WHAT NEXT?

When asthma treatment fails in the emergency department

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SCHOOL OF MEDICINE

PECARN
Pediatric Emergency Care
Applied Research Network

Intermountain
Primary Children's Hospital
The Child First and Always®

Objectives

By the end of this presentation the participant should be able to:

- Have a mental model to distinguish between bronchiolitis and asthma
- Differentiate standard from “rescue” asthma therapies for children
- Recall interventions for bronchiolitis and their evidence base

2 year old boy

- 3 days of cough, '*wheeze*'
- he's been '*breathing hard*'
- parents giving albuterol
  - 2.5 mg neb every 4 hours
- improvement for 2 hrs each time

On arrival

- RR 50/min
- quiet, shy, smiles, tired
- suprasternal and intercostal retractions
- breath sounds decreased but no wheezes
- Sp02 88% on room air

The Acute Care Model: A New Framework for Quality Care in Emergency Medicine

Srikant Iyer, MD, MPH*†‡,
Scott Reeves, MD*‡,
Kartik Varadarajan, MPH†,
Evaline Alessandrini, MD, MSCE*†‡

How sick?

SEGMENTATION

Is it bronchiolitis or asthma?

THERAPEUTIC RELIABILITY

Am I sure?

DIAGNOSTIC ACCURACY

Will he go home?

DISPOSITION

SEGMENTATION

CONSENSUS

How sick?

How likely to be hospitalized?

What about possible response to treatment?

THERAPEUTIC RELIABILITY

Is it bronchiolitis or asthma?

Consider all patients **0-36 months old** who present with **difficulty breathing**, **cough**, or **hypoxia**.

Ask parents: is this child 12-36 months with either
1) **diagnosed asthma** or
2) **prior episodes of wheezing needing albuterol**

If Yes to ANY → **Consider treating as asthma instead**

Consider all patients **24 months or older** who describe their main problem as **difficulty breathing**, **cough**, or **asthma**

Ask parents: does this child have a history of either
1) **diagnosed asthma** or
2) **prior episodes of wheezing needing albuterol**

DIAGNOSTIC ACCURACY

Am I sure?

don't treat
+
miss asthma

treat a lot
+
bronchiolitis
all along

2.5 mg
albuterol

5 mg
albuterol

albuterol
+ steroid

Response: resolved prolongation, more/less wheeze

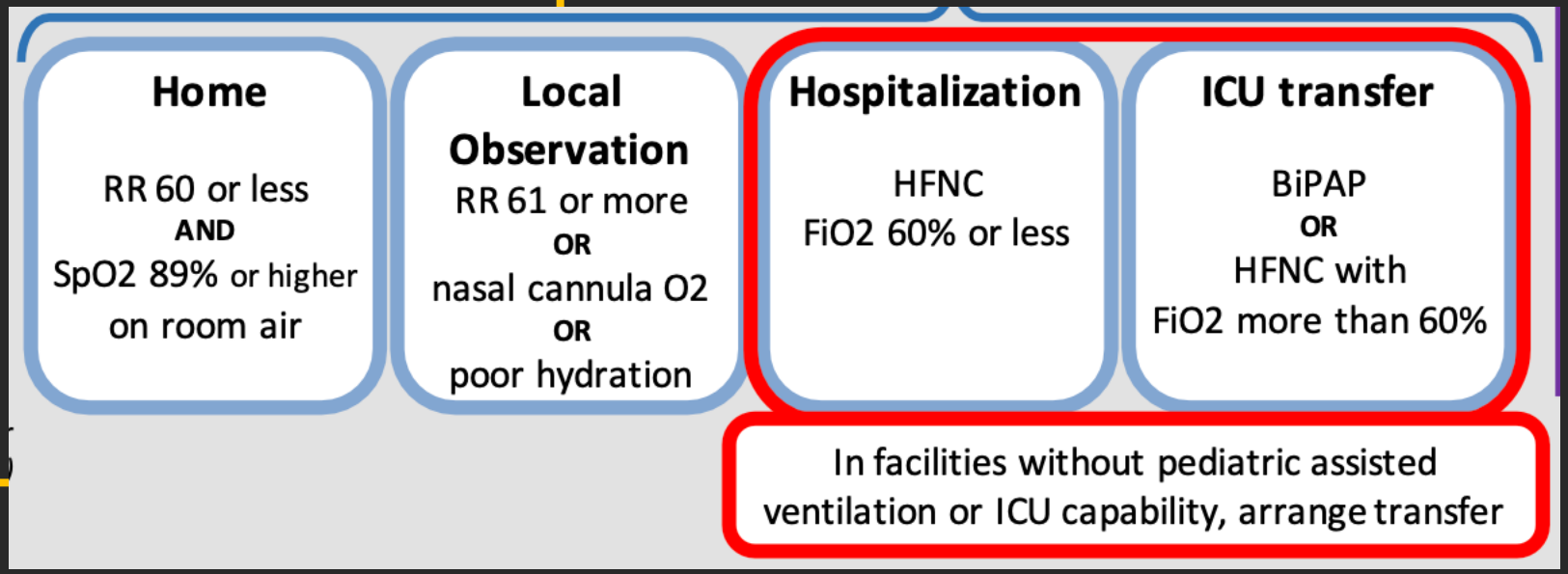
THERAPEUTIC RELIABILITY

Will he go home?

Appropriateness of Hospital Admission for Emergency Department Patients with Bronchiolitis: Secondary Analysis

Gang Luo [1]; Michael D Johnson [2]; Flory L Nkoy [2]; Shan He [3]; Bryan L Stone [2]

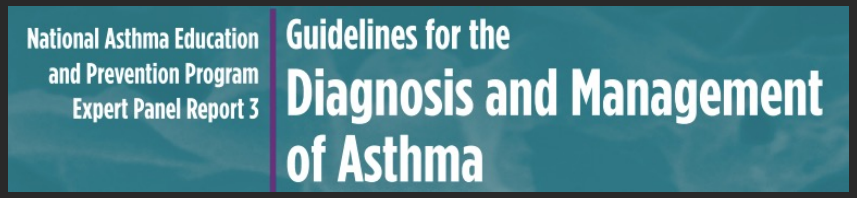
86% of bronchiolitis hospitalizations are deemed necessary (prolonged treatment)



ASTHMA INITIAL treatment

ALBUTEROL	IPRATROPIUM	DEXAMETHASONE
10 mg inhaled	1 mg inhaled	0.6 mg/kg oral

ASTHMA INITIAL evidence



- **Evidence Category A: Randomized controlled trials (RCTs), rich body of data.** Evidence is from end points of well-designed RCTs that provide a consistent pattern of findings in the population for which the recommendation is made. Category A requires substantial numbers of studies involving substantial numbers of participants.

