


Pediatric Respiratory Failure

A close-up photograph of a child's mouth with a blue endotracheal tube inserted into the trachea. The tube is secured with a white strap. The child's lips are slightly parted, and the tongue is visible. The background is a blurred skin tone.

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A street scene in a town with historic buildings. On the left, there's a building with a red frame and large windows. In the center, a building with a decorative facade and a small tower. On the right, a tall brick clock tower with a bell. The sky is clear and blue. A dark blue box with white text is overlaid in the center.

6-year-old male
with difficulty
breathing

- Sick for 3 days
- Fever
- Flu-like symptoms



- **Semi-conscious**
- **Cyanotic**
- **Irregular breathing**



EMERGENCY CARE



13th Edition

Daniel Limmer

Michael F. O'Keefe

Medical Editor: Edward T. Dickinson, MD, FACEP

- **Semi-conscious**
- **Cyanotic**
- **Irregular breathing**

=

**Respiratory
Failure**



Incorrect

The patient got worse.



The patient got a lot worse.



“I CAN’T FEEL A PULSE.”



Respiratory disorders account for almost 10 million of the 30 million emergency department visits by children in the US annually

70-80%

August 7 th , 2018 1800 - 2200	Chapter 32 Obstetric and Gynecologic Emergencies Lab: Childbirth	
August 9 th , 2018 1800 - 2200	Chapter 33 Pediatric Emergencies Chapter 34 Geriatric Emergencies Protocols: 2.12, 2.13, 2.14, 2.15, 8.11	





**4,400 pediatric calls
(4.6%)**

- *124 IVs*
- *12 BVM/PPV*
- *13 pediatric arrests*

So how do we get ready?

