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TITLE PAGE

Title:

Competency-based assessment tool for pediatric tracheotomy: International modified Delphi consensus

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Conflict of Interest
None

ABSTRACT

Objective: Create a competency-based assessment tool for pediatric tracheotomy.

Study design: Blinded modified Delphi consensus process.

Setting: Tertiary care center.

Subjects & Methods: Using the REDCap database, a list of 31 potential items was circulated to 65 expert surgeons who perform pediatric tracheotomy. In the first round, items were rated as "keep" or "remove" and comments were incorporated. In the second round, experts were asked to rate the importance of each item on a 7-point Likert scale. Consensus criteria were determined a-priori with a goal of 7 to 21 final items.

Results: The first round achieved a response rate of 39/65 (60.0%) and returned questionnaires were 99.5% complete. All items were rated as "keep" and 137 comments were incorporated. In the second round, 30 task-specific and 7 previously-validated global rating items were distributed and the response rate was 44/65 (67.7%) with returned questionnaires being 99.3% complete. Of the task-specific items, 13 reached consensus, 10 were near consensus, and 7 did not achieve consensus. For the 7 previously-validated global rating items, 5 reached consensus and 2 were near consensus.

Conclusions: It is feasible to reach consensus on the important steps involved in pediatric tracheotomy using a modified Delphi consensus process. These items can now be considered to create a competency-based assessment tool for pediatric tracheotomy. Such a tool will hopefully allow trainees to focus on the important aspects of this procedure and help teaching programs standardize how they evaluate trainees during this procedure.

Level of Evidence: 5

INTRODUCTION

The teaching and assessment of surgical skills has traditionally followed an apprenticeship model, with the staff surgeon completing a subjective assessment at the end of the trainee's clinical rotation. Depending on the duration of the rotation, this type of evaluation could take place several months after a surgical procedure, thus making it prone to recall bias. Additionally, it does not provide detailed timely feedback to allow the trainee to reflect and improve.[1]

In an effort to improve this evaluation process, the Accreditation Council for Graduate Medical Education (ACGME) and the Royal College of Canadian Physicians and Surgeons developed specific outcome measures to assess surgical competency.[2,3] According to Reznick, in order to better plan instruction and assess the efficacy of curricular interventions designed to enhance technical skills, valid and reliable assessments are needed.[4] To accomplish this, Martin et al. created the Objective Structured Assessment of Technical Skill (OSATS) which provides experts a standardized platform from which to evaluate the abilities of a learner.[5]

The integration of objective and reproducible assessment tools into training is essential because they can serve to monitor skill acquisition and provide a basis for structured evaluations and constructive feedback. Over the past decade, medical educators have been striving to create an overall competency based approach toward medical education.[6] To achieve this goal in Otorhinolaryngology – Head & Neck Surgery (ORL-HNS), OSATS need to be created for all essential surgical procedures. However, a recent review found that assessment tools have only been developed for 11 of the 114 ORL-HNS procedures considered to be core competencies to achieve during residency training.[6] Although an OSAT for tracheotomy has been described and obtained excellent construct validity, the tool was developed by a small number of ORL-HNS faculty members trained in adult tracheotomy from a single institution, making its use in

pediatric tracheotomy and generalizability across institutions uncertain.[7] Anatomic and physiologic differences between the adult and pediatric larynx and trachea require a different approach and surgical technique. In children, palpation to delineate the level of the cricoid may be more difficult, the airway has more lateral mobility making it easier to accidentally move out of the surgical field with retraction, and there may be more fat in the neck making it more difficult to identify anatomical landmarks.[8] Furthermore, the trachea is smaller, making it more difficult to enter and there may be less pulmonary reserve making accidental decannulation and entry into a false passage more detrimental.[8] In addition, smaller tracheostomy tubes may become obstructed more easily and suprastomal collapse is more common.[8]

The purpose of this study was to create an assessment tool to evaluate pediatric tracheotomy. Whereas previous OSATS have traditionally been created with input from a few experts, we sought input from a large international group of experts using a modified Delphi consensus process to make the tool applicable across many training programs. The Delphi process, originally developed by the RAND corporation in the 1950s to forecast the impact of technology on warfare, mathematically narrows down concepts through iterative rounds of anonymous questionnaires until consensus is achieved.[9] We sought to create both task-specific (to evaluate discrete surgical steps) and global-rating (to evaluate overall performance) scales because each appears to measure different aspects of education.

METHODS

Since there have not been any previously published reports outlining the important steps involved in pediatric tracheotomy in the literature, three authors (EJP, EAF, SLI) created an inclusive stepwise list of items that they use when performing this procedure. Two additional authors (NEW, KB) edited and added to this list without removing items. All five authors are fellowship trained pediatric otolaryngologists – head & neck surgeons. EJP has previously published stepwise approaches for trainees to learn how to perform tracheotomy and open airway

surgery, SLI has published extensively on medical education and developed an operative competency assessment tool for pediatric direct laryngoscopy and rigid bronchoscopy, KB has published on using a modified Delphi consensus process, and NEW and EAF have published on residency medical education. The list of items was entered into questionnaire format using Research Electronic Data Capture (REDCap).[10] REDCap was selected because questionnaires can be answered and anonymously submitted directly via the email link through which they are received without respondents needing to download, complete and upload files. Our aim was to make questionnaire completion easy, thereby increasing the response rate and decreasing time to respond.

Experts in the field of pediatric tracheotomy were selected by reviewing the membership list of the American Society of Pediatric Otolaryngology and by reviewing the list of pediatric otolaryngology faculty at each academic institution in the United States and Canada. Individuals with a strong publication record in this field (Pubmed/book chapter editor or author) were included, many of whom had expertise in medical education. Individuals from Europe and Australia known to have a publication record in this field were also included. Sixty-five prospective experts were sent an email invitation with a personalized embedded link to the survey explaining the study purpose and methodology. Membership on the panel was kept anonymous from other experts. Given the amount of work and input required by each respondent, experts were promised authorship in the order in which they responded (tracked by REDCap). Experts were instructed that each round would be tabulated separately and the average from all rounds would be the order used in the final publication. This was done primarily to acknowledge each expert's contributions, but also to increase the response rate and decrease time to respond. Experts were contacted three times (invitation and two reminders) for each round, each one week apart.

