

UPDATE ON PEDIATRIC RESPIRATORY EMERGENCIES

S. Eugene Finch, MD
Pediatric Intensivist
Avera McKennan Hospital

UPDATE ON PEDIATRIC RESPIRATORY EMERGENCIES

- UPPER AIRWAY OBSTRUCTION:
Laryngotracheobronchitis (Croup) and other forms.
- BRONCHIOLITIS.

UPPER AIRWAY OBSTRUCTION- PE

- Nasal flaring
- Stridor
- Suprasternal retractions
- Costal/Subcostal retractions
- Decreased breath sounds
- Delayed/diminished chest rise
- Paradoxical (See Saw) Breathing
- No chest rise (complete obstruction)

UPPER AIRWAY

OBSTRUCTION- Presentations

- Croup- presents in a non toxic toddler or infant after beginning URI with barky cough (like a seal), stridor and suprasternal retractions.
- Epiglottitis- classically, toxic infant/toddler, unimmunized now, muffled voice, no barky cough, tripod position, drooling.
- Retropharyngeal abscess- mod toxic, gurgling respirations, worse when laying flat.

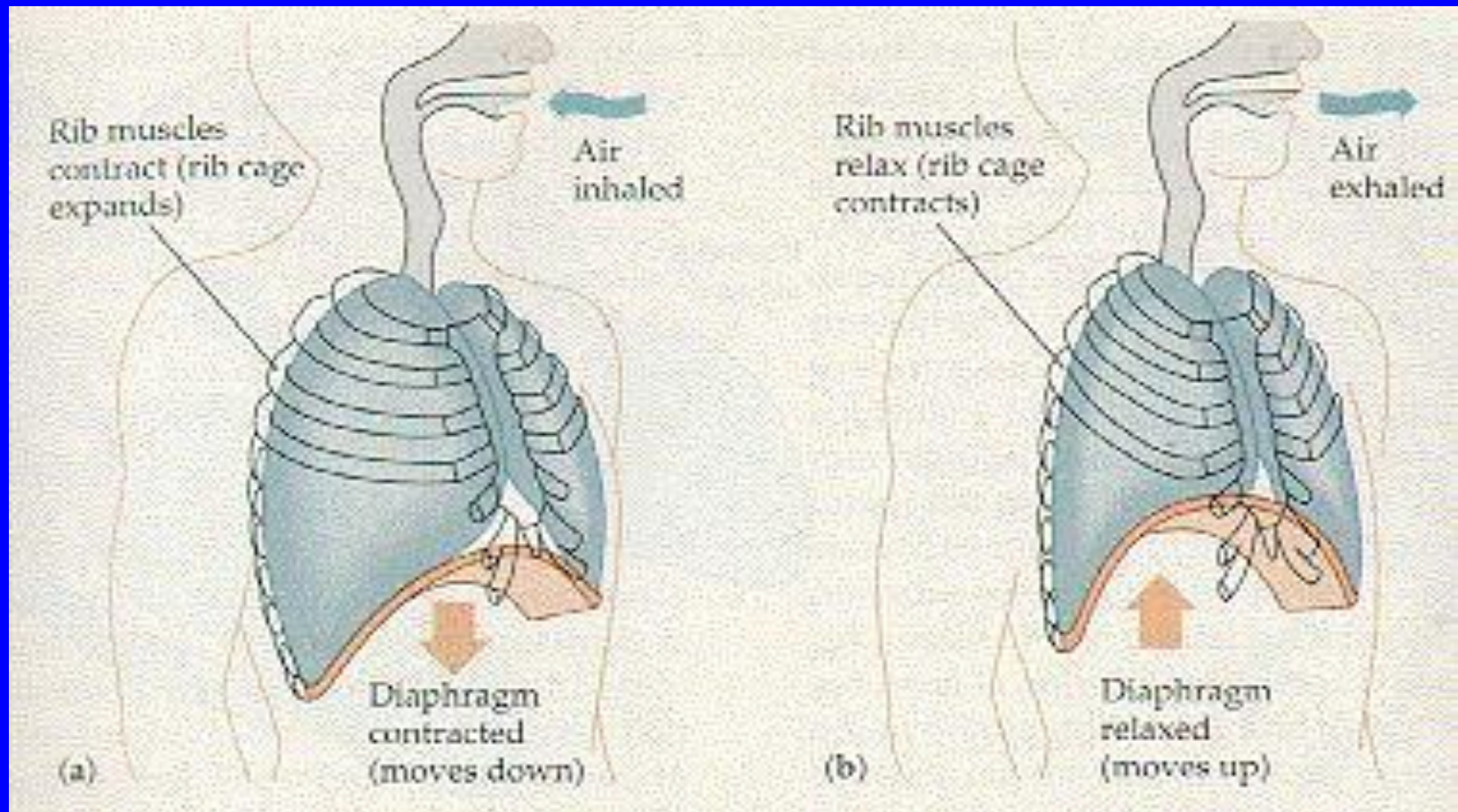
UPPER AIRWAY OBSTRUCTION

- Croup vs epiglottitis was once a constant dilemma, now H. Flu epiglottitis is very infrequent.
- The “Airway Team” of anesthesia, ENT, and peds/ICU, infrequently mobilized now, is still needed for severe upper airway obstruction.
- Patients now requiring tracheal intubation have: staphylococcal supraglottitis, viral supraglottitis, neck abscesses, bacterial tracheitis, anatomic abnormalities.

CROUP

- Usually a viral induced inflammation of the larynx, trachea (subglottic portion particularly), and bronchi, most commonly caused by parainfluenza viruses, RSV.
- Moderate fevers, non-toxic appearance, stridor, barking cough, worse at night, most often without drooling or tripod positioning, are characteristic.
- Signs of upper airway obstruction are usually mild or moderate.
- Clinical assessment and pulse oximetry are frequently all that is necessary for diagnosis. PA and lateral views of the airway may show the “steep sign” of croup, but this may also be seen in expiratory views of normals.

