An Interactive Workshop to Increase Comfort and Knowledge Regarding Adult Tracheostomy Management: A Pilot Study

Scott A. Roof1, Mingyang Gray1, Annika Meyer1, Rocco M. Ferrandino1, Caroline Eden2, Diana Kirke1 and Mark S. Courey1

1 Department of Otolaryngology – Head and Neck Surgery, Icahn School of Medicine at Mount Sinai, New York, NY, US
2 Department of Anesthesia, Columbia University, New York, NY, US
Corresponding author: Scott A. Roof, MD (scott.roof@gmail.com)

Objectives: In standard medical school and residency curricula, there is little formal training in the acute or chronic management of tracheostomies, yet consistent and correct care is critical to prevent and treat complications. The objective of this study was to assess the knowledge and comfort level of non-otolaryngology healthcare providers in the care of adult patients with a tracheostomy. Further, this study evaluated the effectiveness of an easily reproducible 1-hour workshop, employing both didactics and simulation, to enhance comfort and knowledge surrounding care of patients with tracheostomies.

Methods: Eighty-five participants across different medical specialties, levels of training, and care roles were included in this cohort study. The simulation included three 10-minute stations: 1) understanding the component parts of standard adult tracheostomy tubes, 2) management of a dislodged tracheostomy tube, and 3) management of a patient with a tracheostomy who cannot be ventilated. Participants completed a pre- and post-intervention self-assessment and multiple-choice questionnaire assessing comfort and knowledge.

Results: The 1-hour workshop increased participants’ comfort and knowledge. For the seven comfort-based questions, the average comfort level increased from 2.24 pre-intervention to 4.09 on a Likert scale (p < 0.001). For the eight knowledge-based questions, the average correct response rate increased from 36% to 69% (p < 0.001).

Conclusions: In this study, we demonstrated that there are significant knowledge and comfort deficits among non-otolaryngology healthcare professionals caring for patients with tracheostomies. The easily reproducible 1-hour workshop employed may be an effective starting point for improving knowledge of and comfort with adult tracheostomy care.

Keywords: Tracheostomy Care; Medical Education; Simulation

Introduction
In 2006, 113,653 tracheotomies were performed in the United States on patients aged 18 years or older [1], making the tracheostomy one of the most frequently performed procedures in critically ill patients [2]. Consistent and correct tracheostomy care is mandatory to prevent and treat potential complications, which can be life threatening and lead to significant morbidity and mortality [1, 3].

Therefore, it is important that all healthcare workers directly involved in the care of these patients learn to provide proper tracheostomy care. This includes not only chronic daily management of the tracheostomy but also management of acute complications – complications including mucus plugging, accidental decannulation, bleeding, or complications during tracheostomy change [3, 4]. With an overall reported complication rate of 3.2% in the literature, it is imperative that all physicians and nurses have adequate training in management of tracheostomies [1].

In standard medical school and residency curricula, there is little formal training in the management of tracheostomies. One study assessing 87 primary healthcare providers found that both knowledge and comfort were deficient with regard to tracheostomy management—from basics such as identifying the type of tracheostomy tube to management of a plugged or dislodged tracheostomy tube [5]. Another descriptive survey study of 70 healthcare workers, including physicians from two teaching hospitals, showed that knowledge of tracheostomy-related emergencies appears to be insufficient among non-otolaryngology healthcare professionals [2]. These deficiencies are not isolated to physicians alone: one cross-sectional study of inpatient nurses found that only 59 of 128 nurses (46%) reported being "totally
comfortable” with respect to managing tracheostomies [6]. These studies point to a significant lack of training in the management of tracheostomy care among both physicians and nurses.

The objective of this quality improvement project was to assess the knowledge and comfort level of non-otolaryngology healthcare providers in the care of adult patients with a tracheostomy. Additionally, we sought to evaluate the effectiveness of an easily reproducible 1-hour interactive workshop, employing both didactics and simulation, to enhance comfort and knowledge surrounding care of adult patients with tracheostomies.

**Methods**

This project was undertaken as a health system quality improvement project to assess and hopefully improve non-otolaryngology healthcare provider comfort with and knowledge of adult tracheostomy care. The study was granted exemption by the Institutional Review Board at the Icahn School of Medicine at Mount Sinai (IRB #18-01878). Subjects were administered a pre- and post-intervention questionnaire designed to assess knowledge and comfort. Participation in the workshop and completion of pre- and post-intervention questionnaires were voluntary. Questionnaires were not linked to identifiable demographic data, and results were aggregated to ensure confidentiality.

