Pediatric Respiratory Emergencies

Children's Hospital Colorado

Affiliated with University of Colorado Anschutz Medical Campus School of Medicine

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Financial Disclosures

- No relevant financial relationships with any commercial interests.

Patrick Mahar

Objectives

- Review the pediatric airway and signs/symptoms of respiratory distress in pediatric patients.
- Discuss the causes and treatment of common pediatric respiratory issues.
- Discuss approach to different pediatric respiratory cases

Pediatric Respiratory Emergencies

- What scares you about pediatric patients?
- How does pediatric airway differ from adult airway?

Pediatric Airway

- **Large head for size of body**
  - Prone to flexion/obstruction when supine
  - May need to place towels/padding beneath torso to account for big head & maintain c-spine
- **Large tongue for size of mouth**
  - Obstruction
  - Difficult to get out of the way when intubating
- **Everything is smaller**
  - Smaller nasal passages makes them more susceptible to marked increase resistance to airflow

"My baby is having trouble breathing"

- What are you thinking of in route to scene?
- What are primary causes of respiratory distress in pediatric patients?
- What equipment/medications are you getting ready?

A-B-C

- **A**irway
  - Is there anything preventing getting air in?
  - What can we do to improve/fix issues with getting air into/out of lungs
- **B**reathing
  - Is patient breathing? Is there respiratory effort?
  - Is oxygen getting into body? Is CO_2 getting out?
  - How can we support breathing?
- **C**irculation
  - Is heart pumping? Is body being perfused?
  - How can we help/support circulation?

“My baby is having trouble breathing”

- 4 yo with 1 day history of cough, congestion, and fever of 101.
- Woke up from sleep with difficulty breathing.
- FOC and 15 yo brother Covid + 2 days ago

4 yo Respiratory Distress

- 02:22 Arrive at scene
- Pt in arms of mother; loud breathing; fussy/crying
- HR: 185 RR: 60 Pox: 92% Temp: 102.8
- What else do you want to ask?
- What physical exam findings are you looking for?
- What do you want to do?

4 yo Respiratory Distress

Physical Exam:

- Vitals: HR: 185 RR: 40 Pox: 92% Temp: 102.8
- General: Anxious/scared
- Mucous membranes dry, no lesions; + nasal discharge.
- Chest: intercostal and suprasternal retractions;
- Circulation = skin pale, mottled extremities, tachycardic

Now what?

What do you think is going on?

ABC of Pediatric Breathing Issues

- Majority of respiratory issues caused by the BIG THREE of pediatric respiratory diseases

A

B

C

ABC of Pediatric Breathing Issues

- Majority of respiratory issues caused by the BIG THREE of pediatric respiratory diseases

Asthma

Bronchiolitis

Croup

Asthma vs Bronchiolitis vs Croup

Asthma

- Lower airway
- Viral/allergy irritant/???
- Can't getting air out
- Tight cough
- Wheezing
- All day/night

Bronchiolitis

- Upper and lower
- Viral etiology
- Hypoxia/WOB/Apnea
- Wet cough
- Crackles
- Seasonal
- Snot

Croup

- Upper airway
- Viral etiology
- Can't getting air in
- Barky cough
- Stridor
- Middle of the night