Respiratory Challenge

Compensation

**Respiratory
Distress**

Meeting
Metabolic
Demands

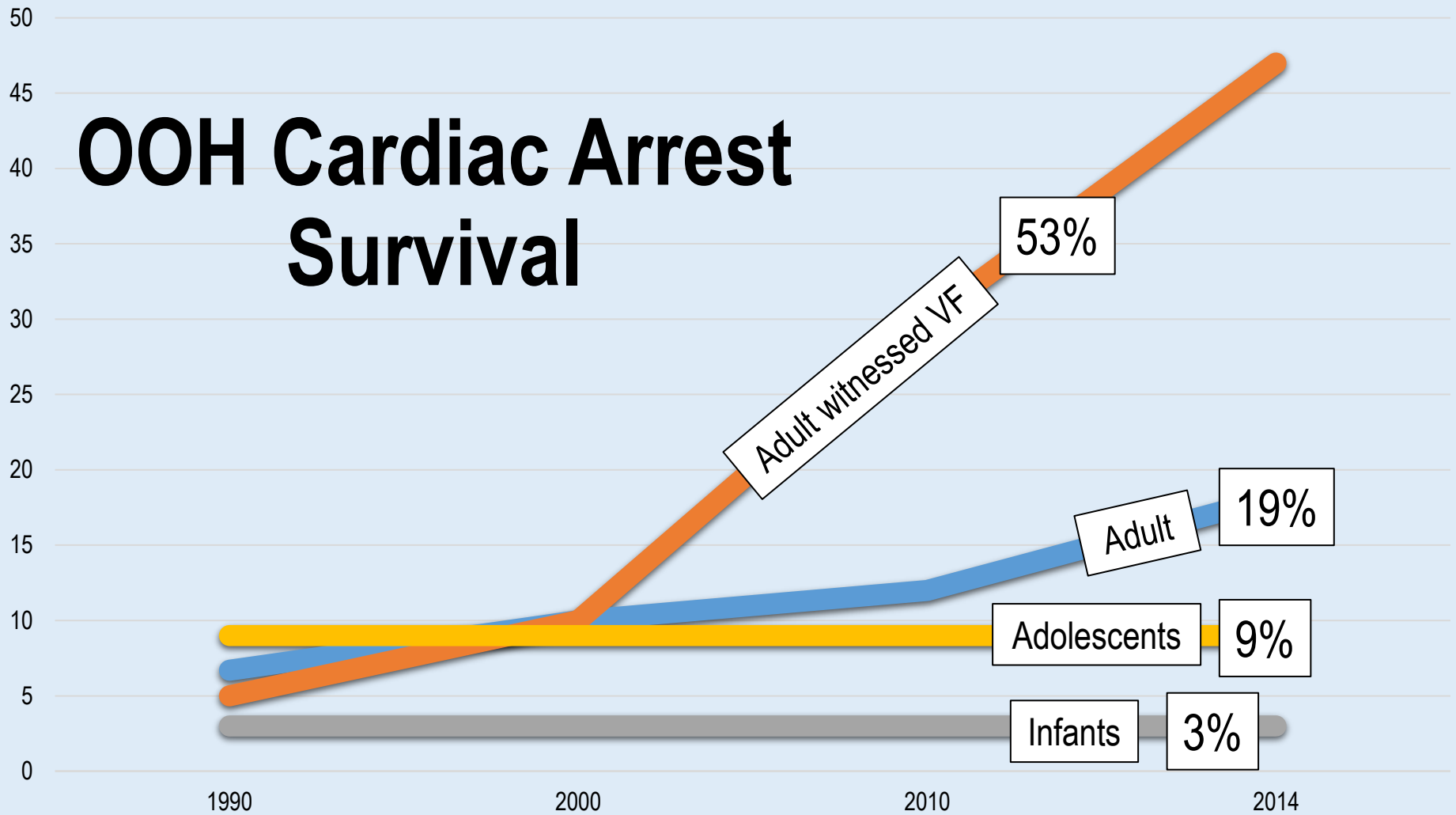
**Respiratory
Failure**

Not Meeting
Metabolic
Demands

peri-arrest state



OOH Cardiac Arrest Survival



Yamaguchi Y, Woodin J, Gibo K, et al. (2017). Improvements in Out-of-Hospital Cardiac Arrest Survival from 1998 to 2013. *Prehosp. Emerg. Care.* 21(5): 616-627.

Fink E, Prince D, Kaltman J, et al. (2016). Unchanged Pediatric Out-of-Hospital Cardiac Arrest Incidence and Survival Rates with Regional Variation in North America. *Resuscitation.* 2016 Oct; 107: 121-128.

2017 Centers for Disease Control and Prevention cardiac arrest survival data

RECOGNIZE



*Kids are hard
to please*

A large, bright fire burning at night, with a text overlay. The fire is composed of many sticks and branches, creating a large, intense flame. The background is dark, suggesting a night scene. The text is in a yellow, sans-serif font and is enclosed in a thin yellow border.