During the first round, experts were instructed to rate each item on the Task-Specific list as "keep" or "remove", and a line for comments and suggestions for adding, modifying or combining items was provided for each item. Anonymous responses were exported to an Excel file and two investigators (EAF, EJP) each independently reviewed anonymous responses and met on one occasion to incorporate suggestions. This was performed with the mindset of inclusivity, without imparting judgment. Each task needed to have 50% of respondents rating it as "keep" for it to be included. In the second round, we decided to use a previously validated Global Rating Scale created by Reznick et al. that has been validated with a variety of different surgical procedures and was not included in the first round.[11]

During the second round, experts were instructed to rate the importance of each item on the Task-Specific list using a 7-point Likert scale (1-Not at all important, 2-Low importance, 3-Slightly important, 4-Neutral, 5-Moderately important, 6-Very important, 7-Extremely important) and a line for comments and suggestions was included for each item. We determined a-priori that anonymous results would be exported to an Excel file and a mean score would be determined for each item, with inclusion dependent on the degree of consensus reached. Based on previous consensus statements in otolaryngology, consensus for both the task-specific list and the global rating scale were calculated as: 1) Reaching consensus (individual responses fall within 2 Likert points of mean with only 1 outlier); 2) Near consensus (individual responses fall within 2 Likert points of mean with only 2 outliers); 3) No consensus (not meeting criteria 1 or 2).[12,13] We determined, based on review of the literature of previous Task-Specific OSATS tools (mean+/-SD), that an ideal Task-Specific list should have 7 to 25 items for inclusiveness and ease of use.[6]

We therefore decided a-priori that if initial results from the second round returned 7 to 25 items meeting consensus, we would not require another iteration. However, if >25 items reached consensus, we would keep the most highly rated 25 items based on each item's mean score. If

<7 items reached consensus, we would pursue another iteration with only consensus and near consensus items and ask experts to rate them again. If <7 items reached consensus again, all items reaching consensus plus the most highly rated items reaching near-consensus based on mean score would be included up to a total of 7 items. We created this modification to the Delphi method to decrease the burden placed on experts and decrease the overall duration of the study.

RESULTS

Sixty-five pediatric otolaryngologists-head and neck surgeons who were experts in the field of pediatric tracheotomy were contacted. The first round achieved a response rate of 39/65 (60.0%). Every item evaluated in the first round attained > 69% of respondents wanting to "keep" it in the list for the second round. There were 6 missing responses out of 1,209 possible items (39 experts, 31 items) for a completion rate of 99.5%. There were 137 comments incorporated into the items to be used in the second phase (Table 1). The time for completion of round 1 was 35 days.

In the second round, 30 task-specific (Table 2) and 7 previously validated global rating (Table 3) items were distributed to determine item importance and the response rate was 44/65 (67.7%). There were 11 missing responses out of 1,628 possible items (44 experts, 37 items) for a completion rate of 99.3%. For the 30 task-specific items, 13 reached consensus, 10 were near consensus, and 7 did not achieve consensus. The 13 task-specific items that reached consensus were all rated positively, with a mean (SD) Likert rating of 6.25 (0.30) (range 5.73 – 6.61). For the 7 previously-validated global rating items, 5 reached consensus and 2 were near consensus. The 5 global rating items that reached consensus were all rated positively, with a mean (SD) Likert rating of 5.94 (0.40) (range 5.7 – 6.6). Tables 2 and 3 show each item, mean score, and consensus level. The time for completion of round 2 was 32 days.

DISCUSSION

The introduction of restricted resident work hours, increased patient safety concerns and a drive towards efficiency have decreased trainee independence and time for hands-on surgical training. These limitations, plus the inherent variability in trainee learning curves when mastering common pediatric otolaryngological procedures, emphasize the need for assessment tools capable of objectively and reproducibly documenting trainee progress. We aimed to develop a competency-based assessment tool for pediatric tracheotomy because it is a complex, low-frequency and often life-saving procedure that is at times performed in a stressful environment. This tool can be used immediately after the procedure is complete to counteract the recall bias often seen in end-of-rotation evaluations.

Our response rate was 60% for the first round and 68% for the second round. A response rate of 60% for survey research is considered acceptable by many biomedical journals.[14] In addition, 99% of items were completed for all submitted questionnaires for each round with the lowest number of items completed by a single respondent being 30/31 (96.8%) in the first round and 35/37 (94.6%) in the second round. This is well above the American Association for Public Opinion Research (AAOPR) suggestion that 80% of all questions answered equals a complete response.[15] We attribute this response rate to the selection of clinicians experienced in this area of medicine, ease of use of the REDCap questionnaire, assurance of anonymity, and offer of authorship. We did not see a decrease in response rate from the first round to the second round, as is often seen with use of the Delphi method. The time for completion of this study was 67 days. We believe the above factors allowed for less fatigue and greater motivation and the short interval between questionnaires kept the interest level high.

Thirteen task-specific items reached consensus in the second round (Tables 2 and 3). Because this fell within the range of 7 to 25 items that we determined to be acceptable a-priori based on

previously published surgical task-specific OSATS, we did not require another round of the Delphi technique.[6] Final items focused on preparation, communication, teamwork, prevention of adverse events and psychomotor skills and a proposed score sheet can be found in tables 4.

Several items reached near to consensus, likely because experts selected similar but perhaps better worded items instead. For example, review of history, physical examination and imaging reached near consensus whereas assessment of anatomy, physical limitations and ventilator settings reached consensus. Discussion of decreasing F_iO_2 and risk of airway fire reached near consensus whereas communication with the anesthesiologist about decreasing the F_iO_2, deflating the endotracheal tube cuff, and pulling it back, reached consensus. Confirmation of the tracheostomy tube being in the trachea through direct visualization, CO_2 color change and bilateral chest rise reached near consensus whereas inserts tracheostomy tube atraumatically, removes obturator and reconnects circuit, reached consensus likely because surgeons rely on visual confirmation of the tube in the trachea rather than secondary measures such as CO_2 color change. Other items reached near consensus likely because they are less specific to tracheotomy, such as obtaining informed consent, arranging transport and injecting local anesthetic, or because they can be arranged by people other than the otolaryngologist – head and neck surgeon, such as arranging the first tracheostomy and tie change, and initiating education of caregivers and plans for discharge.

Five of the 7 items in the Global Rating Scale reached consensus and 2 were near consensus. The 5 global rating items that reached consensus were all rated positively. Surprisingly, appropriate handling of tissue and demonstration of forward planning only reached near consensus. These items were among the highest with respect to mean Likert score, but reached only near consensus because there were two outliers for each item. We believe that 5 of 7 (71%) positively rated items justifies using this previously validated Global Rating Scale with tracheotomy. In addition, the Global Rating Scale has not been validated for use of a subset of

items, supporting using it in its entirety. Lastly, use of the Global Rating Scale is complementary to the task-specific scale, thus reinforcing its importance. A proposed scoring sheet can be found in table 5.