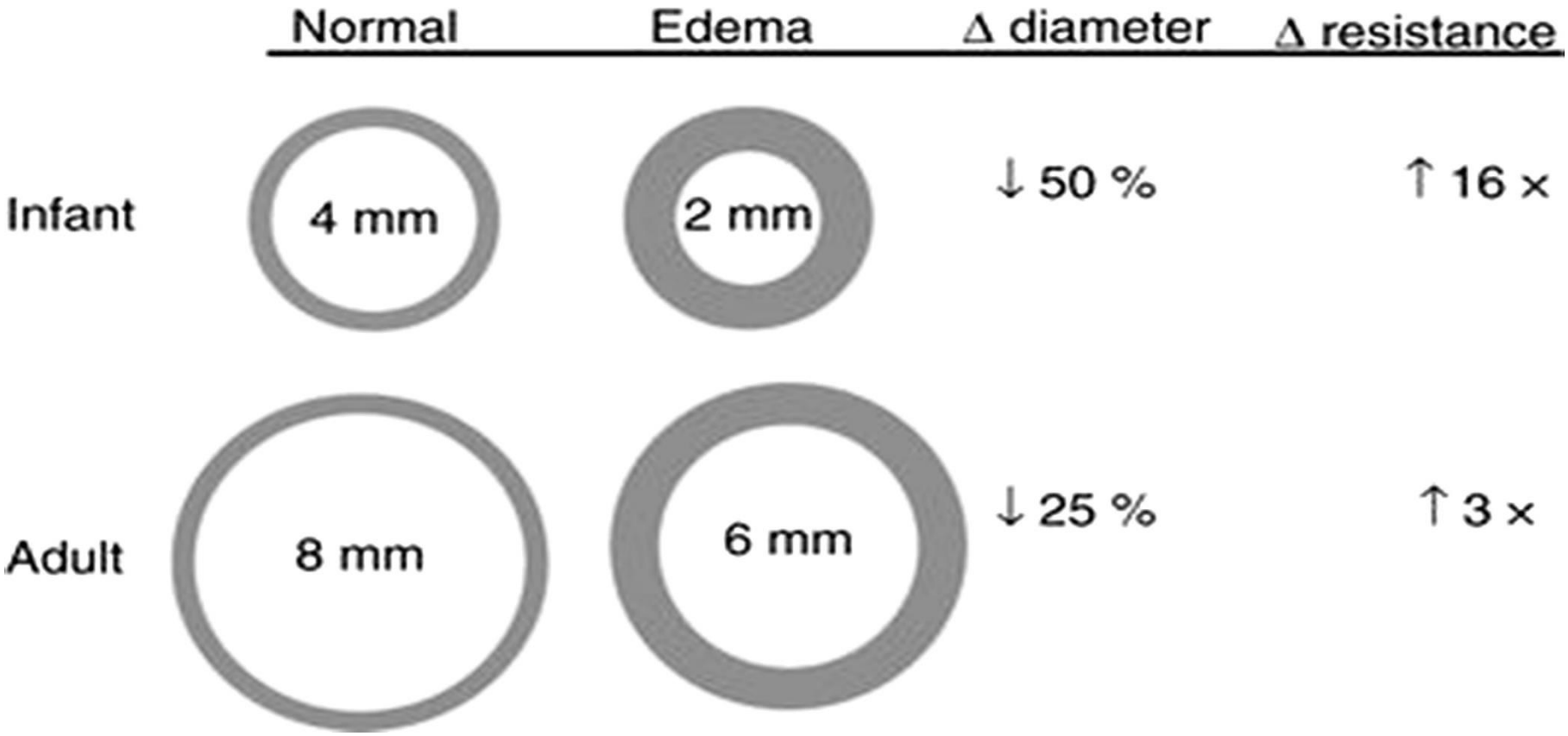
Asthma

- Lower respiratory tract issue
  - Combination:
    1. Airway constriction—smooth muscle
    2. Airway inflammation
- Physical Exam
  - Prolonged expiratory phase
  - Wheezing or minimal aeration
  - Retractions
- Treatment
  - Albuterol-relaxes smooth muscles, thus opens airways
  - Atrovent-(only beneficial in start of treatment)
  - Steroids-decreases airway inflammation
    - 2mg/kg load then 1mg/kg BID for 4-5 days
  - Magnesium-smooth muscle relaxation

Croup

- Typical story:
  - 3 y.o. (6 months -6 years) wakes up in middle of the night and “can’t breath”.
  - Parents report pt was “coughing and wheezing”.
  - Has slight runny nose last evening before bed.
  - Has never had anything like this before.
  - Got better on ride in to ED.
  - When you go to examine pt gets upset and give horse cry

Airway Resistance



Differential of Stridor

- Infection
  - Croup
  - Bacterial tracheitis
  - Retropharyngeal abscess
- Foreign Body-(especially starting in middle of the day)
- Laryngomalacia/Tracheomalacia
- Less common causes:
  - vocal cord paresis,
  - subglottic hemangioma,
    - causes rapidly progressing stridor, sometimes associated with a facial hemangioma
  - vascular ring, vascular sling, fixed mediastinal mass

Croup

- Accounts for over 90% of stridor with fever
- Subglottic stenosis secondary to edematous, inflamed mucosa
  - NOT SMOOTH MUSCLE ISSUE
- Most commonly caused by parainfluenza>>>RSV, adenovirus, and influenza
- With different waves of Covid, we saw large number of Covid+ croup with more recent variants

Croup

- Treatment:
  - Mild-Barky cough, no stridor at rest
    - Decadron: standard dose 0.6mg/kg (max 8mg)
      - Studies have shown as doses as low as 0.2 mg/kg are just as affective
      - No studies have shown benefit from 2nd dose
    - Cool mist-no study to show this is beneficial
  - Severe-Stridor at rest and/or severe distress
    - Racemic epinephrine(0.5 ml of 0.25% solution dissolved in 2.5ml of NS)
      - Watch for 2-3 hours after treatment
    - Heliox-Use limited by hypoxia
  - Pt with significant hypoxia with croup are worrisome for severe disease/critical airways
- Albuterol does not help bc not a smooth muscle issue

15 month with difficulty breathing

- CC: My child is having a hard time breathing and has a fever?
- 2 days of cough, congestion and tactile fever.
- Decreased drinking and post-tussive emesis
- 8 yo sibling with cold;

- Triage vital signs:
  - HR 173 RR: 54 Pulse Ox: 91% Temp: 38.8

15 month with difficulty breathing

- PMHx: None.
- Allergies: Amoxicillin
- Family Hx: MOC: thyroid issues FOC: ulcerative colitis
- Immunizations: UTD

- What else do you need to ask?

