Management of the Pediatric Airway

Denise Baylous, MSN, RN-C, NRP
Nightingale Regional Air Ambulance

Disclosure Information

- I have no relevant financial relationships regarding this presentation.
- I will not discuss off-label uses of any pharmaceutical and/or medical devices in this presentation.

Objectives

- Identify pediatric airway structures
- Describe risk factors for the pediatric airway
- Discuss RSI considerations for the pediatric airway
- Review fundamental principles of pediatric airway management
- Discuss case studies of difficult pediatric airways and their management

Why Manage the Airway?

- Inadequate oxygenation
  - Causes?
- Inadequate ventilation
  - Causes?
- Airway protection
  - Causes?
- Other anticipated issues
  - Causes?

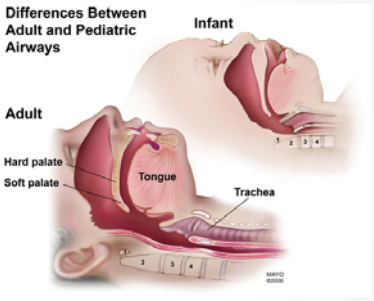
Airway Decisions

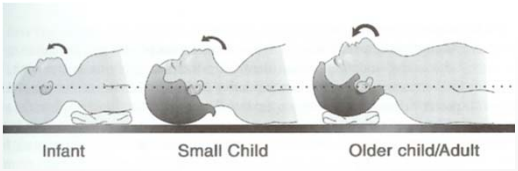
- What do I need to accomplish?
  - Support airway or secure airway?
- How aggressive should I be?
  - Can this be handled with BLS skills or do I need to move to ALS/RSI/intubation?
- What is my back-up plan?
  - What back-up airway device will you use if you are not successful?
  - This is vital if you plan to secure an airway! A provider should never attempt to secure an airway without a back-up plan.
- What is the long-term picture?
  - Can I bag this patient to the hospital?
  - What damage can I cause if the airway isn't handled correctly?
  - What resources do I have, and have they been used?

Pediatric vs Adult Airway

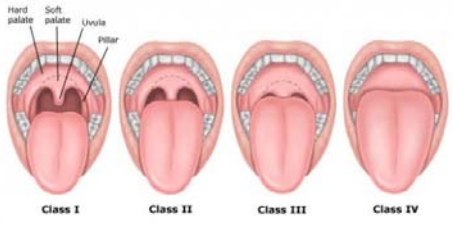
- Pediatric
  - Larger occiput more difficulty airway access
  - Larger tongue
  - Larynx opposite C2-C3 vertebrae resulting in a more anterior airway
  - Epiglottis is omega shaped and softer
  - Short, concave vocal cords and smallest diameter of the airway is below the cricoid ring
  - Less developed lower airway which allows for more injury with ventilation
- Adult
  - Flat occiput allowing for easier airway access
  - Smaller tongue
  - Larynx opposite C4 to C6 vertebrae resulting in an full view of airway anatomy
  - Epiglottis is flat, flexible
  - Vocal cords are horizontal and the smallest diameter are the vocal cords
  - Lower airway well developed and can tolerate different ventilation types but can have injury

Airway differences





Airway Assessment



Basic and Advanced Airway Management

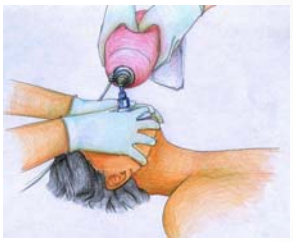
- BLS Airway management
  - Assess airway
  - Positioning
  - Bag valve mask
  - Oral and/or nasal adjuncts
  - Assess oxygenation and ventilation
- ALS Airway management
  - Assess airway
  - Positioning
  - Bag valve mask
  - Decision to intubate!
    - Primary and back-up plans
    - Preparation
    - Rescue devices
  - Oxygenate and ventilate

Predicting the Difficult Airway

- Difficulty intubating
  - External factors
  - Facial anomalies/trauma
  - Obstruction
  - Poor neck mobility/short neck
- Difficulty ventilating
  - Facial trauma
  - Obstructions
  - Asthma

Perfecting the Basics of Airway Management

- Positioning
- Adjuncts
  - Oropharyngeal Airway (OPA)
  - Nasal-pharyngeal Airway (NPA)
- Effective BVM skills
- Suction
- Monitor oxygenation and ventilation



Okay, now my BLS airway management isn't working…now what?

