Advanced Pediatric Airway Team-based Learning

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ABSTRACT:

Audience: While all levels of learner could potentially benefit from this classic team-based learning (cTBL), it is designed for senior emergency medicine (EM) residents or pediatric emergency fellows who are already familiar with basic pediatric airway topics.

Introduction: Respiratory complaints are one of the most common reasons that pediatric patients present to the emergency room, with 9.6 million visits for respiratory-related reasons in 2015.[1] While many of these visits require only minimal interventions such as supportive care, bronchodilators, or oral medications, the emergency provider must always be prepared in the event of a life-threatening airway emergency requiring immediate intervention. However, identifying and managing these cases may be challenging for residents, especially those with infrequent or seasonal pediatric exposure. While there are many individual articles on topics related to respiratory or airway emergencies, there are few case-based activities for emergency medicine providers available, and these are either simulation-based,[2-5] targeted towards anesthesiologists,[6] focused on one disease process,[7,8] or targeted towards medical students.[9,10] Therefore, the goal of this cTBL is to review a variety of unique but complementary life-threatening pediatric airway cases for emergency medicine physicians, including the presentation, workup, and management of each: foreign body obstruction, bacterial tracheitis, status asthmaticus, and post-tonsillectomy bleeding.

Objectives: This cTBL covers a variety of pediatric airway emergencies. Therefore, by the end of this cTBL, the learner will be able to: 1) List the signs and symptoms associated with airway foreign body obstructions. 2) State the appropriate management of upper and lower airway foreign bodies. 3) Discuss the symptoms, signs, and management of bacterial tracheitis. 4) Discuss a step-wise algorithm for emergency asthma treatment in the emergency department setting. 5) Identify the potential complications of tonsillectomy and the acute management of post-tonsillectomy hemorrhage.

Method: This didactic session is a classic TBL.

Topics: Pediatric airway emergencies, airway foreign body, foreign body aspiration, bacterial tracheitis, pediatric asthma, status asthmaticus, post-tonsillectomy hemorrhage.

USER GUIDE

List of Resources:

Learner Audience:
Junior Residents, Senior Residents

Time Required for Implementation:
Instructor Preparation: 30-60 minutes
Learner Responsible Content: 0-60 minutes
In Class Time: 90 minutes

Recommended Number of Learners per Instructor:
Depending on group size, only one instructor is required, though it is helpful to have others familiar with the content to interact with learners during the session. An ideal size for this didactic is 10-30 learners, though it may be completed in larger groups if more instructors are available.

Topics:
Pediatric airway emergencies, airway foreign body, foreign body aspiration, bacterial tracheitis, pediatric asthma, status asthmaticus, post-tonsillectomy hemorrhage.

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1. List the signs and symptoms associated with airway foreign body obstructions.
2. State the appropriate management of upper and lower airway foreign bodies.
3. Discuss the symptoms, signs, and management of bacterial tracheitis.
4. Discuss a step-wise algorithm for emergency asthma treatment in the emergency department setting.
5. Identify the potential complications of tonsillectomy and the acute management of post-tonsillectomy hemorrhage.

Linked objectives, methods and results:
Pediatric airway emergencies are infrequently experienced by resident physicians; therefore, a team-based learning activity which includes a review of multiple presentations and a higher-level discussion of these scenarios may provide enhanced preparation for clinical experiences. Case 1 involves a pediatric patient with a history concerning for an airway foreign body ingestion, and reviews upper versus lower airway foreign body diagnosis and management, and therefore achieves objectives 1 and 2. Case 2 covers a patient with recent croup who now is developing worsening signs and symptoms concerning for bacterial tracheitis, thus achieving objective 3. Case 4 is a patient with asthma refractory to initial interventions, and reviews the presentation, management, and treatment algorithm for status asthmaticus, thus achieving objective 4. Lastly, case 5 is a patient who presents with post-tonsillectomy hemorrhage, and has learners identify the diagnosis, initial managements, and disposition, achieving objective 5. Learners' critical thinking is probed during the activity through discussion with group members to answer questions, and knowledge is solidified through review of the answers with the instructor.

Recommended pre-reading for instructor:
The instructor should primarily be familiar with all cases and instructional materials. Optional pre-reading includes:

- Berdan E, Sato T. Pediatric Airway and Esophageal Foreign Bodies. *Surg Clin North Am.* 2017;97(1):85-91. doi: 10.1016/j.suc.2016.08.006
- Al-Mutairi B, Kirk V. Bacterial tracheitis in children: approach to diagnosis and treatment. *Paediatr Child Health*. 2004;9(1):25-30.
- Camargo C, Rachelefsky G, Schatz M. Managing asthma exacerbations in the emergency department: summary of the National Asthma Education and Prevention Program Expert Panel Report 3 guidelines for the management of asthma exacerbations. *J Emerg Med.* 2009;37(2 Suppl): S6-S17. doi: 10.1016/j.jemermed.2009.06.105
- Lau AS. Post-tonsillectomy bleed. ENTsho.com. https://entsho.com/post-tonsillectomy-bleed/. Updated September 29, 2018. Accessed September 10, 2018.
- Fox S. Post-tonsillectomy hemorrhage. Pediatric EM Morsels. http://pedemmorsels.com/post-tonsillectomy-hemorrhage/. Published August 17, 2012. Updated July 23, 2016. Accessed September 10, 2018.

Learner Responsible Content (LRC):
Prior to the activity, send out the materials below to learners for suggested reading/listening:

- Moses S. Pediatric assessment triangle. Family Practice Notebook https://fpnotebook.com/ER/Peds/PdtrcAssmntTrngl.htm. Published June 1, 2015. Accessed September 27, 2018.
- Seth, D, Kamat, D. Foreign-body Aspiration: a guide to early detection, optimal therapy. Pediatrics Consultant Live. http://www.pediatricsconsultantlive.com/allergy/foreign-body-aspiration-guide-early-detection-optimal-therapy. Published January 2, 2007. Accessed March 26, 2018.
- Ibrahim AF. Pediatric Asthma. CDEM Curriculum. https://cdemcurriculum.com/pediatric-asthma/. Accessed on May 25, 2018.
- Fox S. Post-tonsillectomy hemorrhage. Pediatric EM Morsels. http://pedemmorsels.com/post-tonsillectomy-hemorrhage/. Published August 17, 2012. Updated July 23, 2016. Accessed September 10, 2018.

Results and tips for successful implementation:

Prior to the session, the instructor should prepare materials:

- One individual readiness assessment test (iRAT) per learner.
- One group readiness assessment test (gRAT) per group (recommend 3-5 learners per group). See gRAT section for how to prepare the gRAT.
- One group application exercise (GAE) per group (recommend 3-5 learners per group).
- Copies of all materials, including the keys, for each instructor.

You will need approximately 90 minutes to conduct the session. We suggest the following timeline:

1. Introduce session (1 minute).
2. The instructor hands out the iRAT to all learners and has them complete it individually (5-10 minutes).
3. The instructor assigns learners into groups of 3-5. Ideally, a mix of level of learners in each group is best. Groups complete the gRAT (5-10 minutes).
4. The instructor will answer any questions related to the gRAT (5-10 minutes).
5. Groups complete the GAE (30 minutes); we suggest having all groups complete all cases; however, you may assign some groups to start at case 1, some groups to start at case 2, some groups to start at case 3, etc. to be sure all cases are covered in the allotted time.
6. Review answers from the GAE (30 minutes); a suggested format is to call on groups one at a time to answer each question. Note that the instructor materials provide enhanced answers in case of questions, and not all material will need to be covered.
7. Hand out post-test learning sheet.