**Questionnaire/Assessment Tools**

A validated questionnaire was developed to assess perceived comfort with and knowledge of tracheostomy management (Appendix 1). As no standard test or evaluation of tracheostomy management exists, we enlisted the help of a psychometrician (RF) to assist with the creation of a validated questionnaire. Given that proper tracheostomy care is a basic, non-controversial topic, questions were developed through consensus by two residents (SR and MG) and edited for content and quality by an expert (MC). The validity of the questionnaire content was confirmed by the psychometrician (RF). Questions selected focused on two areas of interest: 1) the component parts of a standard tracheostomy tube and 2) acute and chronic management of a patient with a tracheostomy. The assessment included seven subjective comfort-based questions assessing comfort with various aspects of tracheostomy care. Responses were recorded using a 5-point Likert scale (1 = strongly disagree, 2 = somewhat disagree, 3 = neutral, 4 = somewhat agree, 5 = strongly agree). Additionally, there were eight objective multiple-choice questions with five answer choices each, which assessed participants’ understanding of different types of tracheostomy, tracheostomy component parts, indications for tracheostomy, and acute and chronic management of tracheostomies. The pre- and post-intervention questionnaire used the same questions; however, the order of questions was adjusted on the post-questionnaire in an attempt to reduce recall bias. Completion of the pre- and post-workshop questionnaire was optional but encouraged, and results were anonymous.

**The Intervention**

In order to improve knowledge and comfort regarding the acute and chronic management of patients with a tracheostomy, we developed a one-hour interactive workshop that incorporated concepts of team-based learning and problem-based learning into the intervention. Each session started with a short didactic session, which provided the foundational knowledge of tracheotomy indications, anatomy, and physiology. Then, participants applied their foundational knowledge at three 10-minute interactive work stations. Each station had a simulation-based component as well as an accompanying critical-thinking exercise (Appendix 2). Each work station was equipped with reusable models made with low-cost materials, developed to simulate interactions with parts of a tracheostomy (Figure 1). Participants used these models to complete team-based critical-thinking exercises. Finally, the workshop concluded with a brief summary of key learning points and an opportunity for questions prior to the post-intervention questionnaire.

![Figure 1: A low-cost tracheotomy model used as an interactive teaching tool.](image-url)
The work stations had the following learning objectives:

1) understanding the component parts and different types of standard tracheostomy tubes;
2) management of a dislodged tracheostomy tube;
3) management of a patient with a tracheostomy who cannot be ventilated.

All sessions were facilitated by the same two otolaryngology residents (SR and MG) and assisted by additional otolaryngology residents, faculty, and the hosting department’s academic chief residents, as available. To ensure an effective facilitator-to-participant ratio, each work station had at least one facilitator to guide four to six participants through the learning objective. To increase the participant capacity of the workshop, two sets of the three work stations, aided by a minimum of six facilitators, were used to maintain the desired facilitator-to-participant ratio.

The materials for our workshop were donated by the Department of Otolaryngology at Mount Sinai Hospital; however, the cost of materials for the workshop would be $236.16 to $738.28 per set of three work stations (Appendix 3). All materials were reusable for subsequent sessions.

Setting
Sessions were held at the Icahn School of Medicine at Mount Sinai and Elmhurst Hospital Center in New York in the 6-month period from September 2017 to March 2018. They took place during weekly residency didactics blocks, which were optional to participants. One evening session was provided to medical students and hosted by the Otolaryngology Interest Group at the Icahn School of Medicine at Mount Sinai.

Statistical Analysis
Results of pre- and post-intervention questionnaire comfort- and knowledge-based questions were pooled and compared using Student’s t-test. We performed an additional analysis on responses to individual questions to assess differences in comfort and knowledge in specific areas. Answers to comfort-based questions were categorized according to a Likert scale, while responses to knowledge-based questions were categorized as incorrect or correct. Individual questions were compared using chi-squared tests. We performed all analyses using R Version 3.3.2 (R Foundation for Statistical Computing, Vienna, Austria) and considered a two-tailed p-value ≤ 0.05 as statistically significant.

