Update in Acute Pediatric Airway Management

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Disclosures

- None
  - Sad, isn’t it?
Some hole talking on his cell phone got creamed.
HOSPITAL MEDICAL ERRORS KILL 98,000 AMERICANS EACH YEAR. -- HEARST NEWS INVESTIGATION
Thomas L. Leaman, M.D.

- To err is human
- To forgive is divine
- To sue, American
AVERAGE INDEMNITY BY SPECIALTY (2003-2012)

- Neurosurgery: $439,146
- Neurology - nonsurgical: $416,835
- Obstetric and Gynecologic Surgery: $415,837
- Pediatrics: $394,729
- Radiation Therapy: $372,468
- Anesthesiology: $366,445
- Radiology: $348,536
- Gastroenterology: $333,984
- Pathology: $331,231
- Emergency Medicine: $330,762
- Internal Medicine: $329,107
- Cardiovascular and Thoracic Surgery: $322,485
- Urologic Surgery: $319,062
- General Surgery: $311,699
- Other Nonsurgical Specialties: $309,899
- Cardiovascular Diseases - nonsurgical: $296,289
- General and Family Practice: $287,844
How does an attorney sleep?
How does an attorney sleep?

- First he lies on one side and then he lies on the other.
How many lawyer jokes are there?
How many lawyer jokes are there?

- Only three....
- The rest are true stories.
What do you throw to a drowning lawyer?
What do you throw to a drowning lawyer?

- His partners
What do you call a lawyer gone bad?
What do you call a lawyer gone bad?

Senator
Why does Massachusetts have the most lawyers in the country and New Jersey the most toxic waste sites?
Why does Massachusetts have the most lawyers in the country and New Jersey the most toxic waste sites?

- New Jersey got first choice.
What do you call a lawyer gone bad?

- Senator
What do lawyers use for birth control?
What does a lawyer use for birth control?

- Their personalities
3 Week Old Ashen Infant

“Oh C#@P”
Airway, Breathing, Circulation....

“Oh My!”
I know I can handle this....BUT

“It is a BABY! It is an infant!”
Objectives

• At the end of this session, you will be able to:
  – Describe clinical scenarios and the variety of airway management approaches available.
  – Review current literature for cuffed and uncuffed tubes, as well as a variety of different maneuvers to better visualize the pediatric airway and high flow nasal cannula during intubation.
  – Discuss the use of video laryngoscopy and its potential impact on the visualization of the difficult airway.
What’s New?

• Cricoid pressure not recommended
• Emphasis on bag-mask ventilation
• Cuffed ET tubes preferred
• Atropine in RSI algorithm to prevent bradycardia – is controversial/unlikely prevents
• High flow nasal cannula to prevent hypoxia during apneic period of RSI – this is in!
• Less etomidate – more ketamine in RSI
• Difficult airway – video laryngoscopy and new extraglottic devices
This is Why we are Here

Pediatric Cardiopulmonary Arrests

- 1° Respiratory: 80%
- Shock: 10%
- 1° Cardiac: 10%
The Numbers

• 10% of ALL Pediatric Emergency Visits

• 20% of ALL Hospitalizations

• 1°C >37 = 3-7 breaths per minute additional
  – <12 months can be 7-11 breaths/min
The Dangers of Math

Poiseuille’s Law

\[ R = \frac{8 \pi l}{\pi r^4} \]

If radius is **halved**, resistance increases **16-fold**
Diagram of the Effect of Edema on the Cross-Sectional Airway Diameter

\[ R = \text{radius} \]

**Adult Airway**

Area = \( \pi R^2 = \pi 10^2 = 100 \pi \text{ mm}^2 \) (Normal)

If have 1 mm Edema

Area = \( \pi 9^2 = 81 \pi \text{ mm}^2 \)

Or 81% of normal

**Full Term Newborn**

Area = \( \pi R^2 = \pi 3^2 = 9 \pi \text{ mm}^2 \) (Normal)

If have 1 mm Edema

Area = \( \pi 2^2 = 4 \pi \text{ mm}^2 \)

Or 44% of normal

1 mm = 20% loss

1 mm = 50% loss
Case: 9 month-old boy

9 month-old boy brought in by paramedics with a history of fever presents with seizure at home

• On arrival, patient has stopped seizing, also has stopped breathing, and oxygen saturation is dropping:
  90% - 86%- 80% -75%

• What do you do now?
Where to Begin?

- Start with the basics!
- Move to more advanced procedures as needed
- Standardize approach
- Have contingency plan
- Don’t be afraid to call for airway experts
Airway Management Process

• Position the head
• Open the airway
  – If no air movement consider FB maneuvers/removal
• Consider airway adjuncts to keep airway open
• Oxygen if breathing and risk for hypoxia
• Suction if secretions
• Bag-mask ventilation if apnea or concern for hypoventilation
  – If no chest rise consider FB maneuvers/removal
• ETI [with RSI] – high flow nasal cannula during apneic period
• Difficult airway algorithm (e.g., Video laryngoscopy, extraglottic devices or surgical airway)
• Reassess quickly after each intervention
Position the head and open airway

• Midline
• Avoid excessive flexion or extension
• Towel under shoulders or bump under head to achieve position
• Jaw thrust VERY useful in children in relieving obstruction
Airway adjuncts

• Oropharyngeal airway (OP)
  – May need in unconscious patient to keep tongue from occluding posterior pharynx
  – Cannot use in patients with an intact gag reflex

• Nasopharyngeal airway (NP)

• Use in a semi-conscious patient to keep the airway open

• Excellent for use in overdose patients or seizure patients
Bag Mask Ventilation

Steps:
– Size face mask
– Choose bag [Adult, Pediatric, Infant/Small Child, Neonatal]
– Attach bag to oxygen
– EC-Clamp
– Control rate and volume delivered
Bag Mask Ventilation

**BAG SIZE**

- **Adult**
  - 800-1000 mL
- **Pediatric**
  - 450-500 mL
- **Small Child**
  - 290-400 mL
- **Neonatal**
  - 80-120 mL

Watch Out! Bag could be too small
Bag Mask Ventilation

• EC- Clamp
  – “C” holds mask to face
  – “E” pulls chin into mask – makes a clamp
  – 3 fingers on the jaw line
• Doing BMV is as “EC” (easy) as “1-2-3”
Bag Mask Ventilation

Hand placement:

• EC clamp
  – Infants – avoid pressure on submental area
  – Only 1 finger may fit on jaw line
Bag Mask Ventilation

• Too much cricoid pressure may lead to airway obstruction

• If no chest rise with BMV – lighten cricoid pressure

• AHA 2010 Guidelines deemphasize use of cricoid pressure
Bag Mask Ventilation

• Control rate and volume
• Give only amount of air needed to get chest to rise
• Say Squeeze (just until chest rise initiated) then say release, release
Bag Mask Ventilation

• Maximum ventilation rate:
  – Neonates - 40/min
  – Infants - 30/min
  – Children - 20/min

