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Effectiveness of a Modified Skull Model for Nasopharyngeal Swab Training among Undergraduate Medical Students: A Prospective Interventional Study

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ABSTRACT

Introduction: Nasopharyngeal swab collection is considered one of the most sensitive methods for obtaining upper respiratory tract specimens; however, it requires adequate anatomical understanding and proper technique. Inadequate training may lead to patient discomfort, procedural complications, and false-negative results.

Aim: To assess the effectiveness of a modified skull model in improving knowledge, confidence, and technical skills related to nasopharyngeal swab collection among undergraduate medical students.

Materials and Methods: The present prospective interventional study was conducted among 75 Phase III MBBS students by the Department of Otorhinolaryngology at Varun Arjun Medical College & Rohilkhand Hospital, Uttar Pradesh, India, a tertiary care teaching hospital in Northern India between November 2024 and mid-February 2025. A cadaveric skull model was modified using silicone, cotton pads, and coloured inks to simulate nasal and nasopharyngeal anatomy. Participants received a structured demonstration followed by supervised hands-on practice until three consecutive successful swabs were achieved. Knowledge, confidence, and procedural skills were assessed before and after training using a structured questionnaire and an observational checklist.

Results: The mean knowledge score improved significantly from 1.85±1.06 before training to 8.10±1.20 after training ($p<0.0001$). Confidence levels increased markedly, with 64 participants (85.3%) reporting high confidence (Likert 4-5) after training. Significant improvement was also observed in procedural skills, including swab direction, insertion depth, and correct identification of the nasopharyngeal sampling site ($p<0.0001$).

Conclusion: The modified skull model proved to be an effective, affordable, and reproducible tool for improving knowledge, confidence, and technical proficiency in nasopharyngeal swab collection among undergraduate medical students.

Keywords: Clinical competence, Health personnel education, Simulation-based education, Specimen collection

INTRODUCTION

Nasopharyngeal swabbing has been shown to be more sensitive than other methods of specimen collection from the upper respiratory tract. However, limited familiarity with nasal anatomy and inadequate procedural training may reduce its effective use in clinical practice. During the COVID-19 pandemic, the Centers for Disease Control and Prevention (CDC) issued guidelines on the collection, handling, and testing of clinical specimens for Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) infection. These guidelines recommended upper respiratory specimens, preferably nasopharyngeal samples, collected by trained healthcare professionals. Acceptable alternatives included oropharyngeal swabs, nasal mid-turbinate swabs, anterior nares specimens, nasopharyngeal wash or aspirate, and nasal aspirate [1].

Proper technique during specimen collection is critical for ensuring diagnostic accuracy. In many healthcare settings, training in nasopharyngeal swab collection is often limited to reading written guidelines or watching instructional videos. Lack of confidence or improper technique during swab collection may reduce test sensitivity and contribute to false-negative results.

Nasopharyngeal swabs are also used for the diagnosis of several infectious diseases, including measles-rubella, diphtheria, and pertussis. With the emergence of new respiratory pathogens such as Human Metapneumovirus (HMPV), adequate training in nasopharyngeal specimen collection has become increasingly important for healthcare personnel. Although nasopharyngeal swabbing remains the most widely used and validated technique, it has two major limitations: procedural technicality and patient discomfort. Adequately trained personnel can improve sampling accuracy while minimising patient discomfort [2].

Despite its importance, there is a scarcity of standardised and affordable training models for teaching nasopharyngeal swab collection. Therefore, the present study evaluated a simple teaching approach using a cadaveric skull model available in the department for medical education. The model was modified using readily available materials to simulate the nasal and nasopharyngeal cavity and was used for structured hands-on training of undergraduate medical students. To the best of the knowledge as per authors, the present study is among the first studies to utilise a low-cost modified human skull model for simulation-based training in nasopharyngeal swab collection.