Results
There were four sessions held, with a total of 85 non-otolaryngology resident participants. Session one was held with the Internal Medicine Department at Mount Sinai Hospital during a lunch didactics session with 15 participants. Session two was held in the evening with 19 medical student participants. Session three was held with the Elmhurst Hospital Internal Medicine Department during a lunch didactics session with 27 participants. Session four was held with the Anesthesia Department at Mount Sinai Hospital during a morning didactics session with 24 participants. Eighty-five participants completed the optional pre-workshop questionnaire, and 82 participants completed the optional post-intervention questionnaire.

Results of the assessments were aggregated, as responses were anonymous. The comfort level with caring for patients with tracheostomies, as measured on a 5-point Likert scale for the seven comfort-related questions, increased from 2.24 before the intervention to 4.09 after the workshop (p < 0.001). The average percent of correct responses to the eight knowledge-based questions increased from 36% in the pre-intervention questionnaire to 69% in the post-intervention questionnaire (p < 0.001) (Figure 2).

The subjective comfort level for each of the seven Likert-scale questions improved significantly on chi-square analysis (p < 0.001). For comfort questions regarding tracheostomy component parts (q2, q3, q4, and q5), participants demonstrated a statistically significant improvement in comfort after the workshop intervention (p < 0.001 for each of the four questions). In regards to comfort with managing common complications with tracheostomies (q6 and q7), participants demonstrated a statistically significant improvement in comfort after the workshop intervention (p < 0.001 for each of the two questions). Perhaps most importantly, overall comfort with the care of a patient with a tracheostomy (q1) demonstrated a statistically significant improvement (p < 0.001). The average comfort level for each question in the pre- and post-intervention questionnaire is demonstrated in Figure 3.

The rate of correctly answering questions increased for all the eight knowledge-based questions. In the pre-test, only one question was answered correctly by more than 50% of participants (q8: Which of the following is an indication for a tracheostomy?). In the post-intervention questionnaire, seven out of eight questions were answered correctly by more than 50% of participants. The rate of correct answer selection between the pre- and post-intervention questionnaire data was compared using a t-test, and there was a statistically significant improvement on all questions, except one (q14, p = 0.311) (Figure 4).

There were deficits in knowledge regarding the component parts (q12 and q13), perioperative management (q8, q9, and q14), and acute and chronic management of tracheostomy-related complications (q10, q11, and q15), which demonstrated significant improvement post-intervention (except q14).
### Comfort-Based Questions

<table>
<thead>
<tr>
<th>Category</th>
<th>Question # Pre-Intervention</th>
<th>Question # Post-Intervention</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Comfort</td>
<td>1</td>
<td>4</td>
<td>I feel comfortable taking care of a patient with a tracheostomy</td>
</tr>
<tr>
<td>Tracheostomy Components</td>
<td>2</td>
<td>9</td>
<td>I always determine the size and type of tracheostomy of any newly admitted patient</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>I know how to identify the type and size of a tracheostomy</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
<td>I know the function of an inner cannula on a tracheostomy</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>15</td>
<td>I know the function of the obturator for a tracheostomy</td>
</tr>
<tr>
<td>Acute and Chronic Management</td>
<td>6</td>
<td>11</td>
<td>I know how to tell if there is a cuff leak</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>12</td>
<td>I feel confident managing a tracheostomy that has become dislodged (algorithm for urgent management as well as escalating care)</td>
</tr>
</tbody>
</table>

### Knowledge-Based Questions

<table>
<thead>
<tr>
<th>Category</th>
<th>Question # Pre-Intervention</th>
<th>Question # Post-Intervention</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracheostomy Components</td>
<td>8</td>
<td>13</td>
<td>Which of the following is an indication for a tracheostomy?</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>6</td>
<td>When re-placing a dislodged tracheostomy tube back into a tracheostomy stoma, it is important to use which of the following to ensure easiest/ safest passage into the stoma?</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>7</td>
<td>All of these are types of tracheostomy tubes, except?</td>
</tr>
<tr>
<td>Acute and Chronic Management</td>
<td>9</td>
<td>2</td>
<td>On average, a tracheostomy stoma tract is formalized (healed) after how much time?</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>A patient is acutely unable to be ventilated through a week-old tracheostomy. The patient is in mild distress, saturating 89% with the ventilator FIO2 at 100%. While the respiratory therapist checks the mechanical ventilator, the first thing you do is:</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>5</td>
<td>An 86-year-old male with history of stroke resulting in need for chronic tracheostomy presents to the emergency room in respiratory distress presumed to be due to aspiration pneumonia. The patient has a sterile &amp; cuffless fenestrated tracheostomy in place. It is determined the patient will likely need mechanical ventilation in the next few hours. In anticipation, you . . .</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>14</td>
<td>All of the following are reasons for downsizing a tracheostomy tube, except?</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>8</td>
<td>A patient is admitted for a UTI, who has a trach with speaking-valve in place due to a stroke 1 year ago. Patient was lost to follow-up by original surgeon. The patient is interested in decannulation. If no contraindications, what are the next steps?</td>
</tr>
</tbody>
</table>