The major limitation of this study is that items were selected for this task-specific assessment tool for pediatric tracheotomy based on expert opinion and the scale has not been validated on trainees of varying levels of expertise to obtain construct validity. Additionally, we have yet to determine if this tool will be acceptable to trainees and faculty. We did not include experts from developing and resource-limited regions which may limit use of this tool in these areas. Although our modifications to the Delphi technique appeared to work well for reaching consensus on the important steps involved in pediatric tracheotomy in this study, we cannot extrapolate whether or not these modifications will work well when creating competency-based assessment tools for other surgical procedures or with a different group of experts. Future studies investigating the construct validity of this pediatric tracheotomy tool and the success of this modified Delphi consensus technique for creating other tools are required. To achieve this, broad and structured dissemination of this tool is required to permit independent evaluations.

CONCLUSION

It is feasible to reach consensus on the important steps involved in pediatric tracheotomy. This was made possible using the modified Delphi consensus process described herein. These items can now be considered to create a competency-based assessment tool for pediatric tracheotomy. Such a tool will hopefully allow trainees to focus on the important aspects of this procedure and help teaching programs standardize how they evaluate trainees during this procedure.

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Table 1. Pediatric Open Tracheotomy OSAT Round 1

TASK-SPECIFIC ITEMS	Number Completed	Number Rating Keep (%)	Number Comments
Surgical goals, preparation and potential challenges			
1. Reviews history, physical examination, imaging, and anatomical and patient factors to identify goal of procedure and whether tracheotomy is indicated.	39	38 (97.4)	4
2. Assesses anatomy, physical limitations, and ventilator settings to determine feasibility.	39	38 (97.4)	3
3. Appreciates urgency of tracheotomy.	39	38 (97.4)	5
4. Understands risks, benefits, and potential complications at appropriate level to perform informed consent.	38	37 (97.3)	5
Preparation of instruments			
5. Selects appropriate surgical instruments and verifies availability.	39	32 (82.1)	5
6. Selects appropriate tracheostomy tube (diameter and length).	39	39 (100)	0
Communication with operative team			
7. Creates plan for transport to and from operating room and postoperative disposition.	39	28 (71.7)	6
8. Discusses role in shared airway.	39	37 (94.9)	4
9. Discusses risk of airway fire and management.	39	32 (82.1)	6
Patient position and exposure			
10. Brings head of patient to top of bed.	39	28 (71.7)	3
11. Uses appropriately sized shoulder roll if not contraindicated.	39	34 (87.2)	1
12. Applies antiseptic solution and drapes appropriately.	39	28 (71.7)	7
Tracheotomy			
13. Marks appropriate landmarks and incision, taking into account C-collar if required.	39	39 (100)	1
14. Injects local anesthetic/vasoconstrictive agent.	39	30 (76.9)	5
15. Removes fat from neck, if age appropriate.	38	32 (84.2)	2
16. Identifies and divides midline between strap muscles avoiding anterior jugular veins.	39	39 (100)	4
17. Safely deals with thyroid gland, where necessary.	39	39 (100)	1
18. Palpates neck for high riding innominate artery.	39	33 (84.6)	0
19. Palpates cricoid cartilage and considers need for cricoid hook.	38	37 (97.4)	2
20. Identifies appropriate level of entry into airway.	39	39 (100)	3
21. Prepares equipment (e.g. suction, tracheostomy tube) prior to entering airway.	39	38 (97.4)	4
22. Does not use electrocautery while tracheotomy is being created.	38	31 (81.6)	6

23. Communicates with anesthesiologist to deflate endotracheal tube cuff, where necessary.	39	37 (94.9)	3
24. Places retention sutures that expose the airway and do not pull through cartilage.	38	37 (97.4)	7
25. Places maturation sutures to decrease chances of false passage that do not narrow stoma.	39	27 (69.2)	15
26. Inserts tracheostomy atraumatically, removes obturator, and reconnects circuit without long delay.	39	39 (100)	2
27. Performs flexible or rigid bronchoscopy to ensure tracheostomy tube length is appropriate.	38	30 (78.9)	11
28. Ensures ties prevent tracheostomy from falling out but do not obstruct venous flow.	39	38 (97.4)	4
Postoperative planning			
29. Enters appropriate postoperative orders (safety protocols, chest x-ray where applicable).	39	37 (94.9)	6
30. Arranges first tie change and tracheostomy change.	39	35 (89.7)	2
31. Initiates education of caregivers and creates plan for discharge.	39	30 (76.9)	10

Table 2. Pediatric Open Tracheotomy Task Specific OSAT Round 2

TASK-SPECIFIC ITEMS	Number Completed	Mean (SD) Likert	Consensus
Surgical goals, preparation and potential challenges			
1. Reviews history, physical examination, imaging, and anatomical and patient factors/comorbidities to identify goal of procedure and whether tracheotomy is indicated.	45	6.50 (0.90)	Near
2. Assesses anatomy, physical limitations, and ventilator settings to determine feasibility, potential challenges and concerns.	44	6.33 (1.11)	Yes
3. Appreciates timing considerations of tracheotomy.	44	5.44 (1.42)	No
4. Understands risks, benefits, potential complications and long-term consequences to perform informed consent.	45	6.36 (1.01)	Near
Preparation of instruments			
5. Selects appropriate surgical instruments and tracheostomy tube (diameter, length, cuff) and verifies availability.	45	6.50 (0.63)	Yes
Communication with operative team			
6. Creates plan for transport to and from operating room and postoperative disposition.	45	5.73 (1.30)	Near
7. Discusses roles in shared airway with anesthesiologist.	45	6.43 (0.90)	Yes
8. Discusses decreasing F_iO_2 and risk of airway fire and management.	45	6.23 (0.86)	Near
Patient position and exposure			
9. Brings head of patient to top of bed and uses appropriately sized shoulder roll and extension if not contraindicated.	45	5.70 (1.09)	Yes
10. Applies/directs application of antiseptic solution and drapes appropriately.	45	5.14 (1.41)	No
Tracheotomy			
11. Marks appropriate landmarks and incision, taking into account C-collar if required.	45	6.25 (0.78)	Yes
12. Injects local anesthetic/vasoconstrictive agent at appropriate dose for weight.	45	5.59 (1.34)	Near