Slower rates are best – too hard and too fast will cause gastric distension
Endotracheal Intubation (ETI)

• Preparation is key
  – Equipment and staff
• Consider RSI as a number of studies have shown reduction in complications with its use
• Have a contingency plan if ETI fails
Endotracheal Intubation (ETI)

Equipment:

• Suction
• Oxygen
• ET tube
• Stylet (1 cm from end of tube)
• Laryngoscope with appropriate blade
• Pediatric Magill forceps
• CO2 detector
Calculation of ETT size - Preemies

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Tube size (mm)</th>
<th>Depth of tube (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kg</td>
<td>2.5 mm</td>
<td>7 cm</td>
</tr>
<tr>
<td>2</td>
<td>3.0</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>3.0 - 3.5</td>
<td>9</td>
</tr>
</tbody>
</table>

- Memorize this or put on a card – no good rule
Calculation of ET tube size

• Charts based on weight or length
• Measurement from a length-based resuscitation tape (Broselow Tape)
• Greater than 1 year of age can calculate tube size:
  – Based on age > 1 year:
    – (Age/4) + 4 Uncuffed
    – (Age/4) + 3.5
• Other methods:
  – Width of the child's little finger nail
  – Size of nare
Calculation of ET tube size

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- Measurement from a length-based resuscitation tape (Broselow Tape)
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    - \((\text{Age}/4) + 3.5\)
- Other methods:
  - Width of the child's little finger nail
  - Size of nare

\[\text{X}\]
Ballpark ETT size

- Premature infant (2.5-3.0 mm tube)
- Newborn 3.0-3.5 mm tube
- Up to 6 months of age 3.5 mm tube
  - Note: should measure child with the length-based resuscitation tape - measure from top of head to infant or child's heel
- At one year of age need at least a 4.0 mm uncuffed tube
MGH Quick Method for Uncuffed Tubes

- 1 yr  4 mm (uncuffed)  10 kg
    3.5 mm (cuffed)
- 5 yrs  5 mm (uncuffed)  20 kg
    4.5 mm (cuffed)
- 8-10 yrs  6 mm (cuffed)  30 kg

Extrapolate in between (e.g. 2 year old = 4.5mm ETT)
Cuffed vs Uncuffed Tubes

• Sizing:
  – ½ less than standard formula (except for 3.0 mm)

• When do you use a cuffed tube?
  – Any patient that may require high pressures to ventilate

• Can use it in any critically ill or injured infant or child
  – Studies show same frequency of subglottic stenosis with cuffed tubes and less need for tube exchange
Laryngoscope Blade Size

Miller

Macintosh
Blade size

• Miller 0 - premature infant or small newborn
• Miller 1 - normal newborn to 12 kg (2 years)
• Miller 2 - 13 to 24 kg (7 years)
• Miller 3 - 25 kg + (8 years +)
• Macintosh may be used after 2 years of age

• Too small a blade can get you into trouble
Depth of tube placement

- Watch vocal cord marker go past the cords
- Depth of tube placement in cm can be calculated as 3 X size of tube:
  - (Example: 3.5 mm tube would be placed at 10.5 cm at the lip)
- Depth can also be determined by use of a length-based resuscitation tape or by use of an illuminated ETT
Confirmation of tube placement

• Clinical assessment
  – CO2 detection or monitor
  – Esophageal detection device (EDD)
  – Bulb or syringe
  – Chest radiograph
  – Pulse oximetry

• ETT is too low
Complications post ETI

DOPE:

- Dislodgement
- Obstruction/Oxygen
- Pneumothorax
- Equipment failure
Rapid Sequence Intubation (RSI): 7 Steps

- Preparation
- Pre-oxygenation
- Pretreatment
- Paralysis with induction
- Protection and positioning
- Placement of ET tube in trachea
- Post-intubation management

Order and steps dependent on clinical situation
Preoxygenation

• Add 100% oxygen
• Remember infants become hypoxic quickly – relatively small reservoir in nasopharynx and lung
• High metabolic rate vs adults
• High flow nasal cannula (5-15 L per min) can prevent hypoxia during apneic period
HFNC and RSI

• Net pressure in the alveoli is sub-atmospheric leading to apneic oxygenation
• Achieving apneic oxygenation:
  – Use nasal cannula – in the non-breathing patient
• The oxygen will fill the reservoir of the nasopharynx
• Children/Adults
  – 15+L/min
• Infants/Toddlers
  – 5+L/min (?)
Pretreatment

• Atropine [0.02 mg/kg; min 0.1 mg; max 0.5 mg]

• Guidelines (APLS) - controversial
  – Use in infants < 1 year
  – Children 1-5 years who receive succinylcholine
  – Others who receive second dose of succinylcholine
Bean A: EMJ/BMJ 2011

• Reviewed literature on use of atropine to prevent bradycardia in children during RSI

• 112 papers found – 2 presented best evidence
  – “Evidence from these two studies would indicate that the incidence of reflex bradycardia in children during rapid sequence intubation (RSI) is much lower than previously thought.”

• “Furthermore, it does not appear the paralyzing agent used significantly contributes to incidences of bradycardia.”

• “It appears that hypoxia, not foregoing pre-treatment with atropine, is a stronger predictor of patients who will develop reflex bradycardia following RSI.”

• Or...just have it available when you need it
Sedative Selection

• Hypotension: Ketamine if concerned about sepsis
• Bronchoconstriction: Ketamine
• Head injury without hypotension (or signs of shock): Etomidate or thiopental or midazolam
• Head injury with hypotension: Etomidate or ketamine
Neuromuscular Blocking Agents

• Succinylcholine 2-3 mg/kg
  – ONLY depolarizing NMB: Binds to the Ach receptor on the motor endplate and depolarizes the post-junctional neuromuscular membrane
  – Onset 30-60 sec, duration 3-8 min
  – Shorter duration (plasma cholinesterase hydrolyzes), higher risk of adverse effects
  – Do NOT under-dose in children: can give 3 mg/kg
    • High volume of distribution & danger with repeat dosing

• Rocuronium 1 mg/kg
  – Competitively block ACH transmission at the post-junction cholinergic nicotinic receptor
  – Onset 1-3 min, duration 25-35 min
  – Longer duration, but less potential for adverse effects
Ventilator Management

• Ventilator settings are adjusted based on patients clinical status
  – Chest rise, pulse oximetry, peak inspiratory pressure, end tidal CO2 and blood gas analysis

• Selection of tidal volume based on the following generally 6-8 mL/kg:
  – Visible chest excursion simulating normal breathing
  – Audible air entry
  – Diminution of dyspnea
Case: 2 year-old boy

• Mother rushes into triage with a 2 year-old boy with a craniofacial abnormality
• The child is obtunded with gasping respirations and skin color is pale
• The nurse calls for a physician and places the child immediately in the resuscitation room
• You attempt BMV but are unable to get a seal; O2 sat is 70%; small jaw makes ETI impossible

• What is your next airway option?
Management techniques:

• Consider placement of OP or NP airway/ BMV
• Supraglottic/Extraglottic airway - Laryngeal mask airway (LMA), iGel, Air-Q, Laryngeal tube/King Airway
• Intubate using other methods
  – Video laryngoscopy
  – Lighted stylet or Lightwand
  – Fiberoptic intubation
• Other
  – Elastic Gum Bougie (not for kids- age 14 years+)
  – Combitube (not for kids – age 14 yrs +)
  – Cricothyrotomy (needle children < 6 years?) – if other rescue devices fail and cannot BMV
1. Insert the stylet into the trachea under direct laryngoscopy.