Metabolize oxygen 2X faster than adults



Developing Lungs

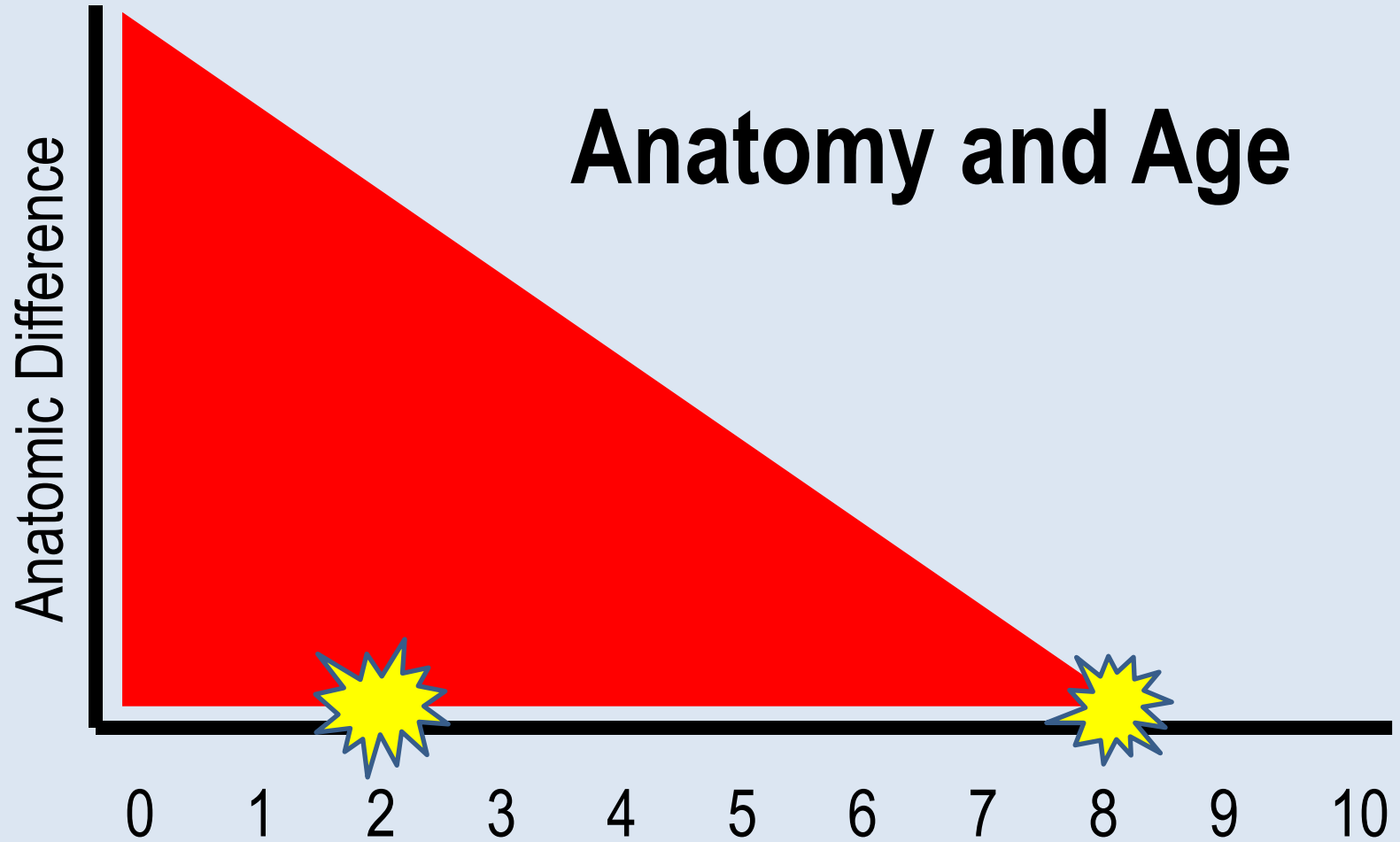
20-50 million alveoli at birth

300 million by the age of 8 years

*Kids
compensate
