


Pediatric Respiratory Distress: Albuterol and Beyond


Theresa A. Walls, MD, MPH
September 4, 2020



1

Disclosures


- \$\$\$
 - No financial disclosures
- Perspective
 - From the “other side”



2

Objective 1


- Outline the steps and medications you would use to care for a child with a severe asthma attack



3

Objective 2

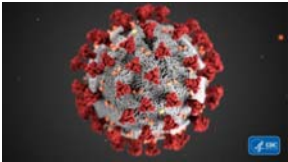
- Summarize evidence for prehospital evaluation and treatment of children with asthma



4

Objective 3


- Explain how the current pandemic changes your treatment of children with respiratory distress



5

[Objective 4]


- Take home at least one idea for improving the emergency care of children in your agency/region



6

Asthma Prevalence in Children


- Nationwide**
 - Over 6 million children diagnosed with asthma
 - 8.3% of children
- Pennsylvania**
 - 291,000 children with asthma
 - 11.2% of children



7

Pediatric Asthma & EMS – National


- Approximately 10% of calls are for patients <18 years old
- 3rd most common chief complaint
- 9% - 14% of pediatric calls are for respiratory distress



8

Pediatric Asthma & EMS – Statewide 2019


- ~100,000 runs for patients <18 yo
 - 911 + interfacility
 - Children = 5% of all calls
- 10,000 calls for "breathing problem"
 - Most common chief complaint
 - 10% of pediatric calls



9

Pediatric Asthma & EMS – Local


- Pittsburgh/SE**
 - Wheeze = 6% of pediatric runs (2014-2017)
- Philadelphia County/PFD**
 - 13,000 pediatric calls in 2019
 - Est ~1,300/yr for asthma



10

Pediatric Asthma : ED Perspective


- Nationwide (yearly)**
 - 1 in 6 children with asthma visit the ED at least once
 - >775,000 visits for asthma
 - 1 in 20 children with asthma are hospitalized
- CHOP (FY 2018)**
 - 7,200 ED visits
 - 2,300 hospital admissions
 - >900 transports from outside hospitals (interfacility)
 - #1 chief complaint



11

Case (MJ)

- 6yo female with history of asthma
- Woke in am with cough & difficulty breathing
- Dad gave albuterol inhaler several times with no improvement
- 911 call placed at 4pm




12

Case (MJ)

- On EMS arrival



HR 120 RR48 Pox 83%
Increased work of breathing
NO aeration on lung exam



13

Pediatric Assessment Triangle


- Respiratory Distress

14

Guidelines for Treatment

- Goals: correct hypoxia & reverse airway obstruction
- Recommendations:
 - Assessment of severity
 - For moderate-severe
 - Short-acting beta agonist (albuterol) every 20 minutes x 3
 - Repeat as needed
 - Ipratropium bromide (Atrovent) with initial beta agonist
 - Steroids (oral or IV)
 - Reassessment




15

Pediatric Asthma – EMS Protocols

- BLS
 - Oxygen
 - Monitor pulseox
 - Assist with inhaler
 - Albuterol nebulizer (if trained)
- ALS
 - Oxygen
 - Monitor pulseox
 - Medication options
 - Albuterol nebulizer
 - IV steroids
 - Methylprednisone
 - Epinephrine*

*with medical command



16

ASTHMA/ COPD/ BRONCHOSPASM STATEWIDE ALS PROTOCOL

Initial Patient Contact - (See protocol A001)

Manage Airway, Ventilate, & Resuscitate *
* Albuterol, Oxygen, Atrovent, Pulse Oximetry

Severe Respiratory Distress?