2. Slide the endotracheal tube over the stylet.

3. Remove the stylet after endotracheal intubation.
Extraglottic/Supraglottic Devices

• Air-Q
  – able to intubate through the device
  – 3 studies in children

• i-gel
  – single-use with non-inflatable cuff composed of thermoplastic elastomer and soft gel cuff
  – has airway tube and gastric tube [one study in 50 children in OR – good insertion rates and few complication rates]
LMA – Sizing on Broselow Tape

- Sizing found on Broselow-Luten Tape (2002 edition or greater)
King Laryngeal Airway

- King systems – Laryngeal tube (Noblesville, IN)
  - Supraglottic airway device with a single lumen
  - Passed blindly into the esophagus
  - Available in 5 sizes
  - Can be used in children
  - >12 kg or 36 inches
  - Few data in children

http://www.kingsystems.com
Video Laryngoscopy in Pediatrics

• Routine or the difficult airway?
• Why use it?
  – Offers expanded view
  – Magnified view enhances visualization
  – Can be performed with neutral neck position
  – Can be performed with reduced oral opening
  – Educational advantages – share the view or record attempt for teaching, performance improvement
# Video Laryngoscopy

<table>
<thead>
<tr>
<th>Device</th>
<th>Classification</th>
<th>Patient Size</th>
<th>Manufacturer/Distributor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airtraq</td>
<td>Channeled device/optical laryngoscope</td>
<td>Infant, child, adolescent</td>
<td>Prodl/ King Systems</td>
</tr>
<tr>
<td>Berci-Kaplan DCI C-MAC</td>
<td>VL</td>
<td>Neonate, infant, child, adolescent</td>
<td>Karl Storz Endoscopy</td>
</tr>
<tr>
<td>Glidescope GVL, Cobalt, Ranger</td>
<td>VL</td>
<td>Neonate, infant, child, adolescent</td>
<td>Verathon Medical</td>
</tr>
<tr>
<td>McGrath Series 5</td>
<td>VL</td>
<td>Adolescent</td>
<td>Aircraft Medical/LMA North America</td>
</tr>
<tr>
<td>Pentax AWS</td>
<td>VL, channeled device</td>
<td>Adolescent</td>
<td>Pentax/Ambu</td>
</tr>
<tr>
<td>Truview EVO2</td>
<td>Optical laryngoscope with video capability</td>
<td>Infant</td>
<td>Truphatek International</td>
</tr>
<tr>
<td>Angulated Video-Intubation laryngoscope</td>
<td>VL</td>
<td>Child, adolescent</td>
<td>Volpi [Not available in US]</td>
</tr>
</tbody>
</table>
Video Laryngoscopy

- Increasing use of video laryngoscopy for routine intubations
- Still primarily used for the difficult airway
- Devices vary in cost and portability
- GlideScope most widely used at this point but others have advantages
More Things To Talk About

• Foreign Bodies
• Croup
• Bronchiolitis
• Asthma
• Pertussis
Case #1

- A 3 year old is sent in by his pediatrician at 2 AM after listening to him coughing by phone
- The child had a URI for 2 days and then began to cough, with progression to hoarseness and what sounds like stridor
- In the ED he is febrile (39), running around the room, without stridor at rest
Assessment

- Awake, abnormal breathing, normal circulation

- Vital signs:
  - T 39, RR 30, P 100, PulsOx 99%
  - PE Mild tachypnea but no Distress
Initial Assessment

A. Patent

B. Tachypnea without retractions

C. Color is normal, skin is warm and dry, pulse is rapid but strong and regular.

D. Alert with no focal neurologic signs; GCS 15

E. No obvious signs of injury
What can be done diagnostically?

- CXR / labs
  - Just say **NO**----the history and PE favor croup

- Quick recheck of immunization status----epiglottitis is still possible in this group

- Prior stenosis due to Trisomy 21 or Subglottic

[Image links: www.andorrapediatrics.com]
What can be done therapeutically?

• Mist therapy  
  – Doesn’t work!

• Corticosteroids
  – Effective in moderate to severe croup—PO/IM superior to nebulized
  – Dexamethasone (0.15 - 0.6 mg/kg) PO/IM

• Racemic Epinephrine
  • Racemic 0.05 mL/kg (max 0.5 mL)
  • L-epinephrine (1:1,000 solution) 0.5 mL/kg (max 5 mL)
  • Observe for 2 hours—rebound unlikely afterward

  – 2 strikes and you’re OUT! Admit

Don’t upset them!
Cochrane Review 2011

• 38 studies met the inclusion criteria (4299pts)
• Glucocorticoid treatment was associated with an improvement in the croup severity score at 6 hours
• Fewer returns and ↓ Length of stay
Airway Darwin Awards
Case #2

- Mother of 13-month-old boy found him choking and gagging next to container of spilled nuts.

- Paramedics noted appearance is alert; work of breathing is increased with audible stridor; subcostal retractions; color is normal.
Upper Airway Obstruction

Consider Etiologies:
Acute anaphylaxis
Choking/foreign body
Infectious
Croup
Epiglottitis
Abscess
Assessment

- Awake, abnormal breathing, normal circulation

- Vital signs:
  - HR 160, RR 60, BP 88/56,
  - T 37.1°C, O₂ sat 93%, Wt 11 kg
Initial Assessment

A | Stridor

B | Tachypnea with retractions, reduced tidal volume

C | Color is normal, skin is warm and dry, pulse is rapid but strong and regular.

D | Alert with no focal neurologic signs; GCS 15

E | No obvious signs of injury
Foreign Body Aspiration

• A history of choking is the most reliable predictor of FB aspiration
  ➢ Specificity >90%
  ➢ Sensitivity 45-76%

• Other signs and symptoms include:
  ➢ Upper airway: Stridor, respiratory or cardiopulmonary arrest
  ➢ Lower airway: Coughing, wheezing, retractions, decreased breath sounds, cyanosis
FOREIGN BODY ASPIRATION

Background:

- 150-300 fatalities in young children each year
- For every death=100 choking related events seen in an E.D.
- 2/3 of cases are in children 1-2yo
FOREIGN BODY ASPIRATION

Often occurs in children <5 years

Common offending agents: foods and home items

Balloons are the most common FB to result in death
"If you were to find the best engineers in the world and ask them to design the perfect plug for a child's airway, you couldn't do much better than the hot dog."

