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EVALUATION OF STRIDOR - UPDATED

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Introduction:

This podcast was written by Taylor Dennison, Dr. Chris Gerdung, and Dr. Melanie Lewis. It is an update to the original episode titled “Evaluation of Stridor,” previously released on September 29th, 2009 by Dr. Gerdung. Taylor is a fourth-year medical student at the University of Saskatchewan. Dr. Gerdung is a pediatric respirologist and sleep specialist for Alberta Health Services, and the assistant program director of the Pediatrics residency program at the University of Alberta. Dr. Lewis is a general pediatrician at the Stollery Children’s Hospital, and is the Medical Director of the Down Syndrome medical clinic. She is also a professor of Pediatrics and chief wellness officer for the Faculty of Medicine & Dentistry at the University of Alberta.

This podcast will use a fictional clinical case to discuss five common causes of acute stridor, as well as the appropriate management for each one.

After this podcast, listeners will be able to:

1. Define stridor and the pathophysiology causing stridor.
2. Create a differential diagnosis based on a patient’s presenting signs and symptoms.
3. Differentiate benign causes of stridor from those that are life-threatening.
4. Describe common pathogens involved in infectious etiologies of stridor.
5. Outline a basic management plan for a patient with stridor, based on the differential diagnoses and investigative findings.

Case

This case is fictional and was developed for the purposes of this episode. Jessie is a 2 year old female who presents with her parents to your local emergency department with respiratory distress. In triage, her parents describe that Jessie has been unwell with low-grade fevers, a runny nose, and a sore throat for about one day. However, this evening around bedtime, she began to have trouble breathing, and now her parents describe her breathing as noisy and worrisome.

You and your preceptor feel that they are describing a sign of partial large airway obstruction called stridor, and urgently begin assessing Jessie.

What is Stridor?

Stridor is a harsh, coarse respiratory sound, that is most commonly inspiratory and is often audible without a stethoscope. Parents will describe it as noisy breathing, wheezing, congestion, or hard breathing; it is imperative to try to probe further into this description of the sound of breathing to differentiate it from other sounds that can be heard. Stridor is typically indicative of extra-thoracic airway obstruction. Inspiratory stridor indicates a dynamic, extra-thoracic obstruction, while biphasic, or stridor with inspiration and expiration, indicates a fixed airflow obstruction. Expiratory stridor is also possible although much rarer. This type of stridor is typically caused by a tracheobronchial obstruction, which is an intrathoracic obstruction. Note that stridor can occur from different parts of the airway, including: 1. the supraglottic zone, or above the vocal folds, 2. the extra-thoracic tracheal zone, including the glottis, or the vocal folds, subglottic area, and proximal trachea, and 3. the intra-thoracic tracheal zone, which can extend to the primary and secondary bronchi.¹

Pediatric patients are particularly susceptible to large airway obstruction from inflammation, edema, or secretions, as their smaller airway diameter means that there is more resistance than in adults. Any subsequent airway narrowing further increases the resistance, as per Poiseuille's law. This means that more respiratory effort is needed to move air, creating turbulent airflow and thus stridor.¹

Although it is common, stridor scares patients, families, and healthcare personnel alike, as it can be the result of a life-threatening condition. Prompt recognition of the underlying problem and treatment is crucial and can mean the difference between life and death.¹

Common causes of acute stridor include: croup, foreign bodies, anaphylaxis, epiglottitis, and bacterial tracheitis.¹

Causes of Stridor Explored:

Back to the Case

Going back to our case, we were seeing Jessie, our 2-year-old with low-grade fevers, runny nose, and sore throat, and who is now presenting to the emergency department with stridor and respiratory distress. On history, we find that Jessie first became sick when she woke up this morning, and was doing well at home all day until this evening. During the day, she developed a barky cough, and had poor appetite, although she was agreeable to drinking fluids. Her fevers reached 38.3°C this afternoon, measured orally at home. Her parents decided to bring her in because shortly before bedtime, Jessie began having noisy breathing and seemed like she was working hard to breathe, which was concerning for them. She has no sick contacts but attends daycare on weekdays. She is previously healthy with no medical conditions, routine medications, or allergies.

