Institutional analysis of intra- and post-operative tracheostomy management for risk reduction

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Abstract

Objectives: Determine variability in intra- and post-operative management of tracheostomies (trachs) at our institution as existing literature suggests that trachs are a frequent trigger for airway-related emergencies. Catalyze the development of an institution-wide protocols for trach care.

Methods: A 39-question online survey was sent to 55 providers who perform open and percutaneous trachs at three of the hospitals within our large, urban, academic medical center. These providers were identified by surveillance of the operating room schedules for 1 year.

Results: The survey was completed by 40 of the 53 eligible providers (75.5%). Response rate by question varied. Respondents included members of all departments that perform trachs at our institution (Otorhinolaryngology, Trauma Surgery, Thoracic Surgery, General Surgery, Cardiovascular Surgery and Interventional Pulmonology). While most responses demonstrated uniformity in practice, notable variations included the following: 80% of percutaneous trach providers stated that morbid obesity was not a contraindication to performing a trach outside of the operating room \((n=20)\) while 58% of open trach providers stated that morbid obesity was a contraindication; only 35% of open trach providers perform a Bjork flap \((n=350)\). The survey also identified significant variability in practice with regards to timing of trach suture removal.

Discussion: Lack of uniformity was identified in several practices related to intra- and post-operative tracheostomy care. Results did, however, trend toward consensus in many areas. The results are being used to establish a more consistent approach to tracheostomy management across our institution to ensure standardization of practice amidst the rapidly evolving practices of trach placement.

Implications for practice: With ongoing evolution in the methods of trach placement and its management, the concepts put forth here will be a resource for health care providers.
INTRODUCTION

Despite tracheostomy (trach) being one of the oldest and most commonly performed procedures, a set of best practices still does not exist in the literature, and many management strategies for trachs continue to be provider-dependent.\(^1\)\(^-\)\(^3\) While clinical consensus statements addressing patient education and procedure techniques have been put forth to help standardize management, the multifactorial and multidisciplinary nature of this procedure give way to variability in trach care.\(^4\) As such, analyses of institutional trach practices are still needed in the literature to make further headway towards quality improvement and uniform practice where possible.

A study performed at our institution from 2011-2015 suggested that tracheostomies are a major risk factor for airway rapid responses with potentially fatal outcomes.\(^5\) This study prompted the creation of a hospital-wide practice improvement plan focused on “tracheostomy awareness and documentation, discrete process changes, and implementation of guidelines for emergency management.”\(^5\) This study fostered the establishment of a multidisciplinary Airway Safety Committee with representatives from most of the specialties performing trachs at our institution (Otolaryngology, Trauma Surgery, General Surgery, Interventional Pulmonology). It also led to the implementation of the UK National Tracheotomy Safety Project as well as utilization of waveform capnography.\(^6\)

With the airway rapid response system in place for emergencies, we decided to study the institution-wide practices for routine tracheostomy across departments as the next target for potential optimization. We hypothesized that there would be substantial consistency in the post-operative management of new tracheostomies across our institution. We determined that, given the inherent differences in the procedures, the most likely source for variability in practice would be between open and percutaneous tracheostomy providers. The intention of our qualitative analysis was to identify areas of variability in practice. This analysis, encompassing both intra- and post-operative tracheostomy management, elucidated practices that differ by specialty as well as by approach (open versus percutaneous). The identification of these differences has allowed us to focus our quality improvement efforts and has catalyzed initiation of hospital-wide protocols for routine trach management. We intend to use these preliminary findings to later study if differences in outcomes exist between the areas of highlighted differences in practice.

METHODS

The Institutional Review Board of the Perelman School of Medicine at the University of Pennsylvania granted exemption for this study as a quality improvement analysis. Both open and percutaneous trach providers at three institutions within our health system were initially identified by daily surveillance of the operating room schedule for 1 year. This surveillance identified 55 providers across the Otorhinolaryngology, Trauma Surgery, Thoracic Surgery, General Surgery, Cardiovascular Surgery and Interventional Pulmonology departments. Of those identified, 2 providers stated that they had very low volume trach practices and were therefore excluded from the study.

