BREATHING HARD OR HARDLY BREATHING: ACUTE SEVERE PEDIATRIC ASTHMA

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http://everclevermom.com/2016/05/evas-asthma-its-a-big-deal/

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EXHAUSTION OR CHANGE IN MENTAL STATUS?

http://everclevermom.com/2016/05/evas-asthma-its-a-big-deal/

FROM THIS TO THIS…

http://everclevermom.com/2016/05/evas-asthma-its-a-big-deal/

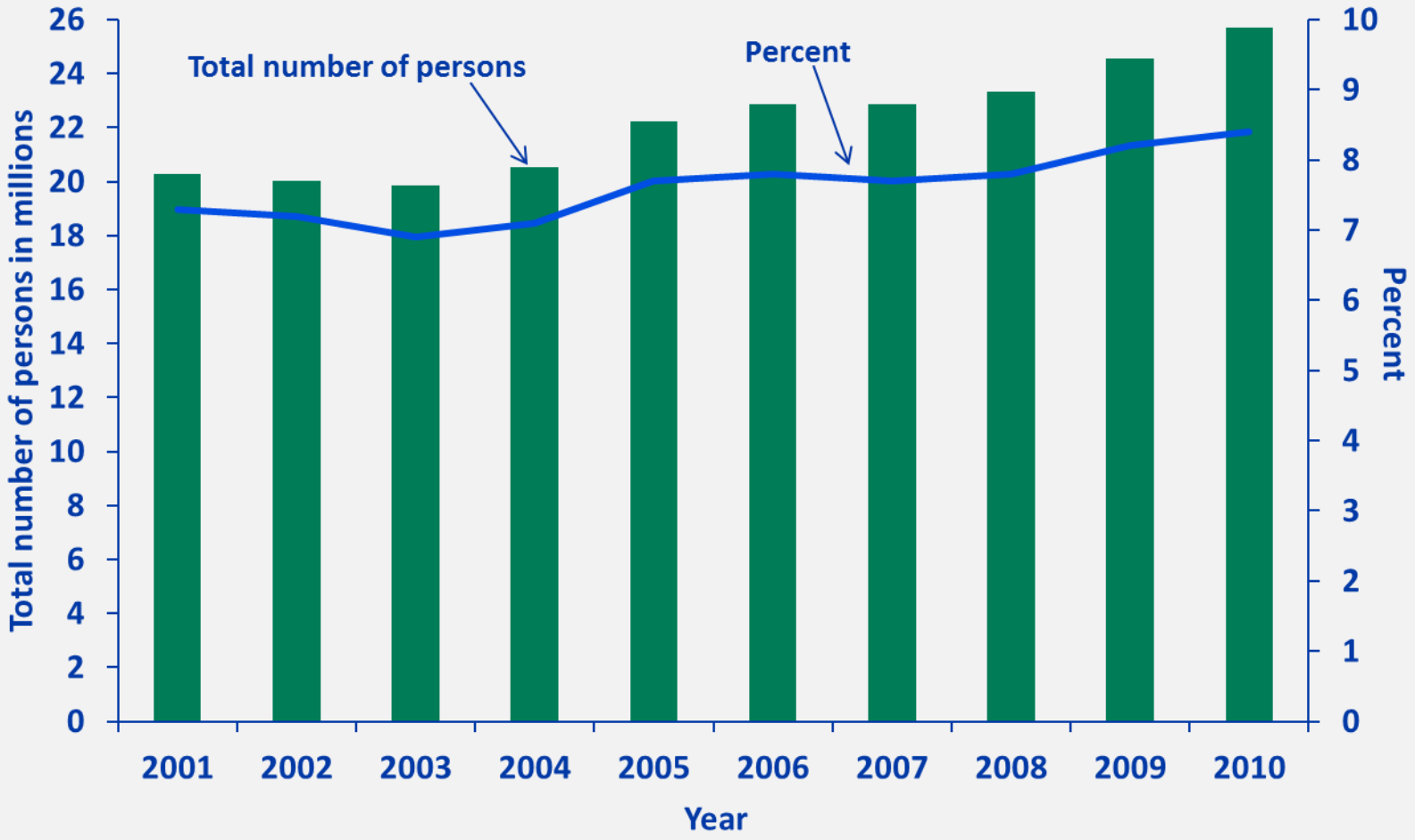
http://savanassalvation.angelfire.com/savanas_first_days_at_st_francis_childrens_hospital/Picture_048.jpg

THEN THIS

Making Asthma Scary Since 1977

Identifying Who is Bad
First Steps
Next Steps
Then What???

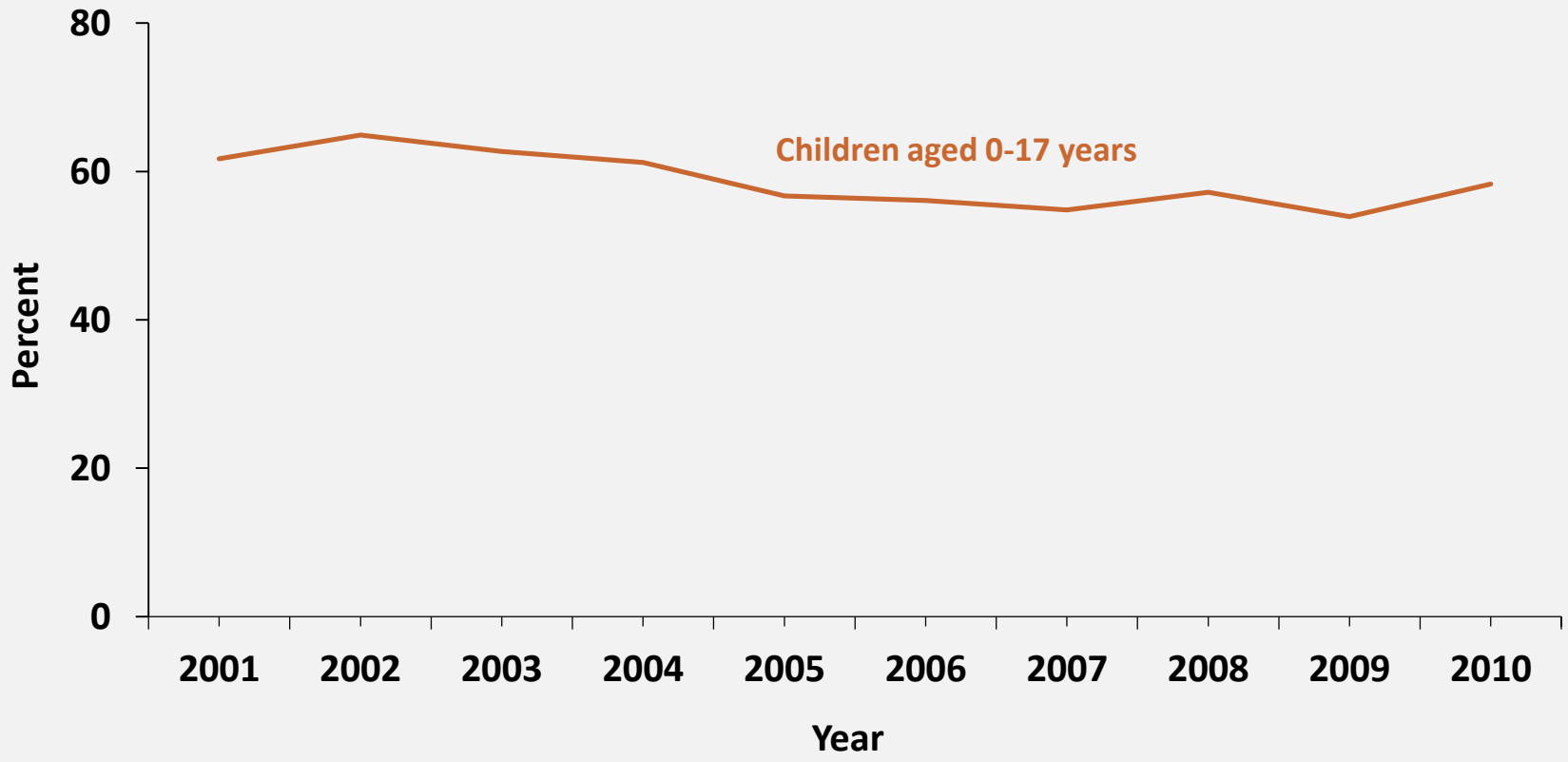
Current Asthma Prevalence: United States, 2001-2010



One in 12 people (about 26 million, or 8% of the U.S. population) had asthma in 2010, compared with 1 in 14 (about 20 million, or 7%) in 2001.

