to participate in the study, and fulfilled the following two conditions: (i) by medical documentation and in response to a direct question, there was no evidence of a known chronic lung disease or a state of immunosuppression; and (ii) by response to a direct question, there was no evidence that in the month prior to inclusion the patient had had a febrile illness, a cough, a throat ache, hoarseness, or a running nose; had taken antibiotic medications; or was definitely or possibly pregnant (in the case of women). For each of the participants in both groups, we collected data concerning age, sex, smoking habits, and vaccination status.

Sampling. Three physicians who were specifically trained for the task took all the samples from the patients and the controls. For all hospitalized patients, the samples were taken as close as possible to the time of admission to the hospital

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TABLE 1. Primers and probes used in pentaplex real-time RT-PCR assays[a]

Tube	Viral set	Primers and probe sequence	Concn (nM)	Target gene	Reference or source
I	Influenza B virus	ATCGGATCCTCAACTCACTCTT	500	NS	
		TGACCAAATTGGGATAAGACTC	500		
		FAM/YAK-CTCGAATTGGCTTTGRATGTCCTTCAT-BBQ	**250**[b]		
I	Parainfluenza virus type 2	ATCCAATCGATACTCGGAGGT	250	N	
		TCTGGTTGTTTGGTTGTCCA	500		
		Cyan500-TGATGGTGAGGACAGAATTGACAAC-BBQ	**125**		
I	Parainfluenza virus type 3	AAGATCTACAAGTTGGCAYAGCAA	500	HN	
		AATGTCCCCATGGACATTCAT	500		
		ROX-TTCCTGGTCTTGATAGCACATTATGCCA-BBQ	**250**		
I	Rhinovirus	TGGACAGGGTGTGAAGAGC	500	5′ UTR	7
		CAAAGTAGTCGGTCCCATCC	500		
		FAM-TCCTCCGGCCCCTGAATG-BHQ1	**150**		
II	Influenza A virus	GGACCTCCACTTACTCCAAAACAGAAAC	100	NS	Modified from reference 15
		GTAAGGCTTGCATGAATGTTATTTGCTC	200		
		YAK-AA+GTTT+GAA+GARATMA+GAT+GGCT-BBQ	**50**		
II	hMPV	AACCGTGTACTAAGTGATGCACTC	500	Np	10
		CATTGTTTGACCGGCCCCATAA	500		
		FAM-CTTTGCCATACTCAATGAACAAACT-BBQ	**250**		
II	RSV	GCCAAAAAATTGTTTCCACAATA	250	L	Modified from reference 15
		TCTTCATCACCATACTTTTCTGTTA	500		
		ROX-TCAGTAGTAGACCATGTGAATTCCCTGCA-BBQ	**125**		
II	Adenovirus set I	ATGACTTTTGAGGTGGATCCCATGGA	100	H	
		GCCGAGAAGGGCGTGCGCAGGTA	100		
		Cyan500-AGCCCACCCTKC+T+T+TA+T-BBQ	**50**		
II	Adenovirus set II	GCCCCAGTGGTCTTACATGCACATC	100	H	8
		GCCACGGTGGGGTTTCTAAACTT	100		
		Cyan500-TCGGAGTACCTGAGCCCGGGTCTGGTGCA-BBQ	**50**		
III	Coronavirus HKU1	TTTTCAGATGGTCAAGGAGTTC	250	NP	
		CCGGCTGTGTCTATACCAATATCC	250		
		Cyan500-TCGGAGTACCCCCTTCTGAAGCAAAAG-BBQ	**125**		
III	Coronavirus NL63	ACGTACTTCTATTATGAAGCATGATATTAA	1,000	POL	7
		AGCAGATCTAATGTTATACTTAAAACTACG	1,000		
		YAK-ATTGCCAAGGCTCCTAAACGTACAGGTGTT-BHQ1	**300**		
III	Coronavirus 229E	CAGTCAAATGGGCTGATGCA	1,000	Np	7
		AAAGGGCTATAAAGAGAATAAGGTATTCT	1,000		
		FAM-CCCTGACGACCACGTTGTGGTTCA-BHQ1	**300**		
III	Coronavirus OC43	CGATGAGGCTATTCCGACTAGGT	125	N	7
		CCTTCCTGAGCCTTCAATATAGTAACC	1,000		
		ROX-TCCGCCTGGCACGGTACTCCCT-BHQ2	**300**		
	Human endogenous retrovirus ERV3 (IC)	CATGGGAAGCAAGGGAACTAATG	233	Human ERV3	Modified from reference 15
		CCCAGCGAGCAATACAGAATTT	233		
		Cy5-TCTTCCCTCGAACCTGCACCATCAAT-BBQ	**116**		