The Airway Safety Committee designed a 39-question online survey encompassing intra-operative and post-operative management of routine tracheostomy. This online survey was sent to providers via e-mail. All questions addressed general practices of the provider and did not contain questions specific to individual patients. The survey contained 21 questions with “yes” or “no” answer choices, 14 questions with multiple choice answers, and 4 questions with free responses. The first question of the survey asked the provider for his or her department. Question 2 asked “Do you perform open tracheostomy?” with yes or no answer options. A “yes” response would allow the provider to complete the next 12 questions, specific to the management of open tracheostomy. A provider responding “no” would be redirected to the question “do you perform percutaneous tracheostomy?” A “yes” response to this question would allow the provider to complete the next 12 questions, specific to the management of percutaneous tracheostomy. Respondents had the option to identify themselves as both open and percutaneous providers. 11 questions at the end of the survey were “for all trach providers” and were not dependent on operative approach. All respondents completing the survey were informed prior to initiation that their answers would remain anonymous.

Anonymous survey responses were recorded by the survey software. These responses were presented to and discussed by the Airway Safety Committee. All data was subject to descriptive statistical analysis yielding frequency scores for categorical data. Statistically significant differences between variables will then be determined by conducting inferential statistical analysis using the Chi-Square test for categorical variable comparisons.
**TABLE 1**  Questions for open trach providers

| Question                                                                 | Type of response | Answers                                                                                   | Number of responses | P value when compared to perc trach providers |
|--------------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------------------|---------------------|----------------------------------------------|
| Do you routinely place sutures to secure the tube?                       | Yes/No           | Yes: 94.3%                                                                                   | 35                  | No significant difference                    |
| How many sutures do you place on each side?                              | 1 or 2           | 1: 8.8%                                                                                     | 34                  | No significant difference                    |
| Do you normally place ties to secure the tube?                           | Yes/No           | Yes: 100%                                                                                  | 35                  | No significant difference                    |
| Do you routinely use a bronchoscope to perform an open trach?            | Yes/No           | Yes: 25.7%                                                                                   | 35                  | P < 0.0001                                  |
| Do you perform a Bjork flap or other technique to secure the trachea to the skin prior to inserting the tube? | Yes/No/other     | Yes: 34.3%                                                                                   | 35                  | N/A                                          |
| What size Shiley tube do you use for a standard adult patient?           | 4-0/5-0/6-0/7-0/8-0 | 4-0: 0                                                                                       | 35                  | No significant difference                    |
| Do you use a cuffed tracheostomy for all new tracheostomies?             | Yes/No           | Yes: 100%                                                                                  | 35                  | No significant difference                    |
| At what post-op day do you remove the sutures securing the tube?         | All sutures vs. Sequential suture removal | All at once:                                                                                   | 32                  | N/A                                          |
| At what post-op day (1–14) do you change the tracheostomy for an uncomplicated case? | Fill in the blank | Day 1: 3%                                                                                     | 33                  | N/A                                          |
| Do you routinely change to a cuffless tracheostomy in uncomplicated patients (who are off the ventilator) for the first trach tube change? | Yes/No           | Yes: 82.4%                                                                                   | 34                  | N/A                                          |
| Do you ever send a patient out of the hospital with trach sutured in place? | Yes/No           | Yes: 22.9%                                                                                   | 35                  | N/A                                          |
| If yes to the previous question, please describe the situation where that occurs. | Free response     | - Difficult airway                                                                         | 8                   | N/A                                          |
|                                                                          |                  | - Rare exception                                                                            |                     |                                              |
|                                                                          |                  | - If otherwise ready for next phase of care                                                |                     |                                              |
|                                                                          |                  | - If going to a facility that could manage the trach                                       |                     |                                              |
|                                                                          |                  | - Free flap                                                                                |                     |                                              |
|                                                                          |                  | - If history of self-decannulation                                                          |                     |                                              |
TABLE 1  (Continued)

| Question | Type of response | Answers                                                                 | Number of responses | P value when compared to perc trach providers |
|----------|------------------|-------------------------------------------------------------------------|---------------------|---------------------------------------------|
|          |                  | To avoid dislodging the trach while outside the hospital, all patients get sutures at the time of the first trach change |                     |                                             |
|          |                  | Free flap                                                               |                     |                                             |

RESULTS

Fourty of the 53 providers who were eligible to complete the survey returned it (75.5%). Response rate by question varied. Respondents included members of all departments that perform trachs at our institution including Otorhinolaryngology, Trauma Surgery, Thoracic Surgery, Cardiovascular Surgery and Interventional Pulmonology.