Basic Physiology



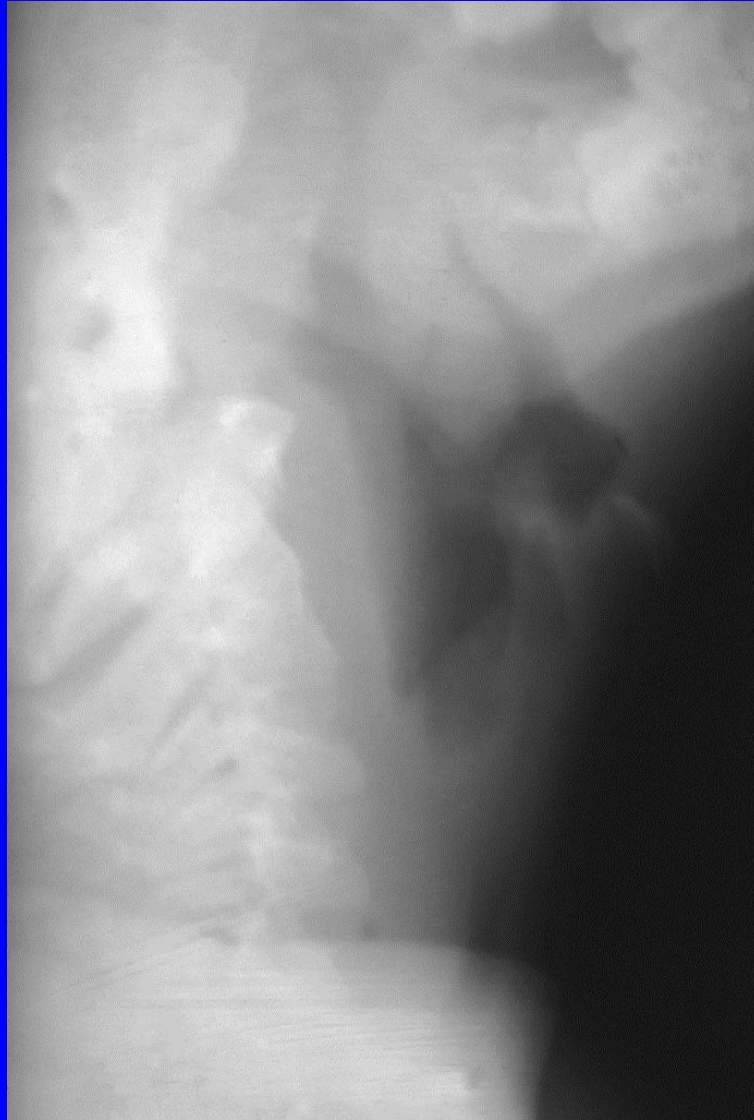
Normal Airway



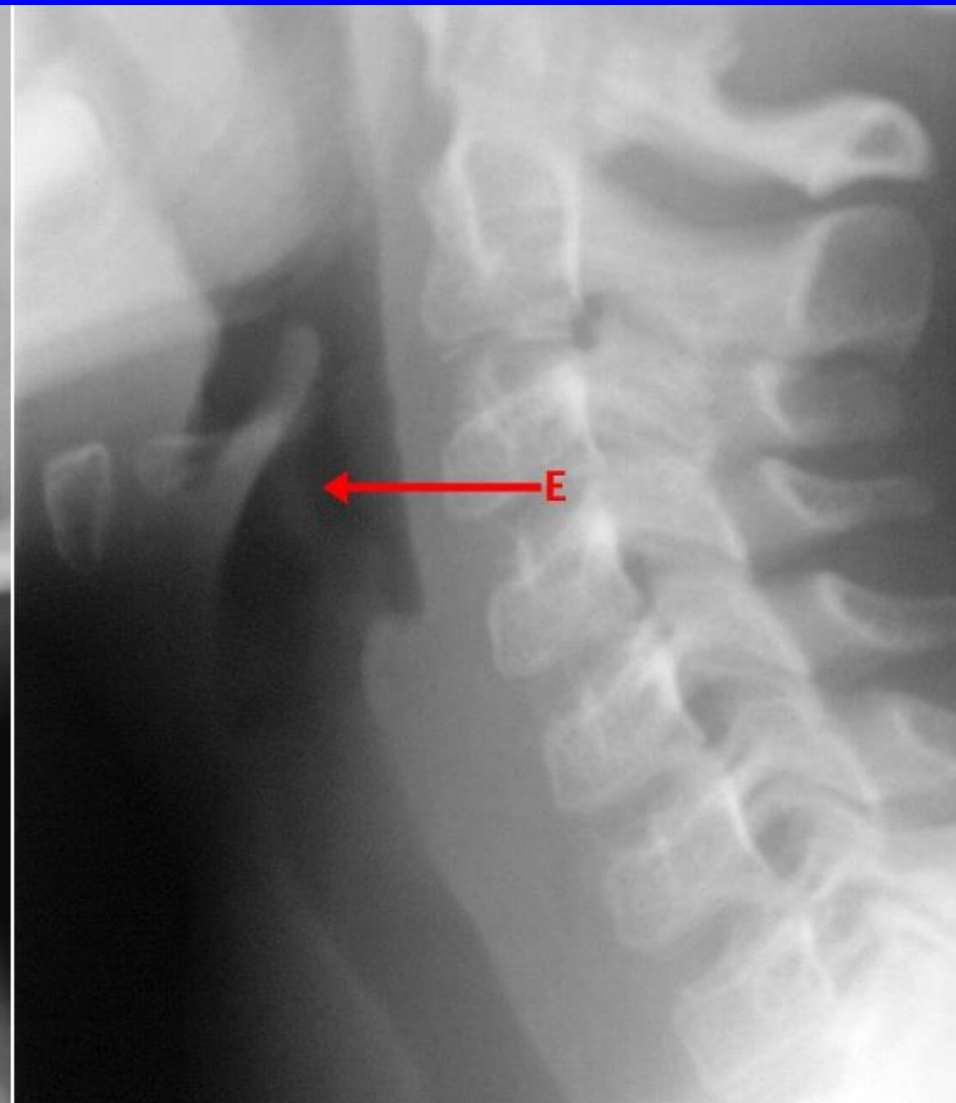
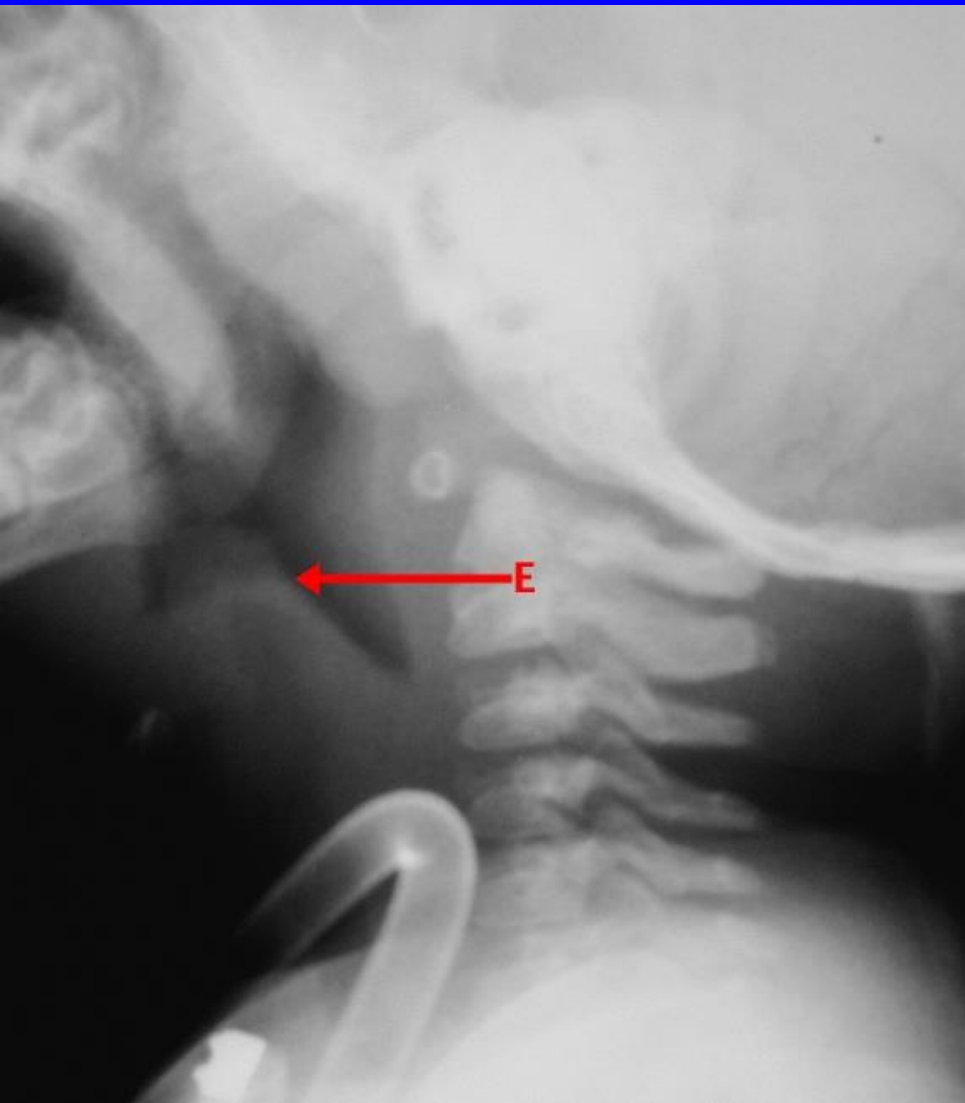
Croup