MATERIALS AND METHODS

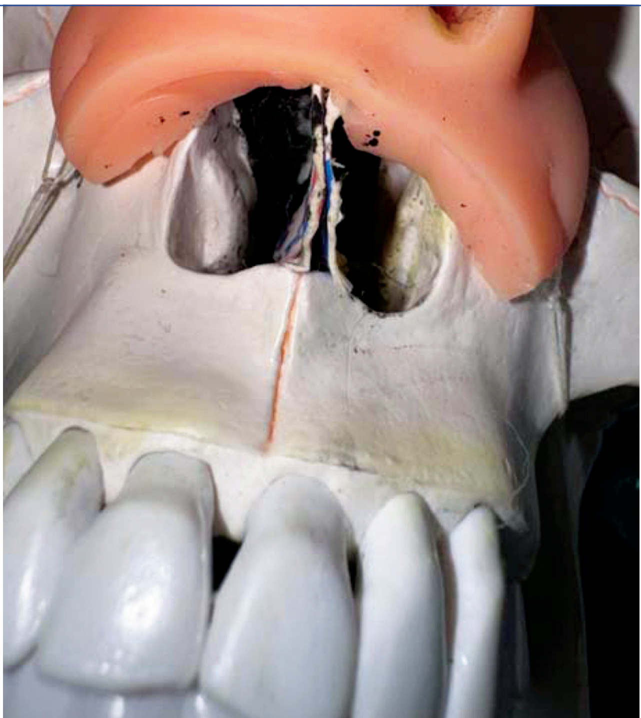
The present prospective interventional study was conducted by the Department of Otorhinolaryngology at Varun Arjun Medical College & Rohilkhand Hospital, Uttar Pradesh, India, a tertiary care teaching hospital in Northern India between November 2024 and mid-February 2025, following approval from the Institutional Ethics Committee {IECVAMC (3790)-ENT-003/Jun-2023}.

Inclusion and Exclusion criteria: All Phase III (Part 1 and Part 2) MBBS students of the institution were invited to participate after obtaining written informed consent. Students who attended the training session, which included demonstration and hands-on practice using a modified skull model, and who completed both pre and post-training questionnaires were included in the study. Students who were unwilling to participate, absent for any part of the session, had previously received formal hands-on training in nasopharyngeal swab collection, or provided incomplete questionnaire responses were excluded. A total of 75 students met the eligibility criteria and were enrolled.

Study Procedure

For training purposes, a routinely available skull bone model was modified to simulate nasal and nasopharyngeal anatomy. A silicone external nose model was secured using threads to represent the external nose, while the cartilaginous nasal septum was fashioned from a cardboard sheet. The middle and superior turbinates and the roof of the nasal cavity were simulated using cotton pads affixed with double-sided tape and stained with black ink. Literature has demonstrated that the mean distance from the anterior nares to the posterior nasopharyngeal wall in adults is approximately 9.4 cm, with a minimum depth of about 8 cm required to reach the nasopharynx. Therefore, insertion of the swab to a depth of approximately 9.5 cm was used in the present training model to simulate correct nasopharyngeal sampling [3]. The modified model is depicted in [Table/Fig-1,2]. A thin swab stick was given to the trainee to correctly collect the sample from the nasopharynx, which was assessed by yellow-colour staining of the swab tip. The other wrong sites of swabbing from the upper nasal cavity and roof were noted by the black colour staining of the swab.

[Table/Fig-1]: Showing the Nasopharyngeal swabbing training session on the modified skull model. Yellow stained padding of the posterior nasopharyngeal wall can also be seen.



[Table/Fig-2]: Showing the interior of the model, with black sponge padding at the roof of nasal cavity.

A standardised observational checklist was developed for this study, based on internationally accepted CDC interim guidelines and peer-reviewed literature on nasopharyngeal specimen collection and the steps were adapted [1,4]. Content validation was carried out by two otorhinolaryngology experts, ensuring that the checklist covered all essential domains of correct swabbing technique preparation, positioning, insertion path, sampling depth, and specimen handling. This checklist was used by the trainer to note down the steps followed by the trainees and further training was given to the trainee till he/she correctly takes the nasopharyngeal samples in three consecutive attempts.

Data was collected on the knowledge levels of the trainees using a pre-designed, structured questionnaire before the training with the model for nasopharyngeal swab collection (Pre-Training survey). The questionnaire used in the present study was developed after adapting the standard procedural guidelines for nasopharyngeal swab collection, including the CDC recommendations [1] and the N Engl J Med video procedure by Marty FM et al., [4] Content validity was established through expert review by two faculty members from the Department of Otorhinolaryngology, who assessed the questionnaire for relevance, clarity, and coverage of key procedural steps. Necessary modifications were made based on the faculty's feedback. Since this tool was specifically designed to assess knowledge and confidence change before and after a brief training intervention (rather than as a psychometric instrument), formal reliability testing (e.g., Cronbach's alpha) was not performed. However, internal consistency was indirectly ensured through expert validation and pilot testing on a small group of 12 students prior to data collection to confirm clarity and feasibility. The results of the present pilot group were not included in the final analysis.