- **Evidence Category B: RCTs, limited body of data.** Evidence is from end points of intervention studies that include only a limited number of patients, post hoc or subgroup analysis of RCTs, or meta-analysis of RCTs. In general, category B pertains when few randomized trials exist; they are small in size, they were undertaken in a population that differs from the target population of the recommendation, or the results are somewhat inconsistent.

- **Evidence Category C: Nonrandomized trials and observational studies.** Evidence is from outcomes of uncontrolled or nonrandomized trials or from observational studies.

- **Evidence Category D: Panel consensus judgment.** This category is used only in cases where the provision of some guidance was deemed valuable, but the clinical literature addressing the subject was insufficient to justify placement in one of the other categories. The Panel consensus is based on clinical experience or knowledge that does not meet the criteria for categories A through C.

INITIAL evidence

National Asthma Education and Prevention Program Expert Panel Report 3

Guidelines for the **Diagnosis and Management of Asthma**

ALBUTEROL

- **SABA treatment is recommended for all patients** (Evidence A) (For recommended doses, see figure 5–5.).

IPRATROPIUM

- **Inhaled ipratropium bromide.**
  - — ***In the ED: recommended*** (Evidence A). Adding multiple high doses of ipratropium bromide (0.5 mg nebulizer solution or 8 puffs by MDI in adults; 0.25–0.5 mg nebulizer solution or 4–8 puffs by MDI in children) to a selective SABA produces additional bronchodilation, resulting in fewer hospital admissions, particularly in patients who have severe airflow obstruction (Plotnick and Ducharme 2000; Rodrigo and Castro-Rodriguez 2005).

DEXAMETHASONE

- **Systemic corticosteroids are recommended for most patients** (For recommended doses, See figure 5–5.):
  - — ***In the ED:*** **Give systemic corticosteroids to patients who have moderate or severe exacerbations and patients who do not respond completely to initial SABA therapy** (Evidence A). These medications speed the resolution of airflow obstruction and reduce the rate of relapse and may reduce hospitalizations (Edmonds et al. 2003; Rowe et al. 2001; Rowe et al. 2004).

INITIAL treatment

ALBUTEROL	IPRATROPIUM	DEXAMETHASONE
10 mg inhaled	1 mg inhaled	0.6 mg/kg oral (max 16)

1 hr after arrival: RR 50/min, SpO2 86%, retractions, wheezes, decreased breath sounds

RESCUE treatment?

ALBUTEROL
10 mg inhaled

+ ? + ?

IV MAGNESIUM

INHALED MAG

NON-INVASIVE POS PRESS.