The survey questions and responses can be seen in Tables 1–3. Table 1 delineates the responses to questions for open trach providers. Unanimity in responses among open trach providers included the use of trach ties to secure the tube (yes, 100%) and the use of a cuffless trach tube for all new tracheostomies (yes, 100%). Questions with notable variability included the use of a bronchoscope to perform an open tracheostomy (yes 25.7%, no 74.3%), the use of a Bjork flap during tracheostomy (yes 34.3%, no 62.9%), changing to a cuffless trach at first trach change in uncomplicated cases (yes 82.4%, no 17.6%).

Table 2 presents survey findings among percutaneous trach providers. All of percutaneous trach providers place 2 sutures on each side of the tracheostomy tube in a new trach and use trach ties. There was not substantial variability in responses among perc trach providers, except in changing to a cuffless trach in routine cases during first trach change (yes 57.9%, no 42.1%). Of note, 5% of percutaneous trach providers do not use a bronchoscope when performing the trach and 80% of perc trach providers do not consider morbid obesity a contraindication to percutaneous tracheostomy.

Further analysis was conducted to assess statistical significance in responses to questions that were asked of both percutaneous and open trach providers. The only statistically significant difference was the use of a bronchoscope when performing a tracheostomy (P < 0.0001).

Table 3 includes results to questions asked to both open and perc trach providers. As hypothesized, there were notable differences in a number of practices when asked of both types of providers. 42.9% of both types of providers perform a routine first trach change when a patient is still on the ventilator while 57.1% do not change the trach. Both types of providers were asked if they performed needle cricothyroidotomies. If they responded “yes,” they were prompted to answer if all needle cricothyroidotomies should be replaced with a trach. 78.6% of providers responded yes to this question and 21.4% of responders replied no. Also of note, when both types of provider were asked if morbid obesity was a contraindication to percutaneous trach, 58.3% responded yes. This was notably different from when perc trach providers were asked the same question (20% responded yes).

DISCUSSION

While tracheostomy is one of the oldest surgical procedures performed, it has undergone significant evolution in practice throughout the 21st century. After Chevalier Jackson introduced his approach to open tracheostomy in 1909, most of the tracheostomies performed in the USA were performed by an otolaryngologist using this technique.7 Thirty years after the initial introduction of the percutaneous trach, adaptations and modernizations in percutaneous trach approaches and technology gave way to more widespread acceptance of this non-surgical method for establishing an airway.8 Over time, there has been a significant shift in preferred methods for establishing tracheostomy as well as the role of the trach provider. According to Patel et al,9 institutional data from the authors’ academic medical center showed that otolaryngologists were performing 44% of tracheostomies in 2000 and only 25% in 2013. During this time, the number of trachs performed by general surgery and cardiothoracic surgery increased steadily by year, and most of these were percutaneous trachs.9 Given the changing landscape of what types of tracheostomies are being performed and who is performing them, examination of institutional practice and potential for quality improvement in this practice is of paramount importance for both positive outcomes and patient safety.

As anticipated, a number of trach practices across specialties at our institution are consistent, with some metrics achieving unanimity across both open and percutaneous trach providers. Among these similarities, a number of interesting differences arose that have prompted further investigation and initiatives towards additional standardization. One interesting difference was that among percutaneous providers, 80% responded that morbid obesity was not a contraindication to performing percutaneous trach. When this question was asked among all trach providers (percutaneous + open), 58% responded that morbid obesity was a contraindication to percutaneous trach. Historically, literature surrounding this topic has concluded that morbid obesity is a contraindication to percutaneous trach placement due to the associated difficulty.
identifying landmarks and co-morbidities of obesity.10-15 However, more recent literature suggests that percutaneous tracheostomy may be safe in the obese population.16-20 Given the increasing prevalence of obesity in the general population, further prospective studies will be needed to definitively determine if the more cost-effective method of percutaneous tracheostomy should be the preferred modality of establishing an airway in these patients. Based on the findings in this study, there are ongoing discussions among our hospital’s Airway Safety Committee regarding the role of percutaneous tracheostomy in obese patients. The protocol addressing this issue will be published in a later study.