13. Discusses fat removal.	45	4.59 (1.35)	No
14. Identifies and dissects midline between strap muscles avoiding or ligating anterior jugular veins.	44	5.98 (0.89)	Yes
15. Safely manages thyroid gland, where necessary.	44	5.95 (1.07)	Yes
16. Palpates neck for high-riding innominate artery.	45	6.16 (0.91)	Near
17. Palpates cricoid cartilage and considers need for cricoid hook.	45	5.82 (0.97)	Yes
18. Identifies appropriate level of entry into airway considering indication for tracheotomy and future surgical considerations.	45	6.48 (0.79)	Near
19. Ensures suction, tracheostomy tube and smaller tracheostomy tube are prepared prior to entering airway.	44	6.60 (0.69)	Yes
20. Places retention sutures that expose the airway and do not pull through cartilage. Considers taping these to the chest and labelling them as “right” and “left”.	45	6.34 (0.64)	Yes
21. Communicates with anesthesiologist prior to entering the airway about decreasing the F_iO_2, deflating the endotracheal tube cuff, where necessary, and pulling back the endotracheal tube, where necessary.	43	6.60 (0.66)	Yes
22. Understands the risk of using electrocautery during and after tracheotomy has been created.	43	6.28 (1.05)	No
23. Considers placing maturation sutures that decrease chances of false passage and do not narrow stoma.	45	5.11 (1.65)	No
24. Inserts tracheostomy tube atraumatically, removes obturator, and reconnects circuit while holding tracheostomy tube in place the entire time without long delay.	45	6.55 (0.82)	Yes
25. Confirms tracheostomy tube is in trachea and patent through direct visualization, by inspecting for condensation, by using CO_2 color change and confirmation of bilateral chest rise.	44	6.56 (0.77)	Near
26. Ensures ties prevent tracheostomy from falling out but do not obstruct venous flow.	45	6.23 (0.86)	Yes
27. Performs flexible or rigid bronchoscopy to ensure tracheostomy tube length is appropriate.	45	5.23 (1.33)	No
Final evaluation			
28. Enters appropriate postoperative orders (safety protocols, chest x-ray where applicable).	44	6.21 (1.23)	No
29. Arranges first tie change and tracheostomy change.	45	5.84 (1.33)	Near
30. Initiates education of caregivers and creates plan for discharge.	45	5.61 (1.51)	Near

Table 3. Pediatric Open Tracheotomy Global Rating Scale OSAT Round 2

GLOBAL RATING SCALE	Number Completed	Mean (SD) Likert	Consensus
Respect of tissue			
1. Appropriate handling of tissue, minimizes tissue damage through appropriate use of instruments and appropriate force.	45	6.11 (0.95)	Near
2. Efficient and economic movement.	45	5.77 (0.89)	Yes
Knowledge of instruments			
3. Familiar with names of instruments required for this procedure, does not ask for wrong instrument or use incorrect names when asking for instruments.	45	5.70 (0.98)	Yes
Instrument handling			
4. Competent use of instruments, fluid movement without stiffness or awkwardness.	45	5.84 (0.81)	Yes

Flow of operation			
5. Demonstrates forward planning; course of operation demonstrated through effortless flow from one movement to the next.	44	6.09 (0.87)	Near
6. Strategically uses assistants to the best advantage at all times.	45	5.73 (0.97)	Yes
Knowledge of specific procedure			
7. Demonstrates familiarity of all steps of the operation/procedure.	45	6.64 (0.53)	Yes

Table 4. Pediatric Open Tracheotomy Evaluation Sheet

Date: (MM/DD/YY) _____
Trainee Name: (Last)_____ (First) _____
Level of Training:_____
Evaluator Name: (Last)_____ (First) _____

TASK-SPECIFIC ITEMS	Not done or done incorrectly	Done Correctly	Not observed
Surgical goals, preparation and potential challenges			
1. Assesses anatomy, physical limitations, and ventilator settings to determine feasibility, potential challenges and concerns.	□	□	□
Preparation of instruments			
1. Selects appropriate surgical instruments and tracheostomy tube (diameter, length, cuff) and verifies availability.	□	□	□
Communication with operative team			
2. Discusses roles in shared airway with anesthesiologist.	□	□	□
Patient position and exposure			
3. Brings head of patient to top of bed and uses appropriately sized shoulder roll and extension if not contraindicated.	□	□	□
Tracheotomy			
4. Marks appropriate landmarks and incision, taking into account C-collar if required.	□	□	□
5. Identifies and dissects midline between strap muscles avoiding or ligating anterior jugular veins.	□	□	□
6. Safely manages thyroid gland, where necessary.	□	□	□
7. Palpates cricoid cartilage and considers need for cricoid hook.	□	□	□
8. Ensures suction, tracheostomy tube and smaller tracheostomy tube are prepared prior to entering airway.	□	□	□
9. Places retention sutures that expose the airway and do not pull through cartilage. Considers taping these to the chest and labelling them as “right” and “left”.	□	□	□
10. Communicates with anesthesiologist prior to entering the airway about decreasing the F_iO_2, deflating the endotracheal tube cuff, where necessary, and pulling back the endotracheal tube, where necessary.	□	□	□
11. Inserts tracheostomy tube atraumatically, removes obturator, and reconnects circuit while holding tracheostomy tube in place the entire time without long delay.	□	□	□
12. Ensures ties prevent tracheostomy from falling out but do not obstruct venous flow.	□	□	□
Number of items performed correctly: ____ Was this a standard case? □ Yes □ No If not, why? _____ Is this resident competent to perform this procedure? □ Yes □ No			

Table 5. Pediatric Open Tracheotomy Global Rating Scale Evaluation Sheet

Date: (MM/DD/YY) _____
Trainee Name: (Last)_____ (First) _____
Level of Training:_____
Evaluator Name: (Last)_____ (First) _____

GLOBAL RATING SCALE					
1. Respect for tissue	1 Frequently used unnecessary force on tissue or caused damage by inappropriate use of instruments	2	3 Carefully handled tissue but occasionally caused inadvertent damage	4	5 Consistently handled tissues appropriately with minimal damage
2. Time and motion	1 Many unnecessary moves	2	3 Efficient but some unnecessary moves	4	5 Clear economy of movement and maximum efficiency
3. Instrument handling	1 Repeatedly made tentative or awkward moves by inappropriate use	2	3 Competent use of instruments but occasionally appeared stiff or awkward	4	5 Fluid moves and no awkwardness
4. Knowledge of instruments	1 Frequently asked for wrong instrument or used inappropriate instrument	2	3 Knew names of <u>most</u> instruments and used appropriate instruments	4	5 Obviously familiar with instruments and their names
5. Use of assistants	1 Consistently placed assistants poorly or failed to use assistants	2	3 Appropriate use of assistants <u>most</u> of the time	4	5 Strategically used assistants to the best advantage at <u>all</u> times
6. Flow of operation and forward planning	1 Frequently stopped operating or unsure of next move	2	3 Some forward planning with reasonable progression of procedure	4	5 Obviously planned course of operation with effortless flow from one move to the next
7. Knowledge of specific procedure	1 Deficient knowledge. Needed specific instruction at most steps	2	3 Knew all <u>important</u> steps of operation	4	5 Demonstrated familiarity with <u>all</u> aspects of operation

Total score (sum all numbers): ____
Was this a standard case? □ Yes □ No If not, why? _____
Is this resident competent to perform this procedure? □ Yes □ No

TITLE PAGE

Title:

Competency-based assessment tool for pediatric tracheotomy: International modified Delphi consensus

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Conflict of Interest
None

ABSTRACT

Objective: Create a competency-based assessment tool for pediatric tracheotomy.