- Popcorn, nuts, grapes, seeds and raw carrots as "high-risk foods."
- Hot dog
  - ~17 percent of food-related asphyxiations
  - ~10,000 children <14 to ED for choking
  - Up to 77 young people die
FOREIGN BODY ASPIRATION

Chest X-ray: Normal in 20-40%
- FB often Radiolucent
- Inspiratory / Expiratory vs. Decubitus

- Lower Airway Obstruction
- HeliOx can be tried
Foreign Body Aspiration

• Begin with BLS maneuvers
  – Infant: Back blows (5) and chest thrusts (5)
  – Child: If conscious, abdominal thrusts/Heimlich
  – Maneuver (5 per cycle)

• If unconscious perform chest compressions
  • ALS maneuvers if BLS fails
  • Use Magill forceps to remove the foreign body
FOREIGN BODY ASPIRATION

- Button Battery
- True Emergency
- Leakage of Contents
- Pressure Necrosis
- Mucosal Burn from Electrolyte Reaction
Case #3

- Mother of 2-month-old boy with 3 days of a URI now with increasing work of breathing. EMS called

- En route patient remained alert and they note a “waterfall of snot” from his nose
Consider Etiologies:

- Asthma
- Pulmonary Edema
- Infectious
- Pneumonia
- Bronchiolitis
Assessment

- Awake, abnormal breathing, normal circulation

- Vital signs:
  - HR 160, RR 60, T 38.4°C, O₂ sat 93%, Wt. 5 kg
Initial Assessment

A. Patent

B. Tachypnea with paradoxical breathing, scattered wheeze

C. Color is normal, skin is warm and dry, pulse is rapid but strong and regular.

D. Alert with no focal neurologic signs; GCS 15

E. No obvious signs of injury
Bronchiolitis

Affects Children <2yo

Viral, often RSV (may be metapneumovirus)

- Differentiate upper vs. Lower in <5 second

- Other signs and symptoms include:
  - Upper airway: Stridor, respiratory or cardiopulmonary arrest
  - Lower airway: Coughing, wheezing, retractions, decreased breath sounds, cyanosis
Bronchiolitis

- RSV NP may be necessary for *bed placement*
- NO need for CXR
  - 72% of bronchiolitis visits had CXR done!
- Who do I admit?

- Clinical predictors of admission in infants with acute bronchiolitis, Arch Dis Child 2011
Clinical predictors of admission in infants with acute bronchiolitis

<table>
<thead>
<tr>
<th>Points</th>
<th>Duration of Sx’s</th>
<th>Respiratory rate</th>
<th>Heart Rate</th>
<th>O2 Sat.</th>
<th>Age at presentation</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>&lt;5days</td>
<td>≥50 Breath/min</td>
<td>≥155 BPM</td>
<td>&lt;97%</td>
<td>&lt;18 weeks</td>
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<td>1</td>
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<td>1</td>
<td>1</td>
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<tr>
<td></td>
<td>≥5days</td>
<td>&lt;50 Breath/min</td>
<td>&lt;155 BPM</td>
<td>&gt;97%</td>
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</table>

- Optimal cut off score ≥3 for admit
- Sensitivity 74%, Specificity 77%
- PPV 67%, NPV 83%
Bronchiolitis-High Flow Nasal Cannula

High-flow nasal cannula therapy for infants with bronchiolitis.

• **RSV**  The median oxygen saturation (SpO2) was higher in the HFNC group at eight hours (100% versus 96%, P = 0.04) and at 12 hours (99% versus 96%, P = 0.04) but similar at 24 hours.

• There was no clear evidence of a difference in total duration of oxygen therapy, time to discharge or total length of stay between groups.

• No adverse events
HFNC-Floor use?

Conclusions: Use of HFNC for oxygen administration is feasible for infants with moderate-severe bronchiolitis in a general pediatric ward.

In these children, HFNC therapy improves O2 saturation levels and seems to be associated with a decrease in both ETCO2 and RR.


High-flow nasal cannula oxygen for bronchiolitis in a pediatric ward: a pilot study.

Bressan S¹, Balzani M, Krauss B, Pettenazzo A, Zanconato S, Baraldi E.
Clinical Practice Guideline: The Diagnosis, Management, and Prevention of Bronchiolitis

*Pediatrics*; originally published online October 27, 2014;
DOI: 10.1542/peds.2014-2742
DIAGNOSIS

1a. Clinicians should diagnose bronchiolitis and assess disease severity on the basis of history and physical examination (Evidence Quality: B; Recommendation Strength: Strong Recommendation).

1b. Clinicians should assess risk factors for severe disease, such as age less than 12 weeks, a history of prematurity, underlying cardiopulmonary disease, or immunodeficiency, when making decisions about evaluation and management of children with bronchiolitis (Evidence Quality: B; Recommendation Strength: Moderate Recommendation).

1c. When clinicians diagnose bronchiolitis on the basis of history and physical examination, radiographic or laboratory studies should not be obtained routinely (Evidence Quality: B; Recommendation Strength: Moderate Recommendation).
2. Clinicians should not administer albuterol (or salbutamol) to infants and children with a diagnosis of bronchiolitis (Evidence Quality: B; Recommendation Strength: Strong Recommendation).

3. Clinicians should not administer epinephrine to infants and children with a diagnosis of bronchiolitis (Evidence Quality: B; Recommendation Strength: Strong Recommendation).

4a. Nebulized hypertonic saline should not be administered to infants with a diagnosis of bronchiolitis in the emergency department (Evidence Quality: B; Recommendation Strength: Moderate Recommendation).

4b. Clinicians may administer nebulized hypertonic saline to infants and children hospitalized for bronchiolitis (Evidence Quality: B; Recommendation Strength: Weak Recommendation [based on randomized controlled trials with inconsistent findings]).
5. Clinicians should not administer systemic corticosteroids to infants with a diagnosis of bronchiolitis in any setting (Evidence Quality: A; Recommendation Strength: Strong Recommendation).

6a. Clinicians may choose not to administer supplemental oxygen if the oxyhemoglobin saturation exceeds 90% in infants and children with a diagnosis of bronchiolitis (Evidence Quality: D; Recommendation Strength: Weak Recommendation [based on low level evidence and reasoning from first principles]).

6b. Clinicians may choose not to use continuous pulse oximetry for infants and children with a diagnosis of bronchiolitis (Evidence Quality: D; Recommendation Strength: Weak Recommendation [based on low-level evidence and reasoning from first principles]).
7. Clinicians should not use chest physiotherapy for infants and children with a diagnosis of bronchiolitis (Evidence Quality: B; Recommendation Strength: Moderate Recommendation).

