AMERICAN ACADEMY OF OTOLARYNGOLOGY–HEAD AND NECK SURGERY
FOUNDATION

OTO Open
2020, 4(3) 1–5

DOI: 10.1177/2473974X20953094
http://oto-open.org
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Assessing the Impact of a Training Initiative for Nasopharyngeal and Oropharyngeal Swabbing for COVID-19 Testing

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Abstract

Objective. The accuracy and reliability of COVID-19 testing are critical to limit transmission. After observing variability in testing techniques, we otolaryngologists at a tertiary medical center initiated and evaluated the impact of nasopharyngeal and oropharyngeal swabbing training, including video instruction, to standardize sampling techniques and ensure high-quality specimens.

Methods. Participants in the training were employees (N = 40). Training consisted of an instructional video on how to perform nasopharyngeal and oropharyngeal swabs and a live demonstration. Participants completed pre- and posttraining surveys assessing their knowledge and confidence in performing nasopharyngeal and oropharyngeal swabs. They then performed swabbing on partners, which was graded per a standardized checklist.

Results. Mean scores for knowledge-based questions and confidence in swabbing were significantly higher after the training session (both $P < .001$). All participants scored ≥ 6 of 8 on the posttraining checklist. Ninety-five percent rated the video as very or extremely useful.

Discussion. Specialized instruction for nasopharyngeal swabbing improved participants' knowledge—specifically, the appropriate head position and minimum swab time in nasopharynx—and their confidence. After the training, their swabbing execution scores were high.

Implications for Practice. Video-assisted hands-on instruction for nasopharyngeal swab sampling can be used to standardize teaching. When prompt and accurate testing is paramount, this instruction can optimize procedural technique and should be used early and often. In addition, there may be a professional responsibility of otolaryngologists to participate in such initiatives.

Keywords

COVID-19, SARS-CoV-2, coronavirus, PS/QI, nasopharyngeal, nasopharynx, nasopharyngeal swab, video

Received July 27, 2020; accepted July 30, 2020.

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has become a global public health crisis. As of June 15, 2020, there were 7,823,289 confirmed cases and 431,541 confirmed deaths worldwide.[1] The most commonly used tests for diagnosing SARS-CoV-2 are aimed at detecting viral RNA in clinical specimens through nucleic acid amplification, generally with reverse transcription polymerase chain reaction (RT-PCR) assays.[2] The Centers for Disease Control and Prevention recommends an upper respiratory specimen, preferably a nasopharyngeal specimen, collected by a health care professional.[3] Acceptable alternatives include an oropharyngeal specimen, nasal midturbinate swab, anterior nares specimen, nasopharyngeal wash/aspirate, or nasal aspirate.

The accuracy and reliability of RT-PCR tests is critical to limit transmission. Recent reports suggest that accurate pharyngeal specimens taken early after exposure may be most useful for reducing virus spread. SARS-CoV-2 can cause asymptomatic, presymptomatic, and minimally symptomatic infections that may still be transmitted and thus result in infected individuals unknowingly spreading the virus.[4,5] Viral loads in asymptomatic patients have been shown to be similar to those in symptomatic patients.[4] Studies have also observed the highest viral loads in pharyngeal swabs at the time of symptom onset, signifying that infectiousness can peak on or before symptom onset.[6] RT-PCR tests are able to identify asymptomatic cases and have

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been shown to be vital in diagnosing mild infections, with 1 study demonstrating 20 of the 32 mild COVID-19 cases being picked up by RT-PCR but not by other methods, such as chest computed tomography.[2,7] Swabs taken before the onset of illness to 7 days after onset showed higher sensitivity than swabs taken >15 days after the onset of illness, suggesting that early testing and early isolation could be effective in preventing viral spread.[8,9]

Nasopharyngeal specimens have been found to have a higher sensitivity over oropharyngeal specimens, but the 2 locations can be combined to maximize sensitivity.[10-13] It has also been reported that nasal specimens appear to have higher viral loads than oropharyngeal specimens.[4,11] The current literature reports of RT-PCR sensitivity is <80%, which is not ideal when diagnosing infectious diseases with severe consequences, such as COVID-19.[2,8,14,15] Consequently, there has been growing concern regarding the potential for false-negative test results. Multiple factors may contribute to inaccurate results—such as collection of samples too early or too late in the disease course; improper storage, transportation, or processing of specimens; and issues with viral mutation or PCR inhibition—but it has also been speculated that inadequate samples or discordant sampling techniques may contribute to higher false-negative rates.