Study design: Blinded modified Delphi consensus process.

Setting: Tertiary care center.

Subjects & Methods: Using the REDCap database, a list of 31 potential items was circulated to 65 expert surgeons who perform pediatric tracheotomy. In the first round, items were rated as "keep" or "remove" and comments were incorporated. In the second round, experts were asked to rate the importance of each item on a 7-point Likert scale. Consensus criteria were determined a-priori with a goal of 7 to 21 final items.

Results: The first round achieved a response rate of 39/65 (60.0%) and returned questionnaires were 99.5% complete. All items were rated as "keep" and 137 comments were incorporated. In the second round, 30 task-specific and 7 previously-validated global rating items were distributed and the response rate was 44/65 (67.7%) with returned questionnaires being 99.3% complete. Of the task-specific items, 13 reached consensus, 10 were near consensus, and 7 did not achieve consensus. For the 7 previously-validated global rating items, 5 reached consensus and 2 were near consensus.

Conclusions: It is feasible to reach consensus on the important steps involved in pediatric tracheotomy using a modified Delphi consensus process. These items can now be considered to create a competency-based assessment tool for pediatric tracheotomy. Such a tool will hopefully allow trainees to focus on the important aspects of this procedure and help teaching programs standardize how they evaluate trainees during this procedure.

Level of Evidence: 5

INTRODUCTION

The teaching and assessment of surgical skills has traditionally followed an apprenticeship model, with the staff surgeon completing a subjective assessment at the end of the trainee's clinical rotation. Depending on the duration of the rotation, this type of evaluation could take place several months after a surgical procedure, thus making it prone to recall bias. Additionally, it does not provide detailed timely feedback to allow the trainee to reflect and improve.[1]

In an effort to improve this evaluation process, the Accreditation Council for Graduate Medical Education (ACGME) and the Royal College of Canadian Physicians and Surgeons developed specific outcome measures to assess surgical competency.[2,3] According to Reznick, in order to better plan instruction and assess the efficacy of curricular interventions designed to enhance technical skills, valid and reliable assessments are needed.[4] To accomplish this, Martin et al. created the Objective Structured Assessment of Technical Skill (OSATS) which provides experts a standardized platform from which to evaluate the abilities of a learner.[5]

The integration of objective and reproducible assessment tools into training is essential because they can serve to monitor skill acquisition and provide a basis for structured evaluations and constructive feedback. Over the past decade, medical educators have been striving to create an overall competency based approach toward medical education.[6] To achieve this goal in Otorhinolaryngology – Head & Neck Surgery (ORL-HNS), OSATS need to be created for all essential surgical procedures. However, a recent review found that assessment tools have only been developed for 11 of the 114 ORL-HNS procedures considered to be core competencies to achieve during residency training.[6] Although an OSAT for tracheotomy has been described and obtained excellent construct validity, the tool was developed by a small number of ORL-HNS faculty members trained in adult tracheotomy from a single institution, making its use in pediatric tracheotomy and generalizability across institutions uncertain.[7] Anatomic and physiologic differences between the adult and pediatric larynx and trachea require a different approach and surgical technique. In children, palpation to delineate the level of the cricoid may be more difficult, the airway has more lateral mobility making it easier to accidentally move out of the surgical field with retraction, and there may be more fat in the neck making it more difficult to identify anatomical landmarks.[8] Furthermore, the trachea is smaller, making it more

difficult to enter and there may be less pulmonary reserve making accidental decannulation and entry into a false passage more detrimental.[8] In addition, smaller tracheostomy tubes may become obstructed more easily and suprastomal collapse is more common.[8]

The purpose of this study was to create an assessment tool to evaluate pediatric tracheotomy. Whereas previous OSATS have traditionally been created with input from a few experts, we sought input from a large international group of experts using a modified Delphi consensus process to make the tool applicable across many training programs. The Delphi process, originally developed by the RAND corporation in the 1950s to forecast the impact of technology on warfare, mathematically narrows down concepts through iterative rounds of anonymous questionnaires until consensus is achieved.[9] We sought to create both task-specific (to evaluate discrete surgical steps) and global-rating (to evaluate overall performance) scales because each appears to measure different aspects of education.

METHODS

Since there have not been any previously published reports outlining the important steps involved in pediatric tracheotomy in the literature, three authors (EJP, EAF, SLI) created an inclusive stepwise list of items that they use when performing this procedure. Two additional authors (NEW, KB) edited and added to this list without removing items. All five authors are fellowship trained pediatric otolaryngologists – head & neck surgeons. EJP has previously published stepwise approaches for trainees to learn how to perform tracheotomy and open airway surgery, SLI has published extensively on medical education and developed an operative competency assessment tool for pediatric direct laryngoscopy and rigid bronchoscopy, KB has published on using a modified Delphi consensus process, and NEW and EAF have published on residency medical education. The list of items was entered into questionnaire format using Research Electronic Data Capture (REDCap).[10] REDCap was selected because questionnaires can be answered and anonymously submitted directly via the email link through which they are received without respondents needing to download, complete and upload files. Our aim was to make questionnaire completion easy, thereby increasing the response rate and decreasing time to respond.

Experts in the field of pediatric tracheotomy were selected by reviewing the membership list of the American Society of Pediatric Otolaryngology and by reviewing the list of pediatric otolaryngology faculty at each academic institution in the United States and Canada. Individuals with a strong publication record in this field (Pubmed/book chapter editor or author) were included, many of whom had expertise in medical education. Individuals from Europe and Australia known to have a publication record in this field were also included. Sixty-five prospective experts were sent an email invitation with a personalized embedded link to the survey explaining the study purpose and methodology. Membership on the panel was kept anonymous from other experts. Given the amount of work and input required by each respondent, experts were promised authorship in the order in which they responded (tracked by REDCap). Experts were instructed that each round would be tabulated separately and the average from all rounds would be the order used in the final publication. This was done primarily to acknowledge each expert's contributions, but also to increase the response rate and decrease time to respond. Experts were contacted three times (invitation and two reminders) for each round, each one week apart.