The first section of the survey questionnaire included sociodemographic details of the participants such as age, gender, and previous experience with nasopharyngeal swabbing. The second section contained 10 knowledge-based multiple choice questions like Swab with maximum sensitivity, preferred timing for swab collection, head position for nasopharyngeal swabbing, depth of insertion of swab stick in the nasopharynx, preferred route to reach nasopharynx through nasal cavity, Ability to identify posterior nasopharyngeal wall on a diagram, each question carrying one mark and also a question on level of confidence of the trainee in nasopharyngeal swabbing on a 6 point Likert Scale from 0-5, with 0 being not at all confident and 5 being fully confident. Same questions were asked in the post-training survey [Annexure I]. The score was obtained out of 10, with no negative markings.

Before the training, the participants were asked to take a trial of the swabbing for three times. Various procedural steps such as correct head positioning, appropriate direction and depth of swab insertion, and accidental sampling from incorrect sites were recorded using the checklist [Table/Fig-3].

The training sessions included a demonstration of the correct nasopharyngeal swabbing technique by the Principal Investigator using the modified skull model. Key aspects demonstrated included proper hand hygiene before and after the procedure, use of personal protective equipment, correct positioning of the head in a comfortable supported position with approximately 30° extension, and relevant pre-procedure assessment such as history of nasal bleeding, nasal obstruction, recent nasal surgery, and inspection of the nasal cavity for gross septal deviation or masses [5].

Participants were divided into small groups of 3-4 students, and each session lasted approximately one hour. The session consisted

[Table/Fig-3]: Showing a student collecting the swab on the modified model.

of a step-by-step demonstration followed by supervised hands-on practice. The procedural steps demonstrated included insertion of the swab along the floor of the nasal cavity toward the nasopharynx to a depth of approximately 9.5 cm until resistance was felt, maintaining the swab in position for 2-3 seconds, and withdrawing it with a gentle rotational movement before placing it into a sterile transport tube.

Each participant practiced repeatedly on the model until three consecutive successful swabs were achieved. Successful sampling was indicated by yellow staining on the swab tip, representing contact with the posterior nasopharyngeal wall, whereas black staining indicated contact with the nasal roof or superior turbinate. The standardised trainer checklist was used by the observer to assess adherence to procedural steps before and after the training.

STATISTICAL ANALYSIS

Data were entered in Microsoft Excel and analysed using EpiInfo 7.2.7. Categorical variables were described using frequencies and percentages, while continuous variables were expressed as mean±standard deviation. Confidence levels of the participants were compared before and after the training, using Chi-square test for trends. Knowledge and skills score before and after the intervention were compared using paired t-test. Findings were considered statistically significant at a p-value of <0.05. Performance before and after training was evaluated using the trainer checklist and analysed using McNemar's test. For checklist-based procedural steps, paired nominal data were analysed using McNemar's test. In addition to p-values, 95% confidence intervals were calculated for the proportion of participants who improved from incorrect performance before training to correct performance after training (discordant pairs). These confidence intervals were derived from the paired proportion difference and therefore are presented as proportions (0-1 scale) rather than percentages.

RESULTS

A total of 75 undergraduate medical students participated in the study. Among them, 40 (53.3%) were male and 35 (46.7%) were female. The mean age of the participants was 21.3±1 years. None of the participants had previous experience with nasopharyngeal swab collection.

The mean pre-intervention knowledge score was 1.85±1.06. The mean post-intervention score was 8.10±1.20. The difference was statistically significant with p-value of <0.0001, using paired t-test.

Before training, 53 participants (70.66%) were not confident (Likert 0), while 22 participants (29.33%) reported minimal confidence (Likert 1). None of the participants reported moderate or high confidence prior to training. After the training intervention, confidence improved markedly: 11 participants (14.66%) reported being confident (Likert 3), 49 participants (65.33%) reported being very confident (Likert 4), 15 participants (20.0%) reported being fully confident (Likert 5) This difference was statistically significant, with p-value of<0.0001, by Chi-square test for trend [Table/Fig-4]. The number of attempts required to achieve three consecutive successful swabs ranged from four to eight attempts.