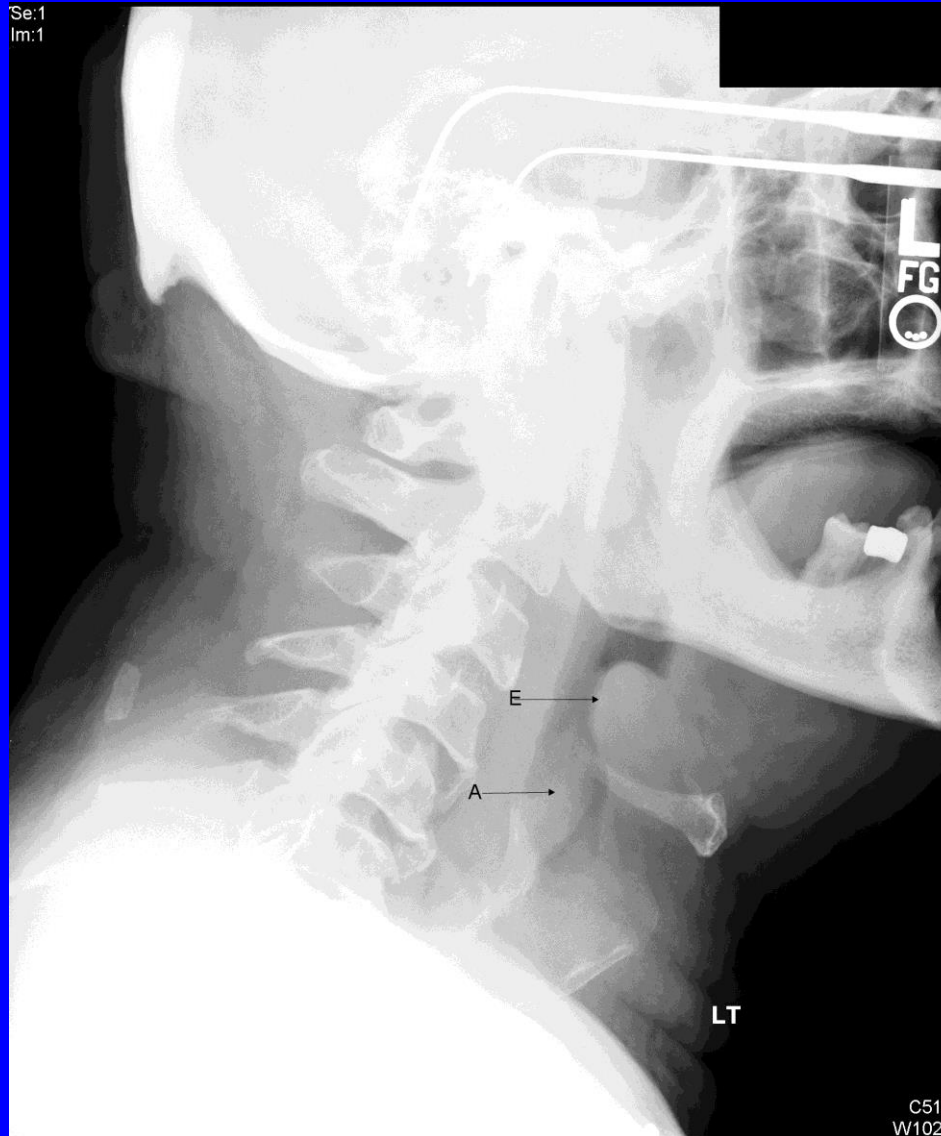
Croup- Lateral



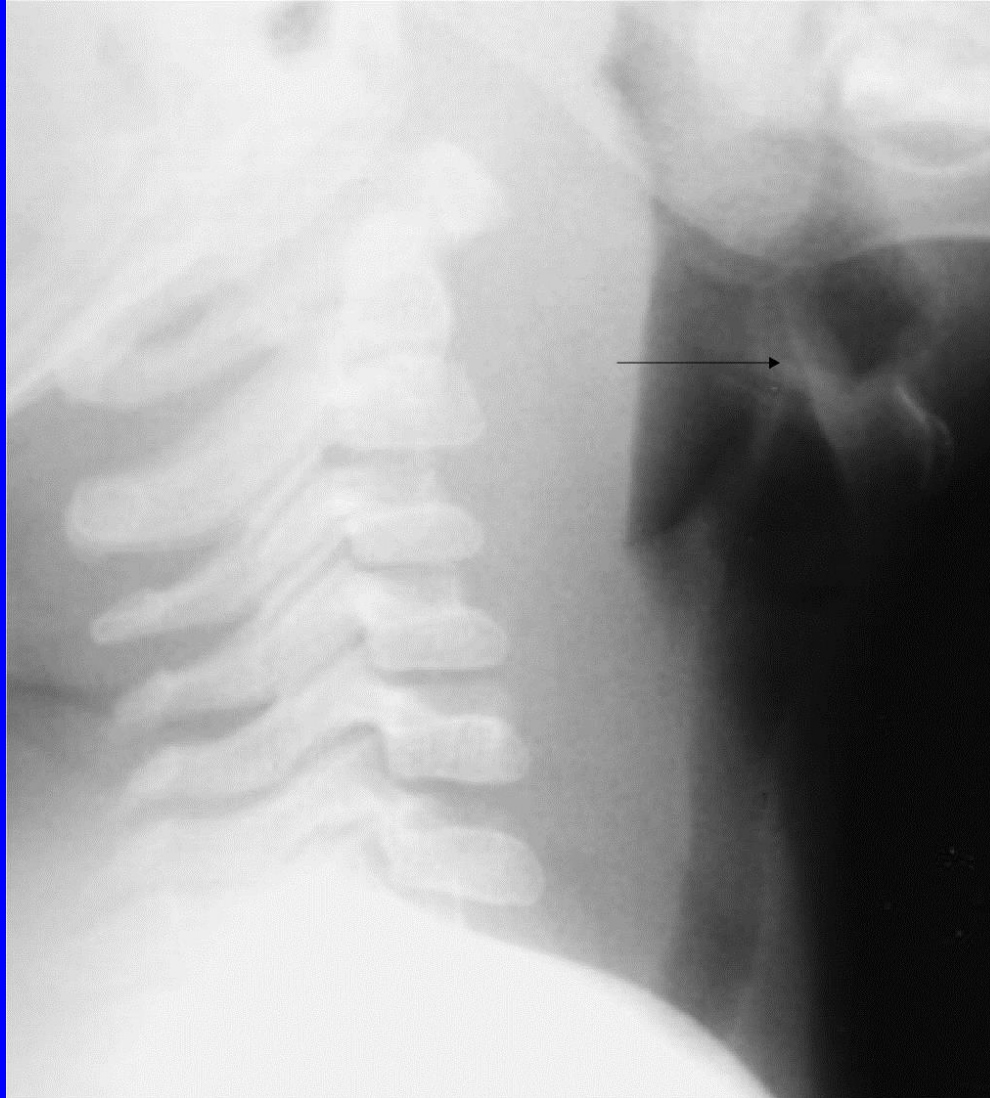
Epiglottitis- Normal



Adult Epiglottitis



Retropharyngeal Abscess



CROUP- RX

- Cool mist, position of comfort, oxygen as needed, and calming were the preferred treatments.
- Racemic (L and D isomers) epinephrine was nebulized for non-responders, and mandated admission (years ago) for fear of rebound.
- The alpha adrenergic effects are most useful to reduce subglottic edema, whereas the beta adrenergic effects on the lower respiratory tract may have additional benefit.
- Epinephrine treatment does not alter the natural course of disease, but temporarily improves breathing.

CROUP

- The “Myth” of racemic epinephrine’s superior safety has been debunked. (Waiisman, Peds, 1992)
- Recommended dose: 5 ml of 1:1000 (0.1%) L-epinephrine solution for injection nebulized.
- Racemic epinephrine doses are 0.25-0.5 ml of 2.25% solution.
- The author has used 5ml of 1:10,000 (0.01%) L-epinephrine “straight” in nebulizer successfully many times.

CROUP

- Early studies (Acta Ped Scand, 1988, JPEDS, 1989) used a single intramuscular dose of dexamethasone 0.6mg/kg and showed decreased need for racemic epinephrine and overall improved croup scores.
- Now oral and nebulized steroids have been shown to decrease admission rates and more rapidly decrease severity scores.
- Successful discharge from ED after racemic epi with IM dexamethasone was initially demonstrated by Predergast (Am J Emerg Med, 1994). Half of patients admitted in that study which used 3 hour observation. Resting stridor at 1 hour predicted hospitalization.

NEBULIZED STEROIDS IN CROUP

- Nebulized budesonide was first shown to lessen croup symptoms (first shown by Klassen, NEJM, 1994) in children with mild and moderate croup compared with placebo.
- Out of 27 children in each group, 15 in the budesonide group and 21 in the placebo group subsequently received dexamethasone.
- Geelhoed (Ped Pulm 1995) compared po dex with neb budesonide. Both were effective in short term, although time to a croup score of 1 was shorter in the po dex group.