On physical exam, her temperature by axilla is 38.1°C. Otherwise, she is vitally stable. Her respiratory rate is slightly elevated at 30 breaths per minute. You note suprasternal and intercostal indrawing, as well as belly breathing at rest. She also has

audible inspiratory stridor at rest, and a barky cough. On auscultation, her lungs sound clear, with equal air entry bilaterally. You and your preceptor feel that she likely has croup.

What is croup?

Croup

Croup, otherwise known as laryngotracheobronchitis, is the most common cause of stridor in children.¹⁻² One study from Alberta demonstrates that 3.2 to 5.1% of ED visits in children less than 2 years old were related to croup.² It is a viral illness, most commonly caused by parainfluenza virus 1 or 3; however, other common causes include influenza A and B, RSV, adenovirus and rhinovirus.¹⁻² Croup is usually caused by a viral infection of the larynx, trachea, and occasionally the bronchioles.³

The classic age of presentation is between 6 months to 3 years old. Presentation typically involves a viral upper respiratory tract infection prodrome, followed by low-grade fever and acute onset of barky cough, inspiratory stridor, hoarseness, and respiratory distress.¹⁻² Stridor occurs because the viral infection causes upper airway inflammation and edema, causing the glottic and subglottic regions to become narrowed, and thus partial upper airway obstruction.² Symptoms are classically worse at night and better during the day. In severe cases, expiratory stridor may also be heard. Symptoms typically last 3-7 days; however, in 60% of patients, the barky cough resolves after 48h.² Patients generally do not appear toxic; however, during the height of a fever, most children will appear quite unwell.³

Management of croup depends on its severity. Mild croup has an occasional barky cough, and either no stridor or minimal stridor at rest. There also may be mild suprasternal or intercostal indrawing.²

Moderate croup frequently has a barky cough, as well as stridor that is easily audible at rest, and indrawing visible at rest. There may be no or limited distress or agitation.²

Severe croup also typically presents with barky cough and has prominent inspiratory and occasional expiratory stridor. It has marked or severe indrawing and may have substantial lethargy.²

Impending respiratory failure occurs when the patient begins to tire out. Their cough is often not prominent due to fatigue, and the stridor is heard at rest but may be quiet or hard to hear. They will demonstrate lethargy or decreased levels of consciousness and will appear dusky or cyanotic without supplemental oxygen.²

The diagnosis of croup is often clinical, and no other testing needs to be conducted. However, in cases where a diagnosis is not clear, AP and lateral x-ray views of the neck can help distinguish croup from other causes of stridor. On AP views, croup classically presents with the "steeple sign," where glottic and subglottic narrowing from inflammation and edema creates the appearance of a steeple. Lateral views can help to distinguish croup from epiglottitis, bacterial tracheitis, and retropharyngeal abscess.³

The mainstay of treatment of croup is corticosteroids. These are used for mild to severe croup. While there is no clear evidence demonstrating which type of oral corticosteroid is better to use, most clinical trials use oral dexamethasone, and demonstrate clinical improvement post-administration. Patients begin to improve within 2 to 3 hours after a single dose. Dosing is typically given as 0.6mg/kg in a single dose.

Children treated with corticosteroids have been shown to have fewer return visits or admissions to hospital. In mild croup, children are unlikely to need further medical care for ongoing symptoms post-administration. In moderate to severe croup, corticosteroids have been shown to reduce the length of stay in the ED or hospital by an average of 12 hours.²

In children with severe croup, nebulized epinephrine should be administered prior to oral dexamethasone to improve respiratory distress and lower the risk of needing intubation and tracheotomy. It has been shown to reduce signs of respiratory distress within 10-30 minutes, and the clinical effect is sustained for 1-2 hours. Traditionally, racemic epinephrine (0.5mL) has been used, but as this is not readily available in Canada, 5mL of 1:1000 L-epinephrine can be used instead, and is equally effective. Note that these doses are used in all patients regardless of age or weight.²

When impending respiratory failure is anticipated, a physician skilled in airway management must be consulted, as complete obstruction can arise quickly.³

Other therapies which are sometimes used include Heliox (a helium-oxygen mixture), antibiotics, and short-acting beta-2-agonist bronchodilators. However, these are not routinely recommended.²

Other aspects to note during management is to ensure that interventions are minimized, and that the patient is placed in a parent's lap and in a position of comfort, as agitation and crying can worsen airway narrowing and thus respiratory distress.²

Once managed, patients with moderate to severe croup should be observed in the emergency department for 2-4h to ensure improvement. Should there be recurrent severe respiratory distress or no improvement, consider hospital admission.²

Now that we have discussed Croup, let's discuss some other etiologies of Stridor.