Likert scale (0-5)	Before training	After training	p-value
0	53 (70.67%)	0	<0.0001
1	22 (29.33%)	0	
2	0	0	
3	0	11 (14.67%)	
4	0	49 (65.33%)	
5	0	15 (20%)	

[Table/Fig-4]: Showing the level of confidence in the participants before and after the training.

The trainer checklist was also assessed to compare participants' performance before and after the training [Table/Fig-5]. For each checklist item, McNemar's test for paired nominal data was applied to compare the proportion of participants performing the step correctly before and after training. The 95% confidence intervals represent the estimated proportion of participants showing improvement between pre-training and post-training observations, derived from paired binary outcomes using McNemar's test. CI values are not

S. No.	Factors observed using checklist	Before training	After training	p-value	95% CI for change
1.	Followed hand hygiene technique	73 (97.33%)	75 (100%)	<0.0001	-
2.	Wore mask and gloves	72 (96%)	75 (100%)		-
3.	Correct positioning of the model by the trainee	48 (64%)	75 (100%)		0.28-0.51
4.	Checking for nasal obstructions like deviated nasal septum	2 (2.66%)	75 (100%)		-
5.	Holding of the swab in correct position	4 (5.33%)	73 (97.33%)		-
6.	Correct direction of insertion of swab into the nasal cavity, along the floor	6 (8%)	74 (98.66%)		0.64-0.86
7.	Waiting for optimal time before withdrawing	5 (6.66%)	72 (96%)		0.62-0.84
8.	Rotational movements done while withdrawing the swab stick	6 (8%)	74 (98.66%)		-
9.	Not Accidentally swabbing superior turbinate /roof of nasal cavity	20 (26.66%)	72 (96%)		0.63 – 0.87
10.	Did not Achieve correct nasopharyngeal swabbing in 3 consecutive attempts	71 (94.66%)	4 (5.33%)		-
11.	Placed the swab correctly in the sterile container provided.	60 (80%)	75 (100%)		0.12–0.35

[Table/Fig-5]: Showing the improvement in the performance by the participants before and after the training.

Note: p-values were calculated using McNemar's test for paired nominal data. The 95% confidence intervals represent the proportion of participants who improved from incorrect performance before training to correct performance after training (discordant pairs). Confidence intervals are expressed as proportions (0-1 scale). CI values are not shown where discordant pairs were insufficient to compute reliable intervals shown where discordant values were zero or insufficient to compute meaningful intervals.

Significant improvement was observed in several procedural steps. Correct positioning of the model increased from 48 (64%) before training to 75 (100%) after training (95% Confidence Interval (CI): 0.28-0.51). Checking for nasal obstruction, such as deviated nasal septum, improved markedly from 2 (2.66%) to 75 (100%). Correct position of holding of the swab stick increased from 4 (5.33%) participants before training to 73 (97.33%) after training. Correct direction of insertion of the swab along the floor of the nasal cavity improved from 6 (8%) before training to 74 (98.66%) after training (95% CI: 0.64-0.86). Waiting for the optimal time before withdrawing the swab increased from 5 (6.66%) to 72 (96%) (95% CI: 0.62-0.84), while performing rotational movements during withdrawal improved from 6 (8%) to 74 (98.66%). Avoidance of accidental swabbing of the superior turbinate or roof of the nasal cavity improved from 20 (26.66%) to 72 (96%) (95% CI: 0.63-0.87).

Importantly, the number of participants who failed to achieve correct nasopharyngeal swabbing in three consecutive attempts decreased markedly from 71 (94.66%) before training to 4 (5.33%) after training. During the initial attempt prior to training, only 4 (5.33%) participants were able to correctly collect the swab from the nasopharynx. The majority, 60 (80%), incorrectly swabbed the superior turbinate or the roof of the nasal cavity, while 11 (14.67%) collected the sample superficially from the nasal cavity, resulting in no visible stain on the swab stick. Following the training, a substantial improvement was observed, with 71 (94.66%) participants successfully collecting the swab correctly from the nasopharynx. Correct placement of the swab into the sterile container also improved from 60 (80%) before training to 75 (100%) after training (95% CI: 0.12-0.35), indicating substantial improvement in procedural competency following the training. The improvements in the overall performance after the training was statistically significant with p-value of <0.0001.

