Training on a simulator improves proficiency of percutaneous tracheostomy placement compared to didactic training: a double-blinded, randomized controlled trial

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Background

Percutaneous tracheostomies (PT) are inserted by general surgeons at our academic centres, and this procedure has a learning curve associated with high patient risk. Learners unfortunately have low volume exposure due to the fluctuating need for tracheostomy, which often leaves them with reading or observation as the only options. Repetitive practice is paramount in surgical education, which makes mastery of this procedure challenging due to short supply of cases. Our aim was to mitigate this difficulty with the introduction of simulation. We hypothesized that practicing on a simulator would improve learner proficiency and confidence for PT insertion. We sought to conclude this to statistical significance to provide incentive for the integration of PT simulation into general surgery training curricula. Simulation training for PT has not been previously reported in the literature.

Methods

Medical students were blindly randomized to either video-only instruction on PT insertion (control) followed by an evaluative PT or video instruction with a subsequent practice attempt on a simulator (intervention) before evaluation. Students with prior exposure to PT were excluded. All PT insertions were videotaped in a deidentified fashion and timed by the blinded lead researcher. The timer began with the touch of the scalpel to the simulated skin and ended with the placement of the tracheostomy flush with the simulated skin.

The primary outcome was time to correct insertion of the PT according to the standardized steps from the video. Corrective coaching was provided via script only if steps were skipped. This reproduced the traditional learning environment for students during observed procedural skills. The students also filled out a survey to assess their confidence with the PT as a secondary outcome.

Deception was used to avoid subject bias. If the participants had been aware of the hypothesis comparing learning strategies, it would have led them to subconsciously perform differently based on the perceived better strategy. The study was thus presented vaguely to the students, who were debriefed afterwards.

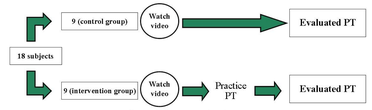


Figure 1: Participant distribution



Figure 2: Screenshot from video of anonymized participant placing PT

1. I felt prepared for the simulation assessment.

Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)

2. I was able to remember all the steps for the procedure.

Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)

3. I could describe the steps of the procedure to a friend.

Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)

4. I felt comfortable doing the procedure.

Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)

5. I felt like my learning strategy was the best way to learn the procedure.

Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)

6. I felt like my learning strategy helped me to complete the final task.

Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)

7. I feel like I could do the final task again in a week comfortably.

Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)

8. I feel like I could do the final task again in a month comfortably.

Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)

9. I feel like I could do a percutaneous tracheostomy in practice with supervision.

Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)

Figure 3: Confidence survey

Results

Median time to correct PT placement was compared between the groups for the baseline attempt.
Control group's only attempt: 547.0 seconds
Intervention group's 1st attempt: 573.0 seconds
p = 0.86 (not statistically significant which was expected)

Group	n	Median Time (s)	IQR	SD	P-value
Control	9	547.0	456.0-655.0	105.7	0.86
Intervention	8*	573.0	510.0-596.0	86.2	

Median time to correct PT placement was compared between the groups for the evaluated attempt.
Control group's only attempt: 547.0 seconds
Intervention group's 2nd attempt: 320.5 seconds
p<0.001 (statistically significant)

Group	n	Median Time (s)	IQR	SD	P-value
Control	9	547.0	456.0-655.0	105.7	<0.001
Intervention	8*	320.5	290.3-355.3	50.6	

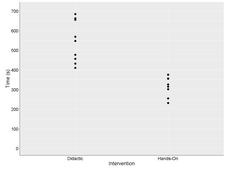


Figure 4: Comparison between evaluated attempts (control & intervention)

Median time to correct PT placement was compared within the intervention group for the two attempts.
Intervention group 1st attempt (training): 573.0 seconds
Intervention group 2nd attempt (evaluation): 320.5 seconds
p=0.016 (statistically significant)

Group	n	Median Time (s)	IQR	SD	P-value
Evaluation	8*	320.5	290.3-355.3	50.6	0.016
Training	8*	573.0	510.0-596.0	86.2	

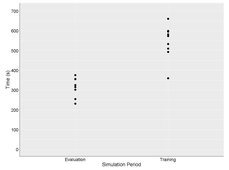


Figure 5: Comparison between attempts in the intervention group

Median confidence scores were compared between the two groups.
Control: 20/45
Intervention: 31/45
p=0.052 (not statistically significant but clinically quite significant)

Group	n	Median Score	IQR	SD	P-value
Control	9	20	18-27	9.8	0.052
Intervention	8*	31	28-35	4.6	

*One video had a technical failure, and this participant had to be excluded from the data.

Conclusion

The study demonstrated to statistical significance that practice on the simulator led to improved proficiency in PT insertion. It also showed that confidence was higher with the opportunity to practice first; although, this did not reach statistical significance.

Medical education curricula work hard to optimize student educational experiences on surgical rotations. With increasing learner volume, it can be difficult for beginners to get adequate tactile experience. The traditional mantra of "see one, do one, teach one" often limits hands-on practice. This concern can be addressed by simulation-based training, which has previously been demonstrated for skills like laparoscopy, central venous line insertion, hysteroscopy, and endoscopy. Demand for PT insertion is unfortunately inconsistent, so simulation can bridge the gap to provide maximum exposure to achieve the proverbial "number needed" for competence.

The Royal College of Physicians and Surgeons of Canada has recently constructed a new residency training paradigm termed Competence by Design. It has increased emphasis on procedural experience and practice. Resident evaluations are designed to reflect independent performance of skills and the need for supervisor prompting. Independence and competence can only be achieved with repetitive practice. In extrapolation of results from our study, residents could practice on the simulator to be more prepared for evaluative insertions. Further research is required to transition this design into the patient domain, but this is a first step to providing as much tactile learning as possible without the patient risk.



Figure 6: Percutaneous tracheostomy simulator

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