- Geelhoed also showed that doses as low as 0.15 mg/kg were as effective.

NEBULIZED STEROIDS IN CROUP

- Klassen (Peds 1996) showed benefit when nebulized budesonide was added to po dexamthasone.
- Klassen (JAMA, 1998) compared varying regimens of po dex and nebulized budesonide and concluded po dex was preferred because of equivalent outcome and lower cost.
- Johnson (NEJM 1998) compared IM dex and nubulized budesonide- 38% vs 23% hospitalized favoring dex. Pts received nebulized epi as well.
- Johnson (Arch Ped Adol Med, 1996) compared nebulized dex to placebo and found a trend to lower hospitalization, but not significant.

CROUP- RECOMMENDATIONS

- Oral or IM dexamethasone (0.15-0.6 mg/kg) are useful early for moderate and severe croup.
- Nebulized budesonide is the nebulized steroid of choice where available.
- Use of racemic or L-epinephrine does not mandate hospital admission when given with corticosteroids. A 3 hour observation period is sufficient.
- Any corticosteroid works- prednisolone is fine!!-
2 mg/kg = 0.6 mg /kg dexamethasone.

CASE PRESENTATION

- A five month old white male had been well until the end of November, when he was diagnosed with croup, and was managed as an outpatient. Afterwards, the patient had a persistent dry cough, especially at night. He was subsequently admitted to the hospital several times over the course of the next two week for bronchiolitis.

CASE PROGRESSION

- Workup of his illness included a barium swallow to rule out a vascular ring, TEF, and GER. An anomalous subclavian artery was suspected based on this study, and was confirmed by echocardiography. The vascular anomaly, however, was felt to be asymptomatic. His therapy included nebulized albuterol, cromolyn, and systemic corticosteroids, ceftriaxone, and ribavirin.

CASE PROGRESSION

- Despite these measures, the patient's illness continued to progress, with worsening respiratory distress and hypoxemia despite high concentrations of inspired oxygen.
- The patient was transported, where the ribavirin was discontinued. The patient immediately improved, with reduction in respiratory rate and oxygen requirement.