Evaluation:

In the pilot session of this cTBL, 9 out of 18 participants (all EM residents, varying from intern to third year residents) completed the post-TBL survey. Overall, this session was rated as "outstanding" (Likert 5/5) by 5 and "excellent" (Likert 4/5) by 4 for a weighted average of 4.56. Eight found the activity "highly engaging," and all participants wanted to repeat the activity in the future. Negative feedback surrounded the desire to have more time for the activity. As a result of feedback, we suggest monitoring the time spent on other portions of the activity closely to allow for more discussion, and allotting at least 90-120 minutes for completion.

References/suggestions for further reading:

1. McDermott, KW, Stocks, C, Freeman, W. Overview of pediatric emergency department visits, 2015. HCUP statistical brief #242, August 2018. Agency for healthcare research and quality (AHRQ), Rockville, MD. https://www.hcup-us.ahrq.gov/reports/statbriefs/sb242-Pediatric-ED-Visits-2015.pdf. Published August 7, 2018. Accessed September 21, 2018.
2. Friedman S, Tozzi M, Siems A, Carey A, Moerdler S, Zackai S. Simulation of airway management for the pediatric resident. *MedEdPORTAL*. 2014; 10:9881. doi: 10.15766/mep_2374-8265.9881
3. Rogers A, Di Rocco J, Soung P. Simulated pediatric respiratory workshop. *MedEdPORTAL*. 2014; 10:9693. doi: 10.15766/mep_2374-8265.9693
4. Reid J, Stone K. Pediatric emergency medicine simulation curriculum: status asthmaticus. *MedEdPORTAL*. 2014; 10:9660. doi: 10.15766/mep_2374-8265.9660
5. Levasseur K, Filips K. Pediatric upper airway obstruction. *MedEdPORTAL*. 2015; 11:10311. doi: 10.15766/mep_2374-8265.10311
6. Breinholt CC, Obr CJ. General anesthesia for a post-tonsillectomy and adenoidectomy bleed. *MedEdPORTAL*. 2016;12:10476. doi: 10.15766/mep_2374-8265.10476
7. Wolff M, Bradin S, Mistry R. Pediatric aerodigestive foreign bodies. *MedEdPORTAL*. 2014; 10:9676. doi: 10.15766/mep_2374-8265.9676
8. Griswold S, Erbayri J. Swallowed a quarter. *MedEdPORTAL*. 2012; 8:9097. doi: 10.15766/mep_2374-8265.9097
9. Gerdung C, Lewis M, Duff J, Graham T, Grewal S. PedsCases - a learning module of acute stridor for medical students. *MedEdPORTAL*. 2011; 7:8276. doi: 10.15766/mep_2374-8265.8276

10. Murphy T, Shah M, Hepper A, et al. Pediatric asthma team-based learning module. *MedEdPORTAL*. 2016; 12:10365. doi: 10.15766/mep_2374-8265.10365
11. Seth, D, Kamat, D. Foreign-body Aspiration: a guide to early detection, optimal therapy. Pediatrics Consultant Live. http://www.pediatricsconsultantlive.com/allergy/foreign-body-aspiration-guide-early-detection-optimal-therapy. Published January 2, 2007. Accessed March 26, 2018.
12. D'Amato, G, Vitale, C, Molino, A, et al. Asthma-related deaths. *Multidiscip Respir Med*. 2016; 11:37. doi: 10.1186/s40248-016-0073-0
13. Roberts, G, Patel, N, Levi-Schaffer, F, Habibi, P, Lack, G. Food allergy as a risk factor for life-threatening asthma in childhood: A case-controlled study. *J Allergy Clin Immunol*. 2003;112(1):168-174. doi: 10.1067/mai.2003.1569
14. Nievas, I, Anand, K. Severe acute asthma exacerbation in children: a stepwise approach for escalating therapy in a pediatric intensive care unit. *J Pediatr Pharmacol Ther.* 2013;18(2):88-104. doi: 10.5863/1551-6776-18.2.88
15. Barnett P, Caputo GL, Basko M, Kuppermann N. Intravenous versus oral corticosteroids in the management of acute asthma in children. *Ann Emerg Med*. 1997;29(2):212-7. doi: 10.1016/S0196-0644(97)70270-1
16. Moraa I, Sturman N, McGuire T, van Driel M. Heliox for croup in children. *Cochrane Database Syst Rev.* 2013;(12):CD006822. doi: 10.1002/14651858.CD006822.pub4
17. Bandar Al-Mutairi, V. Bacterial tracheitis in children: approach to diagnosis and treatment. *Paediatr Child Health*. 2004;9(1):25-30.
18. Fox S. Post-tonsillectomy hemorrhage. Pediatric EM Morsels. http://pedemmorsels.com/post-tonsillectomy-hemorrhage/. Published August 17, 2012. Updated July 23, 2016. Accessed September 10, 2018.
19. Rassi E, de Alarcon A, Lam D. Practice patterns in the management of post-tonsillectomy hemorrhage: An American Society of Pediatric Otolaryngology survey. *Int J Pediatr Otorhinolaryngol*. 2017; 102:108-113. doi: 10.1016/j.ijporl.2017.09.007
20. Berdan E, Sato T. Pediatric airway and esophageal foreign bodies. *Surg Clin North Am.* 2017;97(1):85-91. doi: 10.1016/j.suc.2016.08.006
21. ACLS-Algorithms.com. (PALS) Upper Airway Obstruction. https://acls-algorithms.com/pediatric-advanced-life-support/respiratory-distress-failure/upper-airway-obstruction/. Accessed on May 25, 2018.
22. Ibrahim AF. Pediatric Asthma. CDEM Curriculum. https://cdemcurriculum.com/pediatric-asthma/. Accessed on May 25, 2018.
23. Lau AS. Post-tonsillectomy bleed. ENTsho.com. https://entsho.com/post-tonsillectomy-bleed/. Updated September 29, 2018. Accessed September 10, 2018.
24. Vaschetto R, Bellotti E, Turucz E, Gregoretti C, Corte FD Navalesi P. Inhalational anesthetics in acute severe asthma. *Curr Drug Targets*. 2009;10(9):826-32. doi: 10.2174/138945009789108747
25. Yeo H, Kim D, Jeon D, Kim YS, Rycus P, Cho WH. Extracorporeal membrane oxygenation for life-threatening asthma refractory to mechanical ventilation: analysis of the Extracorporeal Life Support Organization registry. *Critical Care*. 2017; 21:297. doi: 10.1186/s13054-017-1886-8
26. Fox S. Mechanical ventilation for severe asthma. Pediatric EM Morsels. http://pedemmorsels.com/mechanical-ventilation-severe-asthma/. Published November 7, 2014. Accessed September 10, 2018.
27. Beno S, Ackery AD, Callum J, Rizoli S. Tranexamic acid in pediatric trauma: why not? *Critical Care*. 2014; 18:313. doi: 10.1186/cc13965

Advanced Pediatric Airway: individual Readiness Assessment Test (iRAT)

