Original Article

Impact of COVID-19 specific simulation training in improving intubators' level of comfort during intubations of COVID-19 patients - Results from a USA national survey

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ABSTRACT

Background: Tracheal intubation is a hazardous aerosolizing procedure with a potential risk of spreading SAR-CoV-2 between patients and physicians.
Aim: The purpose of this study was to explore the impact of COVID-19 specific simulation training in improving provider level of comfort during the intubation of COVID-19 patients.
Methods: In this cross-sectional national study, an electronic survey was disseminated using a snowball sample approach to intubators from 55 hospitals across the United States. The survey assessed providers' comfort of intubating and fear of contracting the virus during COVID-19 intubations.
Results: A total of 329 surveys from 55 hospitals were analyzed. Of 329 providers, 111 providers (33.7%) reported participating in simulation training. Of those, 86 (77.5%) reported that the simulation training helped reduce their fear of intubating COVID-19 patients. Providers in the simulation training group also reported a higher level of comfort level with intubating both general patients (median [range] no-simulation training group 9 [3—10], simulation training group 9 [6—10]; p = 0.015) and COVID-19 patients (no-ST 8 [1—10], ST group 9 [4—10]; p < 0.0005) than providers in the no-simulation training group.
Conclusions: Our study suggests that COVID-19 specific intubation simulation training promotes provider comfort. Simulation training may be implemented as part of airway management training during the current and novel pandemic situations.

1. Introduction

Front line healthcare providers have been combatting the COVID-19 pandemic for over a year and more than 300,000 physicians have contracted the virus worldwide [1]. Tracheal intubation places providers at risk of contracting SAR-CoV-2 due to airway proximity and aerosolization [2]. Since an estimated 8% of COVID-19 patients eventually require tracheal intubations, there have been multiple studies addressing the safety concerns regarding COVID-19 intubations [2—5]. Few studies have explored the risk of intubating physicians contracting COVID-19 [6]. However, a systematic review evaluating the risk of transmission of the 2003 severe acute respiratory syndrome coronavirus (SAR-CoV-1) showed that intubators had >8 times the odds of developing SARS (95% confidence interval 5.3, 14.4) [7].

Simulation training is a commonly used strategy in airway management education and has been found to increase providers comfort in intubation [8—10]. More recently, simulation training has been used to prepare healthcare providers for airway management of COVID-19 patients [11—15]. One study assessing the

utility of a simulation training educational intervention in 93 physicians found that simulation training increased providers' comfort in suspected COVID-19 intubations compared to baseline comfort prior to the simulation, a difference of 1.3 points on a 5-point Likert scale (95% confidence interval 1.06–1.54, p < 0.001) [12]. Furthermore, studies have demonstrated that simulation training for nasal swabbing and managing a critically ill patient during the COVID-19 pandemic lead to increased provider comfort during these situations [16,17].

To the best of our knowledge, there are no national studies in the US addressing the benefits of simulation training in airway management during the COVID-19 pandemic. To develop a more robust understanding of airway management in patients with COVID-19 in USA hospitals, we created a national survey to assess provider comfort in intubating such patients.

2. Methods

2.1. Ethics committee approval and informed consent

We developed a Research Electronic Data Capture (REDCAP, Vanderbilt, Tennessee) database for this observational project and obtained IRB approval to disseminate this survey to providers across the United States (IRB number: NCR202652) [18]. Informed consent was obtained from all providers prior to participation.

2.2. Survey design and distribution

This cross-sectional, survey-based, national study was conducted during the COVID-19 pandemic from September 2020 to January 2021. We contacted 159 anesthesiology, 254 emergency medicine, and 123 otolaryngology program directors via e-mail to disperse the survey to their residents, fellows, attendings, physician assistants, and certified nurse anesthetists using a snowball sample approach. A follow-up email was sent to program directors that did not respond to our original email after four weeks. We aimed to increase the reliability of our study through many ways. We pilot tested this survey for reliability and validity with a group of anesthesiology residents at our institution. To ensure validity, we used exposure questions retrieved from a COVID-19 healthcare workers stressors survey [23]. Additionally, we emailed multiple specialties and geographic sites to ensure generalizability.