CASE CONCLUSION

- The patient continued to do well, weaning on oxygen and with decreased tachypnea.
- He was subsequently discharged on nebulized albuterol, cromolyn, oral corticosteroids, and chest physiotherapy and suctioning.
- The child has done well as an outpatient.

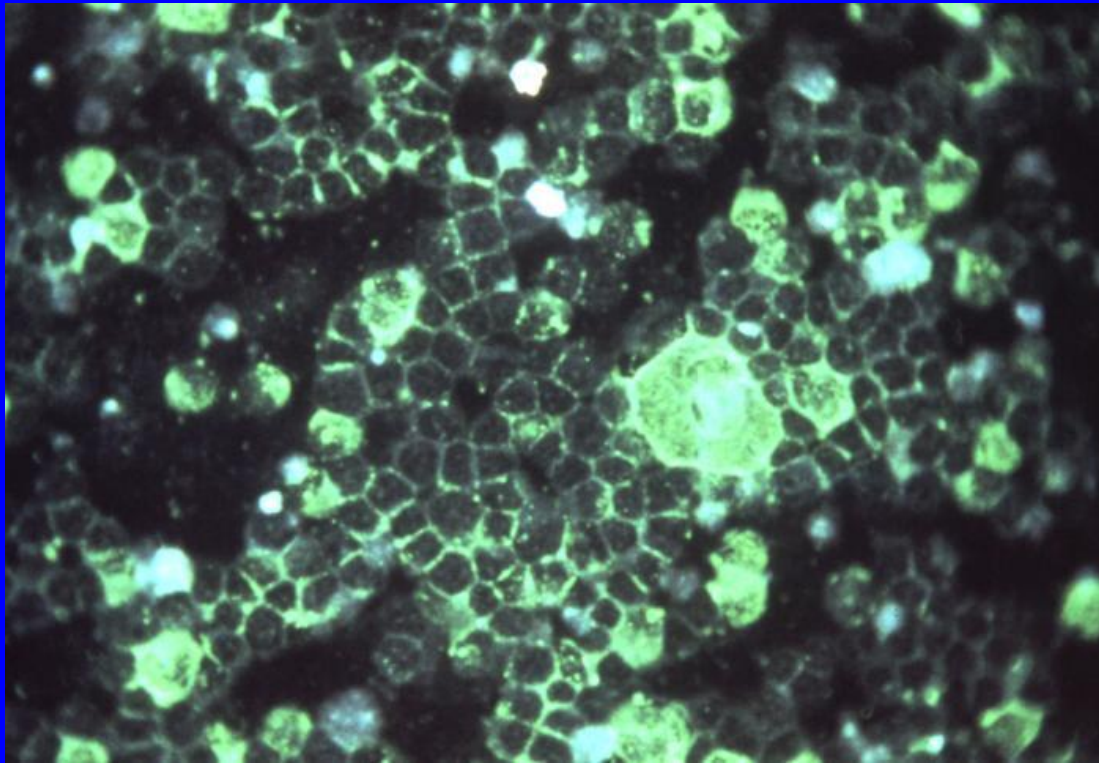
BRONCHIOLITIS

- Defined as inflammation of the bronchioles, caused most commonly by viruses, notably Respiratory Syncytial Virus (80% plus), Human Metapneumovirus (about 7%), Parainfluenza/influenza, Adenovirus, Rhinovirus, Coronavirus, Mycoplasma.
- Most of airway resistance is in bronchioles in infants and young children.
- *Clinically defined as first time wheezing in infants with evidence of viral infection.*

RSV- EPIDEMIOLOGY

- Most important respiratory pathogen in children. Approximately 150,000 hospitalized cases yearly, with nearly universal infection in infancy and early childhood. Annual outbreaks between late fall and early spring, with sporadic cases at other times. Peak month is January. An every other year surge in hospitalized cases has been noted.
Causes disease by necrosis of epithelium with hypersecretion of mucus and edema.
Plugging of bronchioles by edema and mucus.
- Infants less than 3 months are most at risk of severe disease, as are those with prematurity, heart or lung disease.

RSV



RESPIRATORY SYNCYTIAL VIRUS

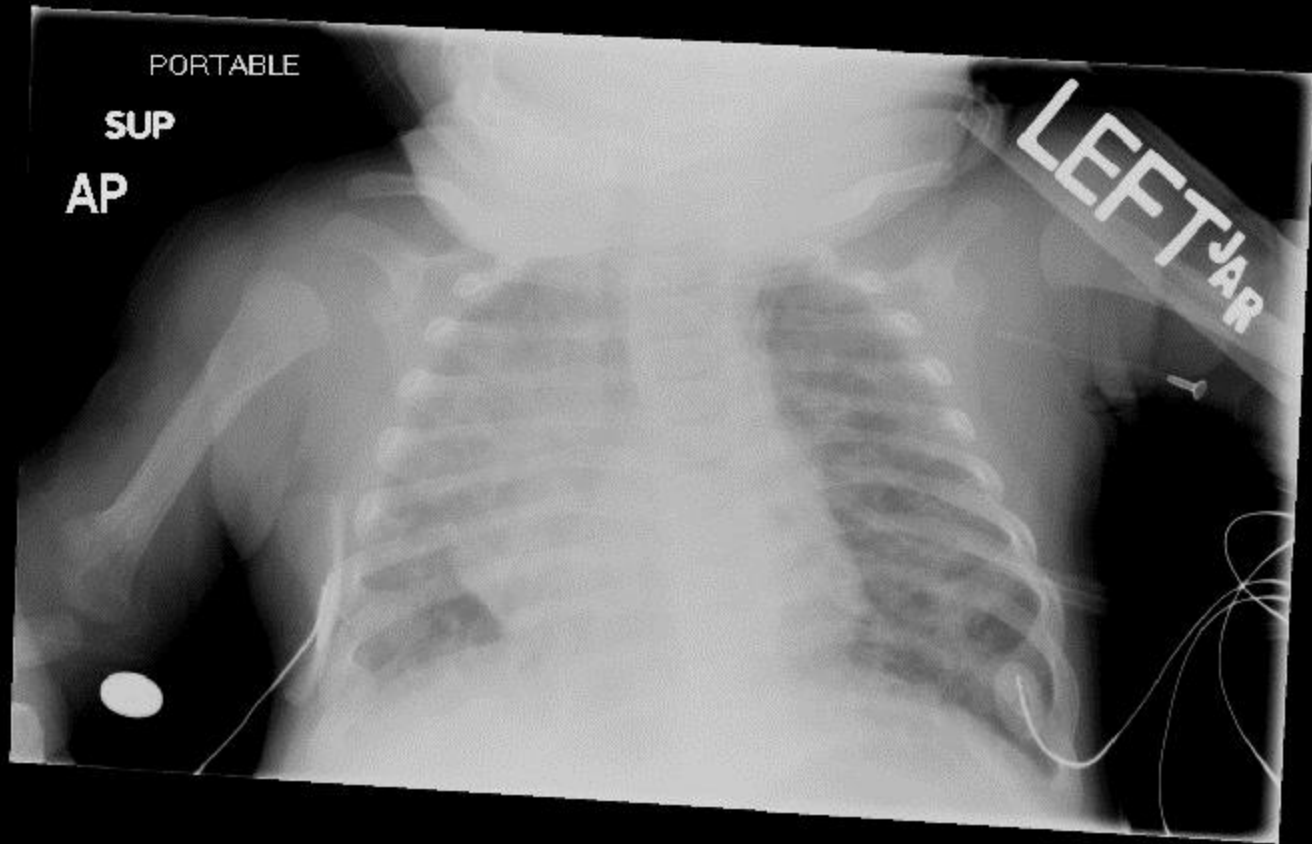
- Medium sized, membrane bound, RNA virus belonging to family of Paramyxoviruses- other members are parainfluenza and mumps.
- Felt to behave as a single serotype, humans only reservoir.
- In tissue culture, produces a syncytial cytopathology.
- Heat labile, specimens must be delivered to laboratory for culture quickly.
- Primary infection tends to be more severe than reinfection, which tends to be less frequent and less symptomatic.
- Maternal antibodies are partially protective.