Asthma Prevalence in the United States, CDC website. June 2014

Asthma Attack Prevalence among Children with Current Asthma: United States, 2001-2010



From 2001 to 2010 children had fewer asthma attacks. For children, asthma attacks declined from at least one asthma attack in the previous 12 months for 61.7% of children with asthma in 2001 to 58.3% in 2010.

ACUTE SEVERE ASTHMA

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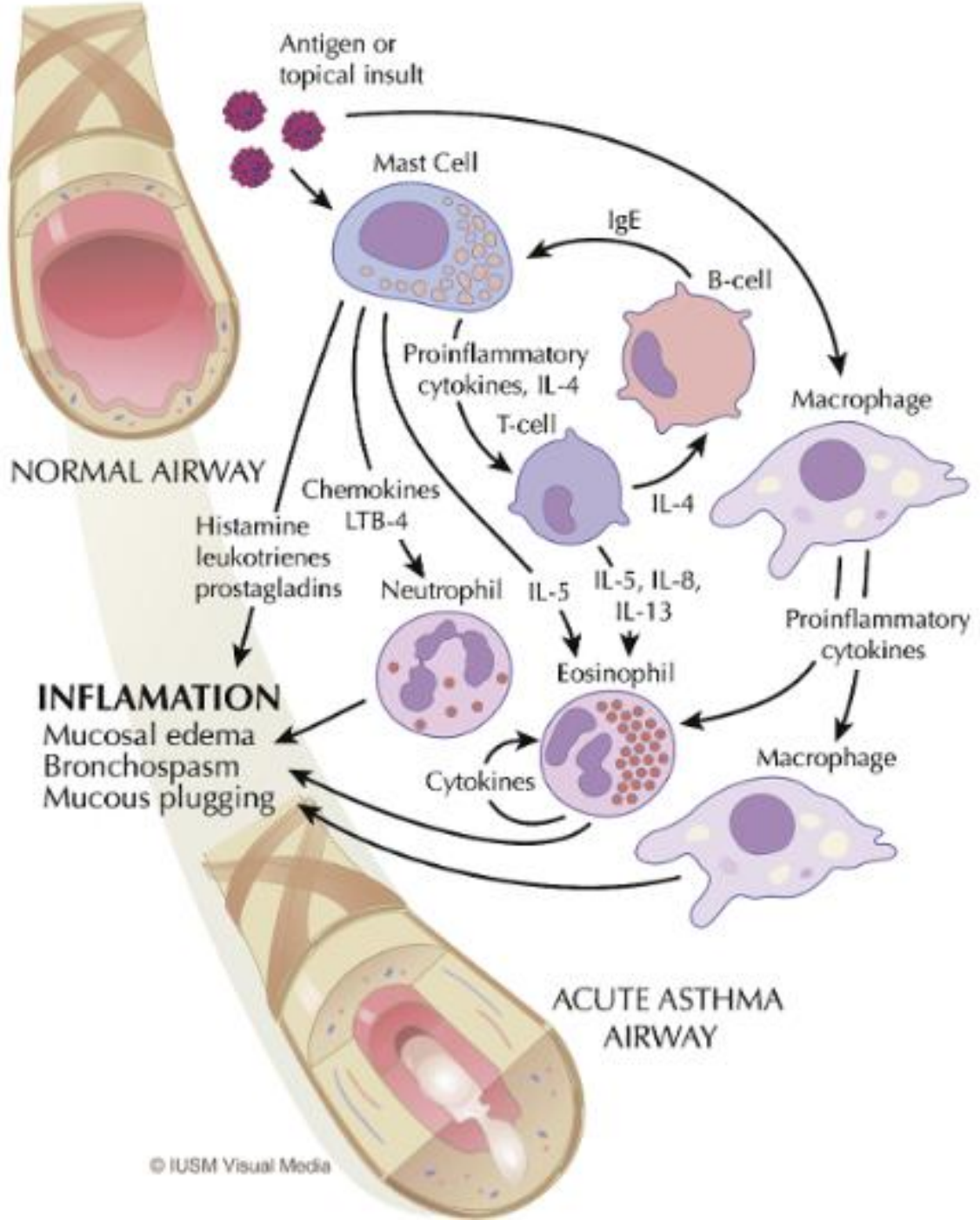
- Terr
  - ‘Flare-up’ is the preferred term for discussion with patients
  - ‘Exacerbation’ is a difficult term for patients
  - ‘Attack’ has highly variable meanings for patients and clinicians
  - ‘Episode’ does not convey clinical urgency

Progressively worsening bronchospasm unresponsive to standard therapy

Wheeler DS, Wong HR, Shanley TP. Pediatric Critical Care Medicine, Volume 2: Respiratory, Cardiovascular and Central Nervous Systems. Springer; 2014.
2016 GINA Report, Global Strategy for Asthma Management and Prevention.

PATHOPHYSIOLOGY

- Inflammation
  - Edema
  - Bronchospasm
  - Mucous plugging
- VQ mismatch
  - Intrapulmonary shunting
  - Hypoxic pulmonary vasoconstriction
- Abnormally high airway resistance
- Dynamic hyperinflation
  - Auto-PEEP
- Cardiovascular effects
  - Pulsus paradoxus



FATAL AND NEAR-FATAL ASTHMA

TYPE 1(80%)

- Slow onset, progressive airway obstruction
- On medications but not compliant
- Frequently using bronchodilators
- Usually undertreated with inhaled corticosteroids
- More inflammation + mucous plugging

TYPE 2 (20%)

- Sudden onset, sudden asphyxial asthma
- More epidemic or sporadic
- Death can follow in only a few hours after start of the clinical symptoms
- Higher incidence of AMS, respiratory arrest, acidemia
- Severe bronchospasm but little to no mucous plugging
- Rapid deterioration but rapid recovery with treatment

Koninckx M, Buysse C, De hoog M. Management of status asthmaticus in children. Paediatr Respir Rev. 2013;14(2):78-85.

RISK FACTORS FOR POOR ASTHMA OUTCOMES

IDENTIFY PATIENTS AT RISK OF ASTHMA-RELATED DEATH

- Any history of near-fatal asthma requiring intubation and ventilation
- Hospitalization or emergency care for asthma in last 12 months
- Not currently using ICS, or poor adherence with ICS
- Currently using or recently stopped using OCS

- Over-use of SABAs, especially if more than 1 canister/month
- Lack of a written asthma action plan
- History of psychiatric disease or psychosocial problems
- Confirmed food allergy in a patient with asthma

2016 GINA Report, Global Strategy for Asthma Management and Prevention.

BUT WHO IS SICK?

Score	R	Muscle Use
0	<	
1	31	
2	46	
3	>	

Classification of severity of an asthma exacerbation

Symptoms	Mild	Moderate	Severe	Imminent Respiratory Arrest
Dyspnoea	When walking	During speech (infant-softer or shorter crying; difficulty drinking	At rest (infant: stops drinking)	Gasping
Talks in:	Sentences	Shorter sentences	Words	None
Alertness:	Can be agitated	Most often agitated	Most often agitated	Decreased or confused
Signs at physical examination				
Breathing frequency (awake patient)	Increased Normal breathing frequency in children Age < 2 months 2-12 months 1-5 years 6-8 years	Increased Normal frequency: (mean) < 48/minute < 42/minute < 28/minute < 24/minute	Often > 30/minute	
Use of auxiliary muscles; Sternal retractions	Most often not	Often	Usually	Paradoxal thoracoabdominal movements
Wheeze	Moderate, most often end-exiratory	Loud, whole expiration	Mostly loud in- and expiratory	Absent
Pulse rate/minute	< 100 Normal pulse rate in children Age 2–12 months 1–3 years 4–12 years	100-120 Normal pulse: 80–180 75–150 60–120	> 120	Bradycardia
Pulsus paradoxus	Absent	Can be present	Often	Absence suggests exhaustion
Fluctuation of pulse pressure between in- and expiration.	< 10 mm Hg	10–25 mm Hg	20–40 mm Hg (child)	
Gas exchange				
SaO_2 (room air)	> 95%	91-95%	< 91%	
$PaCO_2$	< 5.6 kPa	< 5.6 kPa	>= 5.6 kPa	>= 5.6 kPa
PaO_2	Normal	> 8 kPa	< 8 kPa: possible cyanosis	< 8 kPa: possible cyanosis

C.A. Camargo, G. Rachelefsky, M. Schatz. Managing asthma exacerbations in the emergency department. Summary of the national asthma education and prevention program expert panel report 3 guidelines for the management of asthma exacerbations. Proc Am Thoracic Society 2009;6: 357–366.[83]
The presence of several parameters, not necessarily all, gives an indication of the severity of status asthmaticus.
Many of these parameters have not been studied systematically, they only serve as guidance.