**Figure 2:** Questions from the Pre- and Post-Intervention Questionnaire categorized by question type.

**Figure 3:** The range in comfort level on a Likert scale for each comfort-based question.
Discussion

We designed our intervention based on the principles of Bloom’s taxonomy, a framework used by educators to categorize their teaching tools [7]. The taxonomy categorizes learning in a hierarchical fashion, building in complexity from basic recall through generation of new ideas. While a didactic lecture or an online module may get participants to recall or even explain facts, it is through active hands-on interaction and critical-thinking exercises that educators are able to help participants reach higher levels of learning. In creating the interactive work stations, we incorporated aspects of team-based learning and problem-based learning—teaching techniques recognized in the education literature to allow participants to attain a more profound understanding of the subject matter being taught [8, 9]. Further, in order to accurately assess the efficacy of the intervention, we created a validated questionnaire that participants completed at the start and end of the workshop.

This study demonstrated that among residents and medical students within our hospital system who participated in the workshop, there was, at baseline, a lack of comfort with the different parts of the tracheostomy and with the acute and chronic management of the tracheostomy. Further, our pre-intervention knowledge-based questions also demonstrated a deficiency in knowledge regarding fundamental anatomy, complications, and management of related emergencies.

The deficiency in baseline knowledge of and comfort with tracheostomy management is mirrored in several other studies [2, 5]. However, our post-intervention questionnaire demonstrated that our hour-long intervention could increase both knowledge of and comfort with tracheostomy care. The combination of didactics and interactive simulation allows for participants to quickly gain foundational knowledge upon which to expand in the interactive workshop. The benefit of this was reflected on the post-intervention questionnaire—a statistically significant increase in knowledge and comfort.

Figure 4: The percentage of correct answers for each knowledge-based question is depicted in red for pre-intervention and blue for post-intervention. All reached statistical significance except question 14.
There are several limitations of this study. Firstly, it is a small pilot study with a small sample size. In addition, although it took place in two hospitals, the study was only within one healthcare system. As a result, it does not have external validity and may not be representative of all healthcare providers who interact with tracheostomy patients. There is also a lack of long-term assessment: the pre- and post-intervention questionnaires were each administered within the same hour. Although the order of the questions was changed, there is a chance for recall bias. Further, there is no long-term follow-up to assess retention of the concepts taught in the workshop.

In the future, we hope to expand this workshop to other departments that care for tracheostomy patients. This would include emergency medicine, internal medicine, anesthesia, general surgery, physical medicine and rehabilitation, and intensive care units. We also plan to conduct a prospective study to allow tracking of participants’ long-term retention of knowledge and comfort with tracheostomy care. In addition, we hope to incorporate a real-life simulation component into the study to assess workshop participants’ knowledge of and comfort with tracheostomy care at 6 months. We would ideally compare the workshop participants to their peers in both the pre-intervention and post-intervention questionnaires and the simulation sessions to assess the efficacy of our intervention. Further, as part of the prospective study, we will look at departmental resource utilization regarding tracheostomy care pre- and post-intervention.

**Conclusion**

This study demonstrated that we were able to create a succinct, low-cost, reproducible, and scalable interactive workshop that is capable of increasing knowledge and comfort regarding tracheostomy care among non-otolaryngology healthcare providers. The interactive component allowed non-otolaryngology providers to obtain hands-on simulation to improve knowledge and comfort. Further, we created a validated questionnaire to assess healthcare providers’ knowledge of and comfort with tracheostomy care. One drawback to the method is that it requires a relatively high facilitator-to-learner ratio.

**Additional Files**

The additional files for this article can be found as follows:

- **Appendix 1.** Tracheostomy Care Questionnaire. DOI: https://doi.org/10.29024/jsim.51.s1
- **Appendix 2.** Workshop Participant Handout. DOI: https://doi.org/10.29024/jsim.51.s2
- **Appendix 3.** Workshop Materials and Costs. DOI: https://doi.org/10.29024/jsim.51.s3

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**Competing Interests**

The authors have no competing interests to declare.

**References**