DISCUSSION

The present study demonstrated a significant improvement in the knowledge, confidence, and procedural skills of undergraduate medical students following structured simulation-based training in nasopharyngeal swab collection using a modified skull model. A marked increase in the mean knowledge scores was observed after the training intervention. In addition, notable improvement was seen in several critical procedural steps, including correct head positioning, appropriate direction of swab insertion along the nasal floor, adequate insertion depth, and proper specimen handling. Participants also reported increased confidence in performing the procedure following training. These findings indicate that structured hands-on simulation training can effectively enhance both theoretical understanding and technical competence in nasopharyngeal swab collection.

Accurate nasopharyngeal swab collection is essential for the reliable diagnosis of respiratory viral infections, including SARS-CoV-2. Improper technique during specimen collection may result in inadequate sampling, increased patient discomfort, and false-negative test results. In addition to diagnostic inaccuracies, complications related to incorrect swabbing technique have also been reported. Azar A et al., described a case of a fractured aluminum nasopharyngeal swab during drive-through COVID-19 testing that required radiographic detection and removal of the retained fragment [6]. Similarly, Sullivan CB et al., reported a case of cerebrospinal fluid rhinorrhea following elective nasal swab testing, highlighting the importance of careful technique and consideration of prior nasal pathology before performing the procedure [7]. These reports emphasise the importance of adequate training and anatomical understanding among healthcare workers performing nasopharyngeal swab collection.

In the present study, many participants initially demonstrated incorrect swabbing technique during their first attempt. A common error was directing the swab toward the superior turbinate or nasal roof rather than advancing it horizontally along the nasal floor toward the nasopharynx. Similar observations have been reported in previous studies evaluating nasopharyngeal swab practices. Higgins TS et al., noted that many healthcare workers incorrectly direct the swab superiorly due to a common anatomical misconception, resulting in inadequate specimen collection [5]. Likewise, Piras A et al., demonstrated that inappropriate sampling technique is a significant pre-analytical cause of false-negative SARS-CoV-2 test results [8]. Marty FM et al., further emphasised that correct head positioning, appropriate insertion angle, and adequate depth are essential to reach the posterior nasopharyngeal wall and obtain an optimal specimen [4].

Following structured training on the modified skull model, the majority of participants in the present study were able to perform the procedure correctly, with significant improvements in swab direction, insertion depth, and overall procedural performance. These findings support the effectiveness of guided simulation-based training in correcting technical errors and improving procedural accuracy. Similar improvements have been reported following structured training programs. Abud BT et al., demonstrated that targeted instructional interventions significantly improved procedural competence and reduced sampling errors among healthcare workers performing COVID-19 testing [9]. Tagliabue M et al., also highlighted the importance of reinforcing anatomical knowledge during training to improve sampling accuracy and minimise potential complications [10].

Simulation-based training has become an important component of procedural skill development in medical education. It allows learners to practice techniques repeatedly in a controlled and safe environment without risk to patients. Francesca BN et al., reported that mannequin-based training models helped healthcare workers better understand nasal anatomy and improved their ability to perform rhinopharyngeal swab collection [11]. Similarly, Chee J et al., demonstrated that the use of a three-dimensional (3D) printed nasal cavity model enabled trainees to visualise the anatomical pathway and improved adherence to correct swab trajectory and insertion depth during training [12]. Simulation training has also been shown to improve learner confidence and skill retention across a wide range of medical procedures [13].

Various simulation models, including mannequins and 3D-printed anatomical replicas, have been used for training in nasopharyngeal swab collection. However, the availability and cost of such commercial models may limit their widespread use, particularly in resource-limited settings. In the current context, the modified skull model used in the present study offers several practical advantages. The model was constructed using a cadaveric skull and readily available materials such as silicone, cotton pads, and foam padding to simulate key anatomical structures of the nasal cavity and nasopharynx. This design enabled trainees to visualise the correct pathway of swab insertion along the nasal floor while avoiding contact with the nasal roof or superior turbinate. The incorporation of coloured markers within the model also provided immediate visual feedback regarding the accuracy of swab placement, allowing participants to identify and correct procedural errors during practice.

