Recognition and management of respiratory failure in children

Airway differences in children

- **large occiput -** may make head positioning to open airway difficult. Consider placing a roll under shoulders to help maintain open airway
- **relatively large tongue -** may be source of obstruction
- **may have more tonsil/adenoid tissue -** may exacerbate upper airway obstruction
- **larynx more cephalad**
- **larynx funnel-shaped - cricoid cartilage smallest part -** eliminates the need for cuffed endotracheal tubes in small children; an endotracheal tube which fits through the vocal cords may hang up at the cricoid cartilage

- **smaller radius means greater impact of edema on cross-sectional area of airway, greater resistance to air flow -** a one milimeter layer of edema that may be well tolerated in an adult-sized airway can cause significant airway obstruction in a child

Assessment

- **Is the airway patent? -** seems like an easy question to answer, but this assessment is often skipped in favor of assessing adequacy of breathing. A child partial airway obstruction resulting in retractions and increased work of breathing may mistakenly be judged to have pulmonary pathology if the adequacy of the airway is not assessed.
- **Is the child breathing?**
- **Is the breathing *adequate*? -** often a more important assessment, and certainly a more difficult assessment than simply establishing whether or not a child is breathing. Children frequently require intervention even if a respiratory rate is present, due to inadequacy of breathing or fatigue with risk of respiratory failure.

Adequacy of breathing

- **Oxygenation**
- **Ventilation**

  To simplify discussion, breathing can be thought of as providing two separate functions, oxygenation and ventilation. Both can be judged as to their adequacy in an ill child.

Oxygenation

Clinical findings may be used to judge adequacy of oxygenation:

- **Color -** check nailbeds, lips, tongue for evidence of cyanosis
- **Oxygen saturation measurement -** much less invasive than an arterial blood gas, but will only give information about oxygenation, not about adequacy of ventilation
- **Level of consciousness -** obviously, level of consciousness may be depressed by a variety of factors; however, a normal level of consiousness is reassuring that adequate levels of oxygen are reaching the brain.

Ventilation

Adequacy of ventilation may be more difficult to assess than oxygenation. An arterial blood gas will give objective information about CO2 levels, but represents only a single moment in time. Since minute ventilation = tidal volume X respiratory rate, these are used to clinically judge adequacy of ventilation.

- **Air entry -** essentially a clinical estimate of tidal volume. Fairly straightforward assessment if air entry (depth of inspiration) is very good or very poor. Quite subjective if air entry is somewhere in between.
- **Beware of respiratory rates that are *too low* -** Avoid being lulled into a false sense of security if the breathing rate falls quickly or the child presents with a low respiratory rate and a depressed level of consciousness. More likely this represents inadequate ventilation.

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Work of breathing

Even if oxygenation and ventilation are judged to be adequate, increased work of breathing may eventually lead to fatigue and respiratory failure in a child. Clinical indicators of increased work of breathing include the following:

- **respiratory rate -** be familiar with normal respiratory rates in children, so that an abnormally high rate will be recognized
- **retractions -** includes retractions of intercostal muscles, suprasternal and substernal areas. May also include retractions of sternum in small children
- **use of accessory muscles**
- **"abdominal paradox" -**

Airway interventions

- **OXYGEN -** should be the first line drug for anyone in respiratory distress!
- **open the airway**
  - **clear oropharynx of secretions or other material -** do **not** do a blind finger sweep in a child, as this may push a foreign body deeper into the airway. Suction oropharynx with suction catheter or Yankaur if nessesary and remove any foreign body visualized in the oropharynx. Consider suctioning the nose of an infant with bulb suction or a suction catheter as the nose is a major part of the airway in an infant.
  - **head tilt-chin lift or jaw thrust -** place a roll under shoulders to help maintain position
  - **oral or nasopharyngeal airway -** may not be tolerated by an awake child, even if they have respiratory distress