1. The most sensitive feature for a foreign body aspiration event is:
    a. Chest X-ray demonstrating the foreign body
    b. Fever, stridor, and chest pain
    c. History of a coughing, choking, or gagging event
    d. Localized wheezing on physical exam

2. What is the most common foreign body inhaled in infants and toddlers?
    a. Balloons
    b. Coins
    c. Marbles
    d. Peanuts

3. In a child with a diagnosis of asthma, which feature is associated with poor outcomes (i.e. near fatal asthma)?
    a. Daily morning exacerbation of symptoms
    b. Diagnosis of asthma in teen years
    c. History of life-threatening allergic reaction
    d. Slowly progressive onset of asthma exacerbation

4. A 10-year-old female presents with respiratory distress. She has a history of poorly controlled asthma, and has been to the emergency department (ED) multiple times for exacerbations. You treat her with a dose of oral steroids and 3 rounds of nebulized albuterol, and on reassessment she has continued tachypnea, wheezing, and intercostal retractions. What therapy will you initiate next?
    a. A second round of albuterol nebulizers
    b. Intravenous steroids
    c. Epinephrine intramuscularly
    d. High-dose nebulized continuous albuterol

5. A 3-year-old male presents with respiratory distress. He was diagnosed with croup five days ago and was treated with steroids. He was improving until today, when he developed sudden onset of stridor and fever to 38.9°C. He has marked inspiratory stridor and intercostal retractions noted at rest. The child does not improve after racemic epinephrine and intravenous steroids. Which of the following treatments should be initiated for this patient?
    a. Broad-spectrum intravenous antibiotics
    b. Cool air mist
    c. Heliox therapy
    d. Nebulized continuous albuterol

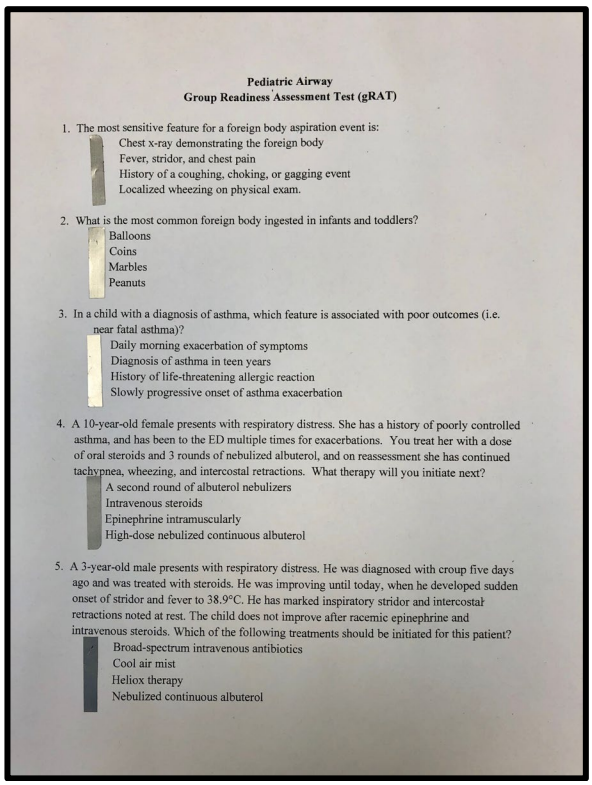
6. A 2-year-old female presents with a complaint of fever and cough. The child recently was diagnosed with croup. On exam, you note audible stridor and the child appears toxic with a temperature of 39°C. There is no neck stiffness or drooling. Which of the following is true regarding the most likely etiology of this disease?
    a. It often begins after a surgery, such as a tonsillectomy
    b. It often begins as a viral prodrome
    c. *Streptococcus pneumoniae* is the most common bacterial cause
    d. The airway should be secured in the emergency department in all cases

7. When is the risk of secondary post-tonsillectomy hemorrhage the highest?
    a. Day 1
    b. Day 3
    c. Day 7
    d. Day 14

8. You are working at a community hospital with no otolaryngology (ENT) coverage and a 6-year-old male presents with bleeding from his recent tonsillectomy site. His mother shows you a photo of a basin (approximately 200 cc) full of blood that started 1 hour prior to arrival. However, on your exam, the bleeding has stopped and there is a clot over the tonsillectomy site. What is his ultimate disposition?
    a. Admit to community hospital for serial H&H and observation
    b. Transfer the patient for ENT consultation
    c. Reassurance and discharge home
    d. Six-hour observation period in ED

Advanced Pediatric Airway: group Readiness Assessment Test (gRAT)

Ideally, to make a gRAT using the immediate feedback assessment technique (IF/AT) you may purchase silver "scratch off stickers" (available at amazon.com) and place the stickers over the index letters as demonstrated in the example below (1st photo is the gRAT to be given to each group and the 2nd photo is the completed gRAT after the group completes the quiz together). If you do not want to create a gRAT in this way, you can simply use the iRAT as a gRAT and either give a blank iRAT copy to each group or have them work together to decide on their final answers.



Pediatric Airway
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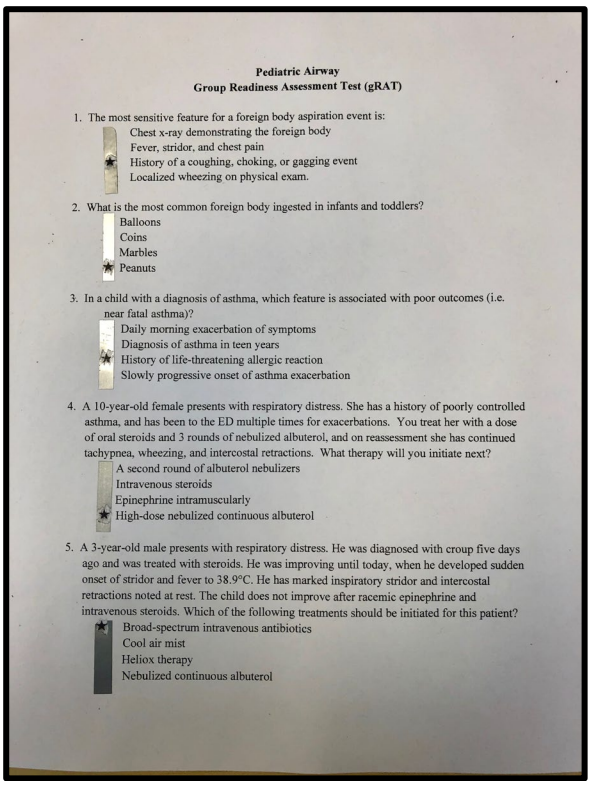

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   a. Admit to community hospital for serial H&H and observation
   ★ Transfer the patient for ENT consultation
   c. Reassurance and discharge home
   d. Six-hour observation period in ED

Advanced Pediatric Airway:
Group Application Exercise (GAE)

Case 1

A 2-year-old otherwise healthy boy presents with complaint of cough for the past two days. The cough is intermittent and non-productive. His mother states his breathing "sounds funny" ever since he was playing with his older sister's toys two days ago. She denies nasal congestion, nasal discharge or fevers. The child otherwise appears non-toxic. He has been afebrile, immunizations are up-to-date, and the patient has no sick contacts.

