A survey of physicians’ appreciation and knowledge about airway safety measures in the wake of COVID-19 pandemic

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Abstract

Background and Aims: The implementation of safety measures during airway management is a major concern to prevent COVID-19 transmission during pandemic. Various guidelines and advisories are in vogue to ensure safe practices. However, their success depends on the caregivers’ knowledge and understanding. This survey was conducted to assess the knowledge and safety concerns amongst physicians towards airway management in the background of COVID-19 pandemic.

Material and Methods: A survey instrument of thirty questions covering three timelines of airway management viz. ‘before’, ‘during’ and ‘after’ airway intervention was created. The questionnaire was electronically mailed to the eligible physicians over a period of one month via a web-based platform and the responses were analyzed. The responses were depicted numerically as percentage. A multiple discriminant analysis was used to test the accuracy of responses after adjusting for common variables.

Results: Out of 407 responses, 300 were eligible for analysis. The respondents with correct answers to questions with single correct response were 46%, 69% and 57.3%, along the three timelines and the respondents with more than 75% correct responses in questions with multiple correct responses were 49%, 58% and 31% along the same timelines. About 75% of the participants became aware of transmission through aerosols aftermath pandemic. About two-thirds of the participants had knowledge about the safety guidelines and recommendations. Majority of the respondents were aware of the safety measures ‘during airway intervention’.

Conclusion: Our study found satisfactory knowledge and appreciable concern among the practicing physicians regarding airway safety measures in the wake of COVID-19 pandemic. However, more physicians were aware about the measures required to be adopted ‘during’ airway intervention. The survey highlights the need for a more focused training of the caregivers about safety measures ‘before’ and ‘after’ airway intervention.

Keywords: Airway safety measures, COVID-19 pandemic, SARS CoV2

Introduction

COVID-19 pandemic has altered many conventional dynamics of patient care. Airway management technique is one such area as it results in increased risk of virus spread due to multiple reasons. The notable ones among them are the spread through aerosols, spread due to inadequate social distancing, and spread owing to the persistence of virus in the adjacent surfaces (‘fomites’). Hence a cautionary approach is obligatory on the part of physicians to minimize the risk of virus transmission.1-3

The anesthetists, intensivists, emergency medicine physicians and pulmonologists are the frontline caregivers involved in the day-to-day airway management and care. Various guidelines and advisories are advocated by...
professional and regulatory bodies towards safe practice during airway management in the wake of COVID-19 pandemic.\[1,4\] However, the success of these guidelines and advisories depend on the physicians’ perception of the safety issues and their comprehension about the remedial measures.\[13,31\]

Therefore, this survey was conducted to test the knowledge about safety measures and elicit the concerns of airway management among practicing anesthetists, intensivists, emergency care physicians and pulmonologists in relation to the published guidelines and advisories in the aftermath of the COVID-19 pandemic.

**Material and Methods**

This cross-sectional survey was based on a self-reported questionnaire received from physicians involved in airway management of patients. All practicing anesthetists, intensivists, emergency care physicians and pulmonologists with post graduate qualifications in their respective specialty and membership in any of the following societies were eligible for enrollment – Indian Society of Critical Care Medicine, Indian Society of Anesthesiologists, Society of Emergency Medicine India and Indian Chest Society. Those below 25 years or above 75 years of age, those who were either non-practicing or retired professionals, and those who responded the questionnaire from an email different from the one used by the investigators for correspondence, were excluded. The survey was conducted between 1\(^{st}\) April 2020 and 3\(^{rd}\) May 2020, with the first questionnaire being sent on 1\(^{st}\) April and the last response received on 3\(^{rd}\) May.

The questionnaire was constructed in two steps. In the first step, two sets of 20 questions each were separately framed by two investigators taking into consideration the safety guidelines and advisories of airway management published after the emergence of COVID-19 pandemic [Table 1]. In the second step, the two drafts were compiled into a single questionnaire of 30 questions by the third investigator on a web-based platform on Google Forms [Annexure 1]. The electronic mode of circulation was chosen for communication ease while ensuring social distancing. The questionnaire was pre tested in ten randomly selected physicians with expertise in airway management for relevance, clarity and appropriateness before putting into use.