15 month with difficulty breathing

- Physical Exam:

- Gen: Tired appearing in MOC's arms. cough
- HEENT: + nasal discharge; TM: erythematous bilat
- Lungs: + retractions; coarse BS with intermittent crackles and wheezing.
- Heart: S1S2 no mur. Tachycardiac
- Abd: soft, NT/ND. No HSM
- Ex: Cap refill 2-3 sec.

What is going on and what do you want to do?

Bronchiolitis

- Acute viral infection- most commonly RSV
- Age ≤ 2 years of age
- Infant's sx are worsen for the first 3-5 days
- Infectious process → **destruction in lining of bronchioles**
  - Bronchoconstriction
  - Mucous plugging
- Most common in winter and early spring
- Apnea= most concerning complication in infants

Bronchiolitis

- **Signs/Symptoms**
- runny nose, coughing, sneezing, tachypnea, retractions, wheezing/crackles, volume depletion due to decreased oral intake, apnea, fever

Bronchiolitis-Interventions

- Contact isolation-mask up
- Supportive care!!
  - SUCTION, SUCTION, SUCTION
  - Oxygen-heated high flow
  - Treat fever
  - ORT with Pedialyte
  - Positive pressure
  - SUCTION again

Supplemental Oxygen

Nasal Cannula

- Simple mask

- Non-rebreather

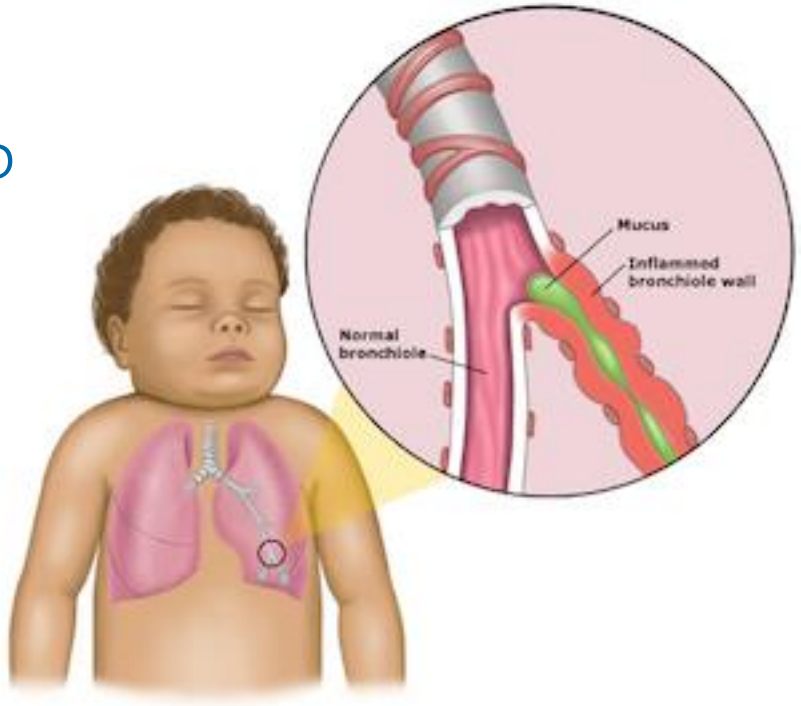
Bronchiolitis

- Viral infection
  - RSV; human metapneumonia virus, parainfluenzea, ……..
- Clinical picture varies with age
  - Neonates/newborns
    - Apnea BEFORE onset of symptoms
  - Toddlers:
    - Nasal secretions/congestion
    - Wet cough
    - Poor PO intake
    - Coarse breath sounds/wheezing/crackles—washing machine
    - Tachypnea
    - +/- Fever
  - School aged
    - Cough-post nasal drip
    - Viral pneumonitis

Bronchiolitis

- What is the problem?
  - Viral infection makes the bronchioles swell and become inflamed. Mucus collects in these airways, which can make it difficult for air to flow freely into and out from the lungs.

- How do we make diagnosis?
  - Clinical diagnosis—NO TEST NEEDED
  - CXR-
    - Unlikely to be helpful
    - Increase Abx→Increased "allergies"
  - Viral DFA
    - Who cares which virus?
    - We never use to care