Airway Interventions

If oxygenation and/or ventilation are judged to be inadequate after oxygen is given and the airway is open the child will require further intervention

- **assist ventilation if necessary**
  - **bag/valve mask -** requires open airway, correct head position; use 100% O2
  - **endotracheal intubation**

Indications for intubation

- **impending respiratory failure**
  - **inadequate oxygenation**
  - **inadequate ventilation**
- **upper airway obstruction -** unrelieved by maneuvers discussed above
- **loss of protective airway reflexes -** child is obtunded and at risk for aspiration from a variety of causes such as ingestion, head trauma
- **apnea -** may be secondary to a variety of causes such as RSV infection, head trauma, intracranial mass lesion
- **need for hyperventilation -** if child is judged to be in impending herniation from increased intracranial pressure, hyperventilation may be used therapeutically even if baseline oxygenation and ventilation are adequate by usual criteria

Before beginning intubation

- **have equipment available**
  - **appropriate monitors:** O2 sat, EKG, blood pressure
  - **suction device and suction catheters ready to use -** suctioning may be required to provide adequate visualization of larynx
  - **bag/mask with 100% O2**
  - **laryngoscope with functional light and appropriate sized blades -** check your equipment *before* you start
  - **appropriate sized endotracheal tube/stylet with smaller tubes immediately available -** if airway edema is present, may require intubation with smaller tube than would normally be predicted for age
  - **tape -** to secure endotracheal tube once it is placed

Rapid sequence intubation

- **preoxygenation**
  - **100% O_2 to spontaneously breathing patient**
  - **O_2 by bag/mask with Sellick maneuver if apneic -** Sellick maneuver prevents regurgitation and aspiration (see below)
- **medications**
  - **atropine -** blocks vagal response to airway stimulation, may be protective against arrhythmias seen with succinylcholine
  - **lidocaine IV if head injury suspected -** prevents increased intracranial pressure associated with laryngoscopy and endotracheal intubation
  - **sedative:**
    - **thiopental -** short acting, rapid onset barbiturate; good choice is increased intracranial pressure is suspected; may cause myocardial depression and hypotension especially if patient is hypovolemic or has other CV compromise prior to administration
    - **versed -** short acting, rapid onset benzodiazepine; amnesiac; may cause hypotension
    - **morphine -** narcotic; used for analgesia and for sedative properties
    - **ketamine -** phencyclidine derivative; may act as bronchodilator so good choice for patient with status asthmaticus; may raise intracranial pressure so not a good choice if increased intracranial pressure is suspected; side effects include increased salivation and emergence dysphoria
  - **neuromuscular blocker:**
    - **succinylcholine -** rapid onset, short acting depolarizing blocker; avoid with neuromuscular disorders, increased intraocular pressure; may raise intracranial pressure, but this is unclear
    - **vecuronium -** slower onset, longer acting nondepolarizing blocker
- **Sellick maneuver -** cricoid pressure holds larynx against esophagus, this occludes esophagus, preventing regurgitation of stomach contents. Assume patient has full stomach on presentation. Cricoid pressure should not be removed until endotracheal tube is in place.
- **intubate and check tube placement -** note length of endotracheal tube at reference point (e.g., teeth or gum line); listen for breath sounds over both lungs and stomach; attach CO_2 indicator if available - no CO_2 is present in the esophagus, so a CO_2 presence indicates placement in airway; vapor in endotracheal tube is an unreliable sign of airway placement; obtain CXR to confirm placement
- **secure endotracheal tube -** once again note length of endotracheal tube at reference point and tape in place

Cases
6 month old brought to medical attention because of "difficulty breathing"
Vitals? T 103° HR 180's RR 80's BP 90/50
Work of breathing? Intercostal and subcostal retractions with abnormal abdominal breathing pattern
O_2 sat? 85% on room air
Level of consciousness? Eyes open, but makes only occasional eye contact with parents, otherwise seems "out of it"
CXR? "white-out" of right chest

Assessment -