differently*



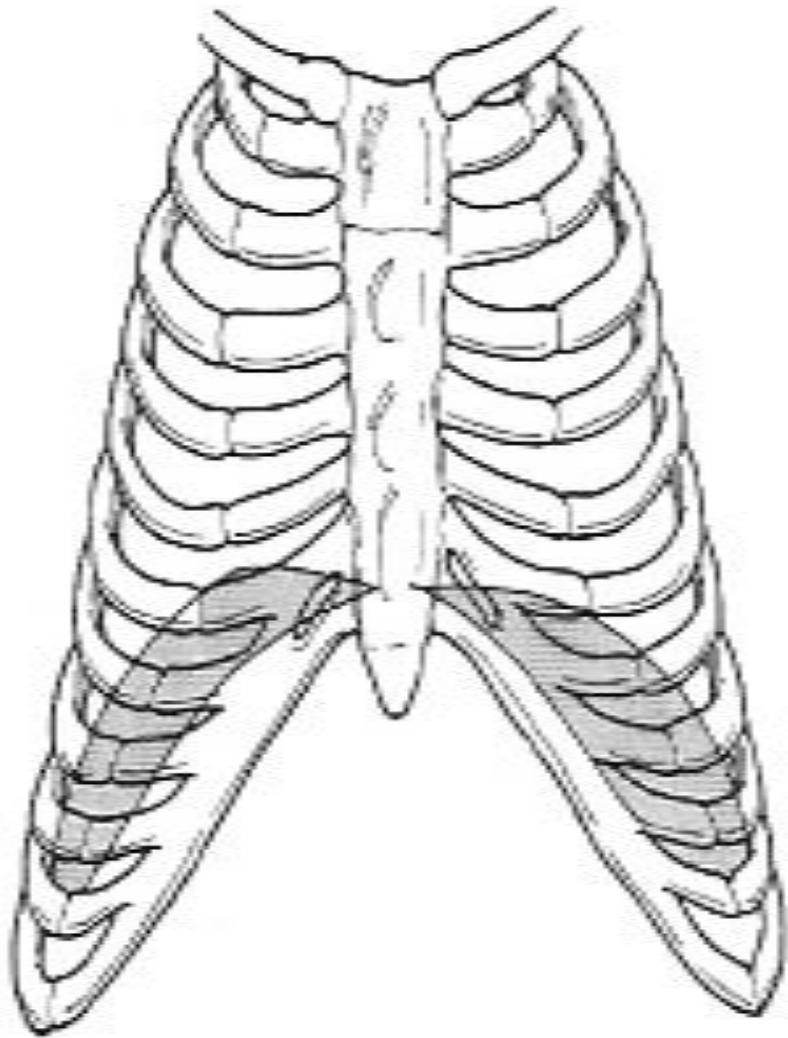
Anatomy and Age



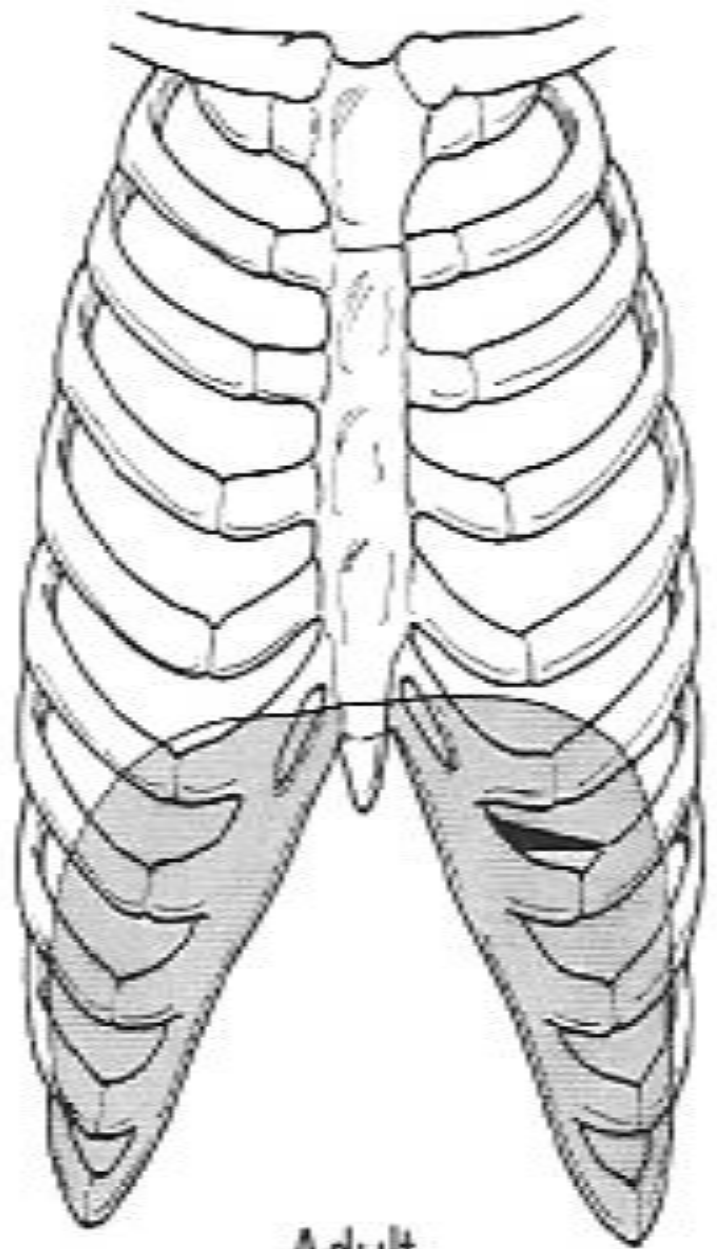


Infant respiratory muscles have reduced type 1 muscle