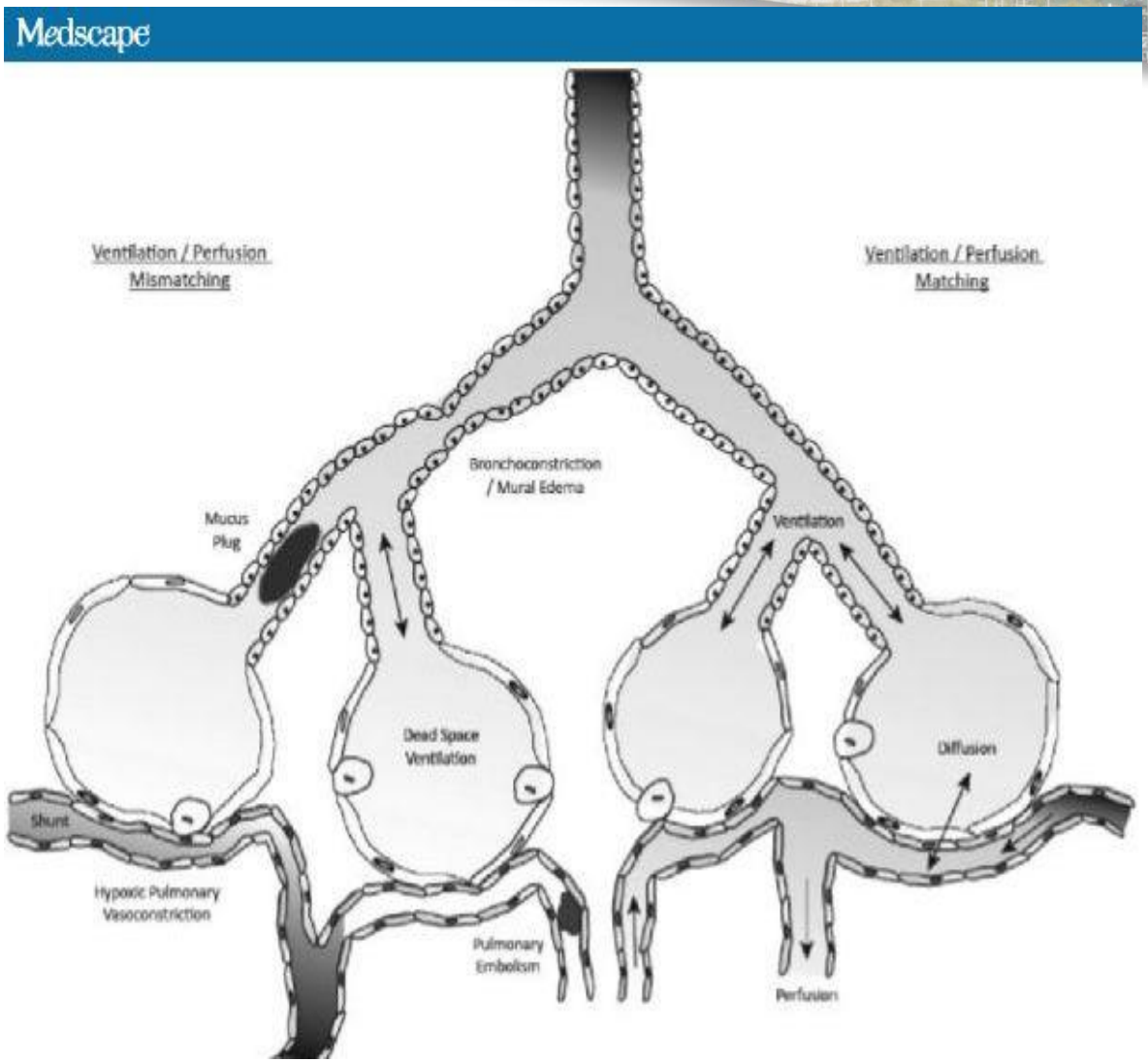
Bronchiolitis

- What do we do?
  - Suctioning—helps clear secretions in upper airway but not lower airway, but has proven beneficial
  - Supplemental O2 when hypoxic
  - Things thought to possibly help, but evidence lacking:
    - Steroids—Decrease airway swelling??—no proven benefit
    - Hypertonic saline nebs: thin secretions/mucus plugging—Studies yet to show significant benefit
    - Albuterol—rarely helps more likely hurts

Albuterol in bronchiolitis??

- How does albuterol work?
- Where does it have its effect?
- Why might this make bronchiolitis worse?

V/Q Mismatch


Medscape
Ventilation / Perfusion Mismatching
Ventilation / Perfusion Matching
Bronchoconstriction / Mural Edema
Mucus Plug
Ventilation
Dead Space Ventilation
Diffusion
Shunt
Hypoxic Pulmonary Vasoconstriction
Pulmonary Embolism
Perfusion

Remember the Basics!!

Albuterol ≠ ”All-better-ol”

15 month with difficulty breathing

- Pt suctioned with nasal saline flush for large amount of thick secretions.
- Pt able to drink 8 ounces.
- Motrin given

- 30 min later:
- HR: 145 RR: 55 Pulse Ox: 84% Temp: 37.5

- Now what?

15 month with difficulty breathing

- Pt placed on O2 via low flow nasal cannula, but pulls it out immediately

- How do we delivery needed O2?
  - Blow by?
  - Facemask?
  - Keep trying nasal cannula?

Why Not Blow-by?

- A manikin of a child with a facemask of appropriate size was transported along a 60 m corridor from OR to the PACU. O2 delivery to the face of the manikin was measured during transport.
- Six blow-by methods were tested with oxygen flows of 3, 6, and 10 L/min and with the facemask at 0 cm from the face and at 5 cm from the face.
- The outcome parameter was: blow-by method reaching and maintaining an FiO2 >50% during transport from OR to the PACU.