NO: Nebulized bronchodilator (see Box 1 below) → Improved to patient's normal state → Consider Medical Command if needed

YES: Patient → Albuterol → Nebulized bronchodilator (see Box 1) → May repeat continuously if needed → Signs of respiratory failure → Consider CPAP/BiPAP → Intubate if GCS ≤ 8 or if no response to treatment → Intubate if GCS ≤ 8 or if no response to treatment → Intubate if GCS ≤ 8 or if no response to treatment

3. Indications of severe respiratory distress include:

- apprehension, anxiety, combativeness
- hypoxia, SpO₂ < 90%
- intercostal/subcostal retractions
- nasal flaring
- cyanosis
- use of accessory muscles

BRONCHODILATOR OPTIONS

Albuterol (approx. 2.5 mg) nebulized
OR
Albuterol (approx. 3 mg) bronchospasmodic (200mcg) combination released

EPINEPHRINE


EPINEPHRINE (1 mg/mL) 0.1 mg/kg (10 mg) (max. 0.5 mg) Consider CPAP or intubation

EPINEPHRINE (0.1 mg/mL) 0.1 mg/kg (10 mg) (max. 0.5 mg) Consider intubation

17

Pediatric Asthma -- Initial Treatment


- Bronchoconstriction
 - Beta agonists
- Airway inflammation
 - Steroids



18

Steroids for Pediatric Asthma

- Early administration in ED improves outcomes
 - Children who received steroids in triage 1.8 times LESS likely to need admission
 - Children who received steroids within 75 minutes of arrival 2.5 times LESS likely to need admission
 - Standard quality measure = receive steroids within 60 minutes
- Prehospital administration?




19

Original Article

THE PREHOSPITAL ADMINISTRATION OF INTRAVENOUS METHYLPREDNISOLONE LOWERS HOSPITAL ADMISSION RATES FOR MODERATE TO SEVERE ASTHMA

Barry Knapp & Chris Wood
Pages 423-426 | Published online: 28 Aug 2009




- ADULT patients with asthma given iv methylprednisolone in prehospital setting vs. in the ED
- Risk of admission 3x LESS for patients who got steroids in prehospital setting

20

Implementation of a Prehospital Protocol Change For Asthmatic Children

Anriada Nassif, MD, Daniel G. Ostermayer, MD, Kim B. Hoang, MD, Mary K. Claiborne, MD, Elizabeth A. Camp, PhD & Manish I. Shah, MD MS
Pages 457-465 | Received 22 Aug 2017, Accepted 20 Nov 2017, Published online: 19 Jan 2018



- Protocol for acute asthma exacerbation in children with moderate-severe symptoms
- Protocol change → steroids (oral or IV) for ALL children with an acute asthma exacerbation

21



Prehospital Oral Steroids – Houston EMS

	Pre-change	Post-change
Steroids	11%	18%
Hospital time	6.1 hours	4.5 hours
Admitted	30%	21%

22

Steroids

- Dexamethasone vs. Prednisone
 - NO difference in time to return to baseline or return visit rate
 - LESS likely to vomit in ED or at home
 - INCREASE in compliance with steroid regimen

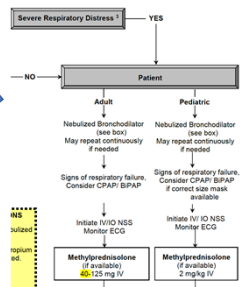



Dexamethasone Dosing	
Wt (kg)	Dose (mg)
5-8	4
8-12	6
>12	8

23

Case (MJ)

- On EMS arrival
HR 120 RR48 Pox 83%
Increased work of breathing
NO aeration on lung exam




24

Prehospital Asthma Treatment – PA EMS

- Doses in 2019 for pts <18
 - Albuterol 3,200
 - Duoneb 267
 - Methylprednisolone 274

(N=10,000 with breathing complaint)



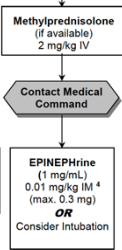
25

Case (MJ)

- On EMS arrival
 - HR 120 RR48 Pox 83%
 - Increased work of breathing
 - NO aeration on lung exam

↓ Duoneb x 2
iv methylpred started


Minimal improvement in aeration



26

SQ/IM Epinephrine - Evidence


- Beta agonist (like albuterol)
- Rapidly relaxes bronchial smooth muscle
[= SQ/IM terbutaline]
- NO evidence for benefit over inhaled beta agonists in severe asthma
- Theoretical benefit: quickly open airways to better receive inhaled therapies