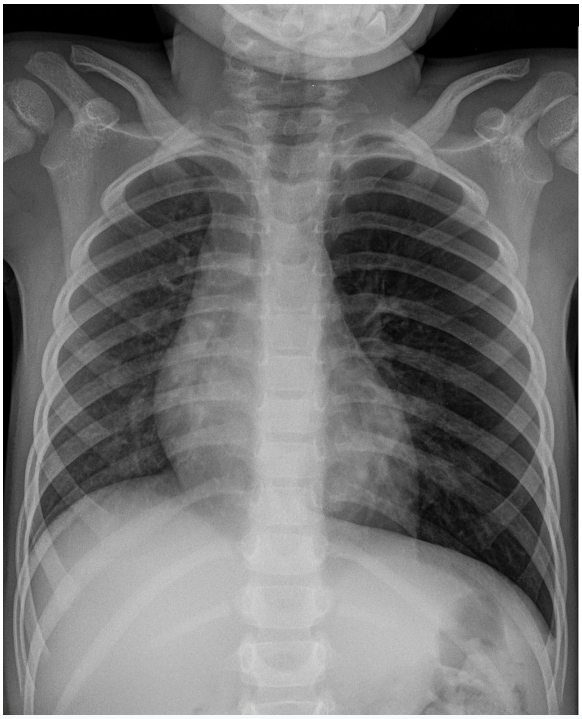
Vital signs: Temperature (T) 37°C Heart rate (HR) 111 Blood pressure (BP) 90/60 Respiratory rate (RR) 25 Oxygen saturation (O_2sat) 97% on room air

1. What is your differential diagnosis for this patient?

2. Your exam is notable for mild wheezing in the left lung field; otherwise, the exam is unremarkable. What initial workup would you perform in the emergency department?

3. What examination findings would differentiate an upper vs. lower foreign body airway obstruction?

4. You obtain the below chest X-ray. What do you see? What are you next steps in management?



Hellerhoff. Röntgenbild der Lunge bei einem 3-jährigen Kind nach Aspiration einer Erdnuss: Die linke Lunge ist durch einen Ventilmechanismus durch die Erdnuss deutlich überbläht. Klar erkennbarer Shift des Mediastinums nach rechts (links im Bild). In: Wikimedia Commons. https://en.wikipedia.org/wiki/Foreign_body_aspiration#/media/File:Erdnussaspiration_3j_-_Roe_pa_-_001.jpg. Published January 10, 2017. CC BY-SA 3.0.

5. A similar patient presents with stridor and overt respiratory distress after his mother states he swallowed a foreign body. He then becomes apneic in the ED. How would you manage this?

LEARNER MATERIALS

Case 2

A 3-year-old otherwise healthy, vaccinated male presents with respiratory distress. On exam, the child is sitting upright in bed but appears somewhat lethargic. He has intercostal and substernal retractions with audible stridor. His lung sounds are clear. His capillary refill is 3 seconds. On further history, you learn that the patient had a diagnosis of croup 5 days ago. His mother states that today, his work of breathing became progressively increased and he developed a high fever. Mother states his voice has been normal. You give racemic epinephrine and steroids; however, the child is not improving after these interventions.

Vital signs: T 39.5°C HR 130 BP 90/60 RR 60 O_2sat 91% on room air

1. What is your differential diagnosis for this patient? What is the most likely diagnosis and why?

2. What are your initial steps in management?

3. What medication choice would you initiate once able?

4. On repeat examination, the child appears more lethargic and is desaturating to 80%. What is your next step in management? What equipment will you use?

LEARNER MATERIALS

Case 3

An 8-year-old boy with history of poorly controlled asthma presents with significant respiratory distress. His mother states he has been "breathing fast" for the prior two days after a recent cold, but seemed worse today prompting the ED visit. He is noted to have intercostal retractions and on lung auscultation, has biphasic wheezing in the upper lobes with very little aeration at the bases.

Vital signs: T 37°C HR 145 BP 98/38 RR 76 O_2sat 87%

1. What is your differential diagnosis for this patient?

2. What is your first-line management for a pediatric patient with an asthma exacerbation?

3. You reassess the patient, and he continues to have significant work of breathing and wheezing. What would you try next (i.e. what are your 2nd line therapies)?

4. The patient continues to have significant wheezing and dyspnea, and appears more lethargic and difficult to arouse. What intervention might you take? What treatment(s) would you try next (i.e. what are your 3rd line therapies)?

LEARNER MATERIALS

Case 4

A 7-year-old girl presents six days after a tonsillectomy and adenoidectomy due to "spitting up some blood." Her mom describes a tablespoon of blood and a blood clot on her pillow at home after waking up from a nap. On exam, she appears pale and tired with a capillary refill of 3 seconds. On the throat exam, you note a fibrin clot but do not see any active bleeding or scab. As you go to write your note, you are called back into the room by the nurse and find the patient coughing and spitting up significant amounts of blood. She quickly fills up a small basin with blood.

Vital signs: T 37.6°C HR 135 BP 102/89 RR 28 O_2sat 98%

1. What is your diagnosis for this patient? When does it commonly present?

2. What are your initial steps in management?

3. The patient is having frequent coughing/gagging events with hypoxic episodes to the low 80's. What is your next step in management? What equipment would you use?

4. You decide to intubate this child. As you prepare your materials, you notice her blood pressure is 80/50. What are your other management priorities? Specifically, what can you do to optimize this child's physiology peri-intubation?

LEARNER MATERIALS

Pediatric Advanced Airway Pearls

Airway Foreign Bodies

- **Most common age**= 2 years old, **most common location**= right bronchus
- **MUST be taken seriously if caretaker reports ingestion** of foreign body
- **Workup**: Chest X-ray with lateral decubitus if patient non-toxic/tolerates
- Presentation of foreign body aspiration may differ based on **location (see below)**
- **Management**: if lower obstruction, call consultant (i.e. pediatric otolaryngology (ENT)/surgery) for bronchoscopy; if impending or complete obstruction, **prepare for intubation and follow PALS algorithm.**

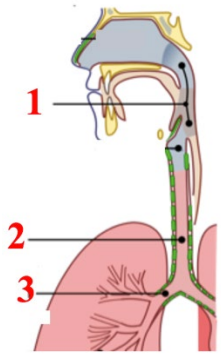


Figure 1

Source: Jmarchn A. Conducting passages of the human respiratory system. In: Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Illu_conducting_passages.svg. Published May 10, 2010. Accessed August 27, 2018. Public Domain.

1 **Larynx:** May present with obstruction, dysphonia, or hoarseness. If blockage is complete, then can have cyanosis and severe distress or cardiac arrest.

2 **Trachea**: May have biphasic stridor, dry cough. Often appear uncomfortable or scared. If required to intubate due to respiratory arrest, could try right mainstem intubation approach.

3 **Bronchus**: May have cough, focal wheezing or rales, and/or decreased breath sounds on side of aspiration. Will be phonating normally.

Read more about airway foreign bodies at:

- Seth D, Kamat D. Foreign-body aspiration: a guide to early detection, optimal therapy. Pediatrics Consultant Live. http://www.pediatricsconsultantlive.com/allergy/foreign-body-aspiration-guide-early-detection-optimal-therapy. Published January 2, 2007.