fibers, specifically the diaphragm





Newborn



Adult



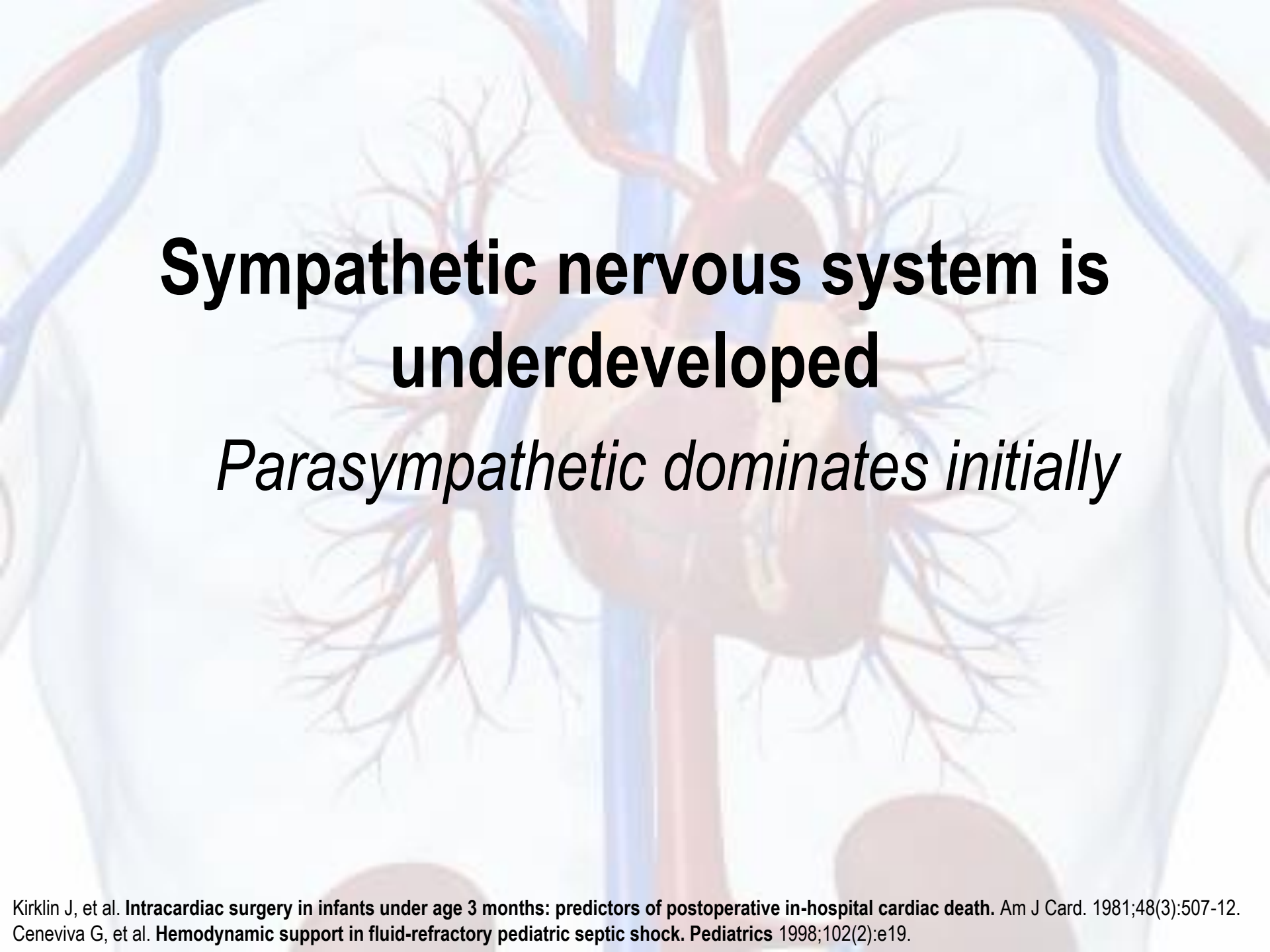
Nitu M, Eigen H, (2009). Respiratory Failure. *Pediatrics in Review*. 30(12): 470-478