The 24-question self-administered anonymous online survey collected demographic data, exposure information, and intubation experience. Demographic data included age, gender, race, position (attending physician, fellow, resident physician), specialty, primary intubation site, and number of confirmed or suspected COVID-19 intubations. Primary intubation sites were then categorized into four statistical regions defined by the United States Census Bureau: Northeast, Midwest, South, and West [24]. Exposure information included history of positive COVID-19 test, quarantine for potential COVID-19 exposure, being the parent or primary caregiver for a school-aged child or infant and/or a person more than 80 years, and having friends/close relatives who have contracted COVID-19. Intubation experience included participation in a dedicated intubation team, education and/or training in donning and doffing personal protective equipment, simulation training, and a negative pressure environment.

In this study, simulation training was broadly defined as participation in exercises like donning and doffing PPE, managing airways with equipment on, and using assistive devices like video laryngoscopes. A scale of 1–10 was used to assess providers' comfort of intubating and fear of contracting COVID-19 during confirmed or suspected COVID-19 intubations. A value of 10 denoted maximum fear or comfort, depending on the question. The comfort question asked: "How comfortable are you with intubation in general?" The fear question asked: "On a scale from 1 to 10, how would you rate your fear of contracting COVID-19 during your FIRST intubation of a confirmed or suspected COVID-19 patient?" Similar questions were asked for "subsequent intubations". The survey is attached in Appendix 1.

Inclusion criteria were: (1) responses from anesthesiology and emergency medicine providers and (2) an experience with at least one confirmed or suspected COVID-19 intubation. We excluded (1) incomplete survey responses, (2) providers who had not intubated a patient with confirmed or suspected COVID-19, and (3) responses from otolaryngology providers due to an insignificant number of responses.

2.3. Statistical analysis

Data analysis was performed using SPSS (version 27, IBM Corp, Armonk, USA). The difference in the distribution of demographic information across the simulation training group and no simulation training group was tested by the chi-square independence test and Fisher's exact test for nominal variables, and Mann-Whitney U for ordinal variables. Additionally, an ordinal logistic regression was used to control for confounding variables and to produce an odds ratio. Statistical significance was declared as a probability of less than 0.05.

3. Results

We received a total of 408 survey responses from providers across the USA. After excluding 63 incomplete responses, 5 responses from otolaryngology providers, and 11 responses from providers with no experience with confirmed or suspected COVID-19 intubations, 329 surveys were used in our statistical analysis. The survey responses came from 55 hospitals. Of those, 39 (70.9%) were from academic centers, 15 (27.3%) were from private hospitals, and 1 (1.8%) was from a military hospital. Thirty-four hospitals (61.8%) had providers participating in simulation training. Most hospital responses came from the Northeast in both the no-simulation training group (22 [44.9%]) and the simulation training group (19 [55.9%]) followed by South in the no-simulation training group (11 [22.4%]) and West (6 [17.6%]) in the simulation training group. The percentage of simulation training participants within each region ranged from 3.8% to 36.5%.

Survey responses were categorized into a simulation training group (111 [33.7%]) and no simulation training group (218 [66.3%]) based on the question, "Did you participate in a simulation training to prepare for COVID intubations?" Most of the responses from both the simulation training group and no-simulation training group were white [85 (76.6%), 160 (73.4%)], male [60 (54.1), 123 (56.4%)], and in the age range between 25 and 35 years [54 (48.6%), 121 (55.5%)]. A similar number of responses came from both attending physicians (96 [43.6%]) and resident or fellow physicians (93 [42.7%]) in the no-simulation training group. However, more responses came from attending physicians (50 [45%]) in the simulation training group. The simulation training group had more responses from anesthesiology or anesthesiology/critical care providers (57 [51.4%]) while the no-simulation training group had more responses from emergency medicine or emergency medicine/critical care providers (119 [54.6%]). Most of the responses reported 0–5 years of practice (61 [55%], 130 [59.6%]) and 1–5 confirmed or suspected COVID-19 intubation(s) (53 [47.7%], 97 [44.5%]) in both the simulation training group and no-simulation training group. There were no statistical differences in demographic information between the simulation training group and the no-simulation training group. Table 1 lists the demographic characteristics of

Table 1
Demographic information (N = 329).