[a] Symbols and abbreviations: +, locked nucleic acid addition; HN, hemagglutinin-neuraminidase; NS, nonstructural protein; UTR, untranslated region; H, hexon protein; N, nucleocapsid protein; Np, nucleocapsid phosphoprotein; POL, RNA polymerase; IC, internal control; FAM, 6-carboxyfluorescein; YAK, Yakima; BBQ, BlackBerry Quencher; ROX, carboxy-X-rhodamine; BHQ1, Black Hole Quencher 1; BHQ2, Black Hole Quencher 2.

[b] Boldface values indicate hydrolysis probes.

and in no case more than 24 h later. Three consecutive samples were taken from each participant in the following order: oropharyngeal swab (OPS), nasopharyngeal swab (NPS), and nasopharyngeal washing (NPW). The OPS was taken under direct observation of the posterior throat and tonsil area by using a commercial rigid cotton-tipped swab applicator (Virocult, green cap, MW950; Medical Wire & Equipment Co. [Bath] Ltd., Corsham, Wiltshire, England). The NPS was taken by using the same type of rigid swab applicator, which was introduced directly into the depth of the inferior meatus of one of the nostrils until resistance was felt. After the samples were obtained, both swab applicators were cut and placed separately into two tubes containing RPMI solution (Biological Industries, Beit Haaemek, Israel). The NPW was obtained by instilling 2.5 ml of a sterile physiological saline solution into one of the patient's nostrils while the patient was lying down. The instilled water was then gently suctioned out through a delicate tube that was introduced deep into the nostril and emptied into a special collection container (Mucous trap; Unomedical A/S, Lynge, Denmark) that was connected to the portable suction equipment (Easy Go Vac aspirator; Precision Medical, Northampton, PA). The two test tubes with the swabs were shaken in a Vortex-Genie mixer (Scientific Industries, Bohemia, NY) for 5 min, after which the head of the applicator was drained against the sides of the test tubes and then removed. The raw washing matter was also added to the test tube containing RPMI solution, which was also shaken. The contents of the three test tubes were frozen within an hour and kept at −80°C until they were processed.

Detection of respiratory viruses. Nucleic acid extraction was performed with a NucliSense EasyMag apparatus (Biomerieux, Marcy l'Etoile, France), according to the manufacturer's instruction. A total of 400 μl of aspirate was extracted into 50 μl of elution solution. The sets of primers and probes used to detect 12 viruses by a multiplex hydrolysis probes-based quantitative real-time reverse transcription-PCR (RT-PCR) are described in Table 1. Each sample was tested in parallel, in three test tubes, for the following viruses: influenza A and B viruses; parainfluenza virus types 2 and 3; human respiratory syncytial virus (RSV); human metapneumovirus (hMPV); rhinovirus; adenovirus; and coronaviruses 229E, HKU1, OC43, and NL63. Amplification was carried out in a final volume of 10 μl with an RNA ultrasense one-step quantitative real-time RT-PCR system (Invitrogen, Carlsbad, CA) with 4 μl of nucleic acid, four sets of primers and probes to detect four viruses, and an internal control set (see Table 1 for details of the concentrations of the primers and probe sets and for virus testing combinations).

Statistical analysis. Sample size calculations were based on data that were collected in a preliminary phase of the study that involved 100 subjects (50 patients and 50 controls). In that population, 11, 16, and 21 viruses were iden-

TABLE 2. Gender and age data by study group and for the entire study population

Characteristic	Patients (n = 550)	Controls (n = 450)	Merged data (n = 1,000)
Age (yr)			
Mean ± SD	63.9 ± 19.4	62.2 ± 15.6	63.1 ± 17.8
Range	19–99	19–93	19–99
No. (%) of population >65 yr of age	329 (59.8)	238 (52.9)	567 (56.7)
No. (%) Females	255 (46.4)	243 (54.0)	498 (49.8)

tified by the use of OPSs, NPSs, and NPWs, respectively. The sample size calculated on the basis of these data by the use of standard methods and an alpha level of 0.05, a power of 80%, and a patient/control ratio of 1:1 was 985 subjects. To adjust for the possibility that the study period might have a lower rate of viral activity, 50 patients were added to the study population at the expense of the control group.