This survey also demonstrated that the timing of suture removal and the person responsible for removing these sutures greatly differed across providers. Such variability prompted further research to establish a standardized protocol for trach suture removal at our institution. This preliminary research has shown that, on average, our hospital has 40-50 tracheostomy patients in-house per day. Among these, 60% were developing skin breakdown across stages during their hospitalization. While research on the ideal timing for suture removal is lacking, some studies suggest anywhere from post-operative day (POD) three to day seven.4,21 In January 2020, a protocol was initiated at our institution that all

### Table 2: Questions for percutaneous trach providers

| Question                                                                 | Type of response | Answers                                                                 | Number of responses | P value when compared to open trach providers |
|---------------------------------------------------------------------------|------------------|------------------------------------------------------------------------|---------------------|----------------------------------------------|
| Do you routinely place sutures to secure the tube?                        | Yes/No           | Yes: 89.5% No: 10.5%                                                   | 19                  | No significant difference                    |
| How many sutures do you place on each side?                              | 1 or 2           | 1: 0 2: 100%                                                           | 19                  | No significant difference                    |
| Do you normally place ties to secure the tube?                           | Yes/No           | Yes: 100% No: 0                                                        | 19                  | No significant difference                    |
| Do you routinely use a bronchoscope to perform a percutaneous trach?     | Yes/No           | Yes: 95.0% No: 5.0%                                                    | 20                  | P < 0.0001                                  |
| What size Shiley tube do you use for a standard adult patient?           | 4-0/5-0/6-0/7-0/8-0 | 4-0: 0 5-0: 0 6-0: 70.0% 7-0: 0 8-0: 30.0%                           | 20                  | No significant difference                    |
| Do you use a cuffed tracheostomy for all new tracheostomies?             | Yes/No           | Yes: 100% No: 0                                                        | 20                  | No significant difference                    |
| At what post-op day do you remove the sutures securing the tube?         | All sutures at once/on what day? vs. Sequential suture removal/on what day? | All at once: POD 7: 75.0% POD 10: 8.3% POD 14: 16.7% First set of sutures removed on: POD 2: 12.5% POD 3: 37.5% POD 4: 25.0% POD 5: 25% | 18                  | N/A                                          |
| At what post-op day (1-14) do you change the tracheostomy for an uncomplicated case? | Free response | Day 1: 6.25% Day 7: 37.5% Day 10: 6.25% Day 14: 50.0%                 | 16                  | N/A                                          |
| Do you routinely change to a cuffless tracheostomy in uncomplicated patients (who are off the ventilator) for the first trach tube change? | Yes/No | Yes: 57.9% No: 42.1%                                                   | 19                  | N/A                                          |
| Do you ever send a patient out of the hospital with trach sutures in place? | Yes/No           | Yes: 10.0% No: 90.0%                                                   | 20                  | N/A                                          |
| If yes to the previous question, please describe the situation where that occurs. | Free response | LTAC If going to LTAC LTAC | 3                   | N/A                                          |
| Do you think morbid obesity is a contraindication for performing a percutaneous trach? | Yes/No           | Yes: 20.0% No: 80.0%                                                   | 20                  | N/A                                          |
ICU patients would have their bottom trach sutures removed on POD 5 by an advanced practice provider and have their top trach sutures removed on POD 7 by critical care registered nurse or respiratory therapist. We have continued to collect data following this intervention to determine its efficacy in preventing skin breakdown to publish further studies advocating for a protocolized approach.