Preparing for Advanced Airway Management: RSI/Intubation

Preparation
Positioning
Pre-oxygenation
Protection/pressure
Pharmacology
Placement of the ETT
Post intubation management

Airway Equipment Considerations

- Miller vs Mac blade
  - Better able to control tongue and epiglottis with miller in peds
- ET tube/Stylet
  - Size-(Age in years/4) + 4
    - Diameter of nares
    - Diameter of pinky
    - Broselow tape
    - Less stability with smaller tube
  - More resistance with intubation so do not force
  - ETT depth – use the black line
  - (Age in years/2) + 12
  - Confirm placement- ETCO2
- Suction
  - Make sure it is available and working before intubation
- Securing devices
- Rescue Devices

More Considerations

- More gastric insufflation with BVM
- Different oxygenation abilities
  - Higher basal usage
  - Less residual lung capacity
  - Quicker desaturation during intubation
    - 10 kg to 90% in <4 minutes (vs. 8 minutes for adult)
- More likely to have vagal response
- Rescue Devices
  - Video laryngoscopes
  - LMAs (laryngeal mask airway)
  - I-LMAs (intubating LMA)
  - Combitube
  - Bougie
  - Trans-tracheal jet ventilation
  - Provider comfort levels

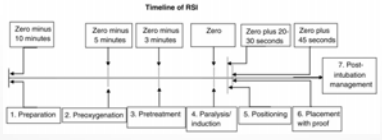
Rescue Devices





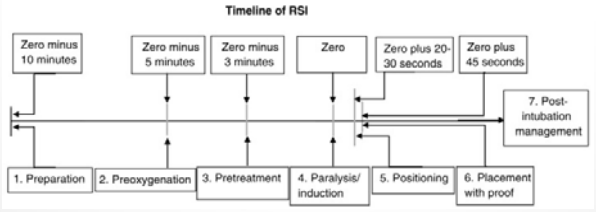

Timeline for RSI

- Preparation (0-10 min):
  - Monitors, patient position, assess airway for difficulty
  - Prepare equipment and RSI meds
- Pre oxygenate (0-5 min)
  - A critical step for success!
  - If spontaneously breathing- 100% NRB mask & avoid BVM if possible
  - Goal >90% SaO2
- Pre treat (0-3 min):
  - Lidocaine- blunts increase in ICP (theory)
  - Atropine- prevents bradycardia with intubation (theory)



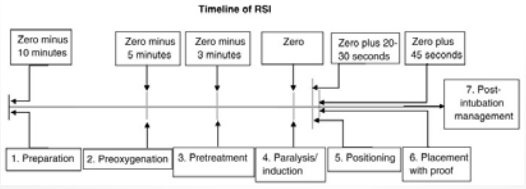
Timeline for RSI continued

- Time of intubation (Time zero):
  - Inject induction agent and paralytic
  - Agents used for RSI are determined by condition, scenario, and situation.
  - Induction Options: Etomidate, Ketamine, Versed
  - Neuromuscular blocking agents: Succinylcholine, Rocuronium, Vecuronium



RSI Timeline Continued

- Protection/Pressure (+30 seconds):
  - Cricoid pressure
- Placement of ETT (+45 seconds):
  - Confirmation of tube placement
    - ETCO2 waveform
    - Assess lungs bilaterally and epigastric area
- Post intubation management (+90 seconds):
  - Bagging
  - Ventilator settings
  - Patient oxygenation and ventilation monitoring



Induction Agent -Etomidate

- Mechanism: Hypnotic sedative, non-narcotic/barbiturate
  - Most hemodynamically stable
  - Inhibits excitation
  - Lowers ICP
- Indications:
  - All inductions
  - Less protection from bronchospasm
- Contraindications:
  - It can lower B/P so be careful with patient's in shock
- Dosage: 0.3 mg/kg

Induction Agent -Ketamine

- Mechanism: Dissociative agent
  - Analgesia, anesthesia, amnesia
  - Bronchodilator
  - Little hemodynamic effect
  - Increases HR and B/P
- Indications:
  - Hemodynamic instability
  - asthmatics
- Contraindications:
  - May elevated ICP (relative contraindication)
  - Re-emergence reactions (dream-like state to emergence delirium)
- Dosage: 1-2 mg/kg