Bacterial Tracheitis

- Average age ~5 years old
- Diffuse infection of trachea, larynx, bronchi most commonly caused by ***Staphylococcus aureus***
- Usually presents with several day **viral upper respiratory infection prodrome;** then patient becomes **febrile, toxic, develops stridor and toxic appearance**
- Will **not** respond as expected to typical croup therapies (racemic epinephrine, steroids)
- Occurs at **cricoid cartilage**, narrowest portion of pediatric airway
- **Management pearls:**
  1) Avoid agitation, painful procedures, intravenous (IV) line placement.
  2) Contact anesthesia/ENT/pediatric surgery (2 person set up in operating room [OR] for airway exam, neck prepped for emergent tracheostomy).
  3) Once able to initiate antibiotics, give broad-coverage including: Vancomycin, ceftriaxone.

Read more about bacterial tracheitis:

- Bandar Al-Mutairi, V. Bacterial tracheitis in children: approach to diagnosis and treatment. *Paediatr Child Health*. 2004;9(1):25-30.

LEARNER MATERIALS

Pediatric Asthma Algorithm

- **First line therapy:** Oral or IV steroids, nebulized albuterol + ipratropium
- **Second line, if continued wheezing:** Continuous albuterol, magnesium infusion
- **Third line, if refractory to above or peri-intubation:** Consider epinephrine or terbutaline, ketamine (subdissociative), bilevel positive airway pressure (BiPAP).
- **Other possible "kitchen sink" therapies:** Aminophylline, heliox, extracorporeal membrane oxygenation (ECMO), inhaled anesthetics (in conjunction with pediatric intensivist)

Read more about pediatric asthma at:

- Camargo C, Rachelefsky G, Schatz M. Managing asthma exacerbations in the emergency department: summary of the National Asthma Education and Prevention Program Expert Panel Report 3 guidelines for the management of asthma exacerbations. *J Emerg Med.* 2009;37(2 Suppl): S6-S17. doi: 10.1016/j.jemermed.2009.06.105

Post Tonsillectomy Bleeding:

- Very traumatic procedure
- Tissue may take up to 2 weeks to fully heal
- Post-tonsillectomy hemorrhage may occur at 2 primary points (see below)

Primary hemorrhage

- **First 24 hours:** Bleeding may occur when eschar (fibrin clot/plug) is shed

Secondary hemorrhage

- **Days 5-7 days:** Fibrin clot dissolves and thick cake forms (see image). Granulation tissue grows on periphery of wound and clot begins to peel off, hence risk of bleeding

Source: Eleonoreo. User appx one week after tonsil removal. In: Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Tonsillectomy_day_7.jpg. Published October 14, 2012. Accessed August 27, 2018. CC BY-SA 3.0.

Management

- If child is stable→
  - Call ENT immediately, Have airway/resuscitation equipment ready
- If child is not protecting airway and emergent intubation needed in ED→
  - Prepare for intubation:
    - Airway equipment, suction, Face shield
    - Have child sitting up
    - Glidescope/CMAC video laryngoscope and direct laryngoscopy blade
  - Prior to intubation, think about optimizing child's physiology:
    - Fluid bolus (20 ml/kg, up to 60 ml/kg in 1st hour)
    - Type & cross
    - 10 ml/kg blood transfusion
  - Once airway established, direct **outward** pressure on tonsillar region with Magill and gauze, topical tranexamic acid (TXA), topical lidocaine with epinephrine

More about post-tonsillectomy hemorrhage:

- Lau AS. Post-tonsillectomy bleed. ENTsho.com. https://entsho.com/post-tonsillectomy-bleed/. Updated September 29, 2018. Accessed September 10, 2018.

INSTRUCTOR MATERIALS

Answer keys to all exercises with explanations, are on the following pages.

Learners: please do not proceed.

Advanced Pediatric Airway: Readiness Assessment Test Key (RAT Key)

1. The most sensitive feature for a foreign body aspiration event is:
    a. Chest X-ray demonstrating the foreign body
    b. Fever, stridor, and chest pain
    c. **History of a coughing, choking, or gagging event**
    d. Localized wheezing on physical exam.

    Explanation: The correct answer is choice (c) history of a coughing, choking, or gagging event in up to 80%-90% of patients with a foreign body.[11] Chest X-ray is an unreliable diagnostic test for foreign body, making choice (a) incorrect. While chest films may show abnormal findings in 40%-80% of cases, these findings are often non-specific and include unilateral hyperinflation, atelectasis, or pneumonia. Additionally, most foreign bodies are radiolucent. Fever, stridor, and chest pain are uncommon findings in a foreign body aspiration, making choice (b) incorrect. Lastly, localized wheezing may be present on physical exam if a foreign body is lodged in the bronchus; however, this is a non-specific finding, making choice (d) incorrect.

2. What is the most common foreign body ingested in infants and toddlers?
    a. Balloons
    b. Coins
    c. Marbles
    d. **Peanuts**

    Explanation: The most common ingestion in infants and toddlers are food items such as nuts, seeds, and food particles. The most common aspiration is peanuts, occurring in 36%-55% of infants and toddlers, making choice (d) correct.[11] In older children, aspiration of paper clips, coins, balls, marbles, and pins are more common. Balloon aspiration is particularly concerning because it is commonly fatal due to the balloon lodging at the carina and blocking airflow into the lungs.

3. In a child with a diagnosis of asthma, which feature is associated with poor outcomes (i.e. near fatal asthma)?
    a. Daily morning exacerbation of symptoms

b. Diagnosis of asthma in teen years
c. **History of life-threatening allergic reaction**
d. Slowly progressive onset of asthma exacerbation

Explanation: Based on asthma research, risk factors for near-fatal and fatal asthma include:[12,13,14]

- A history of near-fatal asthma requiring intubation
- Hospitalization/ED visit for asthma within the past year
- History of recent or current use of oral corticosteroids
- Not taking inhaled corticosteroids
- History of psychosocial stressors or psychiatric disease
- History of poor adherence to asthma action plan, medications
- Severe food allergy in an asthmatic patient

Typically, asthma exacerbations are more common at night, making choice (a) incorrect. More severe asthma is usually associated with a younger age of diagnosis, making choice (b) incorrect. Additionally, a rapid onset of asthma exacerbation is more concerning, making choice (d) incorrect.

4. A 10-year-old female presents with respiratory distress. She has a history of poorly controlled asthma, and has been to the ED multiple times for exacerbations. You treat her with a dose of oral steroids and three rounds of 5 mg nebulized albuterol, and on reassessment she has continued tachypnea, wheezing, and intercostal retractions. What therapy will you initiate next?
   a. Three more 5 mg albuterol nebulizers
   b. Intravenous steroids
   c. Epinephrine intramuscularly
   d. **High-dose nebulized continuous albuterol**

Explanation: This child has a history of poorly-controlled asthma, and does not respond to initial therapies including oral steroids and 3 rounds of 5 mg nebulized albuterol; therefore, she is likely now in status asthmaticus and requires escalating care. In this case, the child should be started on high-dose continuous nebulized albuterol (0.15-0.5 mg/kg/hr,14 not to exceed 15-20 mg/hr), or choice (d). Choice (a) is incorrect because the child is unlikely to respond to a standard dose of albuterol on repeat administration. Choice (b) is incorrect because there is no proven efficacy of intravenous steroids over

oral steroids.15 Choice (c) may be utilized if the child does not respond to high-dose nebulized continuous albuterol, or as a third-line therapy.