The email IDs and telephone numbers of the prospective respondents were retrieved from the directory of Indian Society of Anesthesiologists (ISA), Indian Society of Critical Care Medicine (ISCCM), Society of Emergency Medicine India (SEMI) and Indian Chest Society (ICS) when available with confirmation of their post graduate qualifications. In addition, emails were sent to the offices of these societies soliciting their support in securing the email IDs of more members.

The email along with link to the survey questionnaire was mailed to all the eligible participants between 1\(^{st}\) April, 2020 and 1\(^{st}\) May, 2020. In case of no response, a reminder email was sent. Not more than three reminders were sent to any prospective participant within the stipulated period of one month. The study was also publicized on social media (WhatsApp, Twitter) for wider coverage and the respondents were encouraged to disseminate this information to their peers. The participation was purely voluntary with no incentives and informed consent for publication.

The questionnaire opened with a small description of the background and purpose of conducting the survey followed by a brief credential of the investigators. A total of 30 questions ranging across three timelines—before airway intervention, during airway intervention and after airway intervention—and were chronologically arranged in 4 parts [Figure 1]. All questions were close ended with multiple choice responses with the possibility of either single or multiple correct answers. The correct responses were the ones which were incorporated in any of the guidelines and advisories [Table 1].

The first part of the questionnaire had 9 questions pertaining to the demographic data of the respondents including their specialty, nature of practice, duration of practice, work experience in any COVID facility etc. The second part had 7 questions to assess the physician’s concern while handling a suspected COVID patient. The third part had 8 questions to understand the physicians’ concerns during intubation and ventilation. The fourth part had 6 questions enquiring the post intubation safety concerns and the benefits, if any this survey accrued to them.

The browser rejected incomplete submissions. Once submitted, the choices could not be altered. All completed data was stored electronically for processing and analysis. The qualitative variables were described by frequency distribution, while quantitative variables were described by the mean and standard deviation. The questions with single correct response was evaluated in percentage and the questions with multiple correct responses were divided into three quartiles of less than 50% correct response, between 50-75% correct response and more than 75% correct response. The responses
Table 1: Showing the published guidelines and position statements on safety measures on airway management aftermath COVID-19 pandemic

| Name of the Professional/Regulatory body | Title | Nature and date of publication | Site of publications | Key features used for formulating the survey questionnaire |
|------------------------------------------|-------|---------------------------------|---------------------|----------------------------------------------------------|
| American Society of Anesthesiologists   | Information for Health Care Professionals | Guidelines (March 2020) | https://www.asahq.org/about-asa/governance-and-committees/asa-committees/committee-on-occupational-health/coronavirus | Before airway intervention: AIIR, PPE, Planning (avoid rescue intervention). During airway intervention: Most experienced professional double gloves, RSI, double gloves, HEPA filter. |
| Indian Society of Anesthesiologists     | ISA National Advisory and Position Statement regarding COVID-19 | Advisory and position statement (April 2020) | Indian Journal of Anesthesia | Before airway intervention: PPE, avoid high flow O₂. During airway intervention: Experienced anesthesiologists, exchange filters, two layers of wet gauze over patient's nose and mouth, RSI, immediately inflate cuff, Video-laryngoscope, prophylactic administration of anti-emetic, supraglottic airway devices in 'cannot ventilate' situations. After airway intervention: Closed airway suction system, lung protective strategies: low TV (4-8 mL/kg PBW), High PEEP, Lower inspiratory pressures (PP <30 cmH₂O), pH goal 7.30-7.45. |
| Centre for Disease Control and Prevention | Information for Healthcare Professionals about Coronavirus (COVID-19) | Interim Infection Prevention and Control Recommendations (April 2020) | https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html | Before airway intervention: AIIR, Hand hygiene with 60-95% alcohol or soap and water for at least 20 seconds, PPE. During airway intervention: Limit personnel during procedure. After airway intervention: Disinfect procedure room, surfaces. |
| World Health Organization                | Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected | Interim guidance (March 2020) | https://www.who.int/publications-detail | Before airway intervention: PPE, hand hygiene, assessment if additional precautions needed (e.g., droplet, contact, or airborne), HFNO, NIV with close monitoring. During airway intervention: Intubation by experienced provider using airborne precautions. After airway intervention: MV: low TV (4-8 mL/kg PBW), higher PEEP, low inspiratory pressures (PP <30 cmH₂O), prone ventilation in severe ARDS. |
| Chinese Society of Anesthesiology Task Force on Airway Management | Expert Recommendations for Tracheal Intubation in Critically ill Patients with Novel Coronavirus Disease 2019 | Expert recommendations (February 2020) | Chinese Medical Sciences Journal | Before airway intervention: Airborne droplet PPE. During airway intervention: Experienced anaesthesiologist, familiar airway device, use of wet gauzes preoxygenation for 5 minutes, video-laryngoscopy, modified RSI, second-generation laryngeal mask. After airway intervention: ETT confirmation: direct vision, ETCO₂, thoracic movement, closed airway suction, HEPA filter. |