SO WHY USE THEM?

- Reliably and rapidly identify severity level
- Identify changes in clinical status
- Research purposes
- Protocols, pathways

OTHER CLUES?

BLOOD GAS

7.08/64/62/18

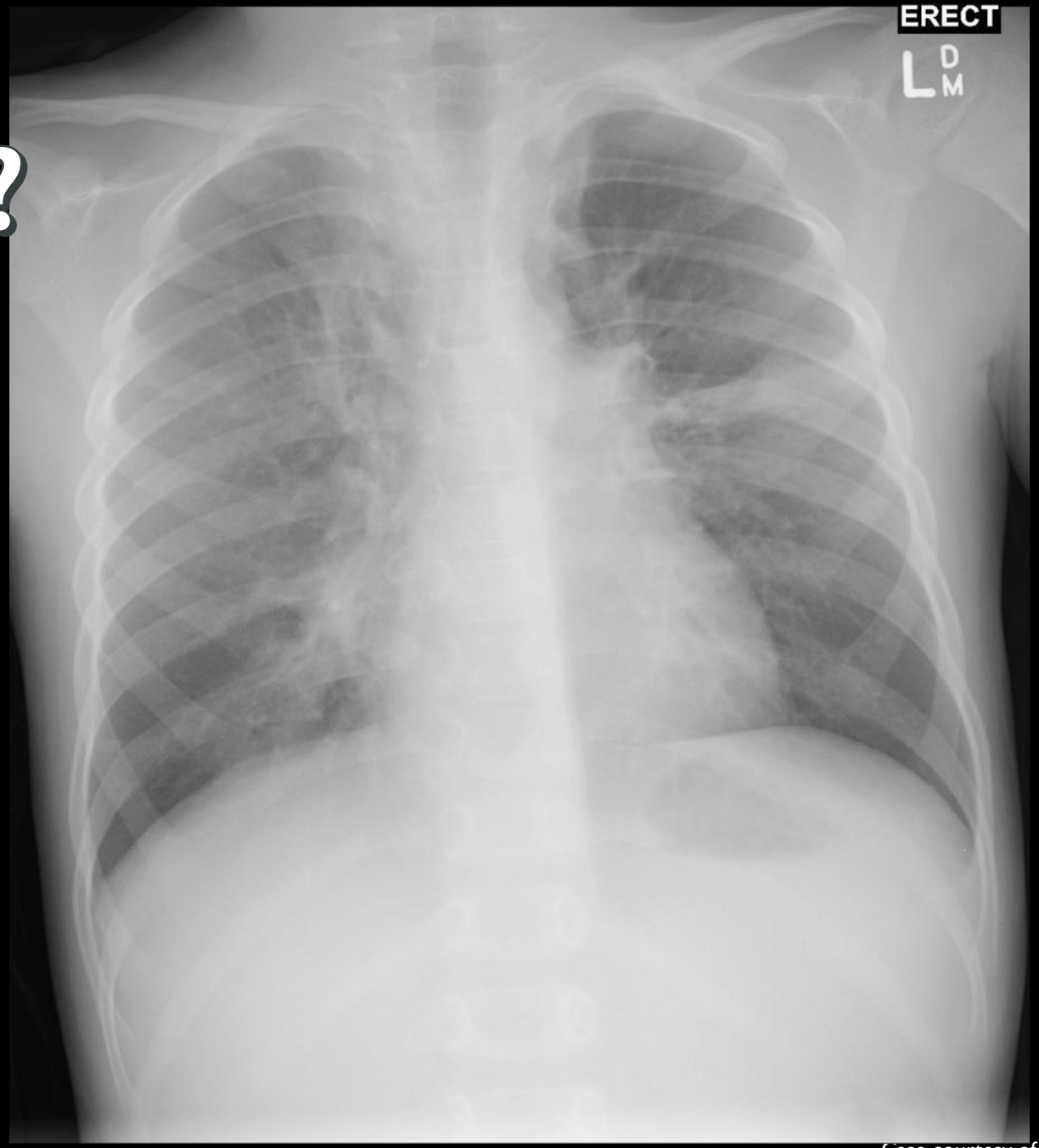
7.39/33/85/22

LABS?

- *Most patients who have an asthma exacerbation do not require any initial laboratory studies.*
  - *CBC if fever*
  - *Electrolytes if on diuretics*

- *If laboratory studies are ordered, they must not delay initiation of asthma treatment*

To Image?



Or Not?

Case courtesy of Townsville radiology training, Radiopaedia.org, rID: 17996

WHAT ARE WE DOING?

- Medications:
  - 90% use steroids
  - 90% use inhaled beta agonists
  - 44% used IV beta agonists
  - 40% use both inhaled and IV
  - 45% use magnesium
  - 14% use methylxanthines
  - 62% use antibiotics
  - 53% use neuromuscular blockade
- Mechanical Support
  - 27% use Heliox
  - 8% only use non-invasive
  - 62% were intubated in ED if intubated
  - 30% were intubated in PICU
- Labs/Imaging
  - 6% obtained a blood gas
  - 6% obtained an xray

Table 4. Therapies used to treat children receiving mechanical ventilatory support in a Collaborative Pediatric Critical Care Research Center

Feature	Collaborative Pediatric Critical Care Research Network Sites						All Collaborative Pediatric Critical Care Research Network N = 303 n (%)
	A N = 50 n (%)	B N = 112 n (%)	C N = 41 n (%)	D N = 65 n (%)	E N = 26 n (%)	F N = 9 n (%)	
Medications							
Steroids	44 (88)	99 (88)	36 (88)	59 (91)	25 (96)	9 (100)	272 (90)
β-agonists							
Inhaled albuterol	48 (96)	106 (95)	38 (93)	54 (83)	24 (92)	9 (100)	279 (90)
Inhaled lev-albuterol[a]	1 (2)	14 (13)	0	0	6 (23)	0	21 (7)
intravenous terbutaline[a]	21 (42)	28 (25)	8 (20)	55 (85)	16 (62)	5 (56)	133 (44)
Inhaled albuterol and intravenous terbutaline[a]	21 (42)	28 (25)	8 (20)	45 (69)	14 (54)	5 (56)	121 (40)
Inhaled ipratropium[a]	35 (70)	45 (40)	27 (66)	57 (88)	23 (89)	2 (22)	189 (62)
Magnesium[a]	24 (48)	30 (27)	26 (63)	40 (62)	13 (50)	3 (33)	136 (45)
Methylxanthines[a]	18 (36)	1 (1)	13 (32)	5 (8)	0	5 (56)	42 (14)
Antibiotics[a]	40 (80)	59 (53)	18 (44)	46 (71)	21 (81)	5 (56)	189 (62)
Neuromuscular blocking agent[a]	30 (60)	32 (27)	32 (78)	38 (59)	20 (77)	9 (88)	160 (53)
Mechanical support							
Heliox[a]	41 (82)	23 (21)	14 (34)	2 (3)	1 (4)	0	81 (27)
Noninvasive only	3 (6)	0	1 (2)	17 (26)	3 (12)	0	24 (8)
Intubated in emergency department[a]	26 (52)	97 (87)	19 (46)	28 (43)	12 (46)	5 (56)	187 (62)
Intubated in pediatric intensive care unit[a,b]	21 (42)	15 (13)	20 (49)	20 (31)	11 (42)	4 (44)	92 (30)
Laboratory testing, median (interquartile range)[c]							
N, blood gases[a]	6 (3–12)	6 (2–20)	4 (1–7)	6 (3–25)	11 (5–19)	16 (5–48)	6 (2–16)
N, x-rays[a]	9 (2–16)	4 (2–17)	4 (1–6)	12 (4–31)	9 (4–17)	12 (5–45)	6 (2–16)
N, magnesium[a]	6 (3–16)	6 (2–12)	4 (1–5)	12 (2–24)	3 (2–6)		