IV TERBUTALINE

IV EPINEPHRINE

KETAMINE

HELIOX

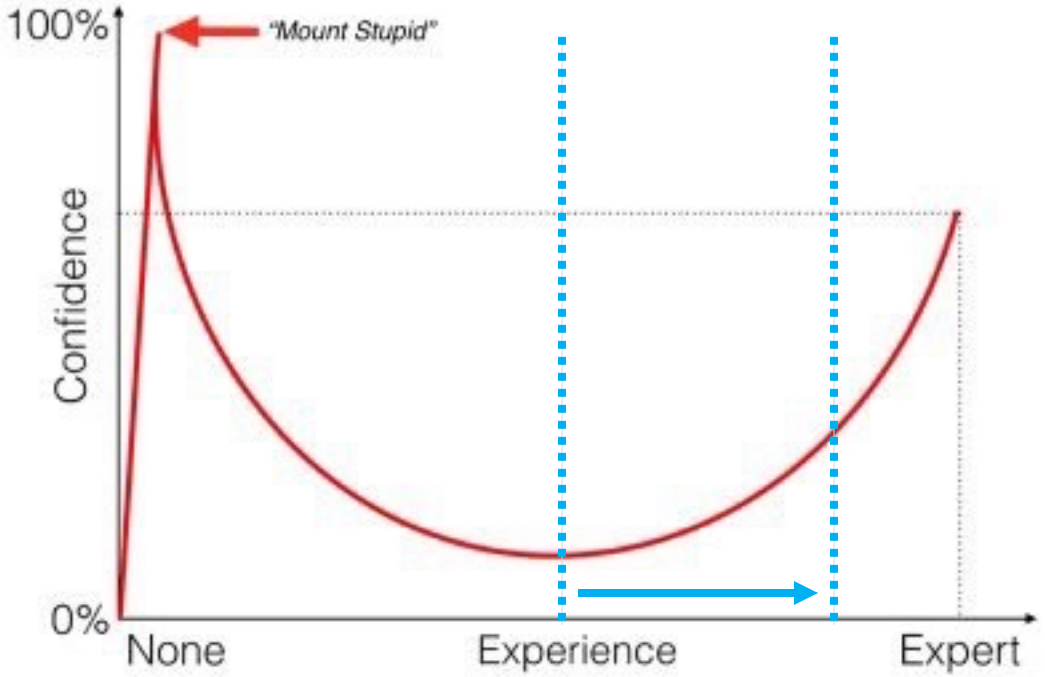
IV MONTELUKAST

INHALED ALBUTEROL

IV AMINOPHYLLINE

Dunning-Kruger Effect

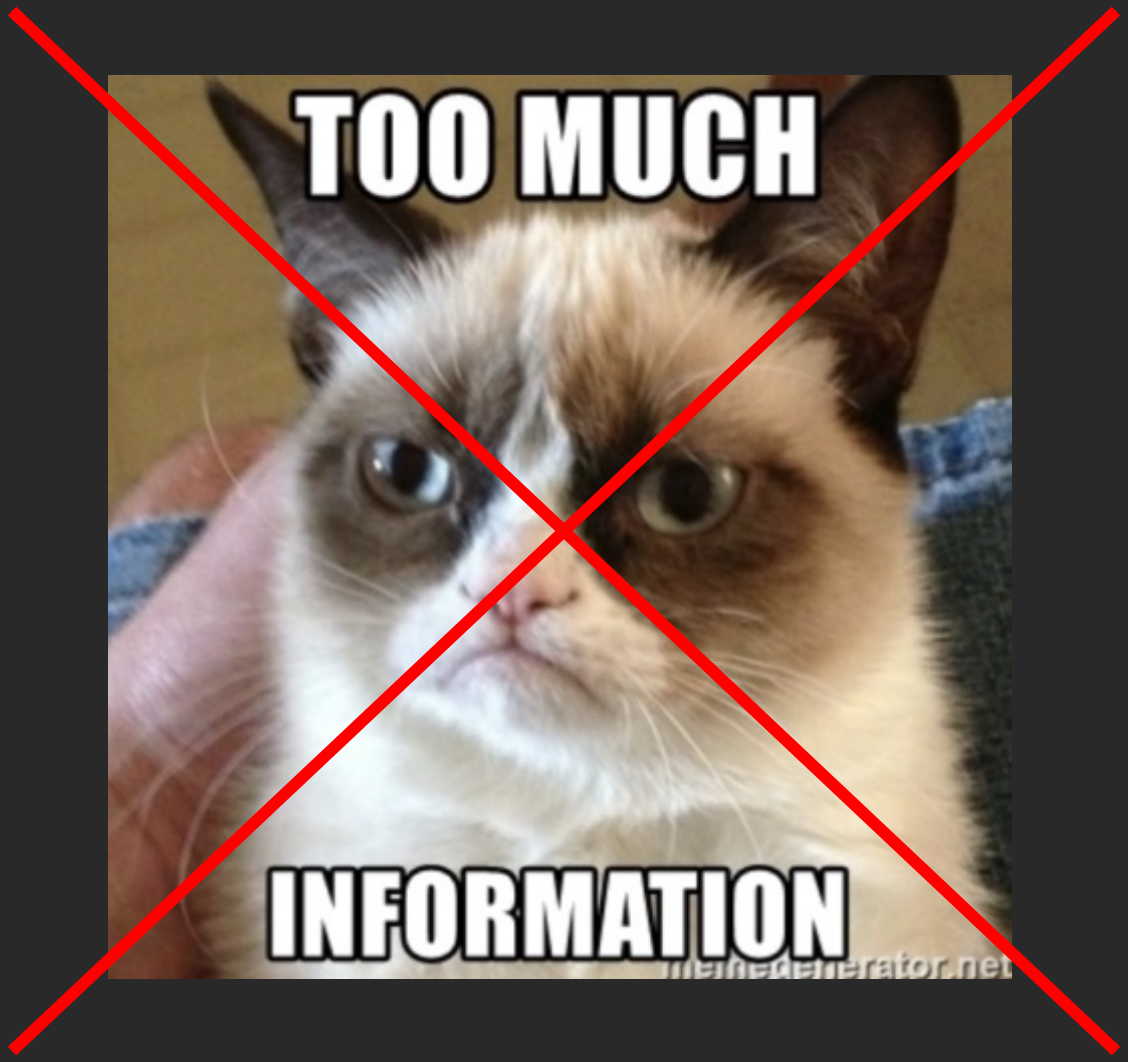
Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments
Kruger, J., & Dunning, D. (1999)



NATIONAL GUIDELINES

COCHRANE REVIEWS

CLINICAL TRIALS



far too little...

“National” Guidelines

NHLBI – National Heart, Lung, and Blood Institute

BTS – British Thoracic Society

GINA – Global Initiative for Asthma

NAC – National Asthma Council Australia

National guidelines

	strong recommendation (all patients)	conditional recommendation (some patients)	NOT recommended (no patients)
high evidence			
moderate evidence			
low evidence			

National guidelines

	NHLBI 2007	BTS 2019	GINA 2019	NAC 2022
INHALED ALBUTEROL ..	●	●	●	●
IV MAGNESIUM	○	○	○	○
IV TERBUTALINE ...	?	○	✖	○
SQ EPINEPHRINE .	?		?	○
IV MONTELUKAST	?	?	?	✖
IV AMINOPHYLLINE	✖	○	✖	○
HELIOX ..	○	?	○	
INHALED MAG	○	○	✖	
NON-INVASIVE PRESSURE.	?	○	?	○
KETAMINE .	?	?		✖

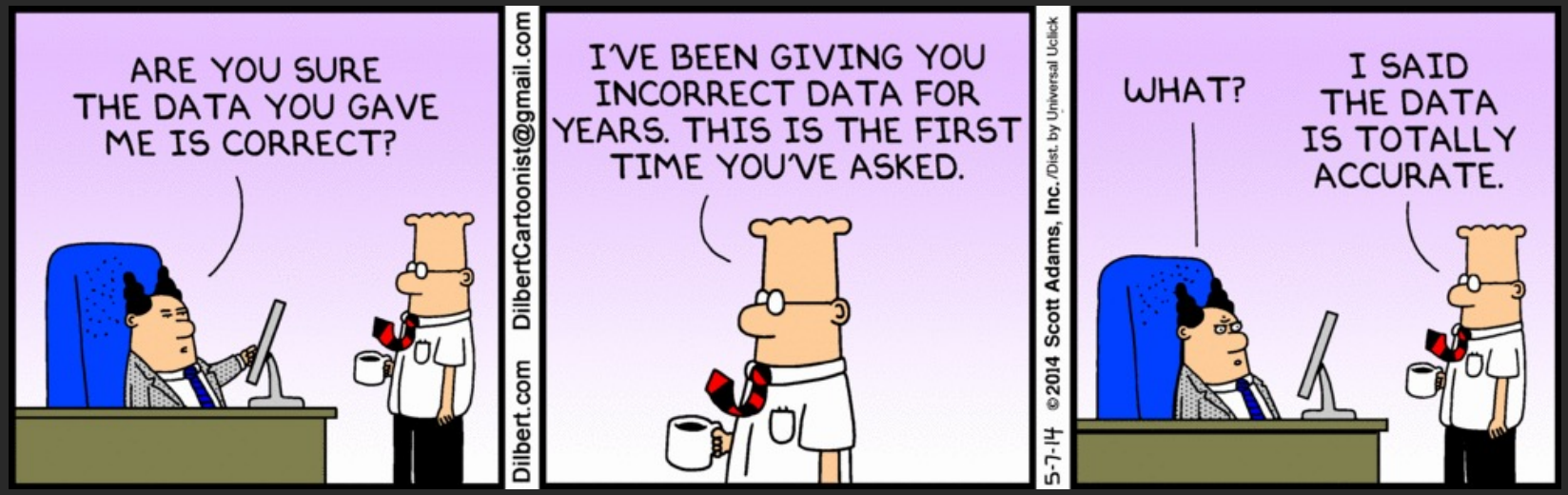
Cochrane Reviews

cochranelibrary.com

1) Asthma (Title, Abstract, or Keyword) (303)
2) limited to Child health (213)
3) limited to Lungs & airways (189)
4) limited to Asthma (acute) (34)

Cochrane Reviews

	NHLBI 2007	BTS 2019	GINA 2019	NAC 2022
INHALED ALBUTEROL	2003			
IV MAGNESIUM	2016			
IV TERBUTALINE	2012			
SQ EPINEPHRINE				
IV MONTELUKAST	2012			
IV AMINOPHYLLINE	2005			
HELIOX	2006			
INHALED MAG	2017			
NON-INVASIVE PRESSURE	2016			
KETAMINE	2012			



old studies, small studies....