Contd...
to both types of questions were depicted numerically as percentage. Pearson’s Chi-square test was used to compare all categorical data. A multiple discriminant analysis was run to find how accurately a participant with formal or informal training can be expected to answer the questions correctly after adjusting for age, specialty and duration experience. All data were analyzed via Statistical Package for the Social Sciences (SPSS, version 24.0, Chicago, IL) software and significance was evaluated as $P < 0.05$ wherever relevant.

### Results

Out of 407 participants, 300 were found eligible for evaluation [Figure 1]. The mean age of the participants was $38 \pm 9.54$ years (mean $\pm$ SD) within a range of 25-75 years and male preponderance (2:1). The majority of the respondents were anesthesiologists (65.7%) followed by intensivists (18.3%). Most of them were practicing in a single institution (89.3%). Their average duration of experience was $9.8 \pm 8.9$ years (mean $\pm$ SD) within a range of 3-44 years. 22.7% of the respondents were working in a dedicated COVID hospital. 23% of the respondents received safety training during airway management in COVID patients and 60.3% were self-trained. Majority of them were practicing in India (98%) [Table 2].

The ‘before airway intervention’ timeline consisted of 3 single correct response questions and 3 multiple correct response questions [Figure 2]. The percentage of participants with correct response to single correct response questions were 63%, 35% and 40%, respectively, and the percentage of respondents with more than 75% correct responses to

### Table 1: Contd...

| Name of the Professional/Regulatory body | Title | Nature and date of publication | Site of publications | Key features used for formulating the survey questionnaire |
|----------------------------------------|-------|---------------------------------|----------------------|----------------------------------------------------------|
| CHEST                                  | COVID-19 Precautions during airway management | Advisory (March 2020) | Official site https://www.chestnet.org/Guidelines-and-Resources/COVID-19/Updates-and-Resources | Before airway intervention
Negative pressure room, anterooms for PPE, designated intubation cart, N95 or higher respirator, minimizing personnel, debrief and share lessons
During airway intervention
Experienced provider, preoxygenation for 5 min, RSI, dedicated Video-laryngoscope, lidocaine as cough suppressant during intubation
After airway intervention
Exposure monitoring for all HCWs exposed to COVID-19 patient |
| Anaesthesia 2020* | Consensus guidelines for managing the airway in patients with COVID-19: | Guidelines (March 2020) | Anaesthesia | Before airway intervention
Negative pressure room $>12$ AE/h, COVID-19 intubation trolley, limit staff (intubator, assistant, drug administrator, runner), PPE with double gloves, communicate plan, cognitive aids
During airway intervention
Best skilled airway manager, preoxygenation for 5 min, two person-two hand technique, video-laryngoscope, supraglottic airway device, HME filters, RSI, clamp tube
After airway intervention
Confirm with capnogram |
| International Anesthesia Research Society | Recommendations for Endotracheal Intubation of COVID-19 Patients | Editorial (March 2020) | Anesthesia- analgesia | Before airway intervention
PPE (head covers not standardized), plan ahead
During airway intervention
Most experienced anesthetist, preoxygenation for 5 min, RSI, avoid awake fibreoptic intubation, high efficiency hydrophobic filter
After airway intervention
Robust communication system: front-line health care providers to provide rapid feedback to policy makers and vice versa |