27

Case (MJ) – Progression

- T37 HR125 RR58 Pox 93% (NRB) BP 105/65
- “decreased aeration bilaterally with intercostal and suprasternal retractions, no wheezing”




28

Case (MJ) – What Now?*

- Treatment Options
 - Magnesium
 - Terbutaline
 - Ketamine
 - Heliox
 - BiPAP

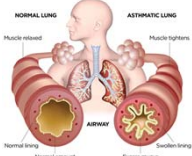
*CALL MEDICAL COMMAND



29

Magnesium IV

- Calcium antagonist: inhibits bronchial smooth muscle contraction & promotes bronchodilation
- “patients who have life-threatening exacerbations and in those exacerbations remain in the severe category after 1 hour of intensive conventional therapy”
- Dose = 25-75 mg/kg over 20 minutes (max 2gm)



30

Magnesium IV – Evidence

- Improved pulmonary function & asthma scores
- Decreased odds of hospitalization by 2-3x
- Theoretical risk of hypotension
 - Not consistent in literature
 - 20cc/kg ivf bolus recommended

Above results for children who ***fail to respond to initial therapies***
NO benefit to inhaled (nebulized) Magnesium


31

Case (MJ) – Progression

- RR58 Pox 93% on NRB
- Suprasternal & intercostal retractions
- Decreased aeration

↓ NS bolus
iv Magnesium
Call to Medical Command

- RR60 Pox 93% on NRB
- Suprasternal & intercostal retractions
- I/E wheezing throughout, poor aeration



32

Terbutaline

- IV beta agonist
- Dose = 10 mcg/kg over 10 minutes (max 750 mcg)
 - Can follow as a drip
- **VERY Limited** Evidence
 - 1 trial in children showed decrease in need for intubation
 - Meta-analysis (few trials included children) showed no benefit
 - Concern for side effects: dysrhythmias, tachycardia, myocardial ischemia
 - **NOT** part of NHLBI Guidelines

33

Ketamine

- Dissociative agent with bronchodilating properties
- Agent of choice for patients with asthma in respiratory failure who require intubation*
- Dose = 1-3 mg/kg for procedural sedation
 - Dose = **unknown** for severe asthma
- Evidence thus far limited to 1 RCT (no benefit) & few case studies
- **NOT** part of NHLBI guidelines

* PLEASE don't intubate


34

Case (MJ) – Progression

- RR60 Pox 94% on NRB BP100/65
- Suprasternal & intercostal retractions
- I/E wheezing throughout, poor aeration

↓ iv Terbutaline
Continuous albuterol
Maintenance ivf
Update medical command

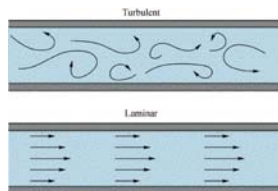
- No change in lung sounds or aeration



35

Heliox

- Mixture of helium & oxygen given via mask
 - Ratio of 70:30 or 60:40
- Helium
 - Inert gas 7x less dense than air
- Benefit via
 - Decreased turbulent flow in constricted airways
 - Improved delivery of beta agonist to distal airways



36

Heliox – Evidence

- Significant improvement in severity scores in children treated with continuous albuterol via heliox compared to standard O₂
- Children treated with heliox were 4 times **LESS** likely to need admission

• CAVEATS

- Maximum FiO₂ = 40%
- NOT available on most interfacility transports



37

CPAP/BiPAP

- Continuous or BiLevel Positive Airway Pressure
- Pressure helps open airways, relieves work of breathing
- Can deliver FiO₂ and nebulized medications thru circuit
- Low settings
 - CPAP 5
 - BiPAP 8/5 to 10/5



38

CPAP/BiPAP – Indications

• Indications

- Hypoxic/hypoxemic despite max O₂ delivery
- Hypercarbia
- Respiratory fatigue

• Caveats

- Requires patient cooperation
- Requires spontaneous respiration
- Can cause gastric distention → risk of aspiration
- NOT a definitive airway