		No simulation training		Simulation training		p-value
		N	%	N	%	
Total N		218	66.3%	111	33.7%	
Age (years)	25–35	121	55.5	54	48.6	0.159
	36–45	56	25.7	27	24.3	
	46–55	20	9.2	18	16.2	
	>60	21	9.6	12	10.8	
	Mean (SD)	37.7 (10.0)		39.5 (10.5)		0.132
Gender	Male	123	56.4	60	54.1	0.683
	Female	95	43.6	51	45.9	
Race	White	160	73.4	85	76.6	0.892
	Asian	24	11	10	9	
	Black	8	3.7	2	1.8	
	Hispanic	5	2.3	2	1.8	
	Other	7	3.2	3	2.7	
	Multiracial	14	6.4	9	8.1	
Position	Attending physician	95	43.6	50	45	0.351
	Resident or fellow physician	93	42.7	40	36	
	CNA or PA	30	13.8	21	18.9	
Specialty	EM or EM/CC	119	54.6	54	48.6	0.308
	Anes or Anes/CC	99	45.4	57	51.4	
Years in practice	0–5	130	59.6	61	55	0.183
	6–10	36	16.5	14	12.6	
	11–15	21	9.6	10	9	
	>16	31	14.2	26	23.4	
	Mean (SD)	7.6 (8.2)		9.5 (9.7)		0.053
Number of confirmed or suspected COVID-19 intubation	1–5	97	44.5	53	47.7	0.204
	6–10	52	23.9	34	30.6	
	11–15	19	8.7	5	4.5	
	16–20	25	11.5	13	11.7	
	>20	25	11.5	6	5.4	
	Mean (SD)	11.1 (10.4)		10.1 (12.2)		0.262

*statistically significant at p < 0.05. CNA= Certified nurse anesthetist; PA= Physician Assistant; EM = Emergency Medicine; Anes = Anesthesiology; CC= Critical Care.

Table 2
Regional differences in simulation training. Providers in the study, N = 329. Hospitals in the study, n = 55.

	No simulation training				Simulation training					% simulation training participants within region
	Hospital		Participants		Hospital		Participants			
	N	%	N	%	N	%	N	%	Total N	
Northeast	22	44.9%	116	53.2%	19	55.9%	67	60.4%	183	36.6%
South	11	22.4%	57	26.1%	4	11.8%	7	6.3%	64	3.8%
West	8	16.3%	39	17.9%	6	17.6%	21	18.9%	60	11.5%
Midwest	8	16.3%	6	2.8%	5	14.7%	16	14.4%	22	8.7%
Total	49	89.1%	218	66.3%	34	61.8%	111	33.7%	339	60.7%

the participants, and Table 2 lists the geographic characteristics of the participants. Table 2 demonstrates that not all providers within a single hospital completed simulation training, even if it was available at their institution.

The majority of responses from exposure questionnaires in both groups reported no positive test for COVID-19, no history of quarantine for potential COVID-19 exposure, not being a parent or primary caregiver for a school-aged child or infant, or a person over the age of 80, and not having friends or close relatives who have contracted COVID-19. There were no statistical differences in various exposure factors between the simulation training group and the no-simulation training group. Fig. 1 summarizes the exposure factors of the participants.

Compared to the no-simulation training group, the simulation training group had a higher intubation comfort level for both general patients (p = 0.015) and COVID-19 patients (p < 0.0005). Table 3 summarizes the intubation experience of the participants. An ordinal logistic regression model showed that the simulation training group had a 2.4 times higher comfort level during COVID-19 intubation compared to the no-ST group (Table 4).

Among the simulation training-group (n = 111), 77.5% of providers (n = 86) reported a "reduction in fear" after simulation training, 13.5% (n = 15) reported "no change in fear", and 9.0% (n = 10) reported "not sure". See Table 5 for detailed information.

4. Discussion

In this cross-sectional, survey-based, national study that examined factors affecting intubations of suspected and confirmed COVID-19 patients in the United States, the majority (77.5%) of survey participants that received simulation training for COVID-19 intubations reported that simulation training helped reduce their fear of intubating COVID-19 patients. Providers in the simulation training group reported a higher comfort level with intubating both the general population and COVID-19 suspected/confirmed patients (p = 0.015 and p < 0.0005, respectively).