5. A 3-year-old male presents with respiratory distress. He was diagnosed with croup five days ago and was treated steroids. He was improving until today, when he developed sudden onset of stridor and fever to 38.9°C. He appears toxic with marked inspiratory stridor and intercostal retractions noted at rest. The child does not improve after racemic epinephrine and intravenous steroids. Which of the following treatments should be initiated for this patient?
    a. **Broad-spectrum intravenous antibiotics**
    b. Cool air mist
    c. Heliox therapy
    d. Nebulized continuous albuterol

    Explanation: This patient was recently diagnosed with croup and was improving until today, when he developed sudden onset of stridor and high fevers unresponsive to steroids and racemic epinephrine. This is concerning for bacterial tracheitis, and therefore the child should be started on broad-spectrum intravenous antibiotics, or choice (a). Choice (b) may be helpful in croup, but will not help this patient who is unresponsive to racemic epinephrine and has a concerning clinical picture for bacterial tracheitis. While choice (c) may have utility in croup, it has no proven efficacy in bacterial tracheitis.[15] Choice (d) is incorrect because albuterol will not help an upper airway inflammatory/obstructive process such as bacterial tracheitis.

6. A 2-year-old female presents with a complaint of fever and cough. The child recently was diagnosed with croup. On exam, you note audible stridor and the child appears toxic with a temperature of 39°C. There is no neck stiffness or drooling. Which of the following is true regarding the most likely etiology of this disease?
    a. It often begins after a surgery, such as a tonsillectomy
    b. **It often begins as a viral prodrome**
    c. *Streptococcus pneumoniae* is the most common bacterial cause
    d. The airway should be secured in the emergency department in all cases

    Explanation: In this case, you have a patient recently diagnosed with croup who is now febrile and toxic appearing. This is concerning for bacterial tracheitis, which often begins with a viral prodrome, choice (b). [17] This is less commonly a post-operative complication,

making choice (a) incorrect. While there are many causes of croup, in the post-antibiotic era the most common bacterial origin is *Staphylococcus aureus*, making choice (c) incorrect. [17] Lastly, it is important to keep this child calm and consider definitive airway management in the operating room unless immediate intubation is necessary, making choice (d) incorrect.

7. When is the risk of secondary post-tonsillectomy hemorrhage the highest?
    a. Day 1
    b. Day 3
    c. **Day 7**
    d. Day 14

    Explanation: The highest risk of secondary post-tonsillectomy hemorrhage is 5-7 days after the surgery, or choice (c).[18] At this point, the thick fibrin clot that is covering the surgical site begins to separate from the underlying tissue as surrounding mucosa begins to grow around it. On day 1, or answer choice (a), a fibrin clot develops. On day 3, there is no particular increased risk for secondary hemorrhage. On day 14, or choice (d), the wound is mostly healed.

8. You are working at a community hospital with no otolaryngology (ENT) coverage and a 6-year-old male presents with bleeding from his tonsillectomy site. His mother shows you a photo of a basin (approximately 200 cc) full of blood that started 1 hour prior to arrival. However, on your exam, the bleeding has stopped and there is a clot over the tonsillectomy site. What is his ultimate disposition?
    a. Admit to community hospital for serial H&H and observation
    b. **Transfer the patient for ENT consultation**
    c. Reassurance and discharge home
    d. Six-hour observation period in ED

    Explanation: Patients with either a clot or active bleeding present on examination require transfer for ENT consultation, or choice (b) because these patients are frequently brought to the operating room to control hemorrhage.[18,19] Choice (a) and (d) are incorrect because ENT consultation is always required for active bleeding or evidence of clot on exam. Choice (c) is incorrect because this child is at high risk of re-bleeding and requires close observation in the hospital with ENT consultation.

INSTRUCTOR MATERIALS

Advanced Pediatric Airway:
Group Application Exercise (GAE) Key

Case 1

A 2-year-old otherwise healthy boy presents with complaint of cough for the past two days. The cough is intermittent and non-productive. His mother states his breathing "sounds funny" ever since he was playing with his older sister's toys two days ago. She denies nasal congestion, nasal discharge or fevers. The child otherwise appears non-toxic. He has been afebrile, immunizations are up-to-date, and the patient has no sick contacts.

Vital signs: Temperature (T) 37°C Heart rate (HR) 111 Blood pressure (BP) 90/60 Respiratory rate (RR) 25 Oxygen saturation (O_2sat) 97% on room air

1. What is your differential diagnosis for this patient?

    - **WARI** (Wheezing Associated Respiratory Illness) may be considered; however, this would frequently be associated with recent viral symptoms (i.e. fevers, nasal congestion, cough) associated with wheezing. But this child has had no illnesses and the symptoms started after a gagging episode.
    - **Bronchiolitis** might be considered in children in this age group (less than 2 years old); however, it is usually associated with fevers, nasal congestion, nasal discharge, cough, and wheezing.
    - **Bacterial pneumonia** is unlikely because the patient is afebrile and non-toxic appearing.
    - **Croup** might be considered in children with "barking" cough, though this child does not exhibit typical symptoms.
    - **"Cardiac wheezing"** associated with congenital or acquired heart disease causing heart failure may be considered; however, these children would likely have ascites or edema, a heart murmur on exam, and are less likely to present in this age group.
    - **Foreign body aspiration** is high on the differential considering a suspected episode of gagging/choking in a child of this age group (1-3 years). This episode is concerning for foreign body aspiration and is the diagnosis until proven otherwise.

2. Your exam is notable for mild wheezing in the left lung field; otherwise, the exam is unremarkable. What initial workup would you perform in the emergency department?

   Initial workup would include a 2-view chest X-ray (posteroanterior/lateral) as well as a lateral decubitus X-ray.

   While chest X-ray is abnormal in only 10%-20% of patients initially, features that may be seen on chest X-ray in children with foreign body aspiration include:[20]
   - Hyperinflation or hyperlucency on the side of foreign body due to "ball-valve" like effect on side of aspiration.
   - Unilateral atelectasis.
   - Later, findings of pneumonia may develop.

3. What examination findings would differentiate an upper vs. lower foreign body airway obstruction?

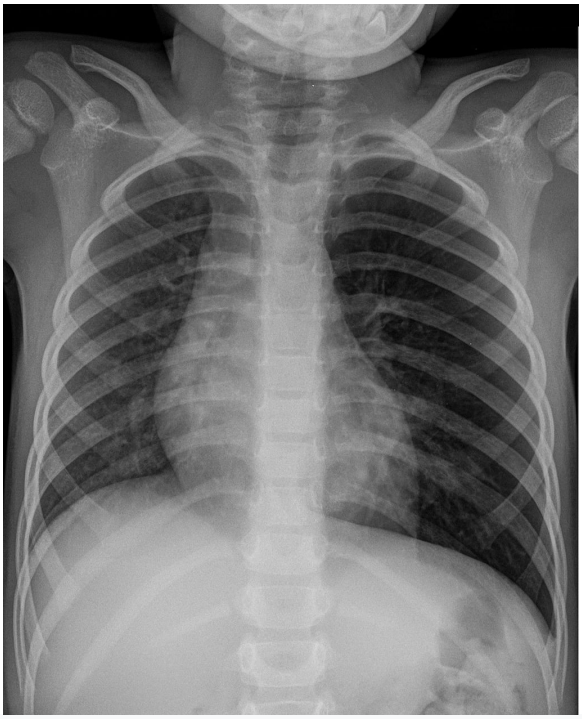
   Foreign body aspiration of the upper airway (larynx, trachea) may be characterized by cough, stridor, hoarseness, tachypnea,[1] or overt respiratory distress if a complete obstruction occurs.