39

CPAP/BiPAP – Evidence **LIMITED**

• **NO** studies of CPAP

• BiPAP

- Few studies in PICU show improved asthma scores in patients on BiPAP but variable results in individual parameters (RR, Pox, oxygen requirement)
- One small ED study showed decrease in need for PICU admission in patients on BiPAP
- Several case series with variable quality & results

40

Case (MJ) – Progression

- Placed on BiPAP 10/5
- Continuous albuterol
- RR48 Pox 98%
- Retractions improved
- I/E wheezing, fair aeration



41

Case (MJ) – Follow Up

- Transferred to tertiary care center
- Spent 3 days in PICU on BiPAP & continuous albuterol
- Transferred to inpatient floor on day 4, nebs weaned
- Hospital discharge on day 6



42

Ketamine


- Dissociative agent with bronchodilating properties
- Agent of choice for patients with asthma in respiratory failure who require intubation*
- Dose = 1-3 mg/kg for procedural sedation
 - Dose = **unknown** for severe asthma
- Evidence thus far limited to 1 RCT (no benefit) & few case studies
- **NOT** part of NHLBI guidelines

* PLEASE don't intubate

43

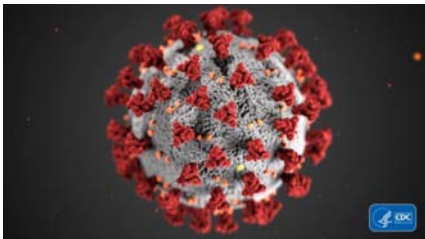
Asthma & Intubation

- Can actually worsen airflow obstruction
 - Hyperreactive airways
- Barotrauma
 - Increased pressure/air trapping
- Hypotension
 - Impaired venous return
- Complications in 10-26%
 - >50% occur during/just after intubation



44

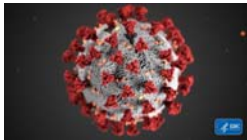
COVID - 19



45

COVID-19 and Children

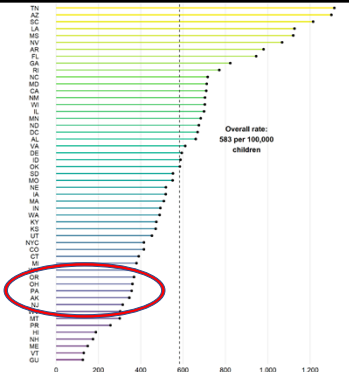
- Fever
- Cough
- Rhinorrhea
- Nasal congestion
- Asymptomatic (20%)



46

Fig 4. Cumulative COVID-19 Cases per 100,000 Children: 8/20/20

- Calculated using state-level population estimates from US Census Bureau (2019)*
- Overall rate: 583 child COVID-19 cases per 100,000 children in the population
- Twenty states and DC reported more than 600 cases per 100,000 children



See detail in Appendix. Data from 48 states, NYC, DC, PR, and GU/VI excluded from figure. All data reported by individual health departments and subject to change. Analyzed by American Academy of Pediatrics and Children's Hospital Association. *Source: US Census Bureau. Data Provided by: Childstats.gov (2019-2018). https://nces.ed.gov/ipeds/data/ipedsdataviz/states/2019-2018/

47

Asthma & COVID-19

Asthma/COPD/Bronchospasm Protocol (4022), the one following may be substituted when albuterol nebulizer is indicated in the protocol prior to contact with medical command, and dose may be repeated in 20 minutes, if needed:

- 1) Albuterol MDI with spacer—5 puffs as described in ILI protocol #931.
- 2) EPINEPHrine (1 mg/mL) 0.3 mg IM for adults
- 3) EPINEPHrine (1 mg/mL) 0.01 mg/kg IM (max 0.3 mg) for pediatrics
- 4) Terbutaline 0.25 mg IM for adults
- 5) Terbutaline 0.01 mg/kg IM (max 0.25 mg) for pediatrics ≥8 y/o. Contraindicated if h/o dysrhythmia, WPW, SVT, epilepsy, or seizure disorder.


b. Avoid Steroids in patients with possible COVID-19 infection: Asthma/COPD/ Bronchospasm protocol #4022 should not administer steroids to these patients unless ordered by medical command physician.