Ye et al analyzed whether standardized throat and lingual sampling by the same experienced nurse could improve the detection rate as compared with sampling by several nurses. They found a higher detection rate when a single experienced nurse used a standardized sampling method for lingual and throat swabs as opposed to several nurses doing the swabbing.[10] Informal querying and observation at testing sites in our tertiary care center revealed considerable variability and confusion regarding appropriate testing technique, confirming an area of educational need.

The Department of Otolaryngology initiated, managed, and evaluated a quality improvement project at our institution with the goal of standardizing sampling techniques and ensuring high-quality specimens. One study found that simulation education on nasopharyngeal swabbing directed at health care workers improved self-assessed clinical competency scores.[16] Current literature shows that video instruction can improve the attainment of surgical and clinical skills.[17,18] Therefore, we developed a training initiative that incorporated not only demonstrations but also an instructional video on recommended sampling technique. Training sessions were held at institutional testing sites. The primary objective of this study was to assess for improvements in knowledge of and confidence in the swabbing technique after participation in the training session.

Methods

Participants

This project was a quality improvement project and granted Institutional Review Board exemption by the University of Illinois at Chicago. Participants were employees at our tertiary care center who were recruited at swab training sessions where attendance was part of standard clinical operations.

Task	Points
Participant correctly prepares workspace to include all items needed during testing: a tongue depressor, the appropriate synthetic swab, viral transport medium, specimen bag	1
Participant correctly confirms the patient name and date of birth	1
Participant explains process of specimen collection to patient	1
Participant positions the patient appropriately with head neutral	1
Participant obtains specimen from the posterior oropharyngeal wall	1
Number of attempts before successfully obtaining nasopharyngeal swab: first attempt, 2 points; second attempt, 1 point; third attempt, 0 points	2
Participant replaces patient mask after specimen is collected	1

Figure 1. Posttraining task checklist.

Data Collection

A pretraining knowledge and confidence survey (Supplemental Figure S1, available online) was administered immediately prior to the training session. Descriptive characteristics were collected, including age, sex, occupational role, presence and quantity of prior swabbing experience, and prior swab training. Volunteers then participated in the training sessions, which an attending otolaryngologist directed and which consisted of an instructional video on how to perform swabbing to obtain optimal nasopharyngeal and oropharyngeal samples (Supplemental Video S1). This 2-minute instructional video was produced by the authors in April 2020. The video describes the equipment needed, the positioning of the patient and examiner, the location of the nasopharynx and oropharynx, the steps to obtain the specimen, as well as how to package the specimen. In the video, the examiner is wearing personal protective equipment as recommended by the Centers for Disease Control and Prevention, which consists of an N95 mask, eye protection, gloves, and a gown. We opted for a mask with a face shield on top of the N95 mask for added protection and to allow continued use of the N95 make between patients. The instructor then performed a live demonstration of the technique.

Immediately after completion of the training session, participants were asked to complete a survey on knowledge and confidence (Supplemental Figure S2, available online). They were also asked to assess the usefulness of the instructional video and overall training. Volunteers then performed nasopharyngeal and oropharyngeal swabbing on partners, which the attending otolaryngologist graded using a standardized task checklist (**Figure 1**).

Outcomes

The primary outcomes were knowledge and confidence in performing swabbing. Out of 3 knowledge-based questions on the pre- and posttraining surveys—head position, swab time in the nasopharynx, and location of the nasopharynx on a diagram—there were 3 possible points to be scored and subsequently compared. Confidence was rated on a 5-point Likert scale ranging from *not at all* (1) to *extremely* (5).

A secondary outcome, assessed on only the posttraining survey, was the score on the posttraining task checklist, ranging from 0 (lowest) to 8 (highest). Another secondary

Table 1. Comparison of Knowledge-Based Questions on Pre- and Posttraining Surveys (N = 40).

	Participants answering correctly, No. (%)		
	Pretraining	Posttraining	*P* value
Head position	19 (47.5)	40 (100)	<.001[a]
Minimum duration swab must be in nasopharynx	29 (72.5)	40 (100)	<.001[a]
Identification of nasopharynx on diagram	28 (70)	32 (80)	.302
Mean total score	1.9	2.8	<.001[a]

[a] $P < .05$.