RSV- EPIDEMIOLOGY

- Most have URI with coryza, pharyngitis, some otitis media. Most have fever.
- Less than half develop LRI: croup (6-8% of all cases of croup), bronchitis, bronchiolitis (45-75%), bronchopneumonia/interstitial pneumonia (15-25%).
- 1-3% of infants require hospitalization. Mortality now about 500/yr.
- Mortality of hospitalized infants was 5% or more, now is <1%.
- LRI more common in boys, occurs earlier in crowded conditions.
- Incubation period is 4 days. Excretion usually for 1-2 weeks after hospitalization, although a month has been reported.
- Spread is via airborne droplet, or conveyed by hands, to the nasal or conjunctival mucosa of a susceptible individual.
- Typically, infants are infected by older siblings or parents.

RSV- CLINICAL MANIFESTATIONS

- URI first: rhinorrhea, pharyngitis, cough, fever, otitis media.
- LRI causes increased cough, **crackles**, tachypnea, retractions, wheezing, cyanosis, apnea, respiratory failure.
- Labs may show normal or increased WBC, hypoxemia +/- hypercarbia, CXR may be normal, or may show hyperinflation, patchy perihilar infiltrates +/- atelectasis, or interstitial pattern.
- Nasal specimen will detect virus by antigen detection or PCR.
- Apnea even before severe lung disease in young/premie infants.