Data were recorded and analyzed with EpiInfo (version 3.3.2) software. Rates between samples were compared by the χ^2 test with the Yates correction or Fisher's exact test, as appropriate. Statistical significance was set at a P value of <0.05 throughout.

RESULTS

The study population consisted of 1,000 subjects that comprised 550 hospitalized patients and 450 controls. Two hundred twenty-eight of the patients were diagnosed with community-acquired pneumonia, 250 with nonpneumonic lower respiratory tract infection, and 72 with acute exacerbation of chronic obstructive pulmonary disease. Table 2 shows the age and gender data for the two study groups and the total study population.

In all, 251 respiratory viruses were identified in 244 subjects (7 subjects had dual infections with two different viruses). These numbers refer to the identification of at least one virus by at least one of the sampling methods in one subject. For this study, this index served to define positivity for a specific virus and was the "gold standard" for the determination of the sensitivity of each of the three sampling methods. Table 3 shows the frequency distribution of the 12 different viruses in the total study population and by study group.

TABLE 3. Frequency distribution of identified viruses by study group and for the entire study population

Virus	No. (%[a]) of subjects		
	Patients (n = 550)	Controls (n = 450)	Merged data (n = 1,000)
Influenza A virus	75 (13.6)	2 (0.4)	77 (7.7)
Influenza B virus	3 (0.5)	0	3 (0.3)
Rhinovirus	41 (7.5)	9 (2.0)	50 (5.0)
RSV	27 (4.9)	4 (0.9)	31 (3.1)
hMPV	5 (0.9)	0	5 (0.5)
Adenovirus	4 (0.7)	0	4 (0.4)
Parainfluenza virus type 3	6 (1.1)	0	6 (0.6)
parainfluenza virus type 2	0	0	0
Coronaviruses			
NL63	6 (1.1)	6 (1.3)	12 (1.2)
229E	11 (2.0)	2 (0.4)	13 (1.3)
OC43	36 (6.5)	8 (1.8)	44 (4.4)
HKU1	5 (0.9)	1 (0.2)	6 (0.6)
Total	219 (39.8)	32 (7.1)	251 (25.1)

[a] The percentage of subjects positive for the specific virus among all subjects in that population.

TABLE 4. Comparison of frequency distribution and sensitivity for detection of all viruses identified by the three sampling methods separately and in combination

Sampling method	No. of viruses identified	Sensitivity (95% CI)[a]
OPS	136	0.542 (0.478–0.600)[b]
NPS	184	0.733 (0.673–0.786)[c]
NPW	213	0.849 (0.797–0.889)
OPS and/or NPS	212	0.845 (0.792–0.886)
OPS and/or NPW	236	0.940 (0.901–0.965)
NPS and/or NPW	239	0.952 (0.916–0.974)
OPS and/or NPS and/or NPW[d]	251	

[a] The sensitivity of the method or combination of methods was calculated as the number of viruses identified by this method or combination of methods of the number of viruses identified by at least one of the three sampling methods (gold standard), which appears on the bottom line of the table. CI, confidence interval.

[b] $P < 0.00001$ versus the results for NPS and versus NPW.

[c] $P < 0.003$ versus the results for NPW.

[d] In addition to the corresponding numbers in Table 5, the number of viruses in this group includes these 15 viruses: parainfluenza virus type 3 (identified in six subjects), hMPV (identified in five subjects), and adenovirus (identified in four subjects).

Table 4 depicts the distribution of all 251 viruses identified by the three methods and the three combinations of these methods and the sensitivity calculated for each method or combination of methods. The sensitivity for sampling from the oropharynx was only 54.2%, which was significantly lower that for the two methods of sampling from the nasopharynx. The NPW technique had a significantly higher sensitivity than the NPS technique (84.9% and 73.3%, respectively). A combination of two of the three methods raised the rate of sensitivity compared to that achieved by each method alone. NPW, combined with an OPS or an NPS, had a sensitivity of more than 94%. None of the three methods or the three combinations yielded the maximal sensitivity, which was attained only when all three methods were combined. The same trend was seen when the rate of sensitivity was calculated separately for the two study groups, i.e., an advantage for nasopharygeal sampling over oropharyngeal sampling and an advantage for NPW over an NPS.