   A lower airway obstruction may be characterized by focal wheezing, tachypnea, or retractions similar to bronchiolitis or asthma. The child is usually phonating normally.

   However, many children will not have overt symptoms so it is very important to maintain a high index of suspicion in a child with a history suspicious for aspiration!

4. You obtain the below chest X-ray. What do you see? What are you next steps in management?

INSTRUCTOR MATERIALS



Hellerhoff. Röntgenbild der Lunge bei einem 3-jährigen Kind nach Aspiration einer Erdnuss: Die linke Lunge ist durch einen Ventilmechanismus durch die Erdnuss deutlich überbläht. Klar erkennbarer Shift des Mediastinums nach rechts (links im Bild). In: Wikimedia Commons. https://en.wikipedia.org/wiki/Foreign_body_aspiration#/media/File:Erdnussaspiration_3j_-_Roe_pa_-_001.jpg. Published January 10, 2017. CC BY-SA 3.0.

There is hyperinflation of the left lung field, suggesting a foreign body obstruction in the left main bronchus in this child who aspirated. Note that more commonly, the obstruction would be in the right main bronchus due to its steeper angle.

Next steps would include contacting a pediatric consultant (either ENT or general surgery) for bronchoscopy in the operating room.

Bronchoscopy is the preferred diagnostic and therapeutic plan.

- Flexible bronchoscopy may be used to define and detect the foreign body, but removal of the foreign body is often more difficult with the flexible scope.
- Rigid bronchoscopy is the preferred procedure for removal of the foreign body.

5. A similar patient presents with stridor and overt respiratory distress after his mother states he swallowed a foreign body. He then becomes apneic in the ED. How would you manage this?

   Based on this patient's history, there is concern for a complete upper airway obstruction. Based on pediatric advanced life support (PALS) recommendations,[21] if the child is pulseless, immediately being cardiopulmonary resuscitation (CPR). If the child has a pulse but is unable to breathe, perform abdominal thrusts in child >1 year old (the Heimlich maneuver) or back thrusts in child <1 year old and then inspect oral cavity and remove if seen; DO NOT perform a blind sweep.

   If initial attempts based on PALS guidelines are unsuccessful, one may consider using a video laryngoscope or light source to attempt to view and retrieve the foreign body using a Magill forceps or Kelly clamp while also preparing jet ventilation or surgical cricothyroidotomy equipment and immediately contacting ENT or surgery for backup.

INSTRUCTOR MATERIALS

Case 2

A 3-year-old otherwise healthy, vaccinated male presents with respiratory distress. On exam, the child is sitting upright in bed but appears somewhat lethargic. He has intercostal and substernal retractions with audible stridor. His lung sounds are clear. His capillary refill is 3 seconds. On further history, you learn that the patient had a diagnosis of croup 5 days ago. His mother states that today, his work of breathing became progressively increased and he developed a high fever. Mother states his voice has been normal. You give racemic epinephrine and steroids; however, the child is not improving after these interventions.

Vital signs: T 39.5°C HR 130 BP 90/60 RR 60 O_2sat 91% on room air

1. What is your differential diagnosis for this patient? What is the most likely diagnosis and why?

    - **Bacterial tracheitis:** While uncommon, tracheitis is high on the differential. The patient recently had croup and was improving, but now has developed a high fever and respiratory distress unresponsive to steroids and racemic epinephrine. This combination of symptoms should trigger concern for tracheitis.
    - **Croup:** Consider severe croup due to the child's audible stridor and retractions; however, typically this would have a therapeutic response to steroids and racemic epinephrine.
    - **Epiglottitis**: With the advent of the *Haemophilus influenzae* Type b vaccine, the incidence of epiglottitis has been decreasing. However, one may consider it on the differential due to the abrupt nature of the fever onset associated with a toxic- appearing child. The child may exhibit the "3 D's": Drooling, dysphagia, and distress or anxiety.
    - **Ludwig's angina:** While Ludwig's angina is a cause of respiratory distress in a child, the child would have evidence of swelling and induration of the submental space consistent with a rapidly spreading cellulitis. They often would also have trismus.
    - **Retropharyngeal abscess (RPA):** A deep space infection in the neck is a consideration in children of this age group and cannot be ruled out. A patient would typically exhibit fever and limited neck mobility, especially with neck extension. On lateral neck X-ray, there may be evidence of a widened pre-vertebral space.

2. What are your initial steps in management?

    - If the child is conscious, try not to move or stimulate the child because this may cause worsening respiratory distress and decompensation. Also avoid agitation, painful procedures, and intravenous (IV) placement unless necessary emergently. At the same time, one could have emergent airway equipment and intravenous or intraosseous access bedside in case of rapid decompensation.
    - Contact anesthesia as well as ENT or pediatric surgery emergently. This patient would ideally have at least two people set up in operating room with gas induction for IV placement and airway exam with neck prepped for emergent tracheostomy.
    - Consider administering nebulized epinephrine.

3. What medication choice would you initiate once able?

    This child should be started on broad-spectrum intravenous antibiotics as soon as possible. Tracheal isolates from children with bacterial tracheitis include S. aureus, M. Catarrhalis, S. pneumoniae and H. influenzae; therefore, reasonable first-line agents include vancomycin for gram positive coverage including methicillin-resistant S. aureus as well as a third-generation cephalosporin such as cefotaxime or ceftriaxone.[17]

4. On repeat examination, the child appears more lethargic and is desaturating to 80%. What is your next step in management? What equipment will you use?

    - If an emergent airway is needed for a situation in which you cannot intubate or oxygenate with no specialists available, consider transtracheal jet ventilation in children <8 years old. Note that this is a temporizing measure because it will only allow oxygenation for about 30 minutes, but poorly ventilates, so patient's pCO_2 will climb.
        - Supplies needed: 14G angiocath, 3.0 endotracheal tube (ETT) adapter, bag valve mask
        - Read more about this procedure at:
            - Whitten, C. Don't be afraid to use percutaneous jet ventilation in an emergency. The Airway Jedi. https://airwayjedi.com/2015/10/29/dont-be-afraid-to-use-

percutaneous-jet-ventilation-in-an-emergency/. Published on October 29, 2015. Accessed on September 21, 2018.

- If a child is >8 years old, the physician should prepare as usual with suction, video, and direct laryngoscopy, and other adjunct airway devices such as a bougie for endotracheal intubation. An important note is that tracheal inflammation may necessitate use of a smaller ETT; therefore, a variety of sizes, including smaller sizing than for age or weight, should be prepared.

INSTRUCTOR MATERIALS

Case 3

An 8-year-old boy with history of poorly controlled asthma presents with significant respiratory distress. His mother states he has been "breathing fast" for the prior two days after a recent cold, but seemed worse today prompting the ED visit. He is noted to have intercostal retractions and on lung auscultation, has biphasic wheezing in the upper lobes with very little aeration at the bases.