8. Clinicians should not administer antibacterial medications to infants and children with a diagnosis of bronchiolitis unless there is a concomitant bacterial infection, or a strong suspicion of one (Evidence Quality: B; Recommendation Strength: Strong Recommendation).
Case #4

• A 6 year old presents with a 3 day history of cough, worse with activity
• “No one smokes inside the house.”
• Strong family history of asthma
Assessment

- Awake, abnormal breathing, normal circulation

- Vital signs:
  - T 37.2, RR 26, P 90, PulsOx 94%, Wt 25 kg

- PE Mild tachypnea but no Distress
Initial Assessment

A. Patent

B. Tachypnea without retractions, No wheezing heard, ? Prolonged expiratory phase

C. Color is normal, skin is warm and dry, pulse is rapid but strong and regular.

D. Alert with no focal neurologic signs; GCS 15

E. No obvious signs of injury
What can be done diagnostically?

- **CXR**
  - in RAD will show hyperinflation AND rule out odd etiologies in “first time wheezers”
What can be done diagnostically?

• Trial of a bronchodilator

  – DEFINITELY indicated since the first symptom of RAD is cough, not wheezing

  – in older kids, Peak Flow measurements pre and post aerosols will often seal the deal

  – many of these chronic cough kids get labeled as “bronchitis”, not really a pediatric disease, and end up on antibiotics

  • Cephakillit all vs. Z-pack vs. Dancing funky chicken
What can be done therapeutically?

- Albuterol and Atrovent
  - Indicated, often X3
  - Use *spacers*

- Steroids
  - give them EARLY, often for 3-5 days, may use Dexmethasone
  - Oral as effective as IV
Spacers vs. Nebulizers

- Analyzed 1,076 children and 444 adults included in 22 trials from emergency department (ED) and community settings
- In addition, 5 trials on inpatients with acute asthma (184 children and 28 adults)
- *Method of delivery of β2-agonist did not appear to affect hospital admission rates*

Cochrane Review, 2009, Cates CJ
Spacers vs. Nebulizers

• No difference in admission rate
  • 95% CI (OR: 0.4 to 2.1)

• Children’s LOS in the ED shorter
  • mean diff: -0.62 hours
  • 95% CI (-0.84 to -0.40)

• No difference for LOS in adults

• Decreased Pulse & tremor in spacer group

• Each spray = 108 microgram
Spacers vs. Nebulizers

Review: Holding chambers versus nebulisers for beta-agonist treatment of acute asthma
Comparison: Holding chamber v. Nebuliser (Multiple treatment studies)
Outcome: Duration in emergency department (hours).

<table>
<thead>
<tr>
<th>Study</th>
<th>Expt n</th>
<th>Expt mean(SD)</th>
<th>Ctrl n</th>
<th>Ctrl mean(SD)</th>
<th>WMD (95% CI)</th>
<th>Weight %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idris 1993</td>
<td>15</td>
<td>1.50(0.80)</td>
<td>20</td>
<td>1.70(0.90)</td>
<td>-0.20[-0.77,0.37]</td>
<td>56.0</td>
</tr>
<tr>
<td>Rodrigo 1993</td>
<td>49</td>
<td>2.20(1.70)</td>
<td>48</td>
<td>1.90(1.50)</td>
<td>0.30[0.34,0.94]</td>
<td>44.0</td>
</tr>
<tr>
<td>Subtotal</td>
<td>64</td>
<td>2.05(1.41)</td>
<td>68</td>
<td>2.05(1.41)</td>
<td>100.0 0.02[0.40,0.44]</td>
<td></td>
</tr>
</tbody>
</table>
| Test for heterogeneity chi-square=1.32 df=1 p=0.25
| Test for overall effect Z=0.09 p=0.90 |

| Children |        |               |        |               |              |          |
| Chou 1995 | 71    | 1.10(0.52)    | 81     | 1.72(0.86)    | -0.62[-0.84,0.40] | 100.0     |
| Subtotal | 71     |               | 81     |               | 100.0 0.62[-0.84,0.40] |          |
| Test for heterogeneity chi-square=0.00 df=0 p=|
| Test for overall effect Z=-5.45 p=0.00 |
Nebulizers versus inhalers

• Conclude
  – MDI + holding chambers produced outcomes that were at least equivalent to nebulizer delivery
  – Holding chambers may have some advantages compared with nebulizers for children with acute asthma

• FYI
  – MDI comes out at 60MPH
  – Spacer decreased med deposition to pharynx by 50%
National Asthma Education and Prevention Program: Expert Panel 3

• **Assess severity**
  – physical examination, and signs and symptoms
  – by lung function measures (for ages 5 years and up)

• **History**
  – Risk factors for severity: most recent ED visits or admissions, prior intubation or PICU admission, rapidly progressive episodes, how often they’ve used steroids and MDI
• Treat to relieve hypoxemia and airflow obstruction; reduce airway inflammation.

  – Use supplemental oxygen as appropriate to correct hypoxemia.

  – Treat with repetitive or continuous SABA (short-acting beta$_2$-agonist), w/ inhaled ipratropium bromide in severe exacerbations.

  – Give oral systemic corticosteroids in moderate or severe exacerbations or for patients who fail to respond promptly and completely to SABA.

  – Consider adjunctive treatments, such as intravenous magnesium sulfate or heliox, in severe exacerbations unresponsive to treatment.

  – Monitor response with repeat assessment of lung function measures, PE, and signs and sx’s, and, in ED, pulse oximetry.
Discharge with medication and patient education:

- Medications: SABA, oral systemic corticosteroids; consider starting ICS (inhaled corticosteroids)
- Referral to follow-up care
- Asthma discharge plan
- Review of inhaler technique and, whenever possible, environmental control measures
Therapy

- Spacer versus Nebulizer
- **Timing of Steroids**
- Ipratropium bromide
- Magnesium SO4
Steroids

• Cochrane Review: May 2001

• 12 Studies:
  • 863 Patients
  • 409 Pediatric

• Main outcome: need for admission
Steroids

**Review:** Early emergency department treatment of acute asthma with systemic corticosteroids

**Comparison:** Population

**Outcome:** Asthmatic Children Only

<table>
<thead>
<tr>
<th>Study</th>
<th>Expt n/N</th>
<th>Ctrl n/N</th>
<th>OR (95% CI Random)</th>
<th>Weight</th>
<th>OR (95% CI Random)</th>
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<tr>
<td>Connett 1994a</td>
<td>13 / 19</td>
<td>15 / 18</td>
<td></td>
<td>8.5</td>
<td>0.43 [0.09, 2.09]</td>
</tr>
<tr>
<td>Connett 1994b</td>
<td>7 / 18</td>
<td>12 / 15</td>
<td></td>
<td>13.9</td>
<td>0.16 [0.03, 0.77]</td>
</tr>
<tr>
<td>Scarfone 1993</td>
<td>11 / 41</td>
<td>19 / 40</td>
<td></td>
<td>24.5</td>
<td>0.41 [0.16, 1.03]</td>
</tr>
<tr>
<td>Storr 1987</td>
<td>53 / 73</td>
<td>65 / 67</td>
<td></td>
<td>32.3</td>
<td>0.08 [0.02, 0.36]</td>
</tr>
<tr>
<td>Tal 1990</td>
<td>4 / 17</td>
<td>4 / 13</td>
<td></td>
<td>6.0</td>
<td>0.69 [0.14, 3.52]</td>
</tr>
<tr>
<td>Wolfson 1994</td>
<td>17 / 42</td>
<td>15 / 46</td>
<td></td>
<td>14.8</td>
<td>1.41 [0.59, 3.36]</td>
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</tbody>
</table>