*AIIR=Airborne Infection Isolation Room, PPE=Personal Protective Equipment, RSI=Rapid Sequence Induction, HME=Heat and Moisture Exchange, HEPA=High Efficiency Particulate Air, MV=Mechanical ventilation, TV=Tidal Volume, PBW=Predicted Body Weight, PP=Plateau Pressure, PEEP=Peak End-Expiratory Pressure, HFNO=High Frequency Nasal Oxygen, NIV=Non-Invasive Ventilation, ARDS=Acute Respiratory Distress Syndrome
Multiple correct response questions were 55%, 32% and 60%, respectively [Figures 3 and 4].

The ‘during airway intervention’ timeline contained 4 single correct response questions and 2 multiple correct response questions [Figure 1]. The percentage of participants with correct response to single correct response questions were 52%, 35%, 76% and 66% respectively and the percentage of respondents with more than 75% correct responses to multiple correct response questions were 71% and 45% respectively [Figures 5 and 6].

It was found that 75% of the participants were unaware about the risk of COVID-19 spread through aerosol generation before the pandemic, but 90% became aware of the same after the pandemic. About 11% were not adopting any measures to minimize the aerosol borne transmission of the virus. About 81% of the participants considered prior training as helpful in improving their knowledge and skills. Two thirds of the respondents were thoroughly abreast with the published safety guidelines and recommendations, while 30% were partially aware but not fully well-versed. About 62% of the physicians found our survey to be useful in expanding their knowledge about safety measures during airway management in relation to COVID-19 pandemic while 35% found it to be moderately useful [Figure 9].

Multiple discriminant analysis was run to find how accurately one can predict if a participant formally trained or informally trained or not at all trained in airways management can provide answer to the questions. The canonical variables were compared to some of the selected questions where the function was represented according to the regression equations depending on the choices of answer. 63% of original grouped cases are correctly classified in this model. Cases in blue color (not trained, but gained information from other sources) were well separated, reflecting fewer errors in classification and 97.8% correct classification [Figure 10].

**Table 2: Demographic profile of respondents**

| Demographic variables | Values |
|-----------------------|--------|
| Age (years) Mean±SD (Range) | 38±9.54 (25-75) |
| Gender n (%) | |
| Male | 186 (62%) |
| Female | 114 (38%) |
| Speciality n (%) | |
| Anaesthesiology | 197 (65.7%) |
| Critical Care | 55 (18.3%) |
| Respiratory Physician | 6 (2%) |
| Emergency Physicians | 42 (14%) |
| Type of hospital practice n (%) | |
| Single hospital | 268 (89.3%) |
| Multiple hospitals | 27 (9.0%) |
| Transport & ambulances | 5 (1.7%) |
| Experience (years) Mean±SD (Range) | 9.86±8.91 (0-44) |
| Working in designated COVID-19 hospital n (%) | |
| Yes | 68 (22.7%) |
| No | 232 (77.3%) |
| Have you received any formal training? n (%) | |
| No, but have gained knowledge | 181 (60.3%) |
| No, no prior knowledge than this | 50 (16.7%) |
| Yes | 69 (23.0%) |
| Geographical location | |
| India | 242 (80.7%) |
| Outside India | 6 (2%) |
| Unknown | 52 (17.3%) |