Why Not Blow-by?

- At 0 cm from the face, blow-by methods maintained a FiO2 >50%
- At 5 cm only at 10 L/min flow blow-by methods were able to maintain an FiO2~50%
- At distance greater than 5cm from face or at flow rates less than 10 L/min, FiO2 decreased to ~21%.
- The decrease in FiO2 typically started within 6-12 meters from the start of the transport

15 month with difficulty breathing

- Nasal cannula put back on with Tender Grips
- Have parent hold child wrapped in blanket.

- Distraction:
  - Provide toys/movie
- 30 minutes later:
  - HR: 145 RR: 52 (with retractions and head bobbing)
  - Pox: 92% on 2Liters
- Now what?

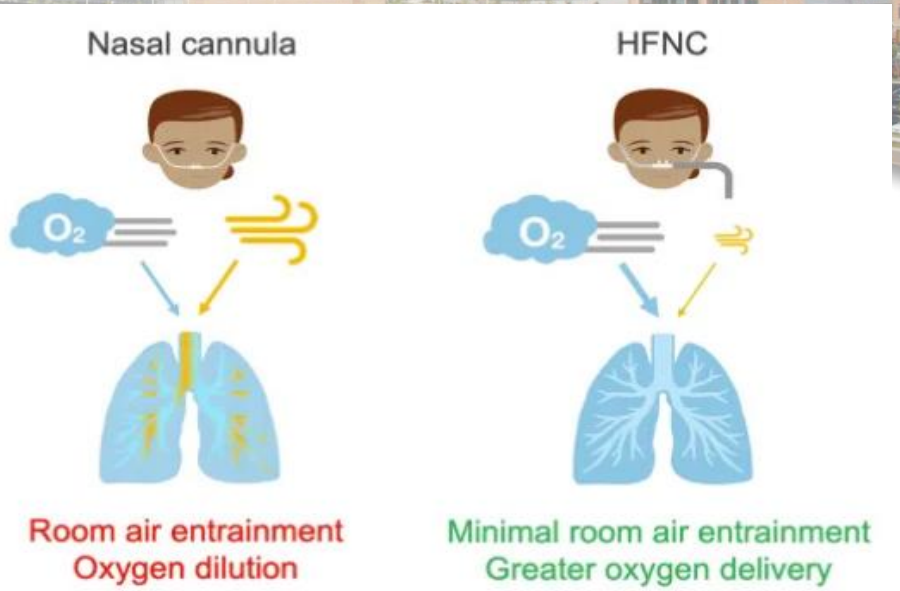
15 month with difficulty breathing

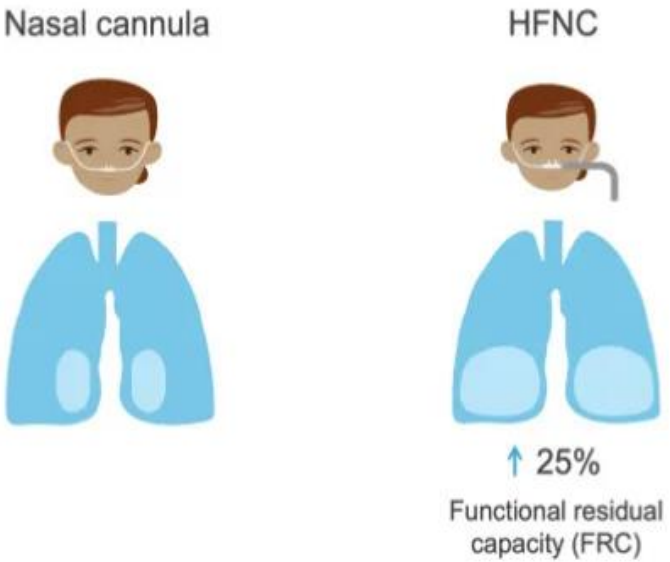
- Pt suctioned and O2 turned up to 4 liters w/out improvement.
- Decision made to increase respiratory support by starting patient on heated high flow (e.g., Vapotherm (i.e., HHF).
- How does HHF work?

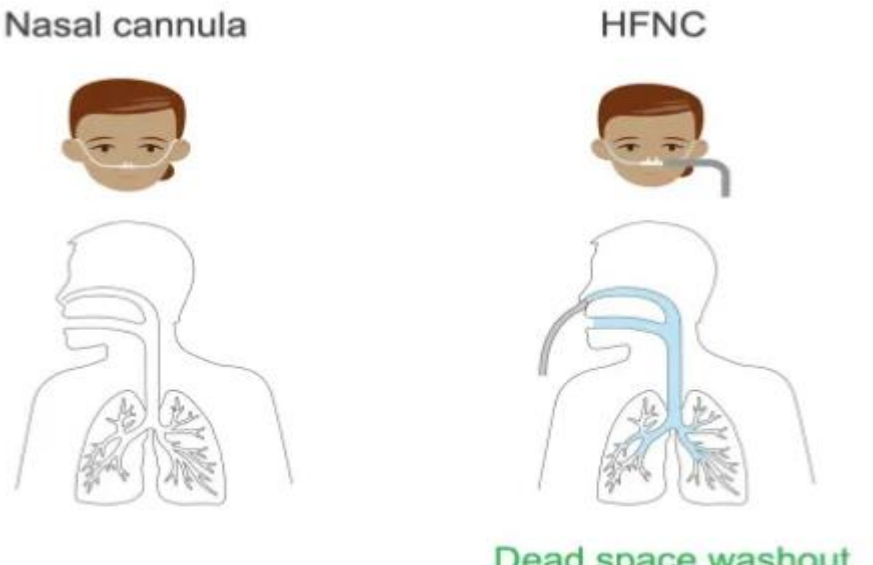
How does HHF work?