Induction Agent- Versed

- Mechanism: Sedative, amnestic, not an analgesic
  - Respiratory depressants
  - Reversible with Flumazenil
- Indications:
  - RSI/intubation where other induction agents are not available
- Contraindication:
  - Hypotensive/shock
- Dosage: 0.1-0.3mg/kg

Paralytic -Succinylcholine

- Mechanism: Depolarizing agent
  - Binds to NMJ and fires
- Indications:
  - Paralysis
- Contraindications/Complications:
  - Hyperkalemia (Burns, crush, renal failure)
  - Increased ICP, globe injury
  - Prolonged blockade, MH
- Dosage: 1.5-2 mg/kg

Paralytic- Rocuronium

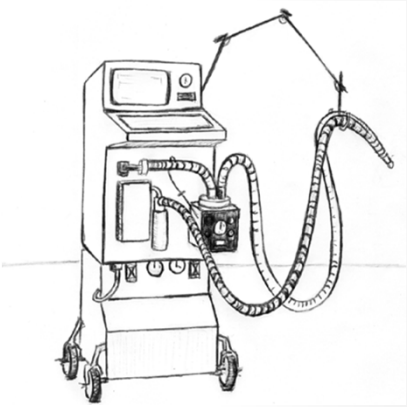
- Mechanism:
  - non-depolarizing agent
- Indications:
  - Paralysis
- Contraindications/Complications:
  - Hypersensitivity
- Dosage: 1mg/kg

Paralytic -Vecuronium

- Mechanism:
  - Non-depolarizing agent
- Indications:
  - Paralysis
- Contraindications:
  - Hypersensitivity
- Dosage: 0.1-0.15 mg/kg
  - Lasts up to 60 minutes

Ventilator Management

- Goal of ventilator management:
  - achieve and maintain adequate pulmonary gas exchange
  - Minimize the risk of lung injury
  - To normalize blood gases
  - Provide comfortable breathing for the patient



Volume vs Pressure Control

- Volume Ventilation
  - Volume delivery constant
  - Inspiratory pressure varies
  - Inspiratory flow constant

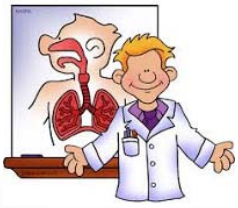
In general pressure control in babies and small infant < 6-8 kg

- Pressure Ventilation
  - Volume delivery varies
  - Inspiratory pressure constant
  - Inspiratory flow varies

In general volume control in children and adolescence > 8-10 kg

Advanced Modes of Ventilation

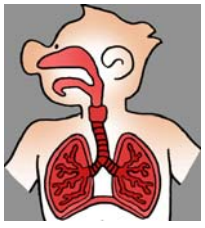
- Pressure regulated volume control (PRVC)
- Volume support
- Inverse ratio (IRV) or airway pressure release ventilation (APRV)
- Bi-level CPAP
- High frequency oscillatory ventilation



Ventilator Take Home Points

The ultimate goal is to optimize gas exchange without damaging the lungs

- To affect oxygenation adjust:
  - FiO2
  - PEEP



- To affect ventilation adjust:
  - Respiratory rate
  - Tidal volume

Case Scenarios

Case Scenario 1

- The mother of a 2 year old child left her in the bathtub approximately 5 minutes to return and find her face down in the water, apneic and cyanotic.
- The child was removed from the water, CPR was started, and 911 was called.

Case Scenario 1

- Assessment:
- Upon EMS arrival, the child had spontaneous respiration's and was crying.
- VS- HR 120; B/P 90/42; RR 26; SaO2-93%
- The patient was transported to the hospital on oxygen, and wrapped in blankets for temperature control.

Case Scenario 1

EMS: What care will you provide?

Emergency Room: What care will you provide?

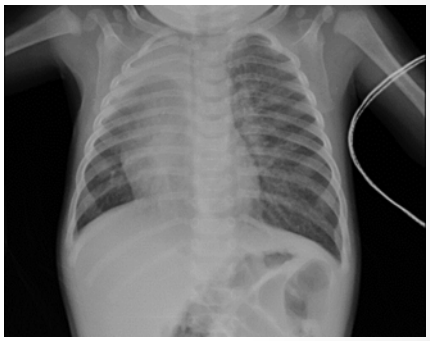
Other disciplines: What care will you provide?