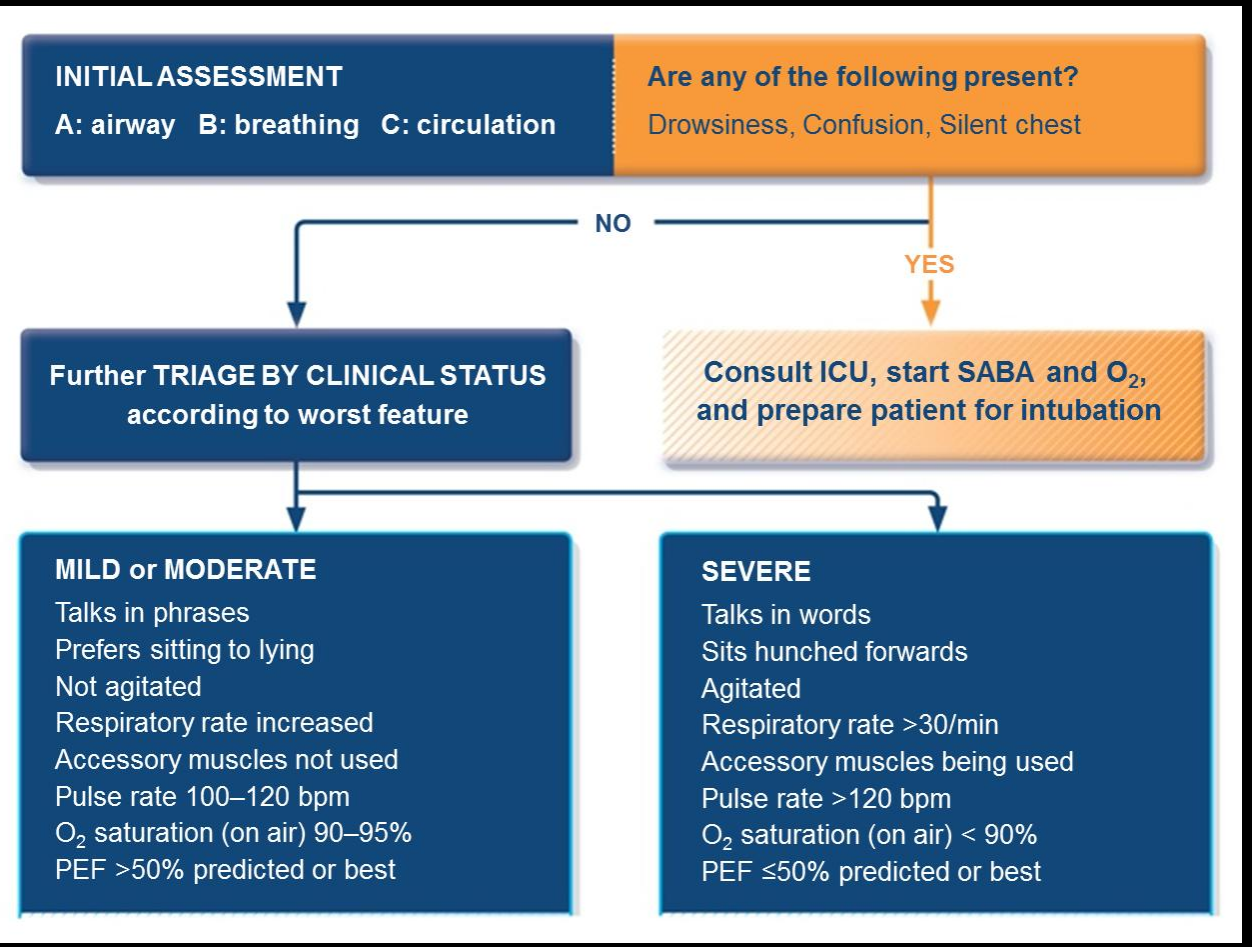
[a]$p < .05$ within groups; [b]includes those with a trial of noninvasive and then intubated in the pediatric intensive care unit; [c]total tests during intensive care stay.

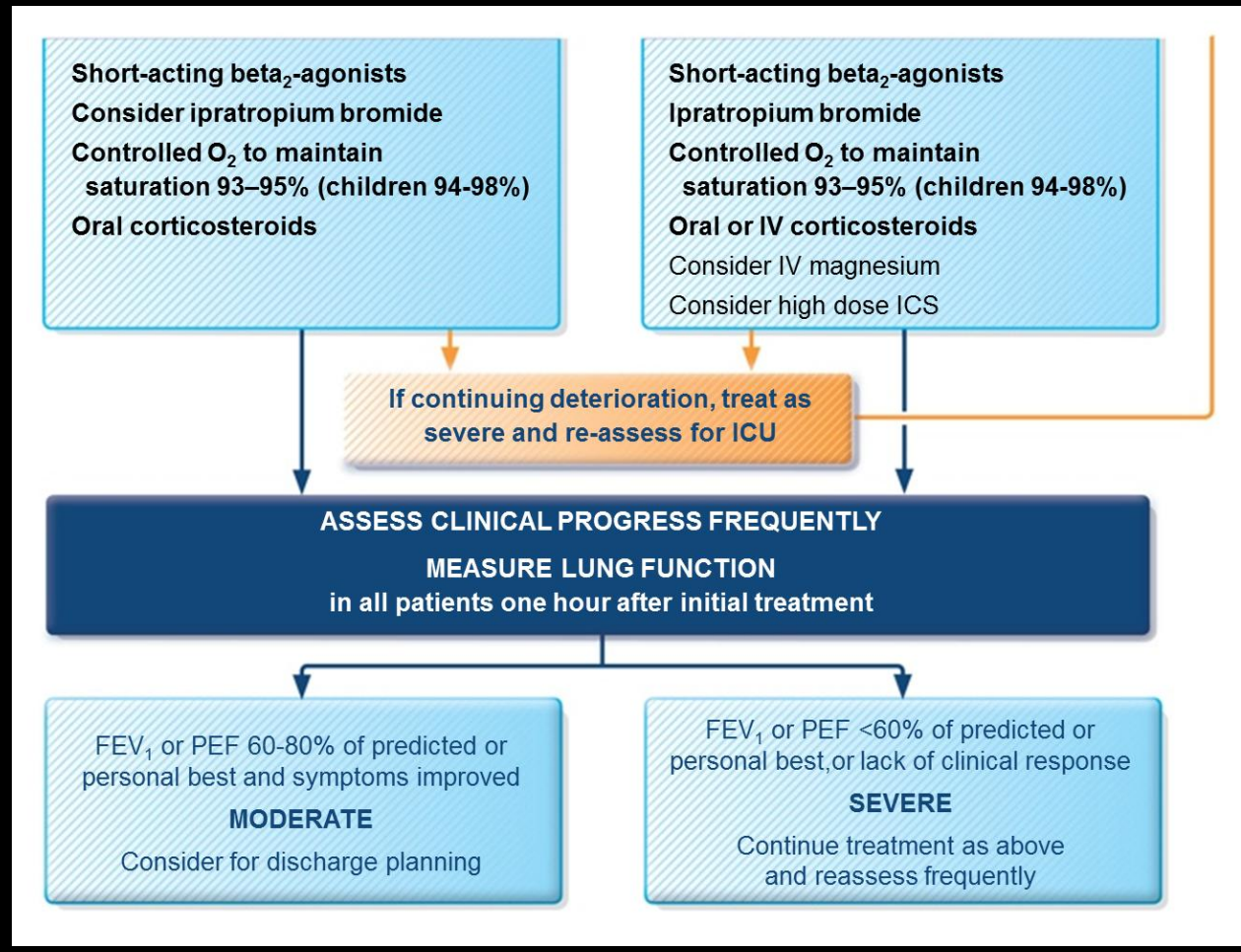
Bratton SL, Newth CJ, Zuppa AF, et al. Critical care for pediatric asthma: wide care variability and challenges for study. Pediatr Crit Care Med. 2012;13(4):407-14.