- There are three main proposed benefits of HFNC:

1. Precise oxygen delivery
2. Functional residual capacity enhancement
3. Dead space washout







How does HHF work?

Summary of Actions:

Dead space washout	Reduce dead space making minute ventilation more efficient
Reduce inspiratory work of breathing	Exceed inspiratory flow thus eliminating nasal resistance
Improved lung Mechanics	Warmed, humidified gas has been shown to improve conductance, lung compliance and lung elasticity
Eliminates metabolic work associated with gas conditiong	Attenuates the energy and water loss associated with conditiong inspiratory gas
Provision of mild distending pressure	Provides positive distending pressure for lung recruitment. It prevents alveolar collapse
Improve secretion mobilisation	Ideal humidification of the inspired gas has been shown to restore muco-cilliary function and reduce symptoms of airway exacerbations

Table adapted from: High Flow Nasal Cannula Therapy in Neonatology (TL Miller 2013).

15 month with difficulty breathing

- Pt improves initially on HHF, but later in the night had increased RR (58) and difficulty maintaining pulse ox (86%)

- Now what?

15 month with difficulty breathing

- Decision made to increase respiratory support and place patient on BiPAP to transfer
- Scuba mask
- IVF (Pt needs to be NPO)
- Sedation:
  - Dexmedetomidine (Precedex)

13 yo vomiting and difficulty breathing

- 16:10 911 call– Something is wrong with my son, he is vomiting and having trouble breathing.

- What are you thinking as you are driving to home?

13 yo vomiting and difficulty breathing

- 16:38 Arrive at house
  - MOC says “He is on the couch and has been throwing up for a couple hours. He is really sleepy and now having hard time breathing”
  - What else do you want to know from parent?
  - When enter house what are you first looking for with patient?

13 yo vomiting and difficulty breathing

- 16:42: HR: 138 BP: 92/42 RR:10 Pox: 92%
  - GEN: Sleepy but moans when you stimulate him.
    Opens eyes when you ask him to and tells you his name
  - HEENT: Mucous membranes-very dry
  - Lungs: No wheezing/stridor. Breathing hard
  - Heart: Tachy.
  - Abd: diffusely tender

  - What else do you want to know?

13 yo vomiting and difficulty breathing

- What is on your differential diagnosis?
- What's next?

13 yo vomiting and difficulty breathing

- Glucometer reads: HIGH
- What's going on?
- What's next?

2 yo "Not breathing"

- Call to EMS:
  - "Help my child is not breathing. Please hurry"
- What are you thinking about when on wat to home?
- What do you want to have ready to go?

2 yo “Not breathing”

- Floppy and dusky child
- Now what?

2 yo "Not breathing"

- Position child to open airway
  - Any foreign body in mouth? → No
  - Any improvement with opening airway? → No
- Any chest rise? → No

- Right Size
- Right Positioning
- Right Rate

Correct
Covers mouth, nose, and chin but not eyes

Incorrect
Too large: covers eyes and extends over chin

Incorrect
Too small: does not cover nose and mouth well

2 yo "Not breathing"

- 60 seconds after starting BVM
  - Improved color;
  - Stronger brachial pulses
  - Vital signs: Pulse Ox 90% HR: 100

- Now what?

- What is on your differential diagnosis?
- Anything you want to ask family?
- Any physical exam findings you looking for?

2 yo “Not breathing”

- Pt continues to require BVM.
- Not fighting BVM
- No movement of limbs.

- Call to ED:
  - This is **** coming lights and sierns with 2 y.o. female with unresponsiveness and requiring bagging. HR 90 Pulse ox 94% being bagged and delayed cap refill. We are 3-5 min out.

2 yo "Not breathing"

- Arrives to ED with BMV in progress.
- Floppy child when moved to bed.
- HR: 100 Pox: 94% BP: 78/44 T: 37.5
- A: No structural abnormalities; no FB seen.
- B: No respiratory effort. Fair aeration with bagging
- C: 2+ brachial pulses.
- D: No obvious major injuries; Dextrose: 94
- E: Warm blanks asked for

- What else do you want to know?
- What do you want to do?