Case Scenario 1

- EMS arrives to the ER- what information do you want to know about the patient?
- How will you treat this child?
- What lab work and/or x-rays will you want on this patient?
- Does this child need to be admitted? If so, why?
- What are your concerns if your patient is not admitted but discharged?
- Discussion

Case Scenario 1

- Upon arrival to the ER, the patient was alert, crying and clinging to her mother with appropriate actions and behavior of a 2 year old child.
- Patient does have intermittent non-productive cough.
- Does she need treated? If so, how and why?



Case Scenario 1

- Children ages 1-4 have the highest drowning rates.
- For every child who dies from drowning, another five receive ER care for nonfatal submersion injuries.
- All victims of a witnessed near drowning should be observed for at least 4-6 hours.
- Delayed pulmonary edema can develop hours or days after the submersion.
- An aspiration victim may develop delayed cerebral edema resulting in sudden death.

Case Scenario 2

- EMS respond to a reported "child bitten by a dog".
- It is 9 in the morning, and you arrive at the home to find a man holding his three year old son, crying for help, both covered in blood.

- ASSESSMENT:
- Child whimpering, breathing spontaneously
- Large tearing injuries to scalp with exposed skull, significant bleeding noted, right ear missing, left ear partially amputated
- Multiple puncture teeth marks and bruising to all extremities
- HR 160's on monitor
- Discussion

Case Scenario 2

Case Scenario 2

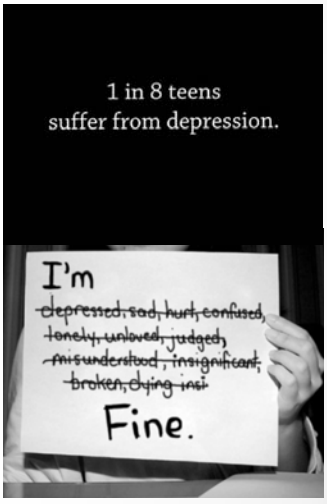
- Dressings applied to bleeding injuries
- PIV placement attempted x 2 without success
- Air medical helicopter dispatched to scene due to transport distance
- Respirations slowing to 6-10, agonal in character
- BVM ventilations initiated, difficult to obtain proper seal due to suspected facial fractures and wounds
- EMS attempts intubation but unable to visualize landmarks
- Continued to assist ventilations, awaiting medevac arrival

Case Scenario 2

- BVM assisted ventilations in progress, injuries as noted before, but minimal bleeding, very large amount of blood on linens beneath patient, temporal and parietal skull exposed
- Skin cool to touch, no IV access
- Patient attempting agonal respirations, weakly withdraws to painful stimuli, no obtainable BP
- IO placed while flight team preparing for intubation
- HR slowed to 30's, no pulses noted, absent heart tones
- CPR and PALS initiated
- Airway anatomy markedly unstable due to injuries.
- Able to intubate on second attempt
- No return of spontaneous circulation, CPR continues.
- Air transported to Trauma center, CPR in progress during entire flight.
- Efforts terminated shortly after arrival to Trauma Bay

Case Scenario 3

- 13yo male who shot himself in the head while at home with his parents.
- Based on the information given, discuss your plan for managing this patient?



Case Scenario 3

EMS: What care will you provide?

Emergency Room: What care will you provide?

Other disciplines: What care will you provide?

Case Scenario 3

- Upon EMS arrival, the patient is unresponsive with a single GSW to the head.
- The entrance wound is at the right submandibular area with the exit wound at the right parietal/posterior skull
- Brain matter is noted to be oozing from the wound.
- Type of airway?
  - BLS or ALS?
- Concerns?
  - RSI
  - Difficult intubation
  - Rescue device
- BVETT or ventilator settings post intubation
  - Why is this important?

Case Scenario 3

The bullet traveled through the right side of the face, including the maxillary sinus, the right orbit, and through the right frontal brain parenchyma out the dorsum of the right parietal bone, creating a large fracture of the right parietal bone with brain extruding through it.

Case Scenario 3

- This patient had multiple neurosurgical plastic surgeries.
- He spent months in the PICU and on the rehabilitation unit.
- Because of teamwork and the care we provided, he returned to home several months later with minimal deficits

Questions?

Denise Baylous
dxbaylou@sentara.com
Office- 757-388-2572

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