Another interesting finding was that only 35% of responders who perform open tracheostomy use a Bjork flap, which mirrors the mixed opinions on this practice seen in the literature.22,23

| Table 3: Questions for both types of trach providers |
|-----------------------------------------------------|
| **Question**                                      | **Type of response** | **Answers**                      | **Number of responses** |
| For patients on the ventilator, do you still perform a “first” trach change? | Yes/No | Yes: 42.9% No: 57.1% | 35 |
| Who should perform the initial trach suture removal? | - Surgeon - Nurse - Respiratory therapist (RT) - Any of the above - Other | - Surgeon: 57.1% - Nurse: 0 - RT: 0 - Any of the above: 34.3% - Other: 17.0% (resident, APP) | 35 |
| Who should perform the initial tracheostomy tube change? | - Surgeon - Nurse - Respiratory therapist (RT) - Any of the above - Other | - Surgeon: 85.7% - Nurse: 0 - RT: 8.6% - Any of the above: 5.7% - Other: 22.9% (resident, APP) | 35 |
| Do you perform surgical cricothyroidotomy? | Yes/No | Yes: 88.9% No: 11.1% | 36 |
| If you perform percutaneous tracheostomy, what is your comfort level with performing open tracheostomy? | Scale of 1-5, with 1 being not comfortable | 1- 10.7% 2- 0 3- 7.1% 4- 7.1% 5- 75.0% | 28 |
| If you perform open tracheostomy, what is your comfort level with performing percutaneous tracheostomy? | Scale of 1-5, with 1 being not comfortable | 1- 14.7% 2- 14.7% 3- 2.9% 4- 14.7% 5- 52.9% | 34 |
| Do you think morbid obesity is a contraindication for performing trach outside of the OR? | Yes/No | Yes: 58.3% No: 41.7% | 36 |
| For trach-related emergencies, who should be the first respondents? | Multiple choice | Surgeon: 45.7% Resident: 54.3% ARR team: 65.7% Other: 11.4% (ARR + surgeon, APP) | 35 |
| Do you perform needle cricothyroidotomy? | Yes/No | Yes: 38.9% No: 61.1% | 36 |
| Do you believe all cricothyroidotomies should be replaced with tracheostomy? | Yes/No | Yes: 78.6% No: 21.4% | 14 |
| If you believe all cricothyroidotomies should be replaced with trachs, at what post-op day would you typically do this? | Multiple choice | Day 1: 53.9% Day 2: 38.5% Day 3: 7.7% | 13 |

Please leave additional survey comments | Free text |
To our knowledge, no randomized controlled trials currently exist to support or reject the use of a Bjork flap as the standard of care. It is currently the standard of practice within the Department of Otolaryngology- Head & Neck Surgery at our institution to use a Bjork flap to prevent mortality from a displaced cannula.\textsuperscript{24} Surgeons in other departments at our institution also use Bjork flaps to a varying degree. Opponents of the Bjork flap claim that it poses increased risk for dislodgement of the flap into the tracheal lumen, tracheal stenosis, stoma infection, dysphagia, and trachea-cutaneous fistula though many subsequent studies have demonstrated the safety of this procedure.\textsuperscript{23,25–28} Based on these findings, a protocol has been established that all new tracheostomy patients have a card above the hospital bed stating whether or not the patient has a Bjork flap.

While this study provides an important platform to target areas for quality improvement, we acknowledge the inherent limitations of survey data. Like all retrospective questionnaires, it is subject to recall bias, which may impact results. Furthermore, while our data at this stage is descriptive and would benefit from statistical analysis, we decided that quantitative assessment would be more informative in a subsequent study in the areas we identified for improvement given the small sample size of this survey. Another limitation is seen in questions that sought to identify who was responsible for certain trach practices (questions 29, 30), where possible answers were surgeon, nurse, respiratory therapist, or other. In these two questions, it was unclear to some respondents if surgeon included residents or not. In future studies, more specific diction will be used to better analyze variability in this area of practice. Despite these limitations, we believe that this is an important analysis to demonstrate the process of standardization and risk reduction in trach practices and may serve as a resource to other institutions also seeking quality improvement in this area of practice.

CONCLUSIONS

Previous studies suggest that trachs are a frequent trigger for airway-related emergencies. Additionally, there are concerns about other short- and long-term complications associated with tracheostomy and postop care of tracheostomy patients. While the most common causes of these airway emergencies in trach patients have been well-characterized, there is currently no standardized protocol for intra-operative and post-operative management of these patients. In this absence of standardization, we sought to analyze variability in trach management practices at our own institution. In doing so, we hope to catalyze the development of an institution-wide protocol for tracheostomy care and adapt to the evolving landscape where both open and percutaneous tracheostomies are feasible options for our patients.

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