Foreign Body

Next on our list of differentials is Foreign body inhalation. Foreign body inhalation is most common between the ages of 1-3 years, although can occur at any age.¹ Young children are particularly vulnerable to significant airway obstruction due to their narrow airways.⁴ Over 50% of non-fatal choking episodes in the United States were caused by small food items. Examples of risky foods include hot dogs, hard candies, nuts and seeds, raw fruits and vegetables, and chewing gum. Other objects that can be aspirated include toys, coins, and small household items.⁴ Objects that are small enough to fit in the airway, and those that are cylindrical and compressible can make them riskier for aspiration.

Signs and symptoms vary depending on the location and degree of obstruction. Presentation can range of being asymptomatic to severe respiratory distress or asphyxiation.⁴ Laryngotracheal foreign bodies present with more acute respiratory distress, stridor, or hoarseness.⁴ The ingested material obstructs the normal airflow path, leading to turbulent flow, and ultimately stridor. Bronchial foreign bodies will present more so with cough, wheeze, dyspnea, decreased breath sounds, or fever.⁴ A history of choking has been reported in 80-90% of children with foreign body aspiration, although the absence of choking does not rule out an aspiration.⁴ It is important to note that patients can present with vague symptoms that have overlap with other common conditions like asthma, pneumonia, or upper respiratory tract infections, therefore a high index of suspicion is required. Patients presenting with a common diagnosis that hasn't

responded to treatment should be investigated for aspiration.⁴ Additionally, the index of suspicion for aspiration is high in patients who develop sudden onset of stridor without another clear diagnosis.

Upon presentation, the first priority as always is making sure that the airway is maintained. Supplemental oxygen should be applied as needed, and experts in airway management, such as ENT or anesthesia, should be available if needed.⁴ X-rays are often used for evaluation, although some objects may be radiolucent, and other findings including emphysema, atelectasis, or pneumonia can be non-specific. At times, an inspiratory/expiratory chest x-ray can be helpful if there is concern for a bronchial foreign body, as unilateral hyperinflation can be seen, though the absence of this does not rule out the presence of a foreign body. Ultimately, bronchoscopy is the best method for both diagnosis and also management. Typically, a rigid bronchoscope is used to diagnose and retrieve the object; flexible bronchoscopy can be used for diagnosis only.⁴

Anaphylaxis

Another entity that should be considered when presented with acute stridor is anaphylaxis.

Anaphylaxis is a severe, acute, potentially life-threatening reaction, often caused by an allergen. Anaphylactic reactions are classified as type I hypersensitivity reactions between an antigen and IgE-bound mast cells and basophils.^{3,5} This leads to systemic vasodilation which can affect all body systems, with the most common being cutaneous manifestations in 80-90% of children, and respiratory and cardiovascular manifestations in 60-70%, and 10-30%, of children, respectively.⁵ Foods are the most common allergen which trigger anaphylaxis, followed by bee and wasp stings, then medications.⁵

While there are three clinical criteria as described by the Canadian Pediatric Society to diagnose anaphylaxis, the one that describes the majority of cases is as follows: an acute onset of illness, in minutes to several hours, with involvement of the skin, mucosal tissue, or both, and either respiratory compromise, cardiovascular compromise, or both. Cardiovascular compromise is defined as reduced blood pressure or associated symptoms of end-organ damage.⁵

When a child presents to the emergency department with anaphylaxis, their complaints are often systemic. They may include numbness of oral mucosa, flushing and pruritis of skin, urticaria, nausea and vomiting, shortness of breath, lightheadedness, stridor, cough, and tightness of the throat.³

The presentation of anaphylaxis is usually readily apparent. Without proper treatment, potentially lethal complete airway obstruction or distributive shock can develop. Principles of management include a primary survey of the airway, breathing, and circulation, with concurrent administration of IM epinephrine, 1:1000, with dosing of 0.01mg/kg. It can be readministered every 5-15 minutes as required, with maximum dosing of 0.5 mg. Note that administration of epinephrine should not be delayed to establish IV access. An airway specialist should also be close by as intubating a swollen, obstructed airway can be challenging. Other second-line therapies include inhaled beta-2-agonists, H1/H2 receptor antagonists, and corticosteroids. IV fluid resuscitation is also especially important, especially when reduced blood pressures are encountered.⁵