IV Magnesium?

- Prior trials were small
  - no dose comparisons
  - none evaluated hospitalization as their main outcome
  - only 30, 30, and 54 patients in prior trials
- The best treatment for severe asthma is unknown
  - magnesium is cheap and available
  - magnesium is commonly and increasingly used
- Uncertainty exists
  - concern about low blood pressure – no poor perfusion
  - use varies widely from place to place (15% to 50%)

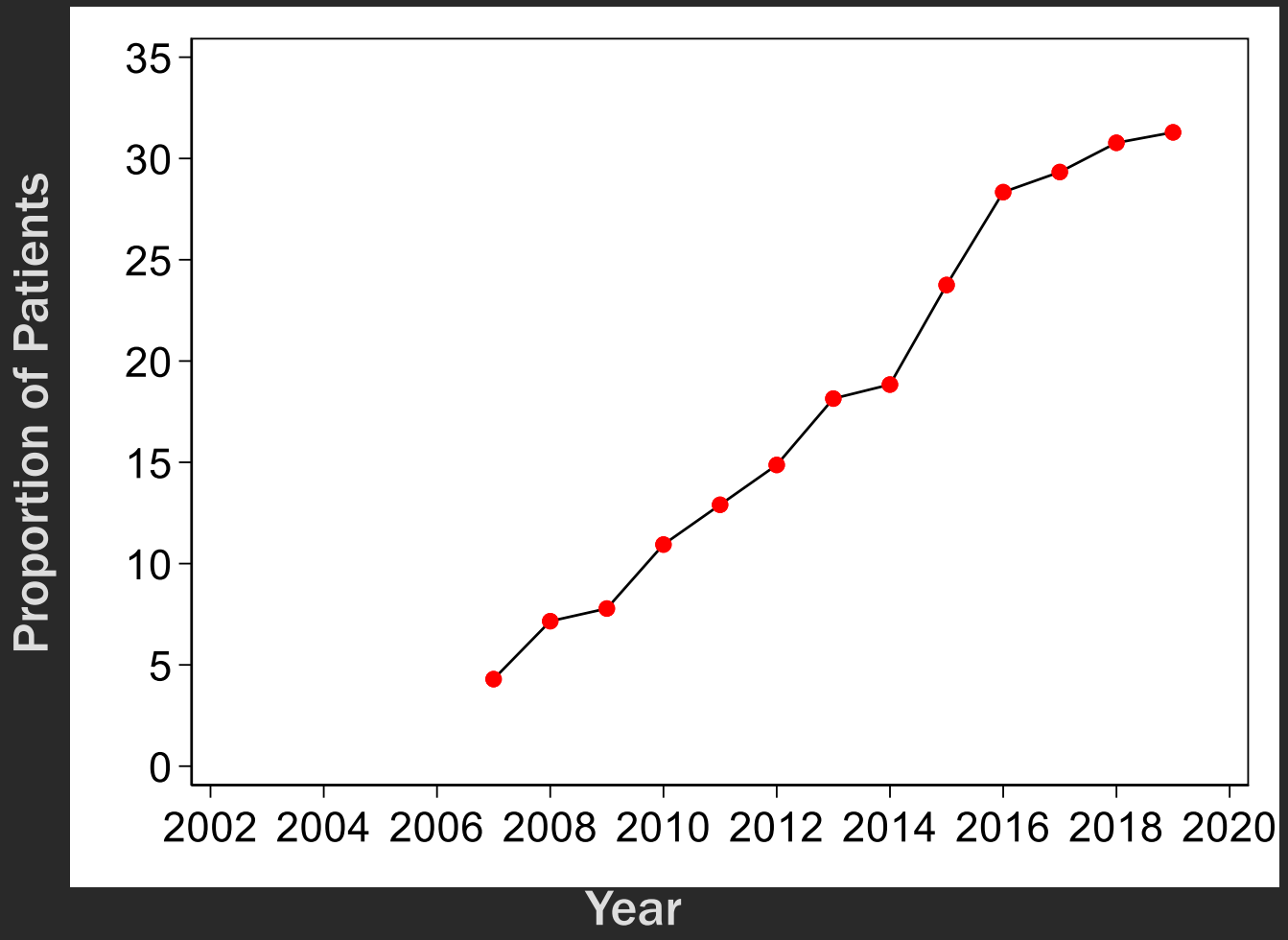
WHAT NEXT?