During the first round, experts were instructed to rate each item on the Task-Specific list as "keep" or "remove", and a line for comments and suggestions for adding, modifying or combining items was provided for each item. Anonymous responses were exported to an Excel file and two investigators (EAF, EJP) each independently reviewed anonymous responses and met on one occasion to incorporate suggestions. This was performed with the mindset of inclusivity, without imparting judgment. Each task needed to have 50% of respondents rating it as "keep" for it to be included. In the second round, we decided to use a previously validated Global Rating Scale created by Reznick et al. that has been validated with a variety of different surgical procedures and was not included in the first round.[11]

During the second round, experts were instructed to rate the importance of each item on the Task-Specific list using a 7-point Likert scale (1-Not at all important, 2-Low importance, 3-Slightly important, 4-Neutral, 5-Moderately important, 6-Very important, 7-Extremely important) and a line for comments and suggestions was included for each item. We determined a-priori that anonymous results would be exported to an Excel file and a mean score would be

determined for each item, with inclusion dependent on the degree of consensus reached. Based on previous consensus statements in otolaryngology, consensus for both the task-specific list and the global rating scale were calculated as: 1) Reaching consensus (individual responses fall within 2 Likert points of mean with only 1 outlier); 2) Near consensus (individual responses fall within 2 Likert points of mean with only 2 outliers); 3) No consensus (not meeting criteria 1 or 2).[12,13] We determined, based on review of the literature of previous Task-Specific OSATS tools (mean+/-SD), that an ideal Task-Specific list should have 7 to 25 items for inclusiveness and ease of use.[6]

We therefore decided a-priori that if initial results from the second round returned 7 to 25 items meeting consensus, we would not require another iteration. However, if >25 items reached consensus, we would keep the most highly rated 25 items based on each item's mean score. If <7 items reached consensus, we would pursue another iteration with only consensus and near consensus items and ask experts to rate them again. If <7 items reached consensus again, all items reaching consensus plus the most highly rated items reaching near-consensus based on mean score would be included up to a total of 7 items. We created this modification to the Delphi method to decrease the burden placed on experts and decrease the overall duration of the study.

RESULTS

Sixty-five pediatric otolaryngologists-head and neck surgeons who were experts in the field of pediatric tracheotomy were contacted. The first round achieved a response rate of 39/65 (60.0%). Every item evaluated in the first round attained > 69% of respondents wanting to "keep" it in the list for the second round. There were 6 missing responses out of 1,209 possible items (39 experts, 31 items) for a completion rate of 99.5%. There were 137 comments incorporated into the items to be used in the second phase (Table 1). The time for completion of round 1 was 35 days.

In the second round, 30 task-specific (Table 2) and 7 previously validated global rating (Table 3) items were distributed to determine item importance and the response rate was 44/65 (67.7%). There were 11 missing responses out of 1,628 possible items (44 experts, 37 items) for a

completion rate of 99.3%. For the 30 task-specific items, 13 reached consensus, 10 were near consensus, and 7 did not achieve consensus. The 13 task-specific items that reached consensus were all rated positively, with a mean (SD) Likert rating of 6.25 (0.30) (range 5.73 – 6.61). For the 7 previously-validated global rating items, 5 reached consensus and 2 were near consensus. The 5 global rating items that reached consensus were all rated positively, with a mean (SD) Likert rating of 5.94 (0.40) (range 5.7 – 6.6). Tables 2 and 3 show each item, mean score, and consensus level. The time for completion of round 2 was 32 days.

DISCUSSION

The introduction of restricted resident work hours, increased patient safety concerns and a drive towards efficiency have decreased trainee independence and time for hands-on surgical training. These limitations, plus the inherent variability in trainee learning curves when mastering common pediatric otolaryngological procedures, emphasize the need for assessment tools capable of objectively and reproducibly documenting trainee progress. We aimed to develop a competency-based assessment tool for pediatric tracheotomy because it is a complex, low-frequency and often life-saving procedure that is at times performed in a stressful environment. This tool can be used immediately after the procedure is complete to counteract the recall bias often seen in end-of-rotation evaluations.

Our response rate was 60% for the first round and 68% for the second round. A response rate of 60% for survey research is considered acceptable by many biomedical journals.[14] In addition, 99% of items were completed for all submitted questionnaires for each round with the lowest number of items completed by a single respondent being 30/31 (96.8%) in the first round and 35/37 (94.6%) in the second round. This is well above the American Association for Public Opinion Research (AAOPR) suggestion that 80% of all questions answered equals a complete response.[15] We attribute this response rate to the selection of clinicians experienced in this area of medicine, ease of use of the REDCap questionnaire, assurance of anonymity, and offer of authorship. We did not see a decrease in response rate from the first round to the second round, as is often seen with use of the Delphi method. The time for completion of this study was 67

days. We believe the above factors allowed for less fatigue and greater motivation and the short interval between questionnaires kept the interest level high.

Thirteen task-specific items reached consensus in the second round (Tables 2 and 3). Because this fell within the range of 7 to 25 items that we determined to be acceptable a-priori based on previously published surgical task-specific OSATS, we did not require another round of the Delphi technique.[6] Final items focused on preparation, communication, teamwork, prevention of adverse events and psychomotor skills and a proposed score sheet can be found in tables 4.

Several items reached near to consensus, likely because experts selected similar but perhaps better worded items instead. For example, review of history, physical examination and imaging reached near consensus whereas assessment of anatomy, physical limitations and ventilator settings reached consensus. Discussion of decreasing F_iO_2 and risk of airway fire reached near consensus whereas communication with the anesthesiologist about decreasing the F_iO_2, deflating the endotracheal tube cuff, and pulling it back, reached consensus. Confirmation of the tracheostomy tube being in the trachea through direct visualization, CO_2 color change and bilateral chest rise reached near consensus whereas inserts tracheostomy tube atraumatically, removes obturator and reconnects circuit, reached consensus likely because surgeons rely on visual confirmation of the tube in the trachea rather than secondary measures such as CO_2 color change. Other items reached near consensus likely because they are less specific to tracheotomy, such as obtaining informed consent, arranging transport and injecting local anesthetic, or because they can be arranged by people other than the otolaryngologist – head and neck surgeon, such as arranging the first tracheostomy and tie change, and initiating education of caregivers and plans for discharge.

Five of the 7 items in the Global Rating Scale reached consensus and 2 were near consensus. The 5 global rating items that reached consensus were all rated positively. Surprisingly, appropriate handling of tissue and demonstration of forward planning only reached near consensus. These items were among the highest with respect to mean Likert score, but reached only near consensus because there were two outliers for each item. We believe that 5 of 7 (71%) positively rated items justifies using this previously validated Global Rating Scale with

tracheotomy. In addition, the Global Rating Scale has not been validated for use of a subset of items, supporting using it in its entirety. Lastly, use of the Global Rating Scale is complementary to the task-specific scale, thus reinforcing its importance. A proposed scoring sheet can be found in table 5.