Our findings support prior studies showing the utility of simulation training in airway management in the general population [9,10,19–21]. Simulation training has been an educational strategy used for more than 50 years [10]. Studies prior to the COVID-19
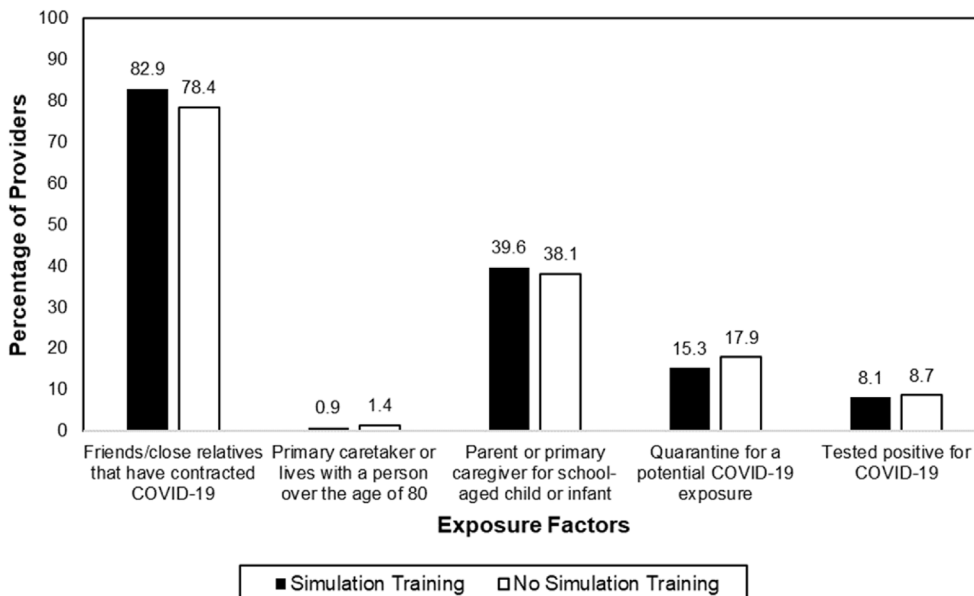
Fig. 1. Comparison of exposure factors between the simulation training and no-simulation training groups (N = 329).

Table 3
Intubation experience (N = 329).

		No simulation training		Simulation training		
		Median (range)	p-value	Median (range)	p-value	p-value
Intubation comfort level[a]	General patients	9 (3—10)	a<0.0005	9 (6—10)	a<0.0005	a0.015
	COVID-19 patients	8 (1—10)		9 (4—10)		a<0.0005
Fear level of contracting COVID-19	First intubation	7 (1—10)	a<0.0005	7 (1—10)	a<0.0005	0.719
	Subsequent intubation	4 (1—10)		3 (1—10)		0.08

[a] Statistically significant at p < 0.05; CC= Critical Care. a1 = least comfortable, 10 = most comfortable. b1 = no fear, 10 = most fear.

Table 4
Comparison of comfort and fear levels between the no simulation training group and the simulation training group.

	General Intubation comfort level		COVID-19 intubation comfort level		Fear level of contracting COVID-19 during <u>first</u> intubation of suspected COVID-19 patients		Fear level of contracting COVID-19 during <u>subsequent</u> intubation of suspected COVID-19 patients	
	p-value	odd ratio	p-value	odd ratio	p-value	odd ratio	p-value	odd ratio
No simulation training	a0.007	1	a0.0005	1	0.632	1	0.054	1
Simulation training		1.96		2.36		1.103		0.67

[a] Statistically significant at p < 0.05 using ordinal logistic regression.

Table 5
Impact of simulation training on fear level (N = 111).

Simulation training	N	%
No change in fear	15	13.5%
Reduction in fear	86	77.5%
Not sure	10	9.0%

pandemic have surveyed otolaryngology and surgery residents and found that simulation training in airway management have increased providers' comfort in performing intubations [9,19,21]. A systematic review and meta-analysis of 6066 participants in anesthesiology found that simulation training in airway management is more effective than no intervention [20].

Our findings also support prior studies showing the utility of simulation training in airway management in COVID-19 patients.

Simulation training in airway management has been shown to improve both technical and non-technical skills in high-risk clinical scenarios [21], which supports the utility of simulation training in the novel and rapidly evolving COVID-19 pandemic. Munzer et al. (2020) designed an airway algorithm and a simulation training clinical scenario for COVID-19 intubation and surveyed 93 physicians about their comfort level before and after the completion of the training in a retrospective fashion [12]. The study found that simulation training increased providers' comfort compared to baseline comfort prior to the simulation, a difference of 1.3 points on a 5-point Likert scale (1.06—1.54, p < 0.001) [12]. Thus, prior literature supports our findings where providers in the simulation training group reported a higher comfort level in intubating COVID-19 suspected and confirmed patients (p < 0.0005). While the previous study was limited in sample size, our study had 329 subjects increasing the generalizability of our findings.

While many of the cited studies have captured the increase of comfort in intubation prior to and after simulation training, these studies may be limited by the Hawthorne effect, where the behaviors of the subjects are altered due to the awareness of being observed [22]. In contrast, our work presents a cross-sectional study mitigating that effect. To the best of our knowledge, this is the first national study addressing the benefits of simulation training in airway management during the COVID-19 pandemic in the USA. Additionally, no prior studies have assessed the relationship between simulation training and perceived fear of contracting SAR-CoV-2 during suspected and confirmed COVID-19 intubations.