Compared with commercially available models, the modified skull model provided realistic tactile feedback and closely simulated the anatomical constraints encountered during actual nasopharyngeal swab collection. In addition, the model was inexpensive, reusable, and easy to assemble, making it suitable for repeated training sessions. These characteristics make it particularly useful for training large groups of medical students and healthcare workers in institutions with limited access to expensive simulation equipment.

Several studies have suggested that false-negative results in respiratory viral testing are often attributable to inadequate specimen collection rather than inherent limitations of the diagnostic assay itself. The diagnostic accuracy of nasopharyngeal swab testing depends greatly on proper sampling technique and adequate specimen collection, as suboptimal collection methods may reduce viral detection and thereby compromise test sensitivity [14]. Similarly, large-scale screening programs described by Kwon KT et al., reported that variability in operator technique during high-volume testing could influence diagnostic accuracy [15]. Systematic reviews comparing different respiratory specimen types have also shown that nasopharyngeal swabs remain the reference standard when collected correctly [16]. Studies evaluating respiratory virus detection, including influenza, further indicate that improper sampling technique rather than specimen type is often responsible for reduced diagnostic sensitivity [17-19]. The significant improvement observed after training in the present study therefore highlights the value of structured simulation-based instruction in ensuring correct specimen collection.

The findings of the present study have important clinical and educational implications. Improving the technical proficiency of healthcare personnel in nasopharyngeal swab collection can enhance diagnostic accuracy, reduce patient discomfort, and minimise procedure-related complications. Introducing structured simulation-based training during undergraduate medical education allows students to develop procedural competence and confidence before performing the technique on patients. The modified skull model described in this study represents a practical, low-cost, and scalable training tool that can be easily implemented in medical institutions, particularly in resource-limited settings.

Limitation(s)

The present study had some limitations that should be considered while interpreting the findings. Although training using simulation models facilitates understanding of anatomical orientation and allows repeated hands-on practice, it cannot completely replicate real clinical conditions. In the present study, nasopharyngeal swab collection was performed only on the modified skull model, and participants' performance on actual patients was not evaluated. Therefore, the clinical transferability of the skills acquired during the training could not be assessed. In addition, the questionnaire used to assess knowledge and confidence was developed based on established procedural guidelines and underwent expert content validation; however, formal psychometric evaluation, such as assessment of internal consistency (e.g., Cronbach's alpha) or test-retest reliability, was not performed. This may limit the precision and reproducibility of the assessment tool. Similarly, although the trainer checklist was developed in accordance with standard procedural guidelines, performance assessment was conducted by a single observer, and inter-rater reliability could not be evaluated. The present study was also conducted at a single institution and involved only undergraduate medical students, which may limit the generalisability of the findings to other healthcare worker groups or educational settings. Finally, participants' awareness of being observed during the training sessions may have influenced their behavior and performance (Hawthorne effect), potentially contributing to the observed improvement after the intervention.

CONCLUSION(S)

The use of a simulated modified skull model for training medical students and healthcare professionals in nasopharyngeal swab collection proved to be an effective, affordable, and easily reproducible training method. The model provided a practical platform for hands-on learning and facilitated improvement in knowledge, procedural skills, and confidence related to nasopharyngeal swabbing. By enabling repeated practice in a controlled environment, such simulation-based training may help reduce inadequate sampling, false-negative results, patient discomfort, and complications associated with improper swabbing technique.

Future studies should evaluate the transferability of skills acquired through this training model to real clinical settings and assess long-term retention of knowledge and technical competence. Multicentric studies involving diverse groups of healthcare workers would further enhance the generalisability of the findings. Additionally, comparative evaluation with commercially available or three-dimensional printed simulation models, along with formal validation of assessment tools, may help strengthen the evidence base and support the integration of such training approaches into medical education curricula.

REFERENCES

[1] Centers for Disease Control and Prevention. Interim guidelines for collecting, handling, and testing clinical specimens from persons for coronavirus disease 2019 (COVID-19) [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2020. Available from: https://www.cdc.gov/coronavirus/2019-ncov/lab/guidelines-clinical-specimens.html.