Alteration in Mental Status
Bradycardia
Inability to Speak
Silent Chest

Asthma Treatments

ASSESSING AND MANAGING EXACERBATIONS IN ACUTE CARE SETTINGS





2016 GINA Report, Global Strategy for Asthma Management and Prevention.

Related Pathway:
Inpatient Asthma Practice Pathway
Primary Care Acute Asthma Pathway

ED Pathway for Evaluation/Treatment of Children with Asthma

Goals and Metrics

Patient/Family Education

Child with Asthma and Respiratory Complaint

Triage (Critical/Acute/Urgent)

Respiratory Arrest Imminent
To resuscitation room

MD/CRNP/RN Brief Rapid Assessment
DETERMINE SEVERITY LEVEL OF ASTHMA EXACERBATION

Mild: ESI Triage 4

Consider Dexamethasone tablet (alternative prednisone/olone)
If needed:
Albuterol MDI -2-4 puffs
MDI spacer teaching
Discharge

Moderate: ESI Triage 3

Dexamethasone tablet (alternative prednisone/olone)
Albuterol MDI q20min x 3, prn RT assess

Severe: ESI Triage1-2

Prednisone/olone/Methylpred
Unineb: Albuterol x3 + ipratropium
Critical: consider SQ terb

ASSESS after completion of β-agonist
Considerations for further diagnostic testing
Oxygen management

None or Mild WOB

Hold Treatment
Reassess after 1 hr

None/Mild

Discharge

Mod-Severe WOB

Place admission order
Repeat albuterol via Unineb
Consider IV Mg

Reassess

Severe
Concern for Resp Failure
→ Continuous albuterol
IV Mg bolus (if not given)
Consider terbutaline SQ/IV bolus (no infusion)
Admit to ICU

Mod / Severe
Needs continuous albuterol
→ Continuous albuterol
Consider IV mg bolus + NS
Admit to inpatient floor
RT assess O2 requirement with blender if sat < 88%
Oxygen management

Moderate
Needs q2h treatment
→ Q2hr albuterol
Admit to floor/EDECU

Albuterol Weight-based Dosing			
Kg	**Unit Dose (0.5%)**	**MDI Puffs**	**Continuous**
5-10	2.5 mg (0.5 mL)	4	7.5 mg/hr
> 10-20	3.75 mg (0.75mL)	6	11.25 mg/hr
> 20	5 mg (1.0 mL)	8	15 mg/hr
Ipratropium Weight-based Dosing			
5-10	500 mcg over 1 hr in unineb or 250 mcg q20 min x 2		
> 10	1000 mcg over 1 hr in unineb or 500 mcg q20 min x 2		
Prednisone/Methylprednisolone			
	2 mg/kg p.o./IV, **MAX 60 mg**		
Dexamethasone: Mild-moderate flare, repeat in 24-48 hours, crush tablet with cherry syrup, juice, or yogurt			
5-8	4 mg		
> 8-12	6 mg		
> 12	8 mg		
Magnesium Sulfate			
	50 mg/kg, **MAX 2 g** Give with Normal saline bolus, 20ml/kg (max 1 liter) q15 min VS, observe in ED 60 min prior to transfer to inpatient floor		
Terbutaline			
	Subcutaneous: 0.01 mg(mL)/kg MAX 0.25 mg (0.25 mL) Bolus 10 mcg/kg (Range 2-10 mcg/kg) MAX 750 mcg Infusion (consider intermittent boluses as alternative) Starting dose 0.4 mcg/kg/min (Range 0.4 mcg/kg-3 mcg/kg/min) Titrate to Max 3 mcg/kg/min		

Learn More

LearningLink Module (for CHOP employees)

The Asthma Program

Journals & Articles

Efficacy and time of action of oral steroids in the ED

Equivalence of MDI and nebulizer for acute asthma

Follow-up Care after an ED visit

Meta-analysis of Dexamethasone for Acute Asthma

Related Links

National Heart Lung and Blood Institute Asthma Guidelines

MMC SEVERE STATUS ASTHMATICUS GUIDELINES

Assess patient. Obtain vital signs, weight, and height upon admission. Consider FEV_1/peak flow if ≥ 5 y old. FEV_1/peak flow may be difficult or impossible to measure due to significant dyspnea and cough. Further, FEV_1/peak flow may not be appropriate in very severe cases of obvious airway compromise or cyanosis.

- Patient is breathless at rest. Dyspnea interferes with conversation (e.g. speaks in words). Patient is using accessory muscles, has suprasternal retractions, may or may not have loud wheezing (throughout inhalation and exhalation), and is tachypneic; and/or,
- FEV_1/peak flow < 40% of predicted or personal best; and/or,
- O2 saturation < 90%.

Administer oxygen to keep saturation ≥ 90%. Administer moderate to high dose nebulized albuterol plus ipratropium q 1 - 3 hours or albuterol continuously. BAN (breath actuating nebulizer) is recommended to increase delivery of nebulized medications in severe exacerbations.

⬇

Corticosteroids (oral – prednisone or equivalent) 1 - 2 mg/kg up to a maximum of 60 mg in children, if not given prior to hospitalization. Consider IV steroids if patient cannot tolerate oral medication. Continue systemic steroids 0.5 - 1 mg/kg q 6 - 12 hours (usual maximum dose 60 mg/day in children < 12 y old, maximum dose 80 mg/day in adults).

⬇

Frequent vital sign monitoring, including pulse, respirations, and continuous pulse oximetry. Once improvement established, monitor FEV_1/peak flow BID if ≥ 5 y old.

⬇

If the patient smokes or is in contact with a smoking environment, consider a urine cotinine level

⬇

Consider chest x-ray, if unequal breath sounds, high fever, or sudden decline in status

⬇ ⬇ ⬇

Good Response

- FEV_1 or PEF ≥ 70%
- Sustained response 60 minutes after treatment
- No dyspnea or oxygen requirement
- Improved physical exam

⬇

- Consider hospitalization
- Refer to "Pediatric Asthma – Inpatient Clinical Practice Guideline; Moderate Exacerbation"

PICU Admission Criteria

- Intubated or pending intubation
- pCO2 greater than 45
- Requiring more than 50% FiO2
- Requiring nebulized therapies more frequently than q 2 hours
- Altered mental status
- Acute pneumothorax
- Use of adjunctive therapies – heliox, terbutaline, magnesium

Incomplete Response

- FEV_1 or PEF 40 - 69%
- Mild to moderate symptoms

⬇

Arrange for hospitalization

- Continue supplemental oxygen
- Continue nebulized albuterol and ipratropium q 1 - 3 hours (while in ED) or albuterol continuously at 0.15 - 0.5 mg/kg/hr (maximum of 10 -15 mg/hr). Ipratropium may be useful q 4 - 6 hours during first 24 hours of hospitalization.
- Continue systemic corticosteroids 0.5 - 1 mg/kg q 6 - 12 hours for 3 - 10 days (usual maximum dose 60 mg/day in children < 12 y old; maximum dose 80 mg/day in adults). Consider tapering for patients requiring > 6 days of systemic corticosteroids.
- Consider other diagnoses
- Continue controller medications
- If not on inhaled corticosteroids, consider initiating treatment prior to discharge

Poor Response

- FEV_1 or PEF < 40%
- pCO2 ≥ 45 mm Hg
- Severe symptoms
- Drowsy, confused

⬇

Admit to PICU - With orders for:

- Supplemental oxygen
- Nebulized albuterol and ipratropium q 1 - 2 hours (while in ED) or continuously at 0.15 - 0.5 mg/kg/hr (maximum of 10 - 15 mg/hr). Ipratropium may be useful q 4 - 6 hours during first 24 hours of hospitalization.
- Systemic corticosteroids 0.5 - 1 mg/kg q 6 - 12 hours
- Consider arterial line for serial ABGs
- Continue controller medications as appropriate
- Consider adjunctive therapies