Heart is less compliant

- *Adult myocardium = 60% contractile elements*
- *Newborn myocardium = 30% contractile elements*

Intravascular volume maintains preload



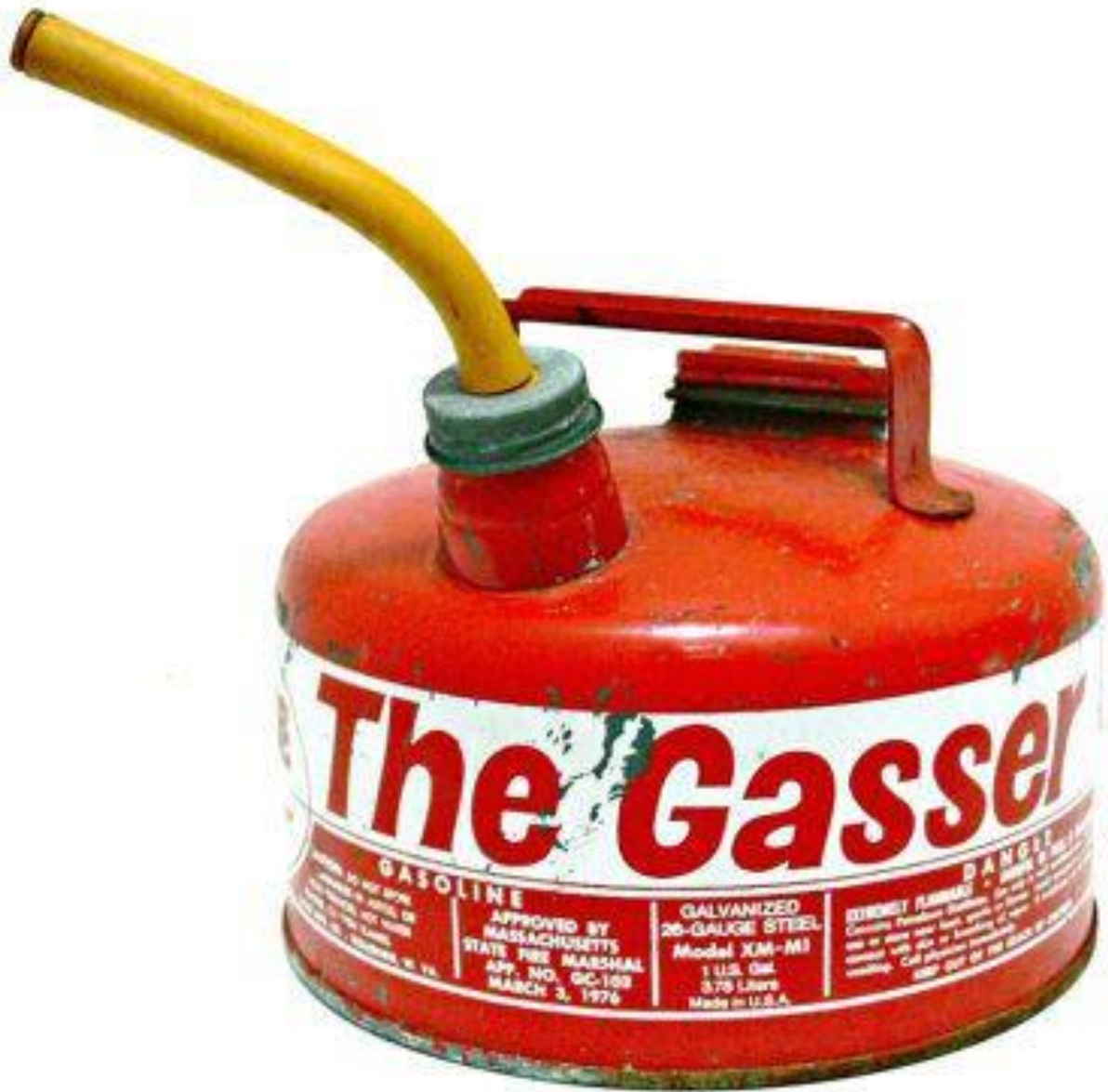
Sympathetic nervous system is underdeveloped