[2] Pondaven-Letourmy S, Alvin F, Boumghit Y, Simon F. How to perform a nasopharyngeal swab in adults and children in the COVID-19 era. Eur Ann Otorhinolaryngol Head Neck Dis. 2020;137(4):325-27.

[3] Callesen RE, Kiel CM, Hovgaard LH, Jakobsen KK, Papesch M, von Buchwald C, et al. Optimal insertion depth for nasal mid-turbinate and nasopharyngeal swabs. Diagnostics (Basel). 2021;11(7):1257. Doi: 10.3390/diagnostics11071257.

[4] Marty FM, Chen K, Verrill KA. How to obtain a nasopharyngeal swab specimen. N Engl J Med. 2020;382(22):e76. Doi: 10.1056/NEJMvcm2010260.

[5] Higgins TS, Wu AW, Ting JY. SARS-CoV-2 nasopharyngeal swab testing—false-negative results from a pervasive anatomical misconception. JAMA Otolaryngol Head Neck Surg. 2020;146(11):993-94.

[6] Azar A, Wessell DE, Janus JR, Simon LV. Fractured aluminum nasopharyngeal swab during drive-through testing for COVID-19: Radiographic detection of a retained foreign body. Skeletal Radiol. 2020;49(11):1873-77. Doi: 10.1007/s00256-020-03582-x.

[7] Sullivan CB, Schwalje AT, Jensen M, Li L, Dlouhy BJ, Greenlee JD, et al. Cerebrospinal fluid leak after nasal swab testing for coronavirus disease 2019. JAMA Otolaryngol Head Neck Surg. 2020;146(12):1179-81. Doi: 10.1001/jamaoto.2020.3579.

[8] Piras A, Rizzo D, Uzzau S, De Riu G, Rubino S, Bussu F. Inappropriate nasopharyngeal sampling for SARS-CoV-2 detection is a relevant cause of false-negative reports. Otolaryngol Head Neck Surg. 2020;163(3):459-61. Doi: 10.1177/0194599820931793.

[9] Abud BT, Hajnas NM, Redleaf M, Kerolus JL, Lee V. Assessing the impact of a training initiative for nasopharyngeal and oropharyngeal swabbing for COVID-19 testing. OTO Open. 2020;4(3):2473974X20953094. Doi: 10.1177/2473974X20953094.

[10] Tagliabue M, Pietrobon G, Ugolini S, Chu F, Ansarin M. Nasopharyngeal swabs during SARS-CoV-2 pandemic: A role for the otolaryngologist. Eur Arch Otorhinolaryngol. 2020;277(7):2155-57.

[11] Francesca BN, Barbara P, Emanuele F, Francesco SDC, Giovanni C, Fabio M, et al. Could a mannequin simplify rhinopharyngeal swab collection in COVID-19 patients? Eur Arch Otorhinolaryngol. 2020;277(10):2947-48. Doi: 10.1007/s00405-020-06113-5.

[12] Chee J, Lin X, Lim WS, Loh WS, Thong M, Ng L. Using 3D-printed nose models in nasopharyngeal swab training. Oral Oncol. 2020;113:105033.

[13] McGaghie WC, Issenberg SB, Petrusa ER, Scalese RJ. A critical review of simulation-based medical education research: 2003-2009. Med Educ. 2010;44(1):50-63. Doi: 10.1111/j.1365-2923.2009.03547.x.

[14] Butler-Laporte G, Lawandi A, Schiller I, Yao MC, Dendukuri N, McDonald EG, et al. Comparison of saliva and nasopharyngeal swab nucleic acid amplification testing for detection of SARS-CoV-2: A systematic review and meta-analysis. JAMA Intern Med. 2021;181(3):353-60.

[15] Kwon KT, Ko JH, Shin H, Sung M, Kim JY. Drive-through screening center for COVID-19: A safe and efficient screening system against massive community outbreak. J Korean Med Sci. 2020;35(11):e123.

[16] Lee RA, Herigon JC, Benedetti A, Pollock NR, Denkinger CM. Performance of saliva, oropharyngeal swabs, and nasal swabs for SARS-CoV-2 molecular detection: A systematic review and meta-analysis. J Clin Microbiol. 2021;59(5):e02881-20.