2 yo “Not breathing”

- Decision made to give Narcan
- How much?
- Pt screams and starts to breath on own.
- Urine Fentanyl POSITIVE

When to take control of airway?

- Insufficient respiratory effort
  - Depressed mental status
  - "GCS<8→Intubate" (Well not always true)
- Impending loss of airway
- Planned/anticipated next step
- Ongoing or potential risk for aspiration

How to take over an airway?

- Supraglottic airway- “Ok, I can do this”
- Intubation with ET tube- “Oh my I hope I can do this”
- Cricothyrotomy – “Oh crap, I need to change my pants”

RSI in 3 slides

- What is Rapid Sequence Intubation
  - Rapid administration of medications for sedating and paralyzing patient to aid in placement of ET tube
  - Ideal given rapidly so no BVM ventilation
    - decreases gastric distention and thus decreases aspiration risk
- Why?
  - Improved view
  - Improved 1st pass success rate
  - Minimize aspiration
  - Shorter times to successful intubation

RSI in 3 slides

- Sedation Meds:
  - Ketamine (2mg/kg)
    - Onset: 30 sec
    - Duration: 5-15 min
  - Etomidate (0.3 mg/kg)
    - Onset: 15 Sec
    - Duration: 3-10 min
- Paralytics
  - Rocuronium (1 mg/kg)
    - Onset: 60-120 sec
    - Duration: 30-60 min (reversal medication: Sugammadex)
  - Succinylcholine (1.5 mg/kg)
    - Onset: 60-90 sec
    - Duration: 3-6 min

RSI in 3 slides

- Post intubation medications
  - Make sure you have a plan prior to intubation
- Sedation/pain:
  - Ketamine
  - Versed/fentanyl
- Paralytic:
  - Vecuronium
  - Rocuronium
  - Propofol

What makes an intubation a difficult intubation?

- Trauma- Direct airway trauma and/or C-collar
- Anatomical abnormalities
- Inexperience for patient type
- Hemodynamically unstable patient
  - Hypotension
  - Hypoxia
  - Acidosis

Risk Factors for Peri-intubation Cardiac Arrest in a Pediatric Emergency Department

Nicholas Pokrajac, MD, Emily Sbiroli, MD,† Kathryn A. Hollenbach, PhD, MPH,‡ Michael A. Kohn, MD, MPP,* Edwin Contreras, MD,§ and Matthew Murray, MD†*

PEC Jan 2022

TABLE 2. Hemodynamic, Respiratory, and Intubation Characteristics of Cases and Controls

	PICA (n = 21)	Controls (n = 84)	OR (95% CI)	*P*
Hemodynamic and respiratory characteristics				
Elevated HR	11 (52.4)	53 (63.1)	0.6 (0.2–1.7)	0.455
Systolic hypotension (or unobtainable)	12 (57.1)	6 (7.1)	**17.3 (5.2–57.5)**	**<0.001**
Diastolic hypotension (or unobtainable)	11 (52.4)	6 (7.1)	**14.3 (4.3–47.1)**	**<0.001**
Elevated SI	6 (37.5)	17 (20.2)	2.4 (0.8–7.4)	0.191
Delayed CRT (>2 s)	18 (85.7)	19 (22.6)	**20.5 (5.5–77.2)**	**<0.001**
Received at least 10 mL/kg IVF	5 (23.8)	31 (36.9)	0.5 (0.2–1.6)	0.312
Hypoxia (or unobtainable)	13 (61.9)	2 (2.4)	**66.6 (12.7–349.1)**	**<0.001**

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TABLE 2. Hemodynamic, Respiratory, and Intubation Characteristics of Cases and Controls

	PICA (n = 21)	Controls (n = 84)	OR (95% CI)	*P*
Type of paralytic agent				0.639
Rocuronium	13 (61.9)	72 (85.7)		
Vecuronium	2 (9.5)	7 (8.3)		
Succinylcholine	1 (4.8)	2 (2.4)		
No paralytic agent	5 (23.8)	2 (2.4)	**12.8 (2.3–71.9)**	**0.003**
Type of sedative agent				0.452
Etomidate	3 (14.3)	29 (34.5)		
Ketamine	2 (9.5)	5 (6.0)		
Benzodiazepine	2 (9.5)	24 (28.6)		
Pentobarbital	3 (14.3)	16 (19.0)		
Other	1 (4.8)	7 (8.3)		
No sedative agent	10 (47.6)	3 (3.6)	**24.5 (5.8–103.2)**	**<0.001**
Night intubation (7:00 PM to 7:00 AM)	9 (42.9)	29 (34.5)	1.4 (0.5–3.8)	0.612
Greater than 1 intubation attempt	14 (66.7)	23 (27.4)	**5.3 (1.9–14.8)**	**0.001**

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ORIGINAL CONTRIBUTION

Identification of the Physiologically Difficult Airway in the Pediatric Emergency Department