**Total**

<table>
<thead>
<tr>
<th>Expt n/N</th>
<th>Ctrl n/N</th>
<th>OR (95% CI Random)</th>
<th>Weight</th>
<th>OR (95% CI Random)</th>
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<tbody>
<tr>
<td>105 / 210</td>
<td>130 / 199</td>
<td></td>
<td>100.0</td>
<td>0.43 [0.27, 0.69]</td>
</tr>
</tbody>
</table>

Test for heterogeneity chi-square = 13.65 df = 5 p = 0.02

Test for overall effect Z = -3.57 p = 0.00
Steroids

Number needed to treat with steroids in the first hour to prevent 1 admission:

6
Canadian Asthma Consensus Group: Level 1 Evidence

• For patients in ED or admitted
  – IV steroid therapy has NO advantage over oral therapy in terms of rate of resolution of airflow limitation

• Dexmethasone 0.6mg/kg (16mg max) in lieu of 5d Prednisolone

• Single dose therapy for mild to moderate asthma (18mg max)
  – IM vs Oral
Therapy

- Spacer versus Nebulizer
- Timing of Steroids
- Ipratropium bromide
- Magnesium SO4
Ipratropium bromide

• Single dose does not work

• Multiple dose decreases admissions
  • NNT 12 overall  95% CI (8, 32)
  • NNT 7 severe subgroup  95% CI (5, 20)
### Ipratropium - Admissions

**Review:** Combined inhaled anticholinergics and beta2-agonists for initial treatment of acute asthma in children

**Comparison:** ANTICHOLINERGIC (multiple doses) + BETA-2-AGONIST vs BETA-2-AGONIST ALONE - FIXED PROTOCOL

**Outcome:** Admission

<table>
<thead>
<tr>
<th>Study</th>
<th>Expt n/N</th>
<th>Ctrl n/N</th>
<th>RR (95% CI Fixed)</th>
<th>Weight %</th>
<th>RR (95% CI Fixed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-intervention: Corticosteroids during study</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qureshi 1997</td>
<td>9 / 36</td>
<td>14 / 31</td>
<td>8.3 [0.28, 1.10]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qureshi 1998 (mod)</td>
<td>8 / 79</td>
<td>9 / 84</td>
<td>4.8 [0.38, 2.33]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qureshi 1998 (sev)</td>
<td>51 / 136</td>
<td>71 / 135</td>
<td>39.3 [0.54, 0.93]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zorc 1999 (mod)</td>
<td>18 / 98</td>
<td>25 / 96</td>
<td>13.9 [0.41, 1.21]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zorc 1999 (sev)</td>
<td>7 / 22</td>
<td>12 / 29</td>
<td>5.7 [0.36, 1.63]</td>
<td></td>
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<tr>
<td>Zorc JJ 1999 (mil)</td>
<td>6 / 60</td>
<td>4 / 57</td>
<td>2.3 [0.42, 4.79]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>99 / 431</td>
<td>135 / 432</td>
<td>74.3 [0.60, 0.91]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test for heterogeneity chi-square = 2.19, df = 5, p = 0.82
Test for overall effect Z = -2.87, p = 0.00

| Co-intervention: No corticosteroids |          |          |                   |          |                   |
| Reisman 1988                    | 2 / 11   | 3 / 13   | 1.5 [0.16, 3.90]  |          |                   |
| Schuh 1995                      | 15 / 40  | 19 / 41  | 10.3 [0.48, 1.36] |          |                   |
| Watson 1988                     | 0 / 16   | 0 / 15   | 0.0 Not Estimable |          |                   |
| Subtotal                        | 17 / 51  | 22 / 54  | 11.9 [0.40, 1.32] |          |                   |

Test for heterogeneity chi-square = 0.00, df = 1, p = 0.98
Test for overall effect Z = -0.85, p = 0.40

| Corticosteroid use variable/not described |          |          |                   |          |                   |
| Peterson 1996                 | 19 / 82  | 25 / 81  | 13.9 [0.45, 1.26] |          |                   |
| Subtotal                      | 19 / 82  | 25 / 81  | 13.9 [0.45, 1.26] |          |                   |

Test for heterogeneity chi-square = 0.00, df = 0, p =
Test for overall effect Z = -1.10, p = 0.30

| Total                          | 135 / 564 | 182 / 567 |                   |          |                   |

Test for heterogeneity chi-square = 2.34, df = 8, p = 0.97
Test for overall effect Z = -3.17, p = 0.00
Results

• Lower rate of hospitalization in treatment group

• Asthma score improved especially in Severe

• No significant difference in moderate

• Significant reduction in severe group
  – PEFR <50%, asthma score 12-15

• NNT(# needed to treat) with severe asthma to prevent 1 admission = 6.6

Effect of nebulized ipratropium on hospitalization rates of children with asthma
Qureshi et al, NEJM, Oct 1998
Therapy

- Spacer versus Nebulizer
- Timing of Steroids
- Ipratropium bromide
- Magnesium SO4
MgSO$_4$

• Mechanism of Action
  – ↓ translocation of Ca$^{++}$ across cell membrane, leads to SM relaxation & bronchodilation
  – Inhibits degranulation of mast cells
  – Decreases release of ACH (↓ excitability of muscle fiber membranes)

• Side Effects:
  – Facial warmth/flushing, hypotension, nausea, emesis, muscle weakness, sedation, loss of DTRs, resp depression

• Dose:
  – 20-100mg/kg (2g max) IV over 20-30 min
IV and nebulized MgSO4 for treating acute asthma in adults and children: A systematic review and Meta analysis:

- 25 Trials (16 IV, 9 Nebulized)
- 1754 patients
- IV MgSO4 (in addition to β2-agonist & Steroids)
  - Improved pulmonary function and ↓ Admission for Children
  - Only improved lung function in adults