Vital signs: T 37°C HR 145 BP 98/38 RR 76 O_2sat 87%

1. What is your differential diagnosis for this patient?

    - **Asthma exacerbation:** This child has a history of asthma which is poorly
    - Controlled; therefore, asthma is high on the differential. Considering his history of intensive care unit stays, he is likely to require repeat and advanced therapies, so frequent reassessment and treatment are indicated.
    - **Anaphylaxis:** In a child with no skin changes, altered mental status, gastrointestinal symptoms or exposures associated with the wheezing and respiratory symptoms, anaphylaxis is a less likely cause of his presentation.
    - **Pneumonia:** The patient recently had a viral illness and now presents with hypoxia and worsening respiratory symptoms. Therefore, one may consider a chest X-ray to rule out pneumonia.
    - **Pneumothorax:** In this patient, bilateral aeration is heard although some diminished lung sounds at the bases, likely related to bronchospasm. Pneumothorax is always a consideration in those children with asthma, though they likely would present with chest pain, hypoxia, and a unilateral difference in lung exam; therefore, a chest X-ray could be considered if clinical concern exists.
    - **Congestive heart failure:** Less likely in a child with no congenital heart issues.
    - **Foreign body aspiration:** Less likely in a child of this age group with no history of foreign body ingestion.

2. What is your first-line management for a pediatric patient with an asthma exacerbation?

    First-Line Therapies:[14,22]

    - If hypoxic (such as this patient), consider administering nasal cannula oxygen to keep oxygen saturation >94%.

- Bronchodilators: short acting β_2-adrenergic agonist which reverses bronchospasm; mainstay of asthma therapy.
    - Back-to-back albuterol nebulizers (0.15 mg/kg, minimum 2.5 mg) every 20 minutes for a maximum of 3 doses.
    - Ipratropium 0.25-0.50 mg nebulizers every 20 minutes for a maximum of 3 doses.
- Corticosteroids: should be provided as soon as possible for asthma exacerbation as they may reduce admission rates; may be given orally, intravenously, or intramuscularly.
    - Prednisone, methylprednisolone, and prednisolone 1-2 mg/kg oral (PO)/intramuscular (IM)/intravenous (IV) (maximum dose 60 mg divided 1-2 times daily for 5 days)
    - Dexamethasone PO/IM/IV 0.6-1.0 mg/kg (maximum dose 16 mg for 2 doses over 2 days)

3. You reassess the patient, and he continues to have significant work of breathing and wheezing. What would you try next (i.e. what are your 2nd line therapies)?

   Second-Line Therapies:
   - Begin continuous albuterol inhalation therapy: albuterol 0.5mg/kg/hr (maximum 15-20 mg/hr) nebulization continuously
   - Magnesium sulfate 25-75 mg/kg (maximum 2g) IV, give over 20 minutes

4. The patient continues to have significant wheezing and dyspnea, and appears more lethargic and difficult to arouse. What intervention might you take? What treatment(s) would you try next (i.e. what are your 3rd line therapies)?

   Third-Line Therapies:[14,22]
   - **Epinephrine 1:1000:** at a dose of 0.01 mg/kg (0.3-0.5 mg) SQ every 20 minutes up to 3 doses (consider terbutaline as an alternative therapy, listed below)
   - **Bilevel positive airway pressure (BiPAP):** may be well tolerated in children as young as 1 year. May decrease work of breathing and improve delivery of inhaled albuterol through increased gas exchange. Consider giving with sub-dissociative ketamine if intolerant.[14] Ketamine infusion (dissociative dose) 0.5-1 mg/kg IV or 2-4 mg/kg IM (be prepared to manage airway with ETT)

- **Intubation:** Use clinical judgment; may be indicated for those children who are exhibiting signs of progressive exhaustion/fatigue and/or altered mental status.26

Other "kitchen sink"/final therapies:[14] use in consultation with pediatric intensivists/consultants:

- **Heliox**: Combination of helium and oxygen (70:30% or 79:21%) which, as a result, is a lower density gas thought to improve "laminar" versus turbulent airflow; may have a role in children with severe, refractory asthma or those asthmatics who are intubated; however, it is NOT routinely recommended because clinical trial results have been mixed.
- **Terbutaline sulfate:** β2-agonist given subcutaneously or intravenously as an alternative to epinephrine because it may have fewer cardiac effects; thought to be useful in those patients who are refractory to continuous albuterol drug delivery.
- **Aminophylline**: Again, often used for severe, refractory asthmatics and/or those on the ventilator; mechanism of action for bronchodilation is complex; however, may have anti-inflammatory and immunomodulatory effects
- **Inhaled anesthetics:** Inhaled volatile anesthetics such as sevoflurane may have bronchodilatory effect and again, work in those asthmatics refractory to other treatments on mechanical ventilation.[24]
- **Extracorporeal membrane oxygenation (ECMO):** The use of ECMO may be indicated for those children refractory to all of the above measures as a way to allow adequate gas exchange via bypass of the lungs in near-fatal asthma[25]. However, one must consider risks/benefits, because it may not be readily available at many sites, is labor/cost-intensive, and has complications such as hemorrhage (most commonly) and renal or cardiac effects.

INSTRUCTOR MATERIALS

Case 4

A 7-year-old girl presents six days after a tonsillectomy and adenoidectomy due to "spitting up some blood." Her mom describes a tablespoon of blood and a blood clot on her pillow at home after waking up from a nap. On exam, she appears pale and tired with a capillary refill of 3 seconds. On the throat exam, you note a fibrin clot but do not see any active bleeding or scab. As you go to write your note, you are called back into the room by the nurse and find the patient coughing and spitting up significant amounts of blood. She quickly fills up a small basin with blood.

Vital signs: T 37.6°C HR 135 BP 102/89 RR 28 O_2sat 98%

1. What is your diagnosis for this patient? When does it commonly present?

   Post-tonsillectomy hemorrhage; commonly presents days 5-7 post-operatively.

2. What are your initial steps in management?

   AIRWAY first: Ensure that the child is sitting up and give them a suction or basin to spit into. Have airway equipment ready in case of rapid decompensation.
   Establish 2 large-bore IV lines.
   Lab work, including type & cross with emergency blood ready.
   Try to keep the environment as calm as possible.
   Emergent ENT consultation.

3. The patient is having frequent coughing/gagging events with hypoxic episodes to the low 80's. What is your next step in management? What equipment would you use?

   This child is at immediate risk for loss of airway protection and requires intubation.

   Both video and direct laryngoscopy should be on hand, as well as a bougie device.

   Once the airway is established, one may consider packing/direct pressure, lidocaine with topical epinephrine on a cotton soaked-gauze, or topical tranexamic acid/thrombin to stop bleeding.[23]

4. You decide to intubate this child. As you prepare your materials, you notice her blood pressure is 80/50. What are your other management priorities? Specifically, what can you do to optimize this child's physiology peri-intubation?

   Prior to intubation of a patient such as this with hypotension secondary to fluid and/or blood volume loss, it is prudent to optimize circulation to avoid peri-intubation cardiac arrest and complications such as coagulopathy.

   One might consider a normal saline bolus (20 ml/kg, up to 3 in first hour) and/or a 10 ml/kg blood transfusion.

   If the bleeding continues, intravenous tranexamic acid may be considered (15 mg/kg up to an adult dose of 1g over 10 minutes, then infuse 2 mg/kg/hr over 8 hours until bleeding stops).[27]