Within the hospitals participating in simulation training, the attendance of simulation training ranged from 6.7% to 100.0%. For example, the attendance was 42.9% at our own institution. At our institution, we ran an intensive two-week simulation training to help familiarize health care providers with emergent COVID-19 related airway and respiratory decompensation. Each training group was comprised of a multidisciplinary team of a safety officer, ICU nurse, respiratory therapist, internal medicine providers, and two airway providers. Each time a COVID BLUE 19 drill was announced, a safety officer arrived to the patient room with a "COVID-19 backpack," containing equipment like a video laryngoscope, ET tube, CO_2 meter, plastic drape, PPE, and medications for proper airway management. To minimize exposure, only airway providers and nurses donned PPE and entered the rooms while everyone else stood behind closed doors to assist with ventilator associated questions. Airway providers practiced how to set up a mock ventilator with the BB25 filter placed proximal to the CO_2 sample line to minimize contamination of airflow into the ventilator. Many providers expressed better comfort and less fear following this training. Given these findings, institutions can improve COVID-19 airway management for patients and the wellness of providers by making simulation training sessions mandatory. Mandatory simulation training sessions have already been reported in the literature [9].

Similar to many survey studies, limitations to our study include response bias, as many institutions did not distribute our survey. We employed strategies, such as emailing institutions individually rather than in one mass email and sending follow up emails to non-respondents, to increase recruitment of subjects. This made it challenging to report a true response rate for this study. Additionally, we piloted the survey with a small group of anesthesiologists at our institution before distributing it on a national level via a Research Electronic Data Capture (REDCAP, Vanderbilt, Tennessee) database. Given the pressing nature of this study, we were unable to pilot the study with physicians from other specialties or complete multiple rounds of revisions. We also acknowledge that a snowball sampling technique may have introduced sampling bias to our study. Initial participants may have nominated people they knew well to complete our survey. As a result, it is possible that subjects from different institutions shared the same characteristics. Ultimately, we decided to use a snowball sampling approach in order to reach populations that may have been difficult to sample using other sampling methods. This method enabled us to gather more responses across the United States in a cost-efficient way.

Future studies from diverse institutions are recommended to explore the impact of simulation training and the generalizability of our findings. Since our study is survey-based and cross sectional, we could not infer causality. While we found that the simulation training group had a higher comfort level in intubating COVID-19 patients as well as general patients, there could be confounding factors influencing the providers' comfort levels. Providers who participated in simulation training for non-COVID-19 specific intubations may have been more inclined to participate in simulation training for COVID-19 specific intubations and therefore benefit from the training. It is also possible that the COVID-19 specific simulation training has helped providers improve their comfort level while intubating general patients.

Although this study asked providers about their participation in COVID-related simulation exercises, it did not analyze responses by exercise type like donning and doffing PPE, managing airways with equipment on, and using assistive devices like video laryngoscopes. Future work should stratify simulation exercises by type and duration of training sessions to assess whether differences in comfort and fear levels were due to variations in equipment and preparation time between and within institutions. Gathering this information will help us upgrade existing exercises and develop further cost-conscious curriculums.

5. Conclusions

This study demonstrates the utility of simulation training in increasing the comfort in the technique of intubation and decreasing the fear of contracting the virus in intubating suspected or confirmed COVID-19 patients. This utility was shown amongst different specialties, ages, years in practice, and position. We hope that our study will encourage institutions to promote attendance of simulation training to improve both the care of COVID-19 patients and the wellness of providers taking care of these patients.

CRediT authorship contribution statement

Reem Qabas Al Shabeeb: Conceptualization, Methodology, Writing − original draft. **Esther Lee:** Conceptualization, Methodology, Data curation, Formal analysis, Writing − original draft. **Muhammad El Shatanofy:** Conceptualization, Methodology, Writing − original draft. **Collin F. Mulcahy:** Conceptualization, Methodology, Writing − original draft. **Marian L. Sherman:** Conceptualization, Methodology, Writing − review & editing, Supervision. **Eric R. Heinz:** Conceptualization, Methodology, Formal analysis, Writing − review & editing, Supervision. **David P. Yamane:** Conceptualization, Methodology, Formal analysis, Writing − review & editing, Supervision.

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tacc.2022.01.004.

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