- Shan Z, Rong Y Respir Med. 2013
## Magnesium - Admissions

**Review:** Magnesium sulfate for treating exacerbations of acute asthma in the emergency department

**Comparison:** Intravenous MgSO₄ vs placebo

**Outcome:** Admission to hospital

<table>
<thead>
<tr>
<th>Study</th>
<th>Expt n/N</th>
<th>Ctrl n/N</th>
<th>petoOR (95% CI Fixed)</th>
<th>Weight %</th>
<th>petoOR (95% CI Fixed)</th>
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<tbody>
<tr>
<td>Severe</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Bloch 1995</td>
<td>7 / 21</td>
<td>11 / 14</td>
<td></td>
<td>13.1</td>
<td>0.17 [0.05, 0.65]</td>
</tr>
<tr>
<td>Ciarallo 1997</td>
<td>11 / 15</td>
<td>16 / 16</td>
<td></td>
<td>5.5</td>
<td>0.10 [0.01, 0.80]</td>
</tr>
<tr>
<td>Devi 1997</td>
<td>9 / 15</td>
<td>15 / 16</td>
<td></td>
<td>8.5</td>
<td>0.15 [0.03, 0.81]</td>
</tr>
<tr>
<td>Skobeloff 1989</td>
<td>7 / 19</td>
<td>15 / 17</td>
<td></td>
<td>13.3</td>
<td>0.12 [0.03, 0.46]</td>
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<tr>
<td>Subtotal</td>
<td>34 / 70</td>
<td>57 / 63</td>
<td></td>
<td>40.5</td>
<td>0.14 [0.07, 0.30]</td>
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<tr>
<td>Test for heterogeneity chi-square = 0.24 df = 3 p = 0.97</td>
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<td></td>
<td></td>
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<tr>
<td>Test for overall effect Z = -5.08 p = 0.00</td>
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<thead>
<tr>
<th>Mild-moderate</th>
<th>Expt n/N</th>
<th>Ctrl n/N</th>
<th>petoOR (95% CI Fixed)</th>
<th>Weight %</th>
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</thead>
<tbody>
<tr>
<td>Bloch 1995</td>
<td>14 / 46</td>
<td>13 / 54</td>
<td></td>
<td>30.1</td>
<td>1.38 [0.57, 3.32]</td>
</tr>
<tr>
<td>Green 1992</td>
<td>13 / 58</td>
<td>11 / 62</td>
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<td>29.4</td>
<td>1.34 [0.55, 3.26]</td>
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<tr>
<td>Subtotal</td>
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<td>24 / 116</td>
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<td>59.5</td>
<td>1.36 [0.72, 2.54]</td>
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<tr>
<td>Test for heterogeneity chi-square = 0.00 df = 1 p = 0.96</td>
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<tr>
<td>Test for overall effect Z = 0.95 p = 0.30</td>
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<table>
<thead>
<tr>
<th>Total</th>
<th>Expt n/N</th>
<th>Ctrl n/N</th>
<th>petoOR (95% CI Fixed)</th>
<th>Weight %</th>
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</tr>
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<tbody>
<tr>
<td></td>
<td>61 / 174</td>
<td>81 / 179</td>
<td></td>
<td>100.0</td>
<td>0.54 [0.33, 0.88]</td>
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<tr>
<td>Test for heterogeneity chi-square = 20.69 df = 5 p = 0.00</td>
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<tr>
<td>Test for overall effect Z = -2.49 p = 0.01</td>
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Magnesium - Harm?

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<tr>
<th>Study</th>
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<th>Weight %</th>
<th>petoOR(95% CI Fixed)</th>
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<tr>
<td>Bloch 1995</td>
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<td>0 / 68</td>
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<td>0.0</td>
<td>Not Estimable</td>
</tr>
<tr>
<td>Ciarallo 1997</td>
<td>0 / 15</td>
<td>0 / 16</td>
<td></td>
<td>0.0</td>
<td>Not Estimable</td>
</tr>
<tr>
<td>Devi 1997</td>
<td>0 / 24</td>
<td>0 / 23</td>
<td></td>
<td>0.0</td>
<td>Not Estimable</td>
</tr>
<tr>
<td>Green 1992</td>
<td>0 / 58</td>
<td>0 / 62</td>
<td></td>
<td>0.0</td>
<td>Not Estimable</td>
</tr>
<tr>
<td>Subtotal</td>
<td>0 / 164</td>
<td>0 / 169</td>
<td></td>
<td>0.0</td>
<td>Not Estimable</td>
</tr>
</tbody>
</table>

Test for heterogeneity chi-square=Not estimable df=0 p=Not estimable
Test for overall effect Z=Not estimable p=Not estimable
IV MgSO4 Cochrane 2009

- 7 trials (5 adult, 2 Peds) = 665 pts.
- Current evidence does not support routine use of IV MgSo4 in ALL patients with acute asthma presenting to ED.
- MgSO4 appears to be safe and beneficial in patients who present with SEVERE acute asthma.
Asthma Statistics

- 18.9 million Americans have asthma (7.2 million children)
- 3400 deaths annually
- 479,000 hospital discharges with asthma as primary diagnosis
  - African Americans hospitalized 3x more than other Americans
  - AA and Hispanic in inner cities are 2-6x more likely to die from asthma
Asthma Stats (cont’d)

• 10,000,000 school absences per year
• 3,000,000 PMD visits annually
• Age of onset:
  – 30% by 1 year old
  – 80-90% by 4-5 years old
Noninvasive Positive Pressure Ventilation and Asthma

• **Controversial??**
• **Concern that it may:**
  – Worsen hyperinflation and air trapping,
  – Increase intrathoracic pressure
  – Decrease venous return and contribute to barotrauma
• **Not in my opinion**
CPAP

• Seems to increase Functional residual capacity and lung compliance
• May decrease fatigue of respiratory muscles
• Decreases the adverse hemodynamic effects of large negative inspiratory swings in pleural pressure which compromise RV and LV performance
BIPAP

• Provides CPAP
• Delivers higher pressure in inspiration than expiration
Auto-PEEP

• Universally found in asthma/COPD exacerbations

• Adding PEEP (PEEPe) helps negative expiratory pressure gradient between alveolus and airway but
  – Asthmatics are less responsive to this intervention

Peigang, Curr Opin Crit Care 2002)
NIPPV

• Respiratory muscles rapidly unloaded
• Dyspnea improved
• RR improved
• Gas exchange improved with low inspiratory pressure
• 12% of patients with NIPPV were intubated
Mask-CPAP

• Causes bronchodilation and decreases airway resistance
• Reexpands atelectasis and promotes removal of secretions
• Rests the diaphragm and inspiratory muscles and may offset PEEPi
• Decreases the adverse effects of large negative peak and mean inspiratory pleural pressures
Non-invasive mechanical ventilation in status asthmaticus

- 7 year retrospective, observational study
- FM NIMV
- 22 patients
  - 3 were later intubated
- Improved alveolar ventilation and reduced the need for intubation in a selected group of patients with status asthmaticus

Fernandez Intensive Care Med 2001;27:486-92
NIMV in Pediatric Status Asthmaticus

- 3 children 9, 11, 15
- Hypercarbic respiratory failure
  - Mean CO2 54.6
- BIPAP
- Inspiratory positive pressure 10-14 cm water
- Expiratory pressure 4-5 cm water

Akingbola Crit Care Med 2002;3(2):181-184
NIMV Pediatric Status Asthmaticus

• Duration of therapy 12-17 hours
  – RR decreased
  – PCO2 decreased
  – Improved ventilation and gas exchange
My Conclusion

- BIPAP is worth a try if it can be tolerated by the patient
Heliox and Noninvasive Ventilation (NIV)

- Acute exacerbation of COPD
- 10 patients
- NIV Heliox at 2 levels of PSV
  - (9+/- 2), (18 +/- 3) vs
  - NIV (air: O2)
- Significant reductions in:
  - Pressure-time index at both PSV
  - Work of breathing
  - PCO2
- NIV with heliox:
  - Reduce patient effort and improve gas exchange