48

Albuterol MDI

- MDI vs. nebulizer
 - NO difference in admission rate
 - Shorter ED length of stay
 - Lower HR

Albuterol Dosing		
Wt (kg)	Nebulizer (mg)	MDI (puffs)
<10	2.5	4
10-20	3.75	6
>20	5	8



49

Asthma & COVID-19

Asthma/COPD/Bronchospasm Protocol (4022), the one following may be substituted when albuterol nebulizer is indicated in the protocol prior to contact with medical command, and dose may be repeated in 20 minutes, if needed:

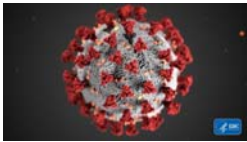
- Albuterol MDI with spacer - 5 puffs as described in ILI protocol #931.
- EPINEPHRINE (1 mg/mL) 0.3 mg IM for adults
- EPINEPHRINE (1 mg/mL) 0.01 mg/kg IM (max 0.3 mg) for pediatrics
- Terbutaline 0.25 mg IM for adults
- Terbutaline 0.01 mg/kg IM (max 0.25 mg) for pediatrics ≥8 y/o. Contraindicated if h/o dysrhythmia, WPW, SVT, epilepsy, or seizure disorder.

o. Avoid Steroids in patients with possible COVID-19 infection: Asthma/COPD/Bronchospasm protocol #4022 should not administer steroids to these patients unless ordered by medical command physician.

50

COVID-19 and Children with Asthma


- Think MDI
- Use epi/terb/Mg early
- Call medical command



51

MIS-C


- Shock
- Cardiac dysfunction
- GI symptoms
- Inflammation
- Link to COVID-19 (2-4 weeks)



52

Objective 1


- Outline the steps and medications you would use to care for a child with a severe asthma attack



53

Objective 2

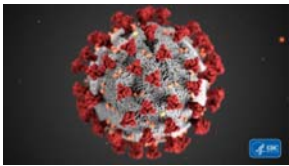
- Summarize evidence for prehospital evaluation and treatment of children with asthma



54

Objective 3


- Explain how the current pandemic changes your treatment of children with respiratory distress



55

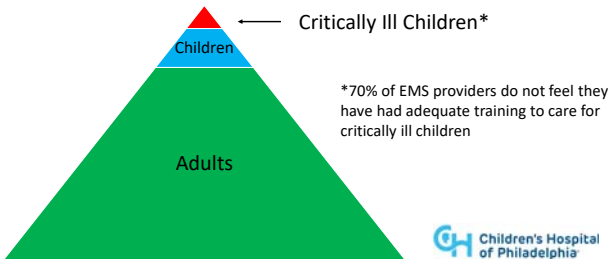
[Objective 4]

- Take home at least one idea for improving the emergency care of children in your agency/region




56

EMS and Children



Critically Ill Children*


*70% of EMS providers do not feel they have had adequate training to care for critically ill children



57

Pediatric Readiness?

Pediatric readiness encompasses the presence of equipment and medications, usage of guidelines and policies, availability of education and training, incorporation of performance improvement practices, and integration of EMS physician medical oversight to equip EMS systems to deliver optimal care to children.⁶⁻⁸ It has been shown that



58

PEDIATRICS/POLICY STATEMENT

Pediatric Readiness in Emergency Medical Services Systems

Brian Moore, MD¹; Manish I. Shah, MD, MS; Sylvia Owusu-Ansah, MD, MPH; Toni Gross, MD, MPH; Kathleen Brown, MD; Marianne Gausche-Hill, MD; Katherine Remick, MD; Kathleen Adelgis, MD; John Lyng, MD, NRP (paramedic); Lara Rappaport, MD; Sally Snow, RN, BSN; Cynthia Wright-Johnson, MSN, RNC; Julie C. Leonard, MD