INHALED ALBUTEROL

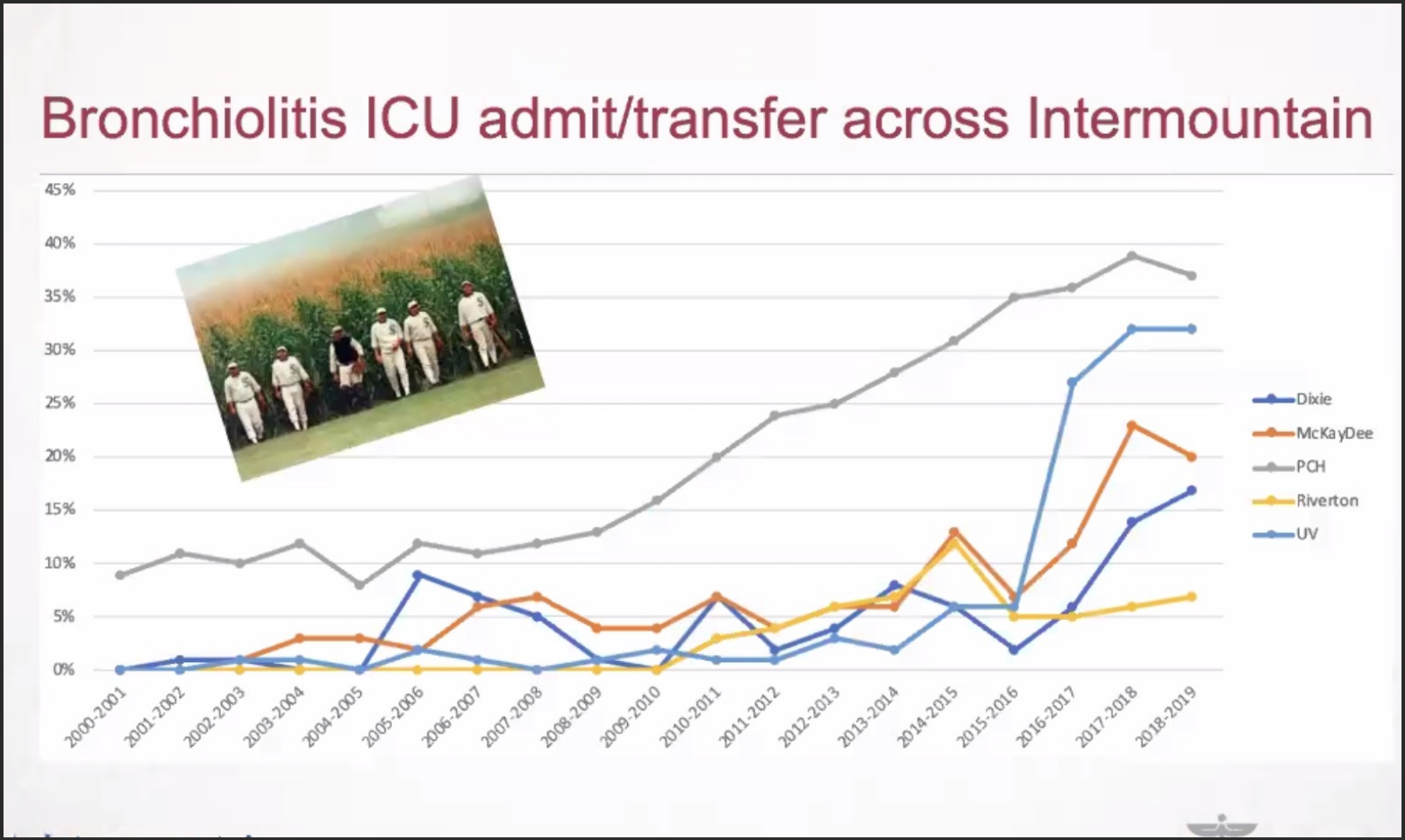
IV MAGNESIUM ?

HFNC ?

PERCENT ON HFNC



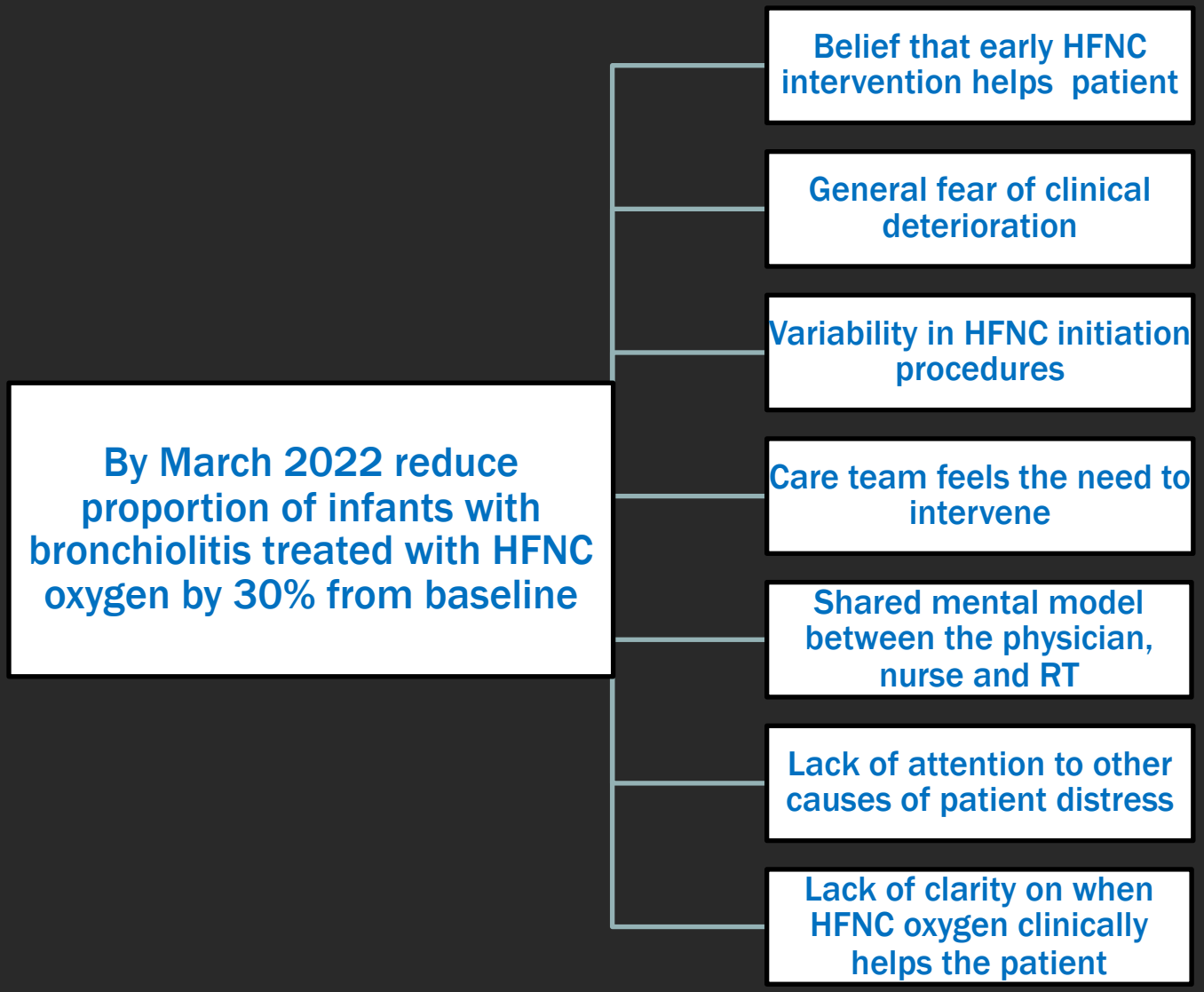
If you build it...