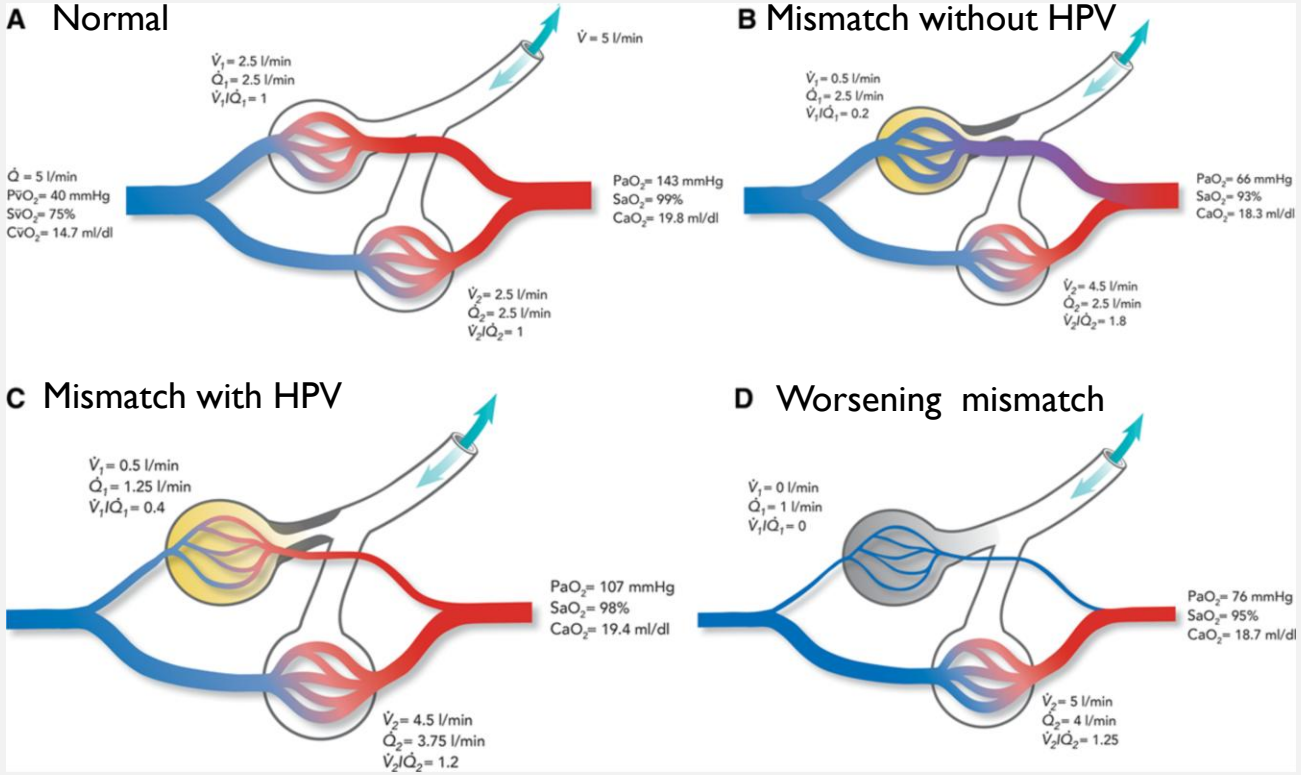
http://everclevermom.com/2016/05/evas-asthma-its-a-big-deal/

PRINCIPAL GOALS AND EXPERT PANEL RECOMMENDATIONS

PRIMARY TREATMENTS

OXYGEN

- **Standard Therapy**
- Results from V/Q mismatch, alveolar hypoventilation, and hypercarbia
- Can produce pulmonary hypertension, worsen bronchoconstriction, and decrease oxygen delivery
- Bronchodilators reduce hypoxic pulmonary vasoconstriction and can worsen the hypoxemia transiently
- Caution with high flow cannulae that can "wash out" the benefit of nebulized beta-agonists



Lumb AB, Slinger P. Hypoxic pulmonary vasoconstriction: physiology and anesthetic implications. Anesthesiology. 2015;122(4):932-46.

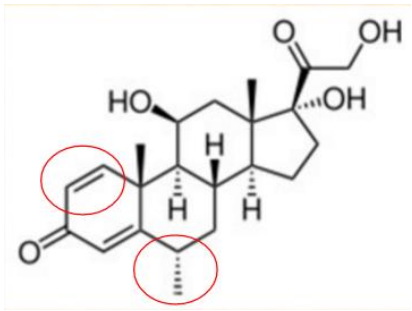
STEROIDS

- 1st line agents
- Reduces the rate of hospital admission
- Improved pulmonary function testing
- Increases the number and sensitivity of Beta-adrenergic receptors
- Potent anti-inflammatory effects

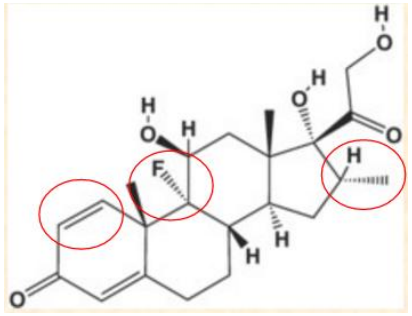
- Start within first hour!

- Typical dose:
  - Methylpred 1-2 mg/kg/day divided BID
  - Prednisolone 1-2 mg/kg/day divided BID
  - Dexamethasone 0.3-1 mg/kg

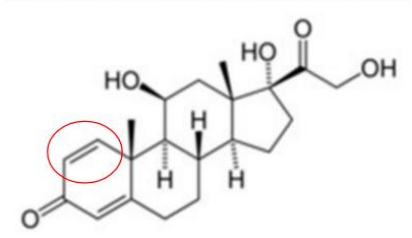
Alangari AA. Corticosteroids in the treatment of acute asthma. Ann Thorac Med. 2014;9(4):187-92.



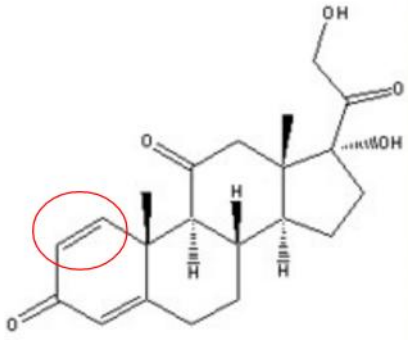
Methylprednisolone



Dexamethasone



Prednisolone



Prednisone

WHAT STEROID?

- Data is too weak to draw any conclusions
- In kids with potential for discharge, either Decadron or prednisolone can be used

- In sick kids, DON'T USE ORAL MEDICATIONS
- Try Solumedrol at 1mg/kg q6h IV

ALBUTEROL

- Reverse bronchoconstriction to open airway and better allow gas exchange

MDI with spacer (6-12 breaths) is equally effective as nebulizer

- Adult studies suggest no difference but lots of confounders
- In kids, MDI associated with shorter ED LOS, maybe less admissions, less systemic effects
  - But NOT performed in critically ill kids

- Typical Dose:
  - 0.15–0.5 mg/kg/hr given usually as the total dose (5mg/hr, 10 mg/hr, 15 mg/hr, 20 mg/hr)
  - Limited by tachycardia

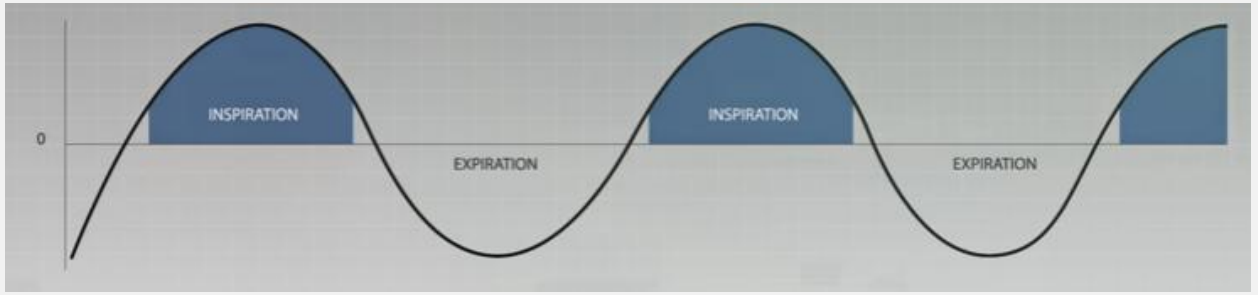
Cates CJ, Welsh EJ, Rowe BH. Holding chambers (spacers) versus nebulisers for beta-agonist treatment of acute asthma. Cochrane Database Syst Rev. 2013;(9):CD000052.
Koninckx M, Buysse C, De hoog M. Management of status asthmaticus in children. Paediatr Respir Rev. 2013;14(2):78-85.

BREATH ACTUATED NEBULIZERS?

The sicker you are, the more improvement you see

AeroEclipse® BAN - this shows the medication getting deep into your lungs.

Conventional Nebulizer - this shows the large particles from a conventional nebulizer ending up in your stomach, not your lungs.



Sabato K, Ward P, Hawk W, Gildengorin V, Asselin JM. Randomized controlled trial of a breath-actuated nebulizer in pediatric asthma patients in the emergency department. Respir Care. 2011;56(6):761-70.

Titus MO, Eady M, King L, Bowman CM. Effectiveness of a breath-actuated nebulizer device on asthma care in the pediatric emergency department. Clin Pediatr (Phila). 2012;51(12):1150-4.

CONTINUOUS OR INTERMITTENT?