Table 2. Comparison of Self-reported Confidence Levels on Pre- and Posttraining Surveys (N = 40).[a]

	Pretraining	Posttraining
Response[b]		
1: Not at all	6 (15)	0 (0)
2: A little	7 (17.5)	2 (5)
3: Somewhat	21 (52.5)	2 (5)
4: Very	4 (10)	25 (62.5)
5: Extremely	2 (5)	11 (27.5)
Mean[c]	2.725	4.125

[a] "How confident do you feel performing a nasopharyngeal/oropharyngeal swab on another person?"
[b] Values are presented as No. (%)
[c] $P < .001$.

outcome was the usefulness of the instructional video, rated on a 5-point Likert scale ranging from *not at all* (1) to *extremely* (5).

Statistical Analysis

Statistical analysis was done with MATLAB software (MathWorks Inc, version Matlab_R2020a). Distribution and summary statistics were evaluated for normality. Ordinal variables were assessed for normality prior to hypothesis testing, and pre- and posttraining comparisons were performed with a Wilcoxon signed rank test. A chi-square test was used for pre- and posttraining comparisons for categorical variables. Median and interquartile range (IQR) are presented unless otherwise specified. $P < .05$ was considered significant.

Results

Descriptive Characteristics

Of the 40 participants included, the median age was 43 years (IQR, 35-54) and 38 (95%) were women. There were 23 (58%) nurses, 7 (18%) nurse practitioners or physician assistants, 4 (10%) medical assistants/technicians, 3 (8%) physicians, and 3 (8%) dentists. According to the pretraining survey, 23 (58%) had prior swab experience. Of those 23, 2 (9%) had performed 1 other swab; 12 (52%), 2 to 10 swabs; and 9 (39%), >10 swabs. Eighteen had prior swab training: 9 (39%), verbal; 8 (35%), live demonstration; and 1 (13%), instructional video.

Primary Outcomes

Table 1 compares the results of the knowledge questions on the pre- and posttraining surveys. Overall knowledge scores were significantly higher after the training session (median [IQR]: pre- vs posttraining, 6 [5, 6.5] vs 7 [7, 7]; $P < .001$). After the training, significantly more participants knew the correct head position and time in the nasopharynx (both $P < .001$). Although more participants correctly identified the nasopharynx after the training session, it was not significant.

Participants were asked how confident they felt performing a nasopharyngeal and oropharyngeal swab prior to training (1, not at all; 5, extremely), and their answers are recorded in **Table 2**. Confidence levels were significantly higher after the training session (median [IQR]: pre- vs posttraining, 3 [2, 3] vs 4 [4, 5]; $P < .001$).

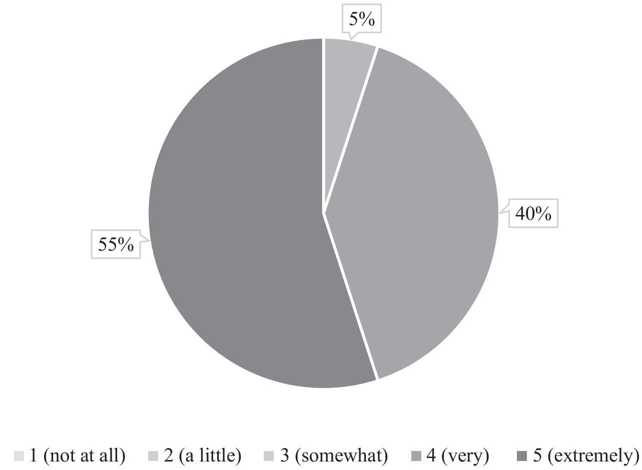

Figure 2. Participant rating of instructional video usefulness.

Secondary Outcomes

All 40 volunteers who participated in the posttraining partner swabbing scored ≥6 out of 8 possible points on the task checklist. Twenty-nine (72.5%) scored 8 points; 8 (20%), 7 points; and 3 (7.5%), 6 points. All participants correctly prepared their work environment, explained the collection process adequately, positioned the head correctly, and collected an oropharyngeal sample properly. Thirty-one (77.5%) obtained a nasopharyngeal sample correctly on their first attempt, as opposed to 8 (20%) on their second attempt and 1 (2.5%) on ≥3 attempts. Three (7.5%) did not replace the patient's mask at the end of the encounter, and only 1 (2.5%) did not confirm patient name and date of birth.