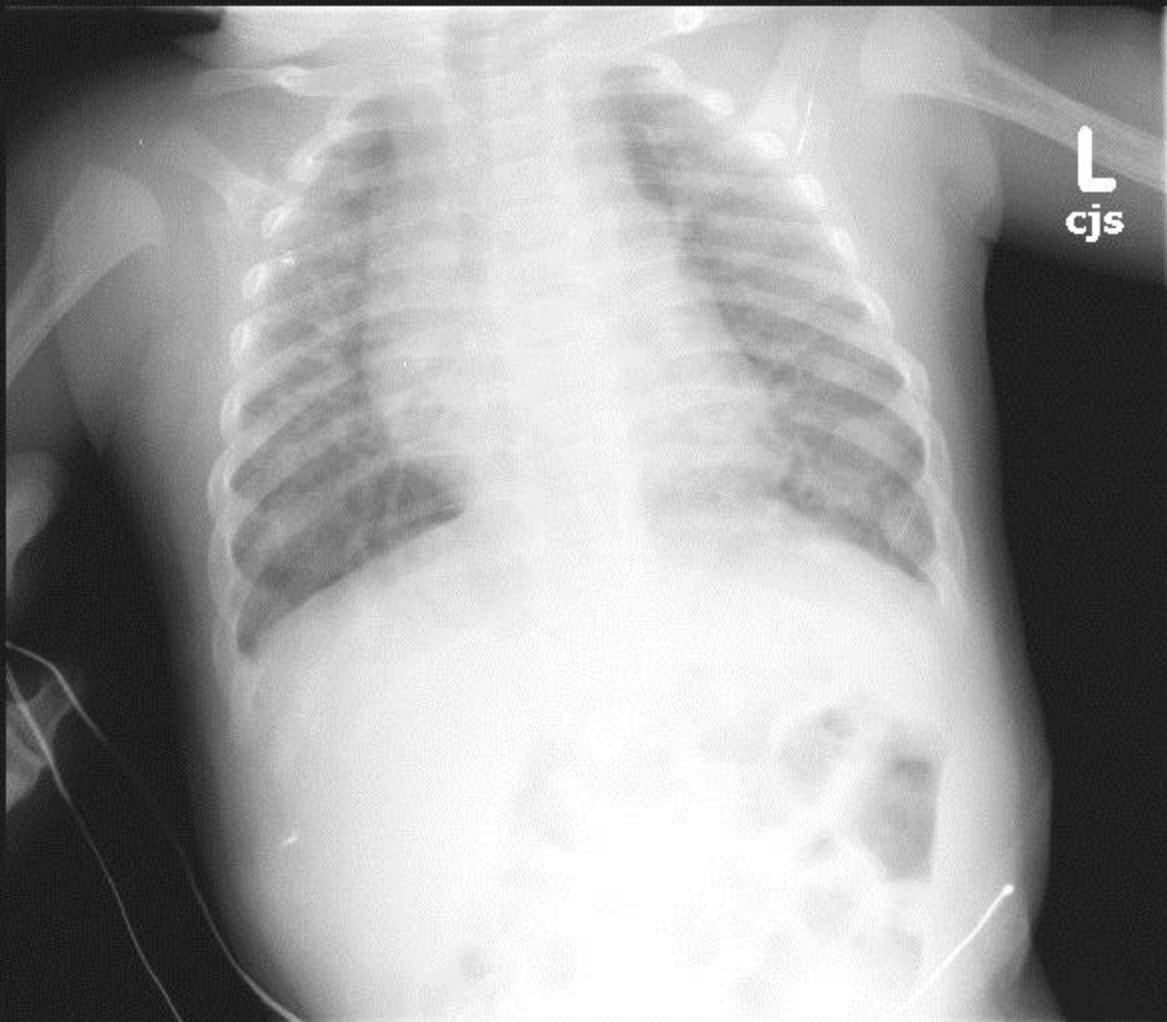


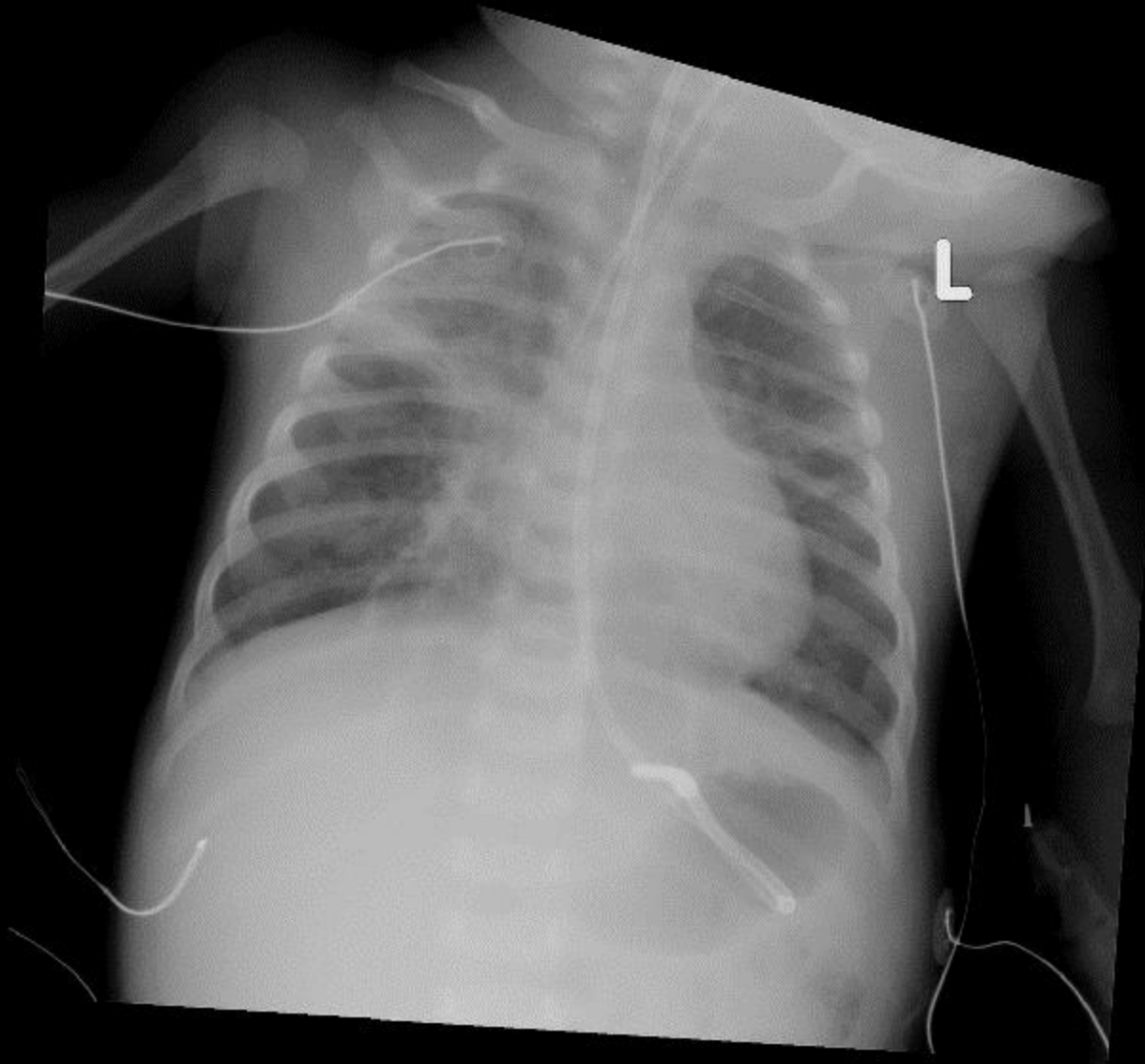
PORTABLE

SUP

AP

LEFT





Clinical Manifestations

- Primary central apnea may occur in young infants and ex premies prior to LRI, and may account for some cases of SIDS.
- Upper airway obstruction due to plugged nasal passages in obligate nasal breathers.
- Respiratory failure due to bronchiolitis.

RSV- DIFFERENTIAL DIAGNOSIS

- Other viruses, particularly parainfluenza and adenovirus, HMPV.
- *Chlamydia trachomatis*- cause of interstitial pneumonia with conjunctivitis.
- Consolidation suggests bacterial suprainfection.
- Coughing paroxysms suggest *Bordetella pertussis*.
- GERD/Cardiac failure.

RSV- OPTIONS FOR CARE

- Oxygen, IVF, antibiotics (macrolide) for atypicals or bacteria.
- Bronchodilators/Epi/HS/ CPT.
- Antiinflammatories- cromolyn, corticosteroids.
- Antiviral therapy.
- CPAP, HFNC, BIPAP, endotracheal intubation.
- Others- Heliox, surfactant.
- *Role of safe enteral feeding, with thickened feeding, NGT, alpha adrenergic nose drops.*

AAP Guidelines 2014

- A very conservative guideline for clinicians (not practicing hospital medicine)
- Focused on office/ED management
- Our inpatient practice utilizes therapies “not recommended” since short term improvement and avoidance of mechanical ventilation are not goals for this guide.
- We’ll discuss the AAP guideline, and then McKennan inpatient management/stabilization

AAP Guidelines 2014

- Diagnose and assess disease severity based on HP
- Assess risk factors for severity: age <12 weeks, premie, Cardiopulmonary disease, immunodeficiency when making decisions.
- No routine labs or xrays
- Do not give: albuterol, epi, HS (inpatient ok), corticosteroids, oxygen (if sats >90%), pulse oximetry, CPT, antibiotics (unless strong infection Sx), palivizumab (>29 wks and healthy).
- Do: NGT feeds or ivf if hydration not maintained, Palivizumab in first year with CHD or CLD of prematurity, hand disinfection with alcohol.
- Do: inquire/counsel about tobacco, encourage breastfeeding, evidence based diagnosis and treatment!

BRONCHIOLITIS- EPINEPHRINE

- Lowell, Peds, 1987- subq epi in wheezing infants.
- Kristjansson, Arch Dis Child, 1993- nebulized racemic epi in bronchiolitis.
- Sanchez, J Peds, 1993- racemic epi vs albuterol.
- Menon, J Peds, 1995- L-epi nebulized vs albuterol.
- Reijonen, Arch Ped Adol Med, 1995, racemic epi and albuterol.
- Lodrup Carlson, Resp Med, 2000, racemic epi improves pfts in bronchiolitic infants versus controls.