*Jaber Am J Respir Crit Care Med 200;161:1191-2000*
Noninvasive Pressure Support and Heliox

- Decompensated COPD
- MICU
- 19 patients with severe COPD
- Noninvasive pressure support
  - Randomized crossover design
    - 45 minutes with air:oxygen or heliox
    - No ventilation for 45 minutes
    - 45 minutes with air:oxygen or heliox

Jolliet Critical Care Med 1999;27(11):2422-2429
Noninvasive Pressure Support and Heliox

- Reduced dyspnea and PCO2 more than air: oxygen
- Did not modify blood pressure
- May reduce the need for intubation

Jolliet 1999
Ketamine

• What is its role?
• Could it prevent need for intubation?
• Bronchodilator
• May increase airway secretions
• Emergence reactions
CONCLUSIONS

• Current therapy in children is based on variable levels of evidence
  – Level 1 evidence to support steroids, Atrovent, MgSO4
  – Level 2 evidence for HELIOX
  – Level 3-5 evidence for ketamine, NO, aminophylline, anesthetic agents
Case #5

• A 6mo presents with cough for 7 days
• What began as a URI has progressed to bursts of coughing followed by post-tussive emesis
• Non-stop cough
• No significant PMH, immunized for age
Assessment

• Awake, normal breathing, normal circulation

• **Vital signs:**
  – T 37, RR 20, P 76, PulsOx 99%

• Subconjunctival hemorrhages and facial petechiae

• Intermittent staccato cough
Initial Assessment

A. Patent

B. No wheezing heard, CTA

C. Color is normal, skin is warm and dry, pulse is rapid but strong and regular.

D. Alert with no focal neurologic signs; GCS 15

E. No obvious signs of injury
• Approximately 42,000 cases of whooping cough were reported last year.
• The largest outbreak of pertussis since 1955
Summary

• Quick recognition of the illness allows rapid triage, isolation, and prevention of nosocomial transmission

• Infants younger than 2 months who have a cough or choking associated with cyanosis
  – as well as a cough and rhonchi on physical examination,
  – have a high likelihood of pertussis and should be identified in triage, isolated immediately, and tested for pertussis

• This may lead to appropriate therapy for this population and decrease the transmission of pertussis to other patients and staff in the ED
What can be done diagnostically?

- **CXR**
  - probably not helpful, but may rule out foreign body
- **Bronchodilator?**
  - NO, this is not a lower airway disease
- **CBC**
  - WBC may show *leukocytosis and lymphocytosis* (pertussis)
- **Pertussis swab**
What can be done therapeutically?

• Avoid any form of oral stimulation
• Provide supplemental oxygen
• Admission?
• Treat the child and household contacts with a Macrolide
• Make sure you’ve received a pertussis immunization
In Summary

- **History of Choking** is the most reliable predictor of Aspirated Foreign Body
- **Standardized** approaches to asthma will improve outcomes
- Steroids have an **EARLY** role in both croup and RAD
- **Pertussis** surveillance is mandatory
Pediatric Airway Management

- Airway management is a process involving assessment followed by interventions followed by reassessment – begin with basics
- Children can be daunting because of sizing issues...keep tools available to help!
- Master basic and advanced techniques
“She is numb from her toes down.”

“Bleeding started in the rectal area and continued all the way to Los Angeles”

“When she fainted her eyes rolled around the room”
Professional Charting

“Both breasts were equal and reactive to light and accommodation”
Professional Charting

“The baby was delivered, the cord clamped and cut, and handed to the physician, who breathed and cried immediately”
Professional Charting

“The pelvic exam will be done later on the floor”
Professional Charting

Discharge status: Alive but without my permission.

The patient refused autopsy.

While in the ER, she was examined, x-rated, and sent home.
Professional Charting

“She has no rigors or shaking chills, but her husband states that she was very hot in bed last night.”
Professional Charting

“Large brown stool ambulating in the hall”
“Exam of the genitalia reveals that he is circus sized”

“She stated that she had been constipated for most of her life until 1989 when she got a divorce.”
Men are From Mars
Women are From Venus

- Recent pediatric study has recently demonstrated:
- The manner in which women and men use their hands together:
  1. develops early in childhood
  2. and is different.
Hey...Be Careful out There!
QUESTIONS???

Dani the asthmatic Muppet

SOMETIMES I FEEL THAT I HAVE THE WORST JOB IN THE WORLD!

YA...RIGHT!
References


Is it true?

“If it is not documented, it was not done.”

Elvoy Raimes, MD; 1997
Illinois Medical Society
Noninvasive Positive Pressure Ventilation in Status Asthmaticus

- Medical ICU
- NPPV in patients with hypercapneic respiratory failure
- 17 episodes of asthma over 3 years
- Face mask to ventilator
- Initial CPAP 4+/− 2 cm water
- Pressure support ventilation (PSV) 14 +/− 5 cm water

*Meduri Chest 1996;110:767-74*
Noninvasive Positive Pressure Ventilation

- Goal of RR 25/min
- Exhaled TV $\geq 7$ cc/kg
- PSV adjusted following ABGs
- Mean age 35
- PCO2 at initiation 65
Noninvasive Positive Pressure Ventilation

• Initial minute ventilation 16
• Mean peak inspiratory pressures 18
  – Always < 25 cm water
• No complications with secretions
• Mean duration 16 +/- 21 hours
# Noninvasive Positive Pressure Ventilation (NIPPV)

<table>
<thead>
<tr>
<th>Time</th>
<th>PCO2</th>
</tr>
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<tbody>
<tr>
<td>Time 0</td>
<td>65 +/- 2</td>
</tr>
<tr>
<td>&lt; 2 hours</td>
<td>52 +/- 3</td>
</tr>
<tr>
<td>2-6 hours</td>
<td>45 +/- 3</td>
</tr>
<tr>
<td>12-24 hours</td>
<td>45 +/- 4</td>
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</tbody>
</table>
NIMV

- Face mask NIMV
- CPAP
  - Fixed values of 5 and 7.5 cm water
  - Keep sat above 90%
- Pressure support ventilation
  - Commercial ventilator
  - Titrated to achieve minimum of 400 cc of expired tidal volume
  - Increased in increments of 3 cm water in accordance with patient’s requirements
  - PEEP used until a substantial improvement in effort required to trigger the ventilator was noted
## NIMV

<table>
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<tbody>
<tr>
<td>ED</td>
<td>53 +/- 13</td>
</tr>
<tr>
<td>ICU</td>
<td>63 +/- 24</td>
</tr>
<tr>
<td>2-6 hour</td>
<td>51 +/- 24</td>
</tr>
<tr>
<td>6-12 hour</td>
<td>48 +/- 14</td>
</tr>
</tbody>
</table>
NIMV

- May start with low level inspiratory pressure support 5-7 cm water
- PEEP 3-5 cm water
- Pressure support increased by 2 cm water every 15 min
- Goal
  - RR < 25
  - Peak inspiratory pressures < 25