Preston N. Dean, MD[1,2], Erin F. Hoehn, MD[1,2,3], Gary L. Geis, MD[1,2], Mary E. Frey, MSN[1], Mary K. Cabrera-Thurman[1], Benjamin T. Kerrey, MD, MS[1,2], Yin Zhang[4], Erika L. Stalets, MD, MS[2,5], Matthew W. Zackoff, MD, MEd[2,5], Andrea R. Maxwell, MD[2,5], Tena M. Pham[5], and Andrew J. Lautz, MD[2,5]

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-primary outcome: peri-intubation cardiac arrest, defined as cardiac arrest (documented chest compressions or non-perfusing rhythm within 10 minutes of the completion of tracheal intubation)

Table 1
Clinical Characteristics of Patients Undergoing Tracheal Intubation in the PED by Risk Group

Characteristic	High Risk (*n* = 36)	Standard Risk (*n* = 177)	p-value*
Age (months)	8.5 (1-118.5)	18 (2-89)	0.489
Indication for RSI			<0.0001
Respiratory	16 (44)	71 (40)	
Altered mental status	9 (25)	30 (17)	
Sepsis	5 (14)	0	
Cardiac arrest	3 (8)	0	
Seizure	3 (8)	76 (43)	
High-risk criteria met			Not applicable
Hypotension	15 (42)	0	
Cardiac dysfunction	12 (33)	0	
Hypoxia	11 (31)	0	
Metabolic acidosis	8 (22)	0	
Post-ROSC	7 (19)	0	
Status asthmaticus	2 (6)	0	

Table 2
Outcome Data for Patients Undergoing Tracheal Intubation in the PED by Risk Group

Outcome	High Risk (*n* = 36)	Standard Risk (*n* = 177)	% Difference (95% CI)	p-value*
Peri-intubation arrest	2 (5.6)	0	5.6 (1.0 to 18.1)	0.0279
Any postintubation arrest in STS	4 (11.1)	0	11.1 (4.1 to 25.3)	0.0007
In-hospital mortality	9 (25)	4 (2.3)	22.7 (11.0 to 38.9)	<0.0001
ECMO	3 (8.3)	0	8.3 (2.5 to 21.8)	0.0044
First-attempt success	17 (47.2)	117 (66.1)	−18.9 (−35.5 to −1.5)	0.0382

Data are reported as *n* (%).

Physiologically Difficult Airway

Patients at increased risk of peri-intubation decompensation if have:

- Hypoxia
- Hemodynamic instability
- Cardiac dysfunction
- Acid/base derangements
- Asthma patient

Plan for Successful RSI

1. Identifying the physiologically difficult
2. Do you need to intubate? Do we need to **RIGHT NOW**?
3. Optimization of physiologic status prior to tracheal intubation
    1. Correct Hypoxia– pre-oxygenation, apneic oxygenation (don't tolerate hypoxia)
    2. Get as close as possible to hemodynamically stable
        1. IVF bolus (improve preload)
        2. Pressors (improve cardiac squeeze and vascular tone→ preload
            1. Epi drip, or "Low dose Epi" (1/10th code dose epi)
    3. Correct acidosis (Myocardium doesn't like acidosis)
4. Having cardiac arrest precaution measures in place
5. Optimize first past success- paralytic, induction agent, and most-experienced intubator

5 yo vomiting and difficulty breathing

- 13:10 911 call– Something is wrong with my son, he is vomiting and having trouble breathing.

- What are you thinking as you are driving to home?

5 yo vomiting and difficulty breathing

- 13:18 Arrive at home
  - MOC w/ patient meet you at the door.
  - Pt coughing and then has his 4th episode of emesis
  - HR: 140 RR: 36 Pox: 92% on RA
  - Pale appearing and coughing
  - Heart: S1 S2 tachycardic
  - Lungs: coughing with every deep breath; poor aeration
  - Derm: diffuse erythematous rash on trunk and lower extremities

- What else do you want to know?

- What is going on?

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Anaphylaxis

- Severe life-threatening allergic rx
- Symptoms can develop rapidly- seconds/minutes
- Can lead to anaphylactic shock (distributive shock)- massive vasodilation

Anaphylaxis-Symptoms

- Flushed/red skin
- Hives
- Intense itching
- Angioedema
- Noisy breathing (stridor, wheezing)
- Tachycardia
- Hypotension
- Anxiety
- N/V

Anaphylaxis- Interventions

- Maintain open airway
- Keep calm
- Oxygen
- IV fluid bolus if suspect severe rxn/BP ⬇
- Bronchospasm- albuterol
- Antihistamines
- Corticosteroids

- Auto-injector epi
- Epinephrine (1:1000)
  - 0.01 mg/kg (0.01 mL/kg)
    IM- lateral thigh

Take Home Points

- Remember ABC's (both of them)
  - Airway, Breathing Circulation
  - Asthma, Bronchiolitis, Croup
- Basic interventions save lives:
  - Suction
  - Good BVM is better than iffy intubation
- Albuterol is not "All-better-ol"
  - Think about how/where it works and what you are treating
- All breathing issues are not a primary respiratory problem

THE END

Questions?

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