Bronchiolitis-Epinephrine

- Ray, Indian Ped, 1/02- RCT 45 epi, 45 albuterol, ED study with discharge as an endpoint as well as sx. More improvement in sx and lower admission rate for epi.
- Numa, Am J Resp Crit Care Med 7/01- Nebulized epi improved airway resistance
- Bertrand, Ped Pulm 4/01- RDBT-30 infants, epi improved clinical scores days 1-3 compared to albuterol. On the fourth and fifth days, more children in albuterol group remained hospitalized.
- Abul-Ainine, Arch Dis Child 4/02- Negative RCT using epi vs placebo, 38 pts.

Bronchiolitis-Epinephrine

- Patel, J Peds 2002- RDBCT, nebulized either epi or albuterol or placebo for the duration of hospitalization. No significant differences in duration of hospitalization noted, however, mean time to less frequent nebulizations was 16 hours versus 34 hours in placebo (31 albuterol), mean time to normal oxygenation was 25 hours versus 37 hours placebo, mean time to adequate fluid intake was 35 hours versus 48 hours placebo.
- None of the differences were statistically significant, and the authors recommended no treatment option.

Bronchiolitis-Epinephrine

- Plint, NEJM, 2009- Epi plus dexamethasone in ED reduced admission (17% vs 26%) vs placebo, but non significant when adjusted for multiple comparisons.
- Wainwright, NEJM, 2003- negative RDBCT with 194 infants compared epi to placebo, times three doses, once on peds ward. No effect on discharge time or respiratory rate or distress score. I believe there were positive trends.
- Ignacio Sanchez, an epi proponent has speculated that epi has most benefits in <6 months of age group, not all infants, and that only three treatments could have affected lack of effect.
- Dr Sanchez also speculates that alpha adrenergic nose drops may be beneficial prior to feeding in bronchiolitis. (Clinical Research Abstracts for Pediatricians- J Peds 1/04)

Bronchiolitis- Epinephrine/Hypertonic Saline

- 2011 Cochrane Review, Hartling- Significant reduction in admissions on day 1, but not day 7. Not surprising since epi was only administered in ED on day 1!
- 2010 Grewal...Klassen. JPAM. 3% saline compared with ns, both groups got epi. Both groups had decreased RACS of 4 and 5 points respectively, and reduced admissions for HS, 8/23 vs 13/23. Non significant result= Negative study.
- Luo, Ped Int, 2010- decreased wheezing and los 7.4 vs 6 days with HS vs NS and salbutamol (both groups).

Corticosteroids in Bronchiolitis

- Garrison, Pediatrics 2000, metanalysis of 6 articles meeting criteria. Length of stay decreased by 0.43 days, reduced clinical score -1.60 .
- Schuh, J Peds 1/02- RDBPCT- 70 pts, oral dex associated with improved resp sx and lower rates of admission in first 4 hours of rx (19% vs 44%).
- Kajosaari, Ped Allergy Immunology 8/00- large study with 117 pts, treatment was conventional, inhaled budesonide for 1 wk, budesonide for 2 months. Rates of asthma per group (follow up 2 years)- 37%, 18%, 12%.

Ribavarin- Long Term Effects

- Edell et al, Chest 9/02- prospective long term trial, 21 controls, 24 exp group to receive ribavarin for severe RSV. Follow up at 1 year showed decreased reactive airway disease subsequently. Fewer episodes of rad, reduced severity, and reduced hospital days (25 vs 90 days/200 pts/year).
- Incidentally, they commented on their regimen of thickened oral feeds (one tablespoon of rice cereal per oz) as reducing aspiration, and aspiration being an unrecognized source of deterioration.- Khoshoo, Ped Pulm 2001, abstract only.

Ribavarin- Long Term Effects

- Everard, Resp Med 2001- 41 patients with moderately severe RSV. Follow up at 6 weeks, 6 months, and 1 year. Assessment of bronchial hyperresponsiveness by total body plethysmography. No difference in frequency of respiratory sx, frequency of prescribed bronchodilators or inhaled steroids.

Bronchiolitis- Other Therapies

- Nitric Oxide- Patel, Inten Care Med, 1999, negative.
- Ipratroprium- multiple negative studies.
- CPAP-Soong, Ped Pulm, 1993, positive.
- Surfactant- Luchetti, 1998 and 2002, positive. Tibby, 2000, positive.
- Heliox- Gross, CCM 2000, negative, Martinon-Torres, Pediatrics 7/02- CT- 39 patients- heliox vs conventional (with epi) rx- improved clinical scores and PICU LOS (3.5 vs 5.4 days).

RSV- PREVENTION

- Palivizumab (Synagis), a humanized monoclonal antibody directed against the F glycoprotein of RSV. (F glycoprotein is well conserved across RSV isolates.)
- Antibody consists of two heavy chains and two light chains, 5% murine sequences and 95% human sequences. Utilizes recombinant techniques.
- Mean half life of 20 days.
- No data in immunodeficient.
- Does not interfere with vaccines.
- Given by monthly intramuscular injection.

RSV- PREVENTION

- Impact-RSV clinical trial, Pediatrics, 1998, 102, 531-537, demonstrated 55% reduction in hospitalizations due to RSV in high risk children. (10% vs <5%)
- No significant adverse events were noted in 1500 infants.
- Also, a reduction in viral shedding in intubated patients treated with palivizumab has been documented. (Malley, J. Infect Dis, 1998)
- This trial, however, did not demonstrate reduction in ventilator days or hospital days, and a worse trend was seen.

RSV- PREVENTION

- Recommendations for Palivizumab:
- Children younger than 2 who have required medical therapy for CLD within 6 months before anticipated RSV season, < 28 wks and < 12 months of age, 29-32 wks and < 6 months.
- Palivizumab for patients with CHD.
- RSV-IG may be considered for immunodeficient who receive IV-IG.
- No role in established RSV bronchiolitis.

Bronchiolitis- Outpatient

- Phenylephrine nose drops (0.125%)
- Thickened feeds if coughing (1 TBS rice cereal/2 ounces formula with #2/3 nipple)
- Admit for distress, hypoxemia, inability to feed, high risk infants.
- High risk: under 3 months (2 months esp), former premie, BPD, CHD, Immunodeficient.

RSV- INPT RECOMMENDATIONS

- Prevent aspiration- Enteral feedings, especially via NGT early should be encouraged. Thickened feedings also useful for coughing infants (1 tablespoon rice cereal per 2 ounces using stage 3 nipple)
- 0.125% phenylephrine nose drops q 4 hrs for 3 days.
- Epinephrine (0.25 -0.5 ml) with 3-4 ml 3% saline nebs can help stabilize.
- High Flow Nasal Cannula or nasal cpap may be helpful.
- Intubation when necessary.
- Aggressive approach for neonates, especially ex-premies.
- Intubation for severe apnea with cyanosis or severe distress.
- We have had very few intubations once in our PICU for RSV bronchiolitis since using this approach!