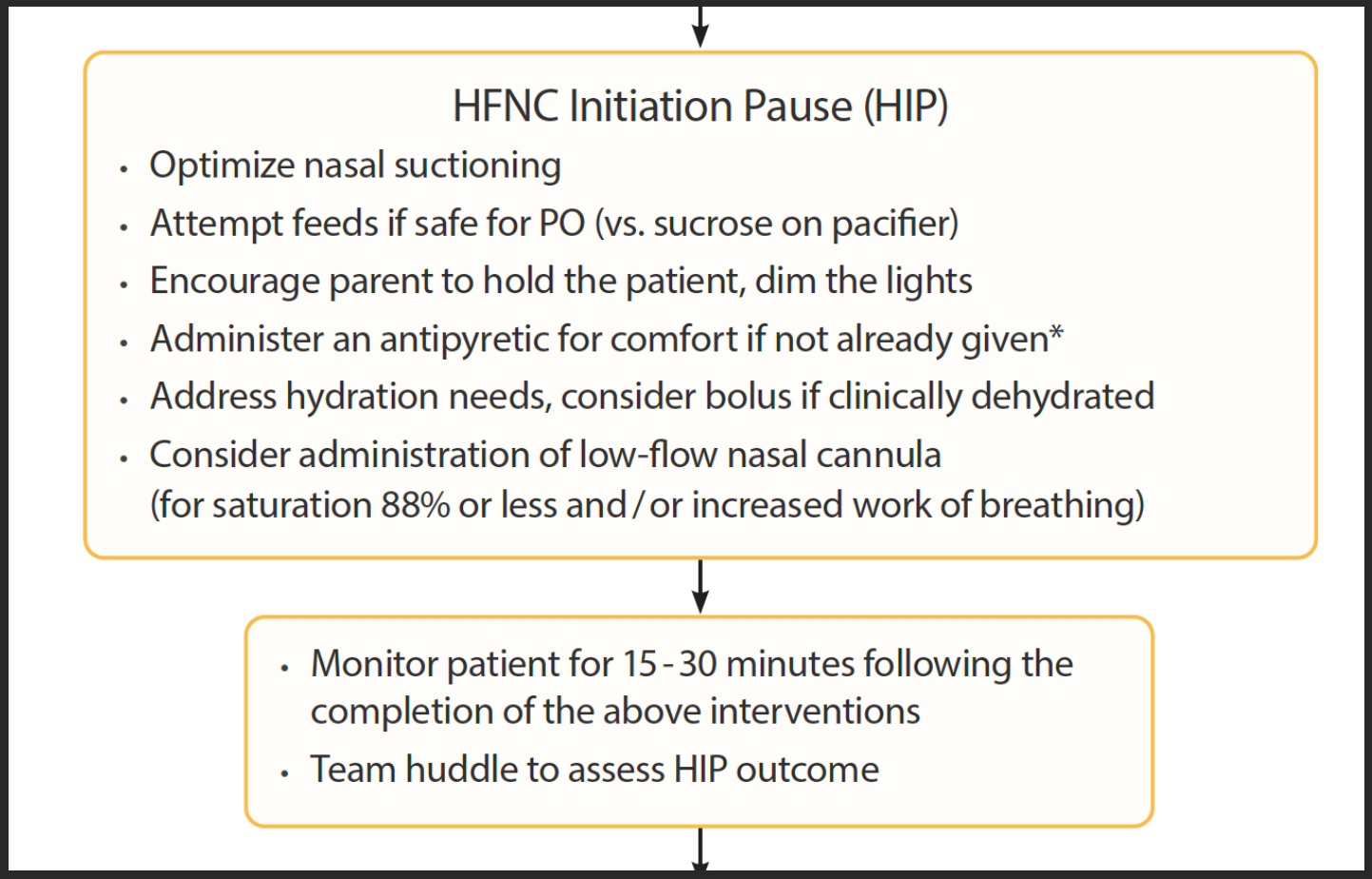
What do we know about HFNC?

- HFNC does not alter the course of moderately severe bronchiolitis. (randomized trial Kepreotes et al.)
- HFNC can reduce effort of breathing at 1.5-2.0 L/kg/minute (Weiler et al.)
- HFNC did not change duration of ICU stay, oxygen therapy, or whether child was intubated (randomized trial, Franklin et al.)