[17] Vlek ALM, Wesselius TS, Achterberg R, Thijsen SFT. Combined throat/nasal swab sampling for SARS-CoV-2 is equivalent to nasopharyngeal sampling. Eur J Clin Microbiol Infect Dis. 2021;40(1):193-95.

[18] Spencer S, Thompson MG, Flannery B, Fry A. Comparison of respiratory specimen collection methods for detection of influenza virus infection. J Clin Microbiol. 2019;57(9):e00027-19.

[19] Patel MR, Carroll D, Ussery E, Whitham H, Elkins CA, Noble-Wang J, et al. Performance of oropharyngeal swab testing compared with nasopharyngeal swab testing for diagnosis of coronavirus disease 2019—United States, January-February 2020. Clin Infect Dis. 2021;72(3):482-85.

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[ANNEXURE I]

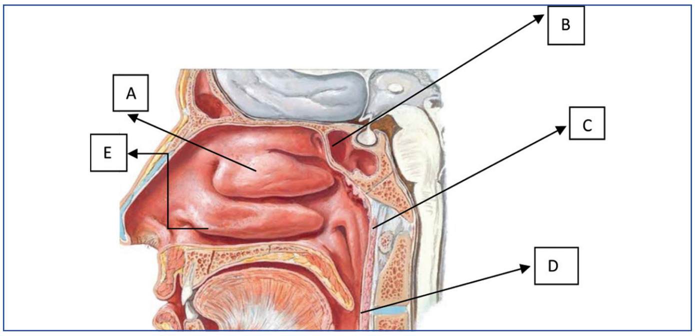
Pre-/post-training survey

Time: 10 min Date: ___________ S.No.______

Age:	Gender:
Have you taken nasopharyngeal swab before? Yes/No	

I. Following are some of the questions related to Nasopharyngeal swab sampling. Mark the option you feel as appropriate:

1. Which type of swab sampling has the maximum sensitivity?
   a. Nasopharyngeal
   b. Oropharyngeal
   c. Nasal
   d. Saliva
2. When is the ideal time to collect a swab from the upper respiratory tract?
   a. On the first day of development of symptoms
   b. On the 3rd day of symptoms
   c. On 4-6th day of symptoms
   d. Anytime it can be taken
3. What is the most preferred head position to take nasopharyngeal swab in adults?
   a. Head tilted slightly forward
   b. Head tilted slightly backwards
   c. Head tilted towards side of taking the swab
   d. Head in neutral position
4. How deep the swab stick must be inserted into the nasal cavity to obtain nasopharyngeal swab?
   a. About 1-2cm
   b. About 4-5 cm
   c. About 9-10 cm
   d. About 10-12cm
5. What is the preferred route to reach the nasopharynx with the swab?
   a. Along the lateral wall of nasal cavity along the floor
   b. Along the roof of nasal cavity near to the septum
   c. Along the roof of nasal cavity near to the lateral wall
   d. Along the floor of the nasal cavity near to the septum
6. What is the correct direction of insertion of swab for nasopharyngeal sampling?
   a. Towards the same side eye
   b. Towards the bridge of the nose along the dorsum
   c. Towards the same side external opening of the ear
   d. Towards the angle of mandible (lower jaw bone)
7. Which wall of the nasopharynx is preferred for swab taking?
   a. Anterior wall
   b. Posterior wall
   c. Lateral wall
   d. Floor/inferior wall
8. Identify the correct site for collecting nasopharyngeal swab in the following diagram of lateral wall of nose:



   a. A
   b. B.
   c. C
   d. D
   e. E
9. For how much time the swab should be left in place in the nasopharynx before withdrawing it?
   a. 1-2 seconds
   b. 1-2 minutes
   c. 3-4 seconds
   d. 8-10 seconds
10. Where should the swab be placed preferably after sampling from the nasopharynx before being sent to the laboratory?
   a. Keep it as it is in a sealed plastic bag
   b. In a vial containing normal saline
   c. In sodium hypochlorite solution
   d. Into viral transport medium

II. How confident are you feeling at present about taking a nasopharyngeal swab?
   a. 0- Not confident at all
   b. 1- Little confident
   c. 2- Somewhat confident
   d. 3- Confident
   e. 4- Very confident
   f. 5- Fully confident