- Can use either method

- Cochran Review 2003:
  - Less admissions with continuous
  - Improved peak flows with continuous
  - Asthma score and duration of time RT spent performing therapies lower with continuous

Camargo CA, Spooner CH, Rowe BH. Continuous versus intermittent beta-agonists in the treatment of acute asthma. Cochrane Database Syst Rev. 2003;(4):CD001115.

IPRATROPIUM

Typical dose:
250–500 mcg inhaled every 20 min for up to three doses
May continue every 4-6 hrs

Vézina K, Chauhan BF, Ducharme FM. Inhaled anticholinergics and short-acting beta(2)-agonists versus short-acting beta2-agonists alone for children with acute asthma in hospital. Cochrane Database Syst Rev. 2014;(7):CD010283.
Griffiths B, Ducharme FM. Combined inhaled anticholinergics and short-acting beta2-agonists for initial treatment of acute asthma in children. Cochrane Database Syst Rev. 2013;(8):CD000060.

FLUIDS

- Higher insensible losses with increased work of breathing
- Lots of variation

- Most would benefit from a fluid bolus
  - 20ml/kg normal saline or normosol/plasmalyte

Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma; National Heart, Lung and Blood Institute, National Asthma Education and Prevention Program; 2007 U.S. Department of Health and Human Services

EXHAUSTION OR CHANGE IN MENTAL STATUS?

http://everclevermom.com/2016/05/evas-asthma-its-a-big-deal/

SECONDARY TREATMENTS

Magnesium

Terbutaline

Ketamine

Theophylline

Heliox

BiPAP

MAGNESIUM

- Significant differences between adults and children
- Improved pulmonary function, reduced admission rates with IV magnesium
- Minimal improvements with nebulized magnesium except in sickest patients

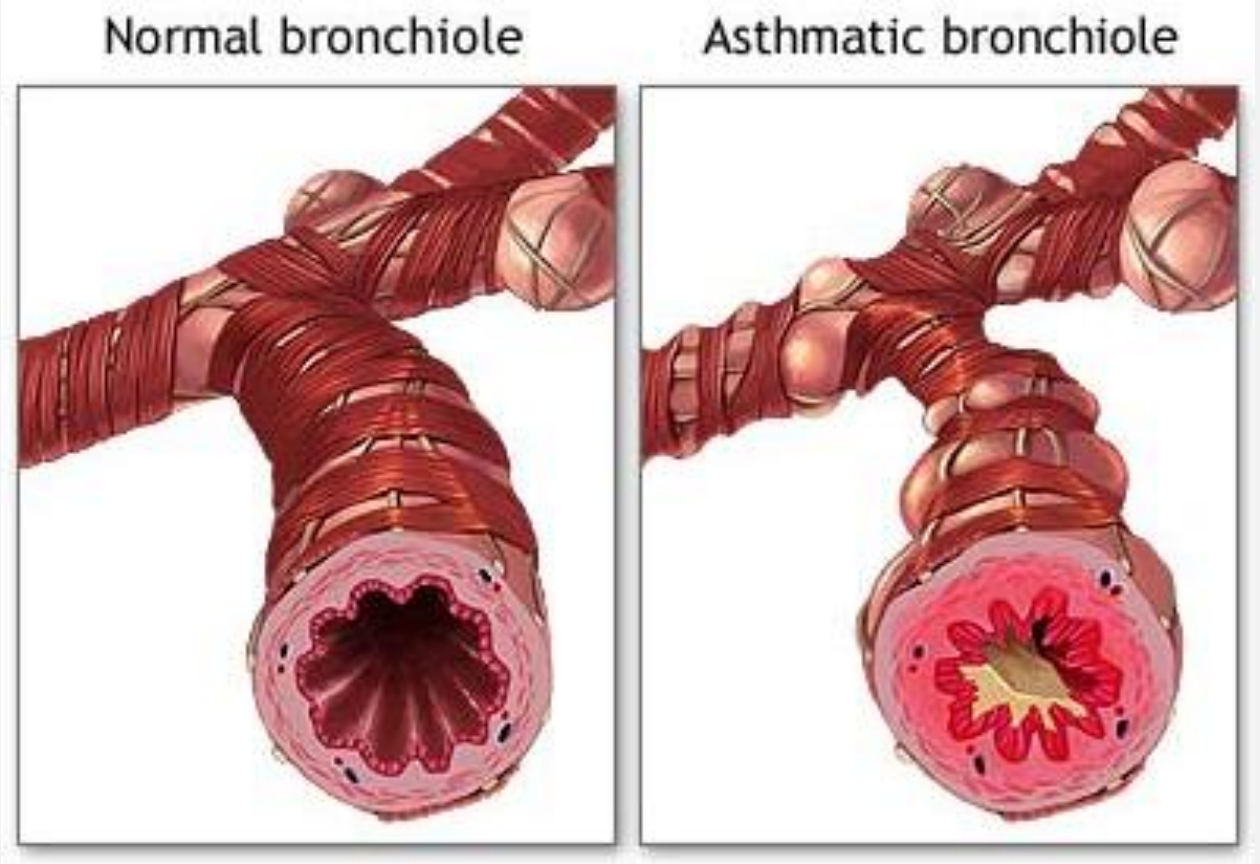
- Typical dose:
  - 25-50 mg/kg over 20 min up to 2g

Shan Z, Rong Y, Yang W, et al. Intravenous and nebulized magnesium sulfate for treating acute asthma in adults and children: a systematic review and meta-analysis. Respir Med. 2013;107(3):321-30.
Powell C, Kolamunnage-dona R, Lowe J, et al. Magnesium sulphate in acute severe asthma in children (MAGNETIC): a randomised, placebo-controlled trial. Lancet Respir Med. 2013;1(4):301-8.

TERBUTALINE

- IV/SQ beta agonist

- 2012 Cochrane Review
  - Limited evidence but possibly beneficial
  - Improvements in severity scores, duration of continuous nebs, and ICU stay but not statistically significant



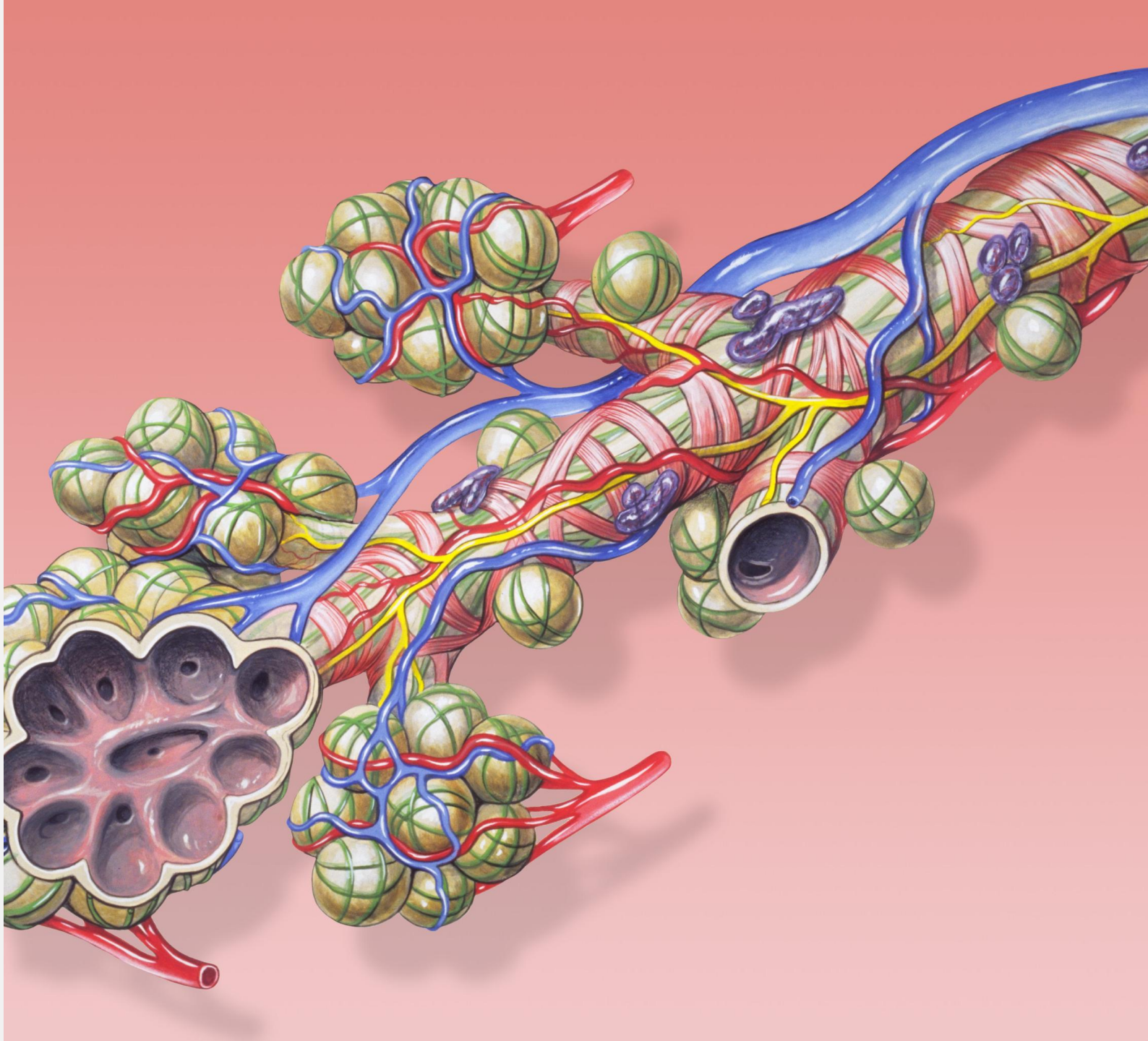
Travers AH, Milan SJ, Jones AP, Camargo CA, Rowe BH. Addition of intravenous beta(2)-agonists to inhaled beta(2)-agonists for acute asthma. Cochrane Database Syst Rev. 2012;12:CD010179.