To analyze the study results in terms of the various respiratory viruses, we grouped the viruses into four main groups: influenza viruses, rhinovirus, RSV, and coronaviruses. Table 5 shows the frequency distributions for each of the four principal virus groups in the same format used for all 251 viruses. In the three groups with the highest frequencies, influenza A and B viruses, coronaviruses, and rhinovirus, the trend was the same as that seen in the analysis for all the viruses, i.e., an advantage for nasopharygeal sampling over oropharyngeal sampling and an advantage for NPW over an NPS. Although the study was not powered to compare the sensitivities of the sampling methods for specific virus groups, some of the differences described above were statistically significant. The results for RSV were different from those for the other viruses, with an identical sensitivity that reached 84% being achieved for the three sampling methods. However, as with the other viruses, samples from both the oropharynx and nasopharynx were required to reach the maximal sensitivity.

TABLE 5. Comparison of frequency distribution and sensitivity for the study viruses identified by the three sampling methods separately and in combination

Sampling method	Influenza A and B viruses		Coronaviruses		Rhinoviruses		RSV	
	No. identified	Sensitivity (95% CI)[a]	No. identified	Sensitivity (95% CI)	No. identified	Sensitivity (95% CI)	No. identified	Sensitivity (95% CI)
OPS	45	0.56 (0.45–0.67)[b,c]	43	0.57 (0.45–0.68)[e,f]	17	0.34 (0.22–0.49)[c,h]	26	0.84 (0.65–0.94)[g]
NPS	61	0.76 (0.65–0.85)[d]	55	0.73 (0.62–0.83)[g]	32	0.64 (0.49–0.80)[i]	26	0.84 (0.65–0.94)[g]
NPW	77	0.96 (0.89–0.99)	57	0.76 (0.64–0.85)	40	0.80 (0.66–0.89)	26	0.84 (0.65–0.94)
OPS and/or NPS	67	0.84 (0.73–0.90)	64	0.85 (0.78–0.92)	38	0.76 (0.61–0.86)	30	0.97 (0.81–0.998)
OPS and/or NPW	80	1.00 (0.94–1.00)	67	0.89 (0.79–0.95)	44	0.88 (0.75–0.95)	31	1.00 (0.86–1.00)
NPS and/or NPW	78	0.98 (0.90–0.996)	72	0.96 (0.88–0.99)	47	0.94 (0.82–0.98)	28	0.90 (0.73–0.97)
OPS and/or NPS and/or NPW	80		75		50		31	

[a] The sensitivity (in percent) of the method or combination of methods was calculated as the number of viruses identified by this method or combination of methods of the number of viruses identified by at least one of the three sampling methods (gold standard), which appears on the bottom line of the table. CI, confidence interval.
[b] $P < 0.02$ versus the results for NPS.
[c] $P < 0.00001$ versus the results for NPW.
[d] $P < 0.0006$ versus the results for NPW.
[e] Not significant versus the results for NPS.
[f] $P < 0.03$ versus the results for NPW.
[g] Not significant versus the results for NPW.
[h] $P < 0.005$ versus the results for NPS.
[i] Not significant versus the results for NPW.

DISCUSSION

The present study compared three accepted sampling methods used for the identification of respiratory viruses. This study is unique and important in that it combines a large adult study population (with a broad age spectrum, including a majority in the elderly age range) with a sophisticated molecular biological method for identifying all main respiratory virus groups. In terms of clinical characteristics, the study population included patients with a broad spectrum of acute respiratory diseases and a control group with an age distribution similar to that of the patient group. All the subjects in the patient group were hospitalized, but the sampling was done close to the time of their admission, with the aim of averting the effect of hospital-based colonization. The study objectives focused exclusively on the technical/methodological aspect of viral identification and purposely ignored the clinical significance of hospital-based colonization, which would require a different study design.

The three sampling methods used in our study sample the upper respiratory tract, in effect, while the subjects included in the study had clinical manifestations of lower respiratory tract infections. It is possible that sampling of the lower respiratory tract by more invasive procedures, such as by bronchoalveolar lavage or with a protected brush swab, would have provided more information, but this is an assumption that is not yet confirmed by information in the literature. The accepted method for the identification of viral etiologies for lower respiratory tract infections as well as upper respiratory tract infections is by naso- or oropharyngeal sampling. Moreover, the high rate of respiratory viruses identified in this study of patients with lower respiratory tract infections compared to the rate identified in the healthy controls supports the possibility that the viral population in the naso- or oropharynx reflects, at least in part, the presence of the same pathogens in the lower respiratory tract.