Parasympathetic dominates initially

Rate is key



**Work of
breathing can
account for
40% of the
cardiac output**



The Gasser

GASOLINE

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It isn't always linear

So how do we recognize it?



Play the odds.

≈50% of documented respiratory failure occurs in neonates and 66% occur in the first postnatal year

Nitu M, Eigen H. (2009). Respiratory failure. *Pediatr Rev.* 30(12):470–478.

Hammer J. (2013). Acute respiratory failure in children. *Paediatr Respir Rev.* 14(2):64–69

Gutierrez J, Duke T, Henning R, et al. (2008). Respiratory failure and acute respiratory distress syndrome. In: Taussig L, ed. *Pediatric Respiratory Medicine*. Vol 2. Philadelphia, PA: Mosby Elsevier. 253–274

*It starts
with a
challenge*



Lung and airway disorders	Respiratory pump failure	
<i>Lung parenchyma</i>	<ul style="list-style-type: none"> • Restrictive lung disorders (kyphoscoliosis) 	
<ul style="list-style-type: none"> • Bronchiolitis 	<ul style="list-style-type: none"> • Chest wall abnormalities: congenital or traumatic (flail chest) 	
<ul style="list-style-type: none"> • Severe asthma 	<ul style="list-style-type: none"> • Neuromuscular disorders (phrenic nerve paralysis, myopathies, muscular dystrophies) 	
<ul style="list-style-type: none"> • Aspiration 	<ul style="list-style-type: none"> • Diaphragmatic disorders (paralysis, congenital diaphragmatic hernia) 	
<ul style="list-style-type: none"> • Pneumonia 		
<ul style="list-style-type: none"> • Pulmonary edema 		Failure to meet increased metabolic needs
<ul style="list-style-type: none"> • Cystic fibrosis 		<ul style="list-style-type: none"> • Septic shock
<i>Airway</i>	Respiratory center failure	
<ul style="list-style-type: none"> • Laryngotracheobronchitis 	<ul style="list-style-type: none"> • Brain injuries (traumatic) 	
<ul style="list-style-type: none"> • Croup 	<ul style="list-style-type: none"> • Central nervous system infection (controlled mechanical ventilation) or hypoxic encephalopathies 	
<ul style="list-style-type: none"> • Tracheitis 	<ul style="list-style-type: none"> • Drug overdose or adverse effects 	
<ul style="list-style-type: none"> • Vascular malformation 	<ul style="list-style-type: none"> • Congenital (leukomalacia) or genetic disorders (congenital hypoventilation syndrome) 	
<ul style="list-style-type: