Original Investigation

Development of the Connecticut Airway Risk Evaluation (CARE) System to Improve Handoff Communication in Pediatric Patients With Tracheotomy

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IMPORTANCE National attention has focused on the importance of handoffs in medicine. Our practice during airway patient handoffs is to communicate a patient-specific emergency plan for airway reestablishment; patients who are not intubatable by standard means are at higher risk for failure. There is currently no standard classification system describing airway risk in tracheotomized patients.

OBJECTIVE To introduce and assess the interrater reliability of a simple airway risk classification system, the Connecticut Airway Risk Evaluation (CARE) system.

DESIGN, SETTING, PARTICIPANTS We created a novel classification system, the CARE system, based on ease of intubation and the need for ventilation: group 1, easily intubatable; group 2, intubatable with special equipment and/or maneuvers; group 3, not intubatable. A “v” was appended to any group number to indicate the need for mechanical ventilation. We performed a retrospective medical chart review of patients aged 0 to 18 years who were undergoing tracheotomy at our tertiary care pediatric hospital between January 2000 and April 2011.

INTERVENTIONS Each patient’s medical history, including airway disease and means of intubation, was reviewed by 4 raters. Patient airways were separately rated as CARE groups 1, 2, or 3, each group with or without a v appended, as appropriate, based on the available information.

MAIN OUTCOMES AND MEASURES After the patients were assigned to an airway group by each of the 4 raters, the interrater reliability was calculated to determine the ease of use of the rating system.

RESULTS We identified complete data for 155 of 169 patients (92%), resulting in a total of 620 ratings. Based on the patient’s ease of intubation, raters categorized tracheotomized patients into group 1 (70%, 432 of 620); group 2 (25%, 157 of 620); or group 3 (5%, 29 of 620), each with a v appended if appropriate. The interrater reliability was \( \kappa = 0.95 \).

CONCLUSIONS AND RELEVANCE We propose an airway risk classification system for tracheotomized patients, CARE, that has high interrater reliability and is easy to use and interpret. As medical providers and national organizations place more focus on improvements in interprovider communication, the creation of an airway handoff tool is integral to improving patient safety and airway management strategies following tracheotomy complications.

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It has been extrapolated that at least 2600 error-related major morbidities and 165 error-related mortalities occur within the specialty of Otolaryngology each year. In root cause analyses of all medical errors, communication errors are the most common cause of sentinel events. To address this issue, the Joint Commission has focused on a standardized approach to handoff communication as part of its National Patient Safety Goals. This has resulted in the creation of multiple checklists, protocols, and best-practice guidelines to improve information transfer and communication.

When considering our tracheotomized patient population, the patient’s indication for tracheotomy and manner of preoperative airway control are the most important drivers of airway management during resuscitation and management of complications. Although the vast majority of airways can be controlled preoperatively with an endotracheal tube (91%), there are patients who require control with a bronchoscope or facemask, and in some emergencies, airway control may not be possible. For patients who require mechanical ventilation, as opposed to spontaneous ventilation, the stakes are even higher in the event of an accidental tracheotomy decannulation. A patient’s most effective means of airway management is thus an important component of their medical history; therefore, a standard scale describing the airway above the tracheotomy tube in pediatric patients would be useful for this purpose.

Our own practice during airway patient handoffs is to communicate a patient-specific emergency plan for airway reestablishment. However, there is currently no standard classification system describing airway risk in tracheotomized patients. In the present study, we propose and assess the reliability of the Connecticut Airway Risk Evaluation (CARE) system, a simple airway risk classification system aimed at improving patient transfers and reducing communication errors.

The objectives of our study were (1) to create a standard classification system for describing tracheotomized patient airways that improves patient handoffs and caregiver risk assessment and (2) to assess the interrater reliability of this system. During analysis, patients were classified into 1 of 3 categories based on diagnosis and airway findings at the time of tracheotomy.

### Methods

The need for an airway classification system was recently highlighted during an event involving the management of one of our tracheotomy patients. In reviewing patient management during an accidental decannulation, it became clear that timely intervention was delayed secondary to unfamiliarity with the patient’s airway above the tracheotomy tube by both the Pediatric Otolaryngology call team and the Pediatric Intensive Care team. This demonstrated the need for an airway classification system to improve airway risk assessment and interprovider communication.

Prior to beginning this study, we obtained institutional review board approval from Connecticut Children’s Medical Center. The need for patient informed consent was waived. We evaluated consecutive tracheotomy patients aged 0 to 18 years and treated between 2000 and 2011. The patients were identified by the International Classification of Diseases, Ninth Revision codes for tracheotomy (31600), tracheotomy at age younger than 2 years (31601), and emergency tracheotomy (31603). We conducted a retrospective review of the identified patients’ hospital medical charts as well as outpatient office medical charts. Data were collected on patient age, sex, preoperative and postoperative diagnoses, flexible nasopharyngoscopy findings, ventilator status, and operative findings, including direct laryngoscopy and bronchoscopy findings; all data were recorded in Microsoft Excel. Patients were excluded if no adequate description of their airway findings at the time of tracheotomy was available.

### Airway Classification System and Airway Rating

Each patient was placed into 1 of 3 CARE groups based on airway findings and ease of intubation at the time of tracheotomy (Table). Although in the CARE system, the initial airway group is assigned at the time of tracheotomy, the group should not be fixed but rather should be updated at the time of surveillance laryngoscopy and bronchoscopy (DLB) to account for evolution of airway findings. Depending on the patient’s indication for tracheotomy, surveillance DLB is performed at varying intervals, with the patient’s airway group reassigned as needed at the time of endoscopy.

#### Group 1 Definition and Case Example

For our study, a patient was considered intubatable if they could be intubated using standard means by any provider with privileges for intubation. Patients classified into CARE group 1 were easily intubatable by a provider with intubating privileges (orotracheally using a standard laryngoscope) with no requirements for special instrumentation.

A patient with an intraventricular hemorrhage and respiratory failure was easily intubated by the pediatric intensive care unit team and was unable to be extubated secondary to their neurologic status. The patient underwent a tracheotomy for respiratory failure (Figure 1).

<table>
<thead>
<tr>
<th>Patient Airway Group*</th>
<th>Description of Patient Intubation Difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 or 1v</td>
<td>Patient is easily intubated without special instrumentation or modifications (ie, a patient with a normal airway with no lesions who is undergoing a tracheotomy for respiratory failure)</td>
</tr>
<tr>
<td>2 or 2v</td>
<td>Patient is intubatable but requires special instrumentation (glidescope, rigid bronchoscope or telescope, flexible bronchoscope, intubating LMA) or modifications (smaller endotracheal tube)</td>
</tr>
<tr>
<td>3 or 3v</td>
<td>Not intubatable despite use of special instrumentation (ie, 99% glottic or subglottic stenosis requiring masking during an emergency tracheotomy)</td>
</tr>
</tbody>
</table>

*All groups may have a “v” appended to the number to indicate need for ventilator support.

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Table. The Connecticut Airway Risk Evaluation (CARE) Classification System

Abbreviation: LMA, laryngeal mask airway.

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Figure 1
Group 2 Definition and Case Example

Patients classified into CARE group 2 required special instrumentation and modifications (ie, rigid bronchoscopy, flexible bronchoscope, glide scope, intubating laryngeal mask airway) for intubation. Additionally, a patient was included in group 2 if they had subglottic stenosis and required placement of a smaller-than-age-appropriate endotracheal tube (Figure 2).

A patient born with choanal atresia was taken to the operating room for a tracheotomy and found to have a small and difficult-to-expose larynx and mild subglottic stenosis requiring placement of a smaller-than-age-appropriate endotracheal tube (Figure 2).

Group 3 Definition and Case Example

The final CARE group, group 3, included patients who could not be intubated despite use of special instrumentation (ie, 99% glottic or subglottic stenosis requiring masking during an urgent tracheotomy).

A patient with stridor and respiratory distress was diagnosed as having subglottic stenosis. They could not be intubated, and an emergency tracheotomy was performed under mask ventilation (Figure 3).

Notation for Ventilator Requirement in Any Group

If the patients in any group required ventilator assistance, a “v” was added to their group number. Using the CARE classification system, the airways of the 155 patients included in the study were rated by 3 pediatric otolaryngologists and one otolaryngology resident. Prior to classification, each rater had access to the database containing the patients’ diagnoses, flexible nasopharyngoscopy findings, direct laryngoscopy and bronchoscopy findings, and operative notes including intubation details. Each rating was performed independently.

Statistical Analysis

After airway rating was complete, interrater reliability was calculated for the 4 raters to assess consistency and reliability of the classification system. We used t tests to compare continuous variables and a 2-tailed Fisher exact test to compare dichotomous variables between groups. All statistical tests were performed using Stata software, version 12 (Stata Corp). Significance was set at \( P < .05 \).

Results

Our chart review identified 169 eligible patients who underwent tracheotomy between January 2000 and April 2011. Fourteen patients did not have adequate data available and were excluded from the analysis, leaving 155 patients available for rating (92%).

Of the 155 patients whose airways were classified by the 4 raters using the CARE classification system, 9 of the patients (5.8%) were classified into one group by 2 of the raters and into a different group by the other 2 raters. For 20 patients (12.9%), 3 of the 4 raters agreed on the airway group, with 1 rater in disagreement. Of those 20 patients, 16 were assigned to airway group 2, and 4 were assigned to group 1. There were no circumstances where 3 different groups were assigned. From these results, the calculated interrater reliability was \( \kappa = 0.95 \), a high value.

The most commonly assigned airway group was CARE group 1 (70%, 432 of 620). CARE group 2 was assigned in 25% of cases (157 of 620), and group 3 was assigned in 5% (29 of 620). Fifty-two percent of our patient population required ventilator assistance. Most patients requiring ventilator assistance were classified as having a group 1 airway (67%, 70 of 104). Only
16% of the patients in group 2 (6 of 38) required ventilator assistance, and none of the patients in group 3 were ventilator dependent.

Discussion

The goal of our pilot study was to create an applicable and reliable airway classification system (CARE) for tracheotomy patients. The importance of having this tool to effectively communicate information about airway risk in tracheotomized patients is best understood when considering the potential risks associated with tracheotomy. The rate of tracheotomy-related complications ranges from 22% to 77%, and their severity ranges from minor to major. Major complications include accidental decannulation and tracheotomy tube obstruction, with rates of tracheotomy tube obstruction estimated to be as high as 72% in premature infants. Other reports vary, with tracheotomy tube obstruction rates estimated to be anywhere from 1.1% to 9.2% after the first tracheotomy tube change. The rate of accidental decannulation has been estimated to be as high as 3.3%. In the event of a tracheotomy-related complication, information that efficiently and effectively conveys the clinical details of a patient’s airway, group 1 vs group 3, could potentially exert direct effects on airway management and overall patient safety.

The importance of provider sign-out and improvement of information transfer and communication between medical care providers is a current focus of the Joint Commission. To highlight this importance, they have included a standardized approach to handoff communication as part of their National Patient Safety Goals. The SBAR (situation, background, assessment and recommendation) mnemonic for patient handoffs is the most commonly cited handoff mnemonic. It has been effectively used across disciplines by multiple groups of medical care providers, including students, residents, attending physicians, and nursing staff. McCrory et al evaluated the use of a modified version of SBAR, the ABC (airway, breathing, circulation)-SBAR, in the handoff of critically decompensating pediatric patients. Their results demonstrated that pediatric interns trained in the use of ABC-SBAR were more likely to quickly and reliably include items essential to summarizing the clinical status of a critically ill patient in their handoffs. This demonstrates that after training in a handoff tool, providers were better able to communicate about their patients.

The need to improve interprovider communication has not gone unrecognized by the otolaryngology community. Kim et al focused on the need for improved interprovider communication during postoperative transfer of care of pediatric surgical airway patients. They developed a checklist and transfer protocol to improve information transfer and communication among their pediatric otolaryngology staff, the pediatric intensivists, and pediatricians. After implementation of their protocol and checklist system, they observed no adverse events and a decrease in airway emergencies owing to communication errors.

There is currently no standard, quick way to stratify airway risk in our pediatric tracheotomy population. We created the CARE classification system to fill this void. Our system focuses on improving interprovider communication in an easy and reliable manner, with intrarater reliability calculated to be high (κ = 0.95). The results discussed herein represent the pilot portion of our study. The next phase of our study will include introducing the CARE classification system to our anesthesia, intensive care, pediatrics, emergency department, and nursing colleagues. Future studies will analyze the intrarater reliability for these groups individually and then overall to assess the ease of use of the classification system. Ultimately, we hope to implement this system institution-wide and include the airway group not only as a standard part of tracheotomy patient handoff, but also as part of the patient’s medical record.

One of the main goals of implementation of the CARE system is to stimulate appropriate acknowledgment of airway concerns and conversations about airway management between providers. Not only does this include a discussion of the best instruments for intubation and ventilation but also of who needs to be aware in the event of a tracheotomy complication (ie, “critical airway” or “critical airway response team [CART]” activation). It is our opinion that group 3 patients (ie, patients who are not intubatable) require not only a sign at their bedside but activation of our CART system in the event of an airway emergency or tracheotomy complication. Group 2 patients would be considered to have critical airways and would require a sign at their bedside and appropriate instrumentation for intubation kept easily accessible. Additionally, this information would be kept on the otolaryngology resident patient list to improve interprovider communication and ensure that both day and night on-call teams are familiar with the patients with high-risk airways. By linking the airway management plans with our airway classification system, we hope to improve information transfer and airway patient handoffs.

This study has a number of limitations to consider. Data analysis depended on the accuracy of patient documentation and the descriptions provided by the medical personnel involved. When determining airway group, raters were dependent on documentation of the intubation events or of operative findings. Second, the CARE system has only been introduced and used by 3 pediatric otolaryngologists and an otolaryngology resident, so we have not yet assessed its broader utility. We have started phase 2 of the CARE study, introduction of the CARE classification system outside of the otolaryngology community. If intrarater reliability is calculated to be high, we are hoping to implement the system and complete a study comparing the number of handoff errors before and after implementation to measure its impact.

In conclusion, the goal of this study was to create a user-friendly, reliable classification system describing the ease of intubation of pediatric patients with tracheotomies. The intrarater reliability of the CARE system was calculated to be high, κ = 0.95. Through creation of an airway classification system, we hope that patient handoffs will be improved and that caregivers and physicians will be better prepared to treat tracheotomy complications and direct airway management.
ARTICLE INFORMATION

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Author Contributions: Drs Hughes and Kavanagh had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Murray, Kavanagh.

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Analysis and interpretation of data: Lawrason Hughes, Murray, Valdez, Kelly, Kavanagh.

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Statistical analysis: Lawrason Hughes, Valdez, Kavanagh.

Administrative, technical, or material support: Murray, Kelly, Kavanagh.

Study supervision: Murray, Valdez, Kavanagh.

Conflict of Interest Disclosures: None reported.

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Correction: This article was corrected on December 5, 2013, to fix academic degrees for an author in the byline.

REFERENCES


CORRECTION

Error in Title: In the Original Investigation titled "Changing Patterns of Hospital Utilization for Head and Neck Cancer Care: Implications for Future Care" published online September 5, 2013, and in the October 2013 print issue of JAMA Otolaryngology–Head & Neck Surgery (2013;139[10]:1043-1047. doi:10.1001/jamaoto.2013.4525), “Combined” was omitted from the title. It should have read “Combined Changing Patterns of Hospital Utilization for Head and Neck Cancer Care: Implications for Future Care.” This article was corrected online.