The major limitation of this study is that items were selected for this task-specific assessment tool for pediatric tracheotomy based on expert opinion and the scale has not been validated on trainees of varying levels of expertise to obtain construct validity. Additionally, we have yet to determine if this tool will be acceptable to trainees and faculty. We did not include experts from developing and resource-limited regions which may limit use of this tool in these areas. Although our modifications to the Delphi technique appeared to work well for reaching consensus on the important steps involved in pediatric tracheotomy in this study, we cannot extrapolate whether or not these modifications will work well when creating competency-based assessment tools for other surgical procedures or with a different group of experts. Future studies investigating the construct validity of this pediatric tracheotomy tool and the success of this modified Delphi consensus technique for creating other tools are required. To achieve this, broad and structured dissemination of this tool is required to permit independent evaluations.

CONCLUSION

It is feasible to reach consensus on the important steps involved in pediatric tracheotomy. This was made possible using the modified Delphi consensus process described herein. These items can now be considered to create a competency-based assessment tool for pediatric tracheotomy. Such a tool will hopefully allow trainees to focus on the important aspects of this procedure and help teaching programs standardize how they evaluate trainees during this procedure.
tracheotomy

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Table 1. Pediatric Open Tracheotomy OSAT Round 1

TASK-SPECIFIC ITEMS	Number Completed	Number Rating Keep (%)	Number Comments
Surgical goals, preparation and potential challenges			
1. Reviews history, physical examination, imaging, and anatomical and patient factors to identify goal of procedure and whether tracheotomy is indicated.	39	38 (97.4)	4
2. Assesses anatomy, physical limitations, and ventilator settings to determine feasibility.	39	38 (97.4)	3
3. Appreciates urgency of tracheotomy.	39	38 (97.4)	5
4. Understands risks, benefits, and potential complications at appropriate level to perform informed consent.	38	37 (97.3)	5
Preparation of instruments			
5. Selects appropriate surgical instruments and verifies availability.	39	32 (82.1)	5
6. Selects appropriate tracheostomy tube (diameter and length).	39	39 (100)	0

Communication with operative team			
7. Creates plan for transport to and from operating room and postoperative disposition.	39	28 (71.7)	6
8. Discusses role in shared airway.	39	37 (94.9)	4
9. Discusses risk of airway fire and management.	39	32 (82.1)	6
Patient position and exposure			
10. Brings head of patient to top of bed.	39	28 (71.7)	3
11. Uses appropriately sized shoulder roll if not contraindicated.	39	34 (87.2)	1
12. Applies antiseptic solution and drapes appropriately.	39	28 (71.7)	7
Tracheotomy			
13. Marks appropriate landmarks and incision, taking into account C-collar if required.	39	39 (100)	1
14. Injects local anesthetic/vasoconstrictive agent.	39	30 (76.9)	5
15. Removes fat from neck, if age appropriate.	38	32 (84.2)	2
16. Identifies and divides midline between strap muscles avoiding anterior jugular veins.	39	39 (100)	4
17. Safely deals with thyroid gland, where necessary.	39	39 (100)	1
18. Palpates neck for high riding innominate artery.	39	33 (84.6)	0
19. Palpates cricoid cartilage and considers need for cricoid hook.	38	37 (97.4)	2
20. Identifies appropriate level of entry into airway.	39	39 (100)	3
21. Prepares equipment (e.g. suction, tracheostomy tube) prior to entering airway.	39	38 (97.4)	4
22. Does not use electrocautery while tracheotomy is being created.	38	31 (81.6)	6
23. Communicates with anesthesiologist to deflate endotracheal tube cuff, where necessary.	39	37 (94.9)	3
24. Places retention sutures that expose the airway and do not pull through cartilage.	38	37 (97.4)	7
25. Places maturation sutures to decrease chances of false passage that do not narrow stoma.	39	27 (69.2)	15
26. Inserts tracheostomy atraumatically, removes obturator, and reconnects circuit without long delay.	39	39 (100)	2
27. Performs flexible or rigid bronchoscopy to ensure tracheostomy tube length is appropriate.	38	30 (78.9)	11
28. Ensures ties prevent tracheostomy from falling out but do not obstruct venous flow.	39	38 (97.4)	4
Postoperative planning			
29. Enters appropriate postoperative orders (safety protocols, chest x-ray where applicable).	39	37 (94.9)	6
30. Arranges first tie change and tracheostomy change.	39	35 (89.7)	2
31. Initiates education of caregivers and creates plan for discharge.	39	30 (76.9)	10

Table 2. Pediatric Open Tracheotomy Task Specific OSAT Round 2

TASK-SPECIFIC ITEMS	Number Completed	Mean (SD) Likert	Consensus
Surgical goals, preparation and potential challenges			
1. Reviews history, physical examination, imaging, and anatomical and patient factors/comorbidities to identify goal of procedure and whether tracheotomy is indicated.	45	6.50 (0.90)	Near
2. Assesses anatomy, physical limitations, and ventilator settings to determine feasibility, potential challenges and concerns.	44	6.33 (1.11)	Yes
3. Appreciates timing considerations of tracheotomy.	44	5.44 (1.42)	No
4. Understands risks, benefits, potential complications and long-term consequences to perform informed consent.	45	6.36 (1.01)	Near
Preparation of instruments			

5. Selects appropriate surgical instruments and tracheostomy tube (diameter, length, cuff) and verifies availability.	45	6.50 (0.63)	Yes
Communication with operative team			
6. Creates plan for transport to and from operating room and postoperative disposition.	45	5.73 (1.30)	Near
7. Discusses roles in shared airway with anesthesiologist.	45	6.43 (0.90)	Yes
8. Discusses decreasing F_iO_2 and risk of airway fire and management.	45	6.23 (0.86)	Near
Patient position and exposure			
9. Brings head of patient to top of bed and uses appropriately sized shoulder roll and extension if not contraindicated.	45	5.70 (1.09)	Yes
10. Applies/directs application of antiseptic solution and drapes appropriately.	45	5.14 (1.41)	No
Tracheotomy			
11. Marks appropriate landmarks and incision, taking into account C-collar if required.	45	6.25 (0.78)	Yes
12. Injects local anesthetic/vasoconstrictive agent at appropriate dose for weight.	45	5.59 (1.34)	Near
13. Discusses fat removal.	45	4.59 (1.35)	No
14. Identifies and dissects midline between strap muscles avoiding or ligating anterior jugular veins.	44	5.98 (0.89)	Yes
15. Safely manages thyroid gland, where necessary.	44	5.95 (1.07)	Yes
16. Palpates neck for high-riding innominate artery.	45	6.16 (0.91)	Near
17. Palpates cricoid cartilage and considers need for cricoid hook.	45	5.82 (0.97)	Yes
18. Identifies appropriate level of entry into airway considering indication for tracheotomy and future surgical considerations.	45	6.48 (0.79)	Near
19. Ensures suction, tracheostomy tube and smaller tracheostomy tube are prepared prior to entering airway.	44	6.60 (0.69)	Yes
20. Places retention sutures that expose the airway and do not pull through cartilage. Considers taping these to the chest and labelling them as “right” and “left”.	45	6.34 (0.64)	Yes
21. Communicates with anesthesiologist prior to entering the airway about decreasing the F_iO_2, deflating the endotracheal tube cuff, where necessary, and pulling back the endotracheal tube, where necessary.	43	6.60 (0.66)	Yes
22. Understands the risk of using electrocautery during and after tracheotomy has been created.	43	6.28 (1.05)	No
23. Considers placing maturation sutures that decrease chances of false passage and do not narrow stoma.	45	5.11 (1.65)	No
24. Inserts tracheostomy tube atraumatically, removes obturator, and reconnects circuit while holding tracheostomy tube in place the entire time without long delay.	45	6.55 (0.82)	Yes
25. Confirms tracheostomy tube is in trachea and patent through direct visualization, by inspecting for condensation, by using CO_2 color change and confirmation of bilateral chest rise.	44	6.56 (0.77)	Near
26. Ensures ties prevent tracheostomy from falling out but do not obstruct venous flow.	45	6.23 (0.86)	Yes
27. Performs flexible or rigid bronchoscopy to ensure tracheostomy tube length is appropriate.	45	5.23 (1.33)	No
Final evaluation			
28. Enters appropriate postoperative orders (safety protocols, chest x-ray where applicable).	44	6.21 (1.23)	No
29. Arranges first tie change and tracheostomy change.	45	5.84 (1.33)	Near
30. Initiates education of caregivers and creates plan for discharge.	45	5.61 (1.51)	Near