Discussion

Our study found a considerable gain in the knowledge of SARS CoV2 transmission via aerosol among physicians involved in airway management aftermath COVID-19 pandemic. There are enough reasons for the same. Although coronaviruses have infected human beings since the late 1960s, their lethal potential was only recognized after the outbreak of severe acute respirator syndrome (SARS) in 2002 and Middle East respiratory syndrome (MERS) in 2012. The major difference between SARS CoV of 2002 and SARS CoV2 of 2019 (COVID-19) is that in the former the virus load reached high levels much later during the
illness and was concentrated much less in the nasal cavity and nasopharynx.[6,7] MERS although had a higher case fatality exceeding 30% but was less transmissible than SARS CoV. Hence, the spread of the virus during airway manipulations occurred in much lesser magnitude after SARS CoV and MERS than SARS CoV2. The lesser spread fostered lesser data and limited sharing of experiences. No guidelines or advisories were published following earlier outbreaks for guiding safety measures during airway management by the professional or regulatory bodies. This was in contrast after SARS CoV2. Long before COVID-19 was declared as a pandemic by WHO, Singapore General Hospital framed guidelines for airborne and contact precautions, including environmental safety measures, staffing pattern, disinfection practices, sterilization safeguards and personal protective equipment (PPE) utilization.[8] Similar guidelines were also in vogue in Korea, Hong Kong and Germany.[9] This led to more sensitization of physicians all over the world and many who were earlier unaware about the risk of virus transmission during airway management became aware of the same during the current pandemic.
that the physicians are more observant and particular during the performance of endotracheal intubation and airway management procedures and hence more careful about the safety measures during such acts. It was reported during SARS CoV outbreak that healthcare workers performing or being exposed to a tracheal intubation had a higher risk of SARS CoV transmission compared to unexposed healthcare workers.[10] Hence, it is obvious that SARS CoV2 which has far greater infectivity than SARS CoV can pose an even higher risk of disease transmission during acts of airway intervention. So, the greater awareness among physicians about safety measures ‘during airway intervention’ as reflected from the increased correct responses can ensure the lesser likelihood of virus spread during airway intervention. But it is important to recognize the high rate of ‘fomite’ born transmission that can take place during airway intervention. But it is important to recognize the high rate of ‘fomite’ born transmission that can take place during airway intervention.

In one study, where generalized estimating equation (GEE) logistic regression models and classification and regression trees (CART) were used for the identification of risk factors for SARS transmission, it was found that the presence more number of personnel and for greater time period inside the

Our study extracted more correct responses for the questions pertaining to the events occurring ‘during airway intervention’ than those ‘before’ or ‘after’ airway intervention. This suggests that the physicians are more observant and particular during the performance of endotracheal intubation and airway management procedures and hence more careful about the safety measures during such acts. It was reported during SARS CoV outbreak that healthcare workers performing or being exposed to a tracheal intubation had a higher risk of SARS CoV transmission compared to unexposed healthcare workers.[10] Hence, it is obvious that SARS CoV2 which has far greater infectivity than SARS CoV can pose an even higher risk of disease transmission during acts of airway intervention. So, the greater awareness among physicians about safety measures ‘during airway intervention’ as reflected from the increased correct responses can ensure the lesser likelihood of virus spread during airway intervention.

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room harboring SARS CoV patient increased the risk of SARS-CoV transmission among healthcare workers.\textsuperscript{[11]} This may be explained on account of failure to maintain sufficient social distancing in the wake of limited availability of PPE in 2002. This is another area where more caution is required as per our survey results. Simulation and debriefs are smart and novel ways for system testing. Besides limiting the PPE usage in resource crunch settings, it can measure the time required for donning in special situations viz. ambulances, ICU etc. The mock PPEs are particularly useful for repetitive exercises like adaption to sign language, task collaboration between ‘clean’ and ‘non-clean’ workers and infection control during handover and transport.\textsuperscript{[12]}