Key Drivers of HFNC



HIP
High Flow Initiation Pause



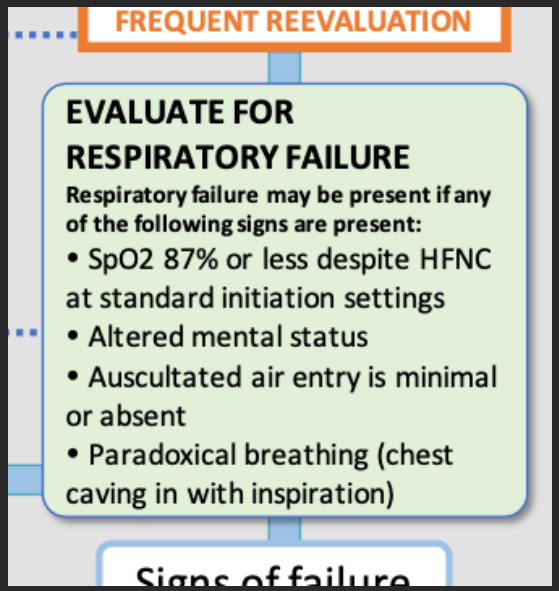
STANDARD REEVALUATION

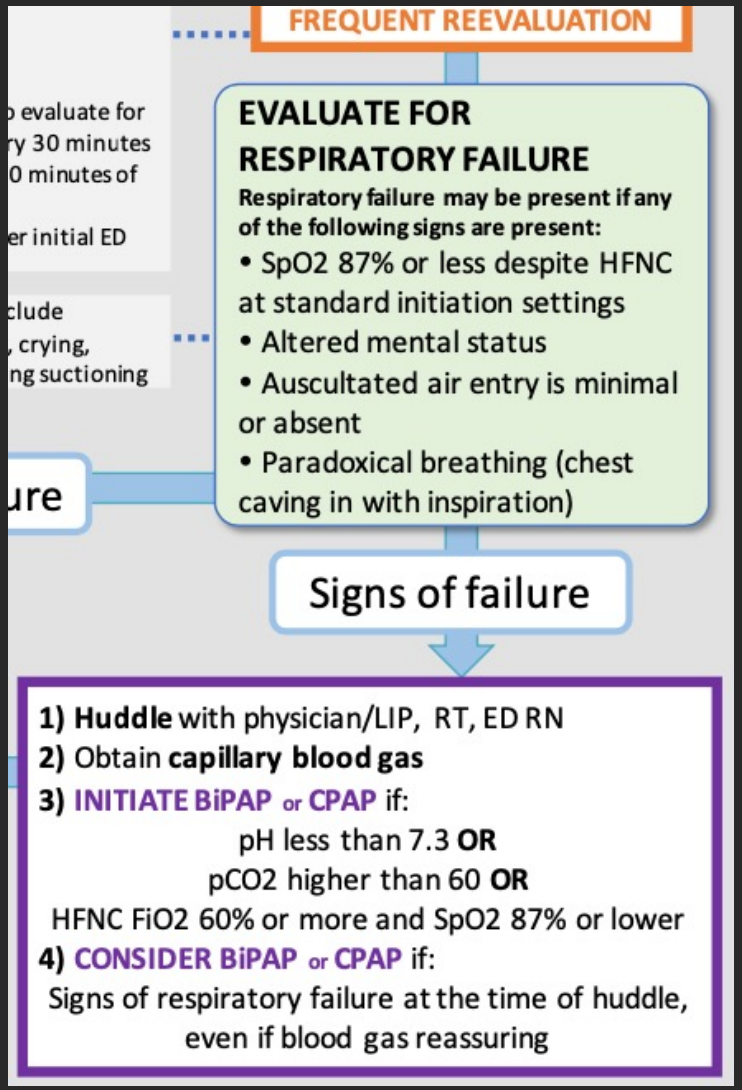
- **spot check pulse oximetry** with vital sign measurement and as needed
- **respiratory assessment and vital signs hourly** while in the ED for 4 hours, then every 2 hours and within 30 minutes of discharge.
- **determine disposition** one hour after triage

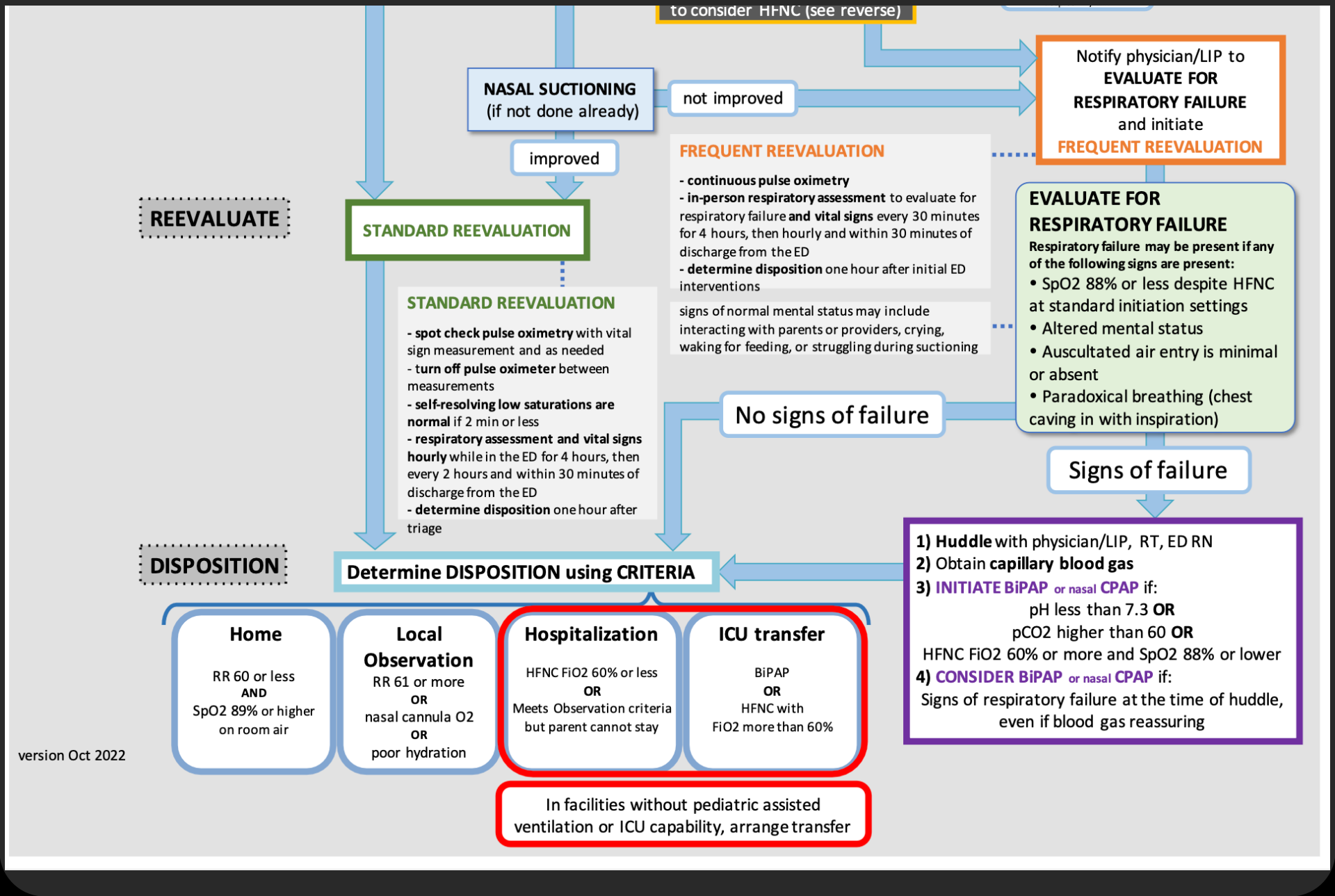
VS

FREQUENT REEVALUATION

- **continuous pulse oximetry**
- **in-person respiratory assessment** to evaluate for respiratory failure **and vital signs** every 30 minutes for 4 hours, then hourly and within 30 minutes of discharge
- **determine disposition** one hour after initial ED interventions


FREQUENT REEVALUATION
EVALUATE FOR RESPIRATORY FAILURE
Respiratory failure may be present if any of the following signs are present:
• SpO2 87% or less despite HFNC at standard initiation settings
• Altered mental status
• Auscultated air entry is minimal or absent
• Paradoxical breathing (chest caving in with inspiration)
Signs of failure