Epiglottitis

Another infectious cause of stridor in young children is epiglottitis. Epiglottitis causes profound swelling of the supraglottic structures, in particular, as you might expect from the name, the epiglottis.⁶ Typically, children from ages 2 to 7 years old are affected, with peak age of incidence at 3 years old.¹ It is caused by a bacterial infection, previously most commonly *H.influenzae* type B.¹ However, as children are currently vaccinated against this bacteria early on during their routine childhood vaccines, cases have markedly decreased, and are now typically seen in unvaccinated children.¹ Other common causes include *Strep pneumoniae*, *Strep pyogenes*, and *Staph aureus*.³

The bacterial infection and supraglottic inflammation leads to patients who appear acutely toxic, with muffled voices and seated in a tripod position.⁶ Classically, children present with the “3 Ds:” drooling, dysphagia, and distress. Partial airway obstruction also leads to stridor. As with croup, care should be taken to avoid stressing the patient, including avoiding phlebotomy, oral examinations, or imaging, to prevent laryngospasm and a transition to complete airway obstruction.⁶ However, if a lateral neck x-ray were to be completed, one would observe the classic “thumbprint” sign of an edematous epiglottis.⁶

Upon the patient’s presentation to the emergency department, surgical airway and anesthesia specialists need to be consulted to secure an airway safely in an operating room. Once an artificial airway has been established, intravenous access can be obtained, as well as a CBC and blood culture, which may help identify the causative agent.³ Early administration of intravenous antibiotics covering for the aforementioned pathogens is also essential. As methicillin-resistant *staph aureus* has been reported, the addition of vancomycin may be considered.⁶

Bacterial Tracheitis

Our final condition to discuss which can cause stridor is bacterial tracheitis. Bacterial tracheitis is a bacterial infection of the trachea. Unlike epiglottitis, however, there is no involvement of the epiglottis. This disease occurs exclusively in children, and is associated with high mortality, with rates approaching 20% in some studies.⁶ The most common cause is *Staph aureus*, but it can also be caused by *H.influenzae* type B in those unvaccinated, as well as *Moraxella catarrhalis*.³ Typically, the infection will follow a viral prodrome lasting 2-7 days. Children will then experience a dramatic worsening of symptoms, including a productive cough due to tracheal exudates and purulent secretions.⁶ Children will appear toxic, and will present with fevers, tachycardia, tachypnea, stridor, a bark-like cough, and respiratory distress. If not managed, symptoms can quickly lead to respiratory failure.⁶

Bacterial tracheitis should be considered if a patient has a croup-like presentation, but also presents with high fevers, and does not improve with the typical management of croup using oral steroids and inhaled epinephrine. In fact, if a soft tissue x-ray of the neck is completed, a steeple sign can be observed, similar to in croup. While the definitive way to diagnose the disease is by bronchoscopy, this procedure is not necessary and should not be done and delay treatment if there is a strong clinical suspicion.⁶

Upon presentation to the emergency department, a timely primary survey should be completed to decide on whether swift intubation is required. If the decision is made

to not proceed with intubation, then the patient should be carefully monitored for deterioration, and treated with IV antibiotics covering gram positive organisms, including methicillin-resistant *staph aureus*. Cultures of sputum or exudates should be obtained to further guide treatment.⁶

These are five common causes of stridor in pediatrics. Altogether, the most common causes can be grouped into the following three categories: 1. Croup, 2. Foreign bodies, 3. Bacterial infections. While anaphylaxis should be considered in the differential, it is not one of the most common causes of stridor, and often is not seen in isolation, and thus isn't included in this list of top differentials. Now, let's finish with our case.

Case Conclusion:

With your working diagnosis of moderate croup, your team orders a single dose of oral dexamethasone at 0.6mg/kg. Your preceptor felt that there was no need for nebulized epinephrine. Within 2 hours, Jessie's stridor disappears, and her respiratory distress improves significantly. She is monitored for 4 hours total, then discharged home with precise return to care instructions if she begins having trouble breathing again.

Hopefully this podcast has helped clarify what differentials you should consider when presented with a patient in an acute setting with stridor. We thank you for listening to this episode.

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