The likelihood of extra cautious during endotracheal intubation that is depicted in our survey from the high correct response rates to such questions have been also observed in the earlier studies.\textsuperscript{[13,14]} This approach is reassuring because it allows early recognition of failures and facilitates post exposure prophylaxis in cases of PPE failure.\textsuperscript{[15]}

In the timelines of ‘before’ and ‘after airway intervention’ the lesser number of correct responses to the survey questionnaire suggests lesser vigilance of the physicians towards the safety measures. This may be possible on account of shared responsibility of the physicians with other workers which can lead to diminution in their vigilance.\textsuperscript{[16]} Furthermore, many maneuvers like tracheobronchial toileting, drug nebulization etc. are performed by the nursing personnel, anesthesia assistant etc., and not by the physicians or intensivists. Therefore, considerable scope for increased virus transmission exists during these acts if the concerned workers are less vigilant. Hence, good nursing education coupled with good training of the paramedical personnel is necessary for preventing virus transmission to the healthcare workers during these steps.\textsuperscript{[16,17]}

The participants in our survey were wary about the ventilation maneuvers and some of the answers to the survey questions were incongruent. This occurred due to repetitive changes in the position of the expert bodies about the ventilatory strategies for COVID patients. While the initial recommendations called for either oxygen therapy or early invasive ventilation with near total abolition of non-invasive ventilation (NIV) and high flow nasal cannula (HFNC), the later directives urged for HFNC in selective patients. This occurred after the recognition of L and H as 2 distinct variants of COVID-associated pneumonia where spontaneous ventilation was preferred in the former and early invasive ventilation in the later. Even when invasive ventilation was required, the applied PEEP was normal to low in the former and high in the later.\textsuperscript{[18-20]} These frequent shifts in our ventilatory strategies within a narrow time frame created some knowledge gap amongst physicians. The variable responses to the questions about ventilatory strategies in our survey highlight this fact.

In our study, more physicians felt the need for comprehensive training programs. This not only points to some inadequacies in our current training methods but also proposes to use a focused approach during training of professionals. In reality there may be much variation in physicians’ practice of donning and doffing of PPE, in the performance of bronchoscopy and overall aptitude. A specialty-based focused training of professionals can correct the specific deficiencies in a better way. A focused training can also identify such barriers which show inter-individual variation viz. inability to converse after wearing PPE, easy of response to sign language etc. Since the learning curves depend on the specialty and exposure, simulation based training can be utilized as corollary to real time scenarios. Our survey found that the physicians were happier after receiving training in a COVID hospital. This may be due to the psychological effect of experiencing training in real time. Most of the findings of our study are likely to yield correct responses as per the multiple discriminant analysis in our canonical graphs.

Finally, our survey found that many participants gained knowledge about the safety measures against virus transmission during airway management after participating in our survey. Therefore, besides gathering information, our survey was useful in propagating awareness the airway safety measures. This happened because many of our participants were not affiliated to teaching institutions and were practicing in small hospitals. There were also logistic constraints across many parts of our country owing to inadequate PPE supply, lack of N95 masks etc. during the initial phase of the pandemic. Therefore, despite propagation of awareness, its implementation on ground level was wanting.

Our survey had some limitations. One, it was conducted in a diverse group of practitioners with large variation in their experience, knowledge and skills. This can influence or results. Second, the sample was small as only twenty five percent of the emails were responded. This may be because of the hectic duty shifts of the physicians during the pandemic. Third, our survey was pre tested among the physicians of 2 out of 4 specialties before use, and hence may have escaped the more stringent scrutiny. Despite these shortcomings, we were able to secure reliable data and perform consistent analysis.

To conclude, our survey found satisfactory knowledge and requisite concern among the practicing physicians towards the
risk of virus transmission during airway management in the wake of COVID pandemic. However, since our observation is based on a small and heterogeneous cohort of physicians from multiple specialties it cannot be generalized for entire population. More studies are required to understand the subtle differences in practice patterns and create measurement tools for ensuring safety of the patient and health care workers in such environment.

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**Conflicts of interest**

There are no conflicts of interest.

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