AMERICAN ACADEMY OF PEDIATRICS
Committee on Pediatric Emergency Medicine and Section on Emergency Medicine EMS Subcommittee

AMERICAN COLLEGE OF EMERGENCY PHYSICIANS
Emergency Medical Services Committee

EMERGENCY NURSES ASSOCIATION
Pediatric Committee

NATIONAL ASSOCIATION OF EMERGENCY MEDICAL SERVICES PHYSICIANS
Standards and Clinical Practice Committee




NATIONAL ASSOCIATION OF EMERGENCY MEDICAL TECHNICIANS
Emergency Pediatric Care Committee



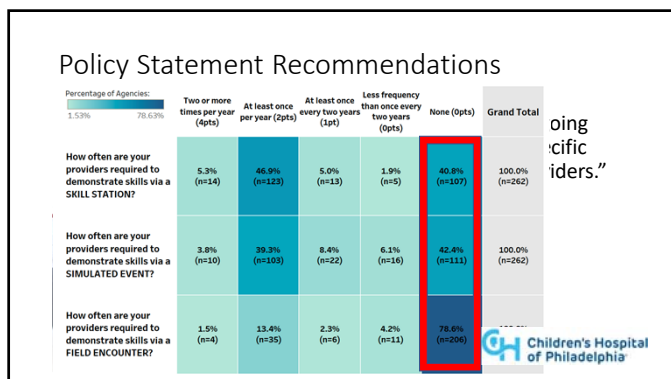
59

Policy Statement Recommendations

“Collaborate with professionals in pediatric emergency care, public health experts, and family advocates for the development and improvement of EMS operations, treatment guidelines, and performance improvement initiatives.”

60



61

Policy Statement Recommendations

“Include provisions for caring for children and families in emergency preparedness planning and exercises, including the care and tracking of unaccompanied children and timely family reunification in the event of disasters.”

Children's Hospital of Philadelphia

62

Policy Statement Recommendations

“Consider using resources compiled by the Emergency Medical Services for Children program when implementing the recommendations noted here.”

Children's Hospital of Philadelphia

63

Emergency Medical Services for Children

- Federal program started in 1984
- Goal: ensure optimal emergency care of children all along continuum of care
- Provide resources for education, research, and program implementation

Children's Hospital of Philadelphia

64

<https://emscimprovement.center>

New: A five-part miniseries on prehospital management of pediatric seizures. [Start Learning Now!](#)

EMSC Innovation and Improvement Center

65

EMSC IIC | Innovation & Improvement Center

Home / Focus Areas / PreHospital Based Care

Home / Education & Resources / Toolkits / Prehospital Education Toolkit

PreHospital Based Care

- Performance measures
 - % of agencies reporting to NEMESIS
 - % of agencies with PECC
- Courses (PEPP, TRIPP, PHTLS)
- Sample policies & procedures
 - Family-centered care
 - Disaster management
 - Child abuse

Children's Hospital of Philadelphia

66

Pediatric Emergency Care Coordinator (PECC)

- Individual who is responsible for coordinating pediatric-specific activities
- Recommended by IOM in 2006
- Evidence for PECC
 - Better compliance with policies/guidelines
 - Improvements in clinical care
 - Increased staff awareness of pediatric considerations



67



papecc.org

- Are you a Pennsylvania EMS Agency?
- Do you respond to 911 emergency calls as a licensed QRS, BLS or ALS agency?
- Do you have the potential to care for pediatric patients as part of your 911 response?

If you answered yes to these questions, then you need to know more about PA PECC and how it can help you be better prepared to respond and care for pediatric patients.

68

Case (MJ)

- 6yo female with history of asthma
- Woke in am with cough & difficulty breathing
- Dad gave albuterol inhaler several times with no improvement
- 911 call placed at 4pm



69

THANK YOU!

- Resources from talk listed in Adobe
- wallst1@email.chop.edu



70