FREQUENT REEVALUATION
o evaluate for
ry 30 minutes
0 minutes of
er initial ED
clude
, crying,
ng suctioning
ure
EVALUATE FOR RESPIRATORY FAILURE
Respiratory failure may be present if any of the following signs are present:
• SpO2 87% or less despite HFNC at standard initiation settings
• Altered mental status
• Auscultated air entry is minimal or absent
• Paradoxical breathing (chest caving in with inspiration)
Signs of failure
1) Huddle with physician/LIP, RT, ED RN
2) Obtain capillary blood gas
3) INITIATE BiPAP or CPAP if:
pH less than 7.3 OR
pCO2 higher than 60 OR
HFNC FiO2 60% or more and SpO2 87% or lower
4) CONSIDER BiPAP or CPAP if:
Signs of respiratory failure at the time of huddle, even if blood gas reassuring


to consider HFNC (see reverse)
Notify physician/LIP to EVALUATE FOR RESPIRATORY FAILURE and initiate FREQUENT REEVALUATION
NASAL SUCTIONING (if not done already)
not improved
improved
FREQUENT REEVALUATION
- continuous pulse oximetry
- in-person respiratory assessment to evaluate for respiratory failure and vital signs every 30 minutes for 4 hours, then hourly and within 30 minutes of discharge from the ED
- determine disposition one hour after initial ED interventions
REEVALUATE
STANDARD REEVALUATION
EVALUATE FOR RESPIRATORY FAILURE
Respiratory failure may be present if any of the following signs are present:
• SpO2 88% or less despite HFNC at standard initiation settings
• Altered mental status
• Auscultated air entry is minimal or absent
• Paradoxical breathing (chest caving in with inspiration)
STANDARD REEVALUATION
- spot check pulse oximetry with vital sign measurement and as needed
- turn off pulse oximeter between measurements
- self-resolving low saturations are normal if 2 min or less
- respiratory assessment and vital signs hourly while in the ED for 4 hours, then every 2 hours and within 30 minutes of discharge from the ED
- determine disposition one hour after triage
signs of normal mental status may include interacting with parents or providers, crying, waking for feeding, or struggling during suctioning
No signs of failure
Signs of failure
DISPOSITION
Determine DISPOSITION using CRITERIA
1) Huddle with physician/LIP, RT, ED RN
2) Obtain capillary blood gas
3) INITIATE BiPAP or nasal CPAP if:
pH less than 7.3 OR
pCO2 higher than 60 OR
HFNC FiO2 60% or more and SpO2 88% or lower
4) CONSIDER BiPAP or nasal CPAP if:
Signs of respiratory failure at the time of huddle, even if blood gas reassuring
Home
RR 60 or less
AND
SpO2 89% or higher on room air
Local Observation
RR 61 or more
OR
nasal cannula O2
OR
poor hydration
Hospitalization
HFNC FiO2 60% or less
OR
Meets Observation criteria but parent cannot stay
ICU transfer
BiPAP
OR
HFNC with FiO2 more than 60%
In facilities without pediatric assisted ventilation or ICU capability, arrange transfer
version Oct 2022

EVIDENCE-BASED BRONCHIOLITIS CARE

Pulse Oximetry

- **Don't use continuous pulse oximetry routinely in children with acute respiratory illness unless they are on supplemental oxygen.**
- The utility of continuous pulse oximetry in pediatric patients with acute respiratory illness is not well established. Use of continuous pulse oximetry has been previously associated with increased admission rates and increased length of stay. The clinical benefit of pulse oximetry is not validated or well documented.

Observation and Home Oxygen Therapy

- **Infants with bronchiolitis with hypoxia can be safely sent home on oxygen by nasal cannula**.
- An observation period of a minimum of 6 hours is sufficient to determine if a child on a small amount of oxygen (≤0.5 L/min NC O2 <12 mo old, ≤0.75 L/min NC O2 ≥12 mo old) can be discharge home with oxygen supplied by a home-health company and followup with a primary care provider within 48 hours. This period of observation can be safely completed in the emergency department, in a dedicated observation unit, or in a hospital unit.

Bronchodilators

- **Don't routinely use bronchodilators in children with bronchiolitis.**
- Published guidelines do not advocate the routine use of bronchodilators in patients with bronchiolitis. Comprehensive reviews of the literature have demonstrated that the use of bronchodilators in children admitted to the hospital with bronchiolitis has no effect on any important outcomes. There is limited demonstration of clear impact of bronchodilator therapy upon the course of disease. Additionally, providers should consider the potential impact of adverse events upon the patient.

Corticosteroids

- **Don't use systemic corticosteroids in children under 2 years of age with an uncomplicated lower respiratory tract infection.**
- Published guidelines recommend that corticosteroid medications not be used routinely in the management of bronchiolitis. Furthermore, additional studies in patients with other viral lower respiratory tract infections have failed to demonstrate any benefits.

Chest Radiography

- **Don't order chest radiographs in children with uncomplicated asthma or bronchiolitis.**
- National guidelines articulate a reliance on physical examination and patient history for diagnosis of asthma and bronchiolitis in the pediatric population. Multiple studies have established limited clinical utility of chest radiographs for patients with asthma or bronchiolitis. Omission of the use of chest radiography will reduce costs, but not compromise diagnostic accuracy and care. Chest radiography should be reserved for children sick enough to require ICU care.

Antibiotics

- **Don't administer or prescribe antibiotics for children with uncomplicated bronchiolitis.**
- Treatment with antibiotics has no effect on length of illness, length on supplemental oxygen, or length of hospitalization. In the emergency department, chest radiography is not helpful to determine if a child has pneumonia and would benefit from antibiotics.

EVIDENCE-BASED BRONCHIOLITIS CARE

American Academy of Pediatrics, Diagnosis and Management of Bronchiolitis, Subcommittee on Diagnosis and Management of Bronchiolitis, Pediatrics. 2014; 134(2):415-420.

Sandweiss DR, Mundorff MB, et al. Decreasing Hospital Length of Stay for Bronchiolitis by Using an Observation Unit and Home Oxygen Therapy. *JAMA Pediatr*. 2013;167(5):422-428.

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Roback MG, Dreitlein DA. Chest radiograph in the evaluation of first time wheezing episodes: review of current clinical efficacy. Pediatr Emerg Care. 1998 Jun;14(3):181-4.

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Von Woensel JB, van Aalderen WM, Kimpen JL. Viral lower respiratory tract infection in infants and young children. BMJ 200;327(7405):36–40.

Farley R, Spurling GK, Eriksson L, Del Mar CB. Antibiotics for bronchiolitis in children under two years of age. *Cochrane Database Syst Rev*. 2014;2014(10). doi:10.1002/14651858.CD005189.pub4

Video for patients

- One more resource – bronchiolitis video
  - https://www.youtube.com/watch?v=aVi4s8B3viU&t=10s