Table 3. Pediatric Open Tracheotomy Global Rating Scale OSAT Round 2

GLOBAL RATING SCALE	Number Completed	Mean (SD) Likert	Consensus
Respect of tissue			
1. Appropriate handling of tissue, minimizes tissue damage through appropriate use of instruments and appropriate force.	45	6.11 (0.95)	Near
2. Efficient and economic movement.	45	5.77 (0.89)	Yes
Knowledge of instruments			
3. Familiar with names of instruments required for this procedure, does not ask for wrong instrument or use incorrect names when asking for instruments.	45	5.70 (0.98)	Yes
Instrument handling			
4. Competent use of instruments, fluid movement without stiffness or awkwardness.	45	5.84 (0.81)	Yes
Flow of operation			

5. Demonstrates forward planning; course of operation demonstrated through effortless flow from one movement to the next.	44	6.09 (0.87)	Near
6. Strategically uses assistants to the best advantage at all times.	45	5.73 (0.97)	Yes
Knowledge of specific procedure			
7. Demonstrates familiarity of all steps of the operation/procedure.	45	6.64 (0.53)	Yes

Table 4. Pediatric Open Tracheotomy Evaluation Sheet

Date: (MM/DD/YY) _____
Trainee Name: (Last)_____ (First) _____
Level of Training:_____
Evaluator Name: (Last)_____ (First) _____

TASK-SPECIFIC ITEMS	Not done or done incorrectly	Done Correctly	Not observed
Surgical goals, preparation and potential challenges			
1. Assesses anatomy, physical limitations, and ventilator settings to determine feasibility, potential challenges and concerns.	□	□	□
Preparation of instruments			
1. Selects appropriate surgical instruments and tracheostomy tube (diameter, length, cuff) and verifies availability.	□	□	□

Communication with operative team			
2. Discusses roles in shared airway with anesthesiologist.	□	□	□
Patient position and exposure			
3. Brings head of patient to top of bed and uses appropriately sized shoulder roll and extension if not contraindicated.	□	□	□
Tracheotomy			
4. Marks appropriate landmarks and incision, taking into account C-collar if required.	□	□	□
5. Identifies and dissects midline between strap muscles avoiding or ligating anterior jugular veins.	□	□	□
6. Safely manages thyroid gland, where necessary.	□	□	□
7. Palpates cricoid cartilage and considers need for cricoid hook.	□	□	□
8. Ensures suction, tracheostomy tube and smaller tracheostomy tube are prepared prior to entering airway.	□	□	□
9. Places retention sutures that expose the airway and do not pull through cartilage. Considers taping these to the chest and labelling them as "right" and "left".	□	□	□
10. Communicates with anesthesiologist prior to entering the airway about decreasing the F_iO_2, deflating the endotracheal tube cuff, where necessary, and pulling back the endotracheal tube, where necessary.	□	□	□
11. Inserts tracheostomy tube atraumatically, removes obturator, and reconnects circuit while holding tracheostomy tube in place the entire time without long delay.	□	□	□
12. Ensures ties prevent tracheostomy from falling out but do not obstruct venous flow.	□	□	□
Number of items performed correctly: ____ Was this a standard case? □ Yes □ No If not, why? _____ Is this resident competent to perform this procedure? □ Yes □ No			

Table 5. Pediatric Open Tracheotomy Global Rating Scale Evaluation Sheet

Date: (MM/DD/YY) _____
Trainee Name: (Last)_____ (First) _____
Level of Training:_____
Evaluator Name: (Last)_____ (First) _____

GLOBAL RATING SCALE					
1. Respect for tissue	1 Frequently used unnecessary force on tissue or caused damage by inappropriate use of instruments	2	3 Carefully handled tissue but occasionally caused inadvertent damage	4	5 Consistently handled tissues appropriately with minimal damage
2. Time and motion	1 Many unnecessary moves	2	3 Efficient but some unnecessary moves	4	5 Clear economy of movement and maximum efficiency
3. Instrument handling	1 Repeatedly made tentative or awkward moves by inappropriate use	2	3 Competent use of instruments but occasionally appeared stiff or awkward	4	5 Fluid moves and no awkwardness
4. Knowledge of instruments	1 Frequently asked for wrong instrument or used inappropriate instrument	2	3 Knew names of <u>most</u> instruments and used appropriate instruments	4	5 Obviously familiar with instruments and their names
5. Use of assistants	1 Consistently placed assistants poorly or failed to use assistants	2	3 Appropriate use of assistants <u>most</u> of the time	4	5 Strategically used assistants to the best advantage at <u>all</u> times
6. Flow of operation and forward planning	1 Frequently stopped operating or unsure of next move	2	3	4	5

			Some forward planning with reasonable progression of procedure		Obviously planned course of operation with effortless flow from one move to the next
7. Knowledge of specific procedure	1 Deficient knowledge. Needed specific instruction at most steps	2	3 Knew all <u>important</u> steps of operation	4	5 Demonstrated familiarity with <u>all</u> aspects of operation
Total score (sum all numbers): ____ Was this a standard case? □ Yes □ No If not, why? _____ Is this resident competent to perform this procedure? □ Yes □ No					