Some methodological issues related to the study require clarification. The first is the merging of the two study groups, the patients and the controls, for the purpose of data analyses. This could be problematic, at first glance, in light of the differences in the rates of respiratory viruses that were identified in the two groups. However, in this study we purposely ignored the question of the identification rates in the study groups and focused only on the methodological issue of the relative sensitivity of the three sampling methods for the identification of respiratory viruses. The sensitivity of each of the three methods was compared separately between the two study groups, and the sensitivities were found to be similar. In light of this, we believe that merging of the data for the two groups for further data analyses was justified. A second issue has to do with the swab type used in our study. Samples were obtained by using conventional cotton-tipped swabs. In many clinical settings, these are now being replaced by flocked swabs, explicitly on the basis of the findings of studies that have indicated that the flocked polyester material has less adsorption and markedly better recovery of respiratory pathogens from OPSs and NPSs than the older cotton swabs (3, 11). This weakens the observations and conclusions of our study in relation to the inferiority of the sensitivities of OPSs and NPSs compared to the sensitivity of NPWs, inasmuch as both of these sample types are likely to have performed better with the newer swab material. This does not affect the comparison between OPSs and NPSs, however, as the same swab type was used for both types of sampling and the improved recovery on NPSs compared to that on OPSs should be independent of this.

Another issue is the two specific methods that were used for nasopharyngeal sampling. First, to swab the nasopharynx, a rigid swab applicator and not a flexible one was used. At the preliminary stage of this study, the investigators tested both types of applicators for nasopharyngeal swabbing. Their impression was that adult patients are much more tolerant of the rigid applicator than the flexible one, so the rigid applicator was used for all nasopharyngeal samplings in this study. This choice would not necessarily be made for the pediatric population, the sampling of which is usually conducted while the child is held by the parents or the staff. The second method for

nasopharyngeal sampling was washing. This method, which is commonly used to identify viruses in children, is not used routinely for adults. Gooskens et al. (5) found that sampling by washing was as sensitive as the use of NPSs when the samples were tested by PCR. However, they believed that it would be impractical for use with older adults due to the functional limitations of nursing homes residents (5). In contrast, our impression of the collection of washings from our very large number of adult subjects was that this method is well tolerated by all adults, including the elderly adults with low functional capacities who were included in the study. Furthermore, in our study, the rate of sensitivity obtained by the use of this method was higher than that when NPSs were used.

Nasopharyngeal sampling was shown to have advantages over oropharyngeal sampling for the identification of influenza viruses in previous studies with adult and mixed adult-pediatric populations (2). A similar advantage was found in a study that tested for all viruses in a pediatric population (6). A comprehensive review of the literature did not reveal any corresponding studies for all viruses in adults. Only the two studies cited above compared nasopharyngeal sampling by the use of NPSs and NPWs in adults, and in those cases, the studies were only for the influenza viruses. Similar rates of sensitivity of the two methods were found when samples from nursing home residents were tested by PCR (5). In another study with a mixed adult and pediatric population, NPWs were found to have an advantage over NPSs when two non-PCR detection methods were used (2).

The paucity of publications on studies conducted with adults lends greater importance to the results of the present study. In relation to all respiratory viruses, we found a clear and significant advantage to the use of nasopharyngeal sampling compared to the use of oropharyngeal sampling and an advantage for NPWs over NPSs. These differences did not change when we conducted separate analyses for the three common groups of respiratory viruses, influenza viruses, coronaviruses, and rhinovirus, although there was a mild variation among these groups in the degree of the differences found among the three sampling methods. The use of combinations of two of the three sampling methods significantly raised the rate of sensitivity for the identification of all viruses, and this rate reached 94 to 95% when one of the sampling methods was the NPW method. The same trend was found when the sensitivity achieved by the use of combinations of the three methods for the common virus groups was analyzed. To reach maximal sensitivity for the detection of all viruses tested, it was necessary to use all three sampling methods. We do not think that there is a clear-cut answer to the question of whether it is important to attain the maximal sensitivity rate compared to a rate that is close to this rate in routine clinical work. We believe that this depends on the clinical circumstances in which the test is conducted, the exact degree of the differences in sensitivity rates, as well as the outlook of the clinician who faces the question. In contrast to the results seen for the three common virus groups, the rates of sensitivity for the detection of RSV were identical for the three sampling methods. In two studies limited to pediatric populations in which NPSs and NPWs were compared, similar rates of sensitivity for the diagnosis of viral respiratory disease were found for both methods (1, 4).

We conclude that nasopharyngeal sampling is superior to oropharyngeal sampling and that NPWs superior to NPSs with rigid cotton swabs for the identification of respiratory viruses in adults. To obtain a complete picture of respiratory virus infection, the three methods need to be combined.

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