When asked how useful they found the instructional video, 95% rated it as very useful or extremely useful, with the remaining 5% rating it as somewhat useful (**Figure 2**).

Discussion

From a public health perspective, sufficient anatomic knowledge and procedural skill are imperative when performing screening tests to ensure adequate samples and decrease false-negative results. The nasopharynx cannot be directly seen, and knowledge of the anatomy of the nasopharynx is crucial to obtaining an adequate sample and minimizing patient discomfort. This study identified that video instruction with live demonstration improved participants' knowledge of and confidence in nasopharyngeal swabbing. From a knowledge standpoint, it significantly improved their ability to correctly identify the appropriate head position for testing and the minimum swab time in the nasopharynx, with all participants able to do so after the training. The ability to identify the nasopharynx on a diagram did not significantly improve after the training. The reason may be that patients found the label arrows confusing or that the diagram was presented in a sagittal 2-dimensional view, as they still performed well on the posttraining task checklist.

On this checklist, the most clinically relevant task was the ability to successfully obtain a nasopharyngeal swab. The majority of participants successfully obtained a nasopharyngeal sample on the first attempt, but some required a second or third. Based on these differences, it is important to keep in mind that, in addition to our instruction, experience and practice may play a role in the accurate performance of procedural skills.

The majority of participants rated the video as very or extremely useful. We also asked for written feedback in the form of comments. It is our observational experience that healthcare workers demonstrated apprehension regarding the risks and, specifically, the depth of insertion of nasopharyngeal swabs. Interestingly, in regard to what participants found most helpful about the training, the most frequently noted comment was that they learned the correct placement, angle, and depth of the nasopharyngeal swab. Knowledge of the location of the nasopharynx through training with diagrams and video instruction helped alleviate these concerns. Instructional videos can be used alone or as an adjunct to other training modalities, such as visual, written, or oral instruction, simulation, and observation.

Another study implementing swab training used simulation education, without video instruction, and assessed only self-perceived competence, without objective evaluation of technique.[16] One of the benefits of video instruction, as used in our study, is that even when there is instructor variability, the content remains consistent. Resources such as video instruction are also quickly and easily distributed over a wide breadth and are universally available in settings that may not have access to simulation models. We also objectively measured skill by direct observation and a standardized task checklist.

One limitation of our study was that 23 participants had some form of prior swab training, in verbal, live demonstration, or video format. Another limitation was that technique grading was not blinded. A better design would have been to grade swabbing accuracy pre- and postinstruction such that the evaluators were blinded to the participants' status. The logistics, however, for gathering the volunteers in this fashion were untenable. A final limitation of our study was that we did not test for knowledge retention. We encountered difficulty organizing participants outside their clinical duties amid this busy time and thus deferred a repeat assessment.

Implications for Practice

Our background as otolaryngologists puts us in a unique position to contribute to this SARS-CoV-2 pandemic. Our familiarity with head and neck anatomy allows us to effectively train and compose educational materials for those performing nasopharyngeal swab testing. The training session with video instruction and live demonstration of swab testing for RT-PCR assays targeting SARS-CoV-2 showed improvement in the knowledge and confidence of the health care workers who participated. We encourage implementing video instruction as a tool to aid in the procurement of clinical and procedural skills. In particular, when prompt and accurate testing is paramount, as is the case in a global pandemic, tools that optimize procedural technique and are widely distributable, such as video instruction, should be used early and often.

Acknowledgments

John Wilson IV, MD, for the aid in using MATLAB software for the data analysis.

Author Contributions

Brittany T. Abud, design, data acquisition, data analysis, data interpretation, drafting, revising; **Natalia M. Hajnas**, design, data acquisition, data analysis, data interpretation, drafting, revising; **Miriam Redleaf**, conception, design, data acquisition, data interpretation, revising; **Julia L. Kerolus**, conception, design, data acquisition, data interpretation, revising; **Victoria Lee**, conception, design, data interpretation, revising.

Disclosures

Competing interests: None.

Sponsorships: None.

Funding source: None.

Supplemental Material

Additional supporting information is available at http://journals.sagepub.com/doi/suppl/10.1177/2473974X20953094

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