TERBUTALINE

- Use when air movement is drastically decreased

- Limited by tachycardia
- Can cause troponin leak

- Typical dose:
  - SQ 0.01 mg/kg/dose (max of 0.3 mg)
  - IV Loading 10 mcg/kg IV over 10 min, followed by continuous infusion at 0.1–10 mcg/kg/min

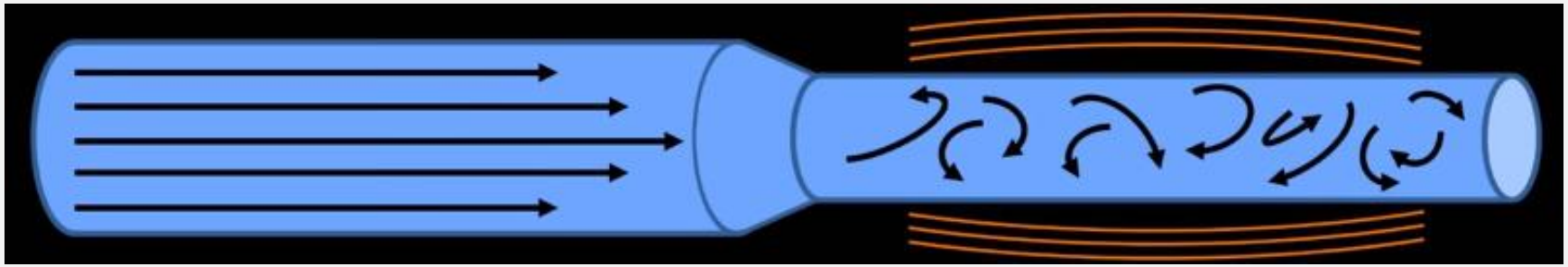


THEOPHYLLINE

- Evidence does not support the routine use
- Lots of side effects

HELIOX

- Improve laminar flow
- Greater percentage of lung particle deposition potentially resulted in improved scores
- Limited by degree of hypoxemia



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Kim IK, Phrampus E, Venkataraman S, Pitetti R, Saville A, Corcoran T, Gracely E, Funt N, Thompson A. Helium/oxygen-driven albuterol nebulization in the treatment of children with moderate to severe asthma exacerbations: a randomized, controlled trial. Pediatrics 2005;116(5):1127–33.

- Dose dependent preservation of airway tone/reflexes
- Bronchodilatory effects

- 2012 Cochrane Review
  - No significant difference in oxygen saturation, respiratory rate, hospital admission rate, and the need for endotracheal intubation

- Case reports show improvement in oxygenation, respiratory rate and decreased admissions

- Typical dose:
  - 1-2 mg/kg IV bolus
  - If using an infusion, consider 0.5mg/kg/hr – 2mg/kg/hr

Jat KR, Chawla D. Ketamine for management of acute exacerbations of asthma in children. Cochrane Database Syst Rev. 2012;11:CD009293.
Hendaus MA, Jomha FA, Alhammadi AH. Is ketamine a lifesaving agent in childhood acute severe asthma?. Ther Clin Risk Manag. 2016;12:273-9.
Goyal S, Agrawal A. Ketamine in status asthmaticus: A review. Indian J Crit Care Med. 2013;17(3):154-61.

CAN WE AVOID THIS…

http://everclevermom.com/2016/05/evas-asthma-its-a-big-deal/

http://savanassalvation.angelfire.com/savanas_first_days_at_st_francis_childrens_hospital/Picture_048.jpg

MECHANICAL VENTILATION

- Can aid in oxygenation
- Improves delivery of aerosolized medications
- Significantly reduces rate of intubation
- Some thought that earlier is better

BIPAP

- How:
  - Facilitates "stenting" open the airway to enable better ventilation and oxygenation
  - Improves V/Q mismatch
  - Decreases work needed by patient
- Who:
  - Extreme tachypnea
  - Impressive use of accessory muscles
  - Profound hypoxemia
- Initial Settings:
  - IPAP: 10-16 (based on age and severity of presentation)
  - EPAP: 5-10
  - Rate: low (aim for I:E ratio of 1:3 or greater)

Basnet S, Mander G, Andoh J, Klaska H, Verhulst S, Koirala J. Safety, efficacy, and tolerability of early initiation of noninvasive positive pressure ventilation in pediatric patients admitted with status asthmaticus: a pilot study. Pediatr Crit Care Med. 2012;13(4):393-8.
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Intubation of an asthmatic should be a last ditch effort or the therapy of last resort

The decision to tracheally intubate should be based upon the clinical examination and not the results of an arterial blood gas

Alteration in Mental Status
Bradycardia
Silent Chest

Children who present to a community hospital ED (as opposed to a pediatric ED) are more likely to be tracheally intubated

INTUBATION

- Who:
  - The MOST experienced and skilled physician available
- How:
  - Induction with Ketamine (2mg/kg IV)
  - Neuromuscular blockade with sux (1.5mg/kg IV) or rocuronium (1mg/kg IV)
  - Consider fluid bolus
  - Slow, breaths allowing for complete exhalation

Wheeler DS, Wong HR, Shanley TP. Pediatric Critical Care Medicine, Volume 2: Respiratory, Cardiovascular and Central Nervous Systems. Springer; 2014.

VENTILATOR MANAGEMENT

- Low Tidal Volume (6cc/kg)
- Short iTime
- Low respiratory rate
- Mode could be PRVC or volume mode if watching PIP's
- Use of PEEP is controversial
- Use of muscle relaxant is controversial

Wheeler DS, Wong HR, Shanley TP. Pediatric Critical Care Medicine, Volume 2: Respiratory, Cardiovascular and Central Nervous Systems. Springer; 2014.

ECMO

Step	Therapy	Dosing/Comments
1	Oxygen	Maintain SaO2 > 92%
2	Steroids	Methylprednisolone 1mg/kg IV
3	Continuous Albuterol	0.15-0.5mg/kg/hr If <10kg: 7.5mg/hr; 10-20kg: 10-15mg/hr; >20kg: 15mg/hr
4	Ipratropium	If <20kg: 250mcg; If >20kg: 500 mcg inhaled every 20 min for up to three doses
5	IV Magnesium	25-50mg/kg up to 2g over 20 min
6	IV/SQ Terbutaline	SQ 0.01 mg/kg/dose (max of 0.3 mg) up to every 20 min IV Loading 10-20 mcg/kg IV over 10 min, followed by continuous infusion at 0.1–10 mcg/kg/min
7	IM Epinephrine	0.01 mL/kg of 1:1,000 concentration up to every 20 min
8	Non-Invasive Ventilation	BiPAP IPAP 10-16 EPAP 5-10 Rate: Spontaneous
9	IV Ketamine	1-2mg/kg IV 0.5mg/kg/hr – 2mg/kg/hr
10	Intubation	Ketamine 2mg/kg IV, rocuronium 1mg/kg

Wheeler DS, Wong HR, Shanley TP. Pediatric Critical Care Medicine, Volume 2: Respiratory, Cardiovascular and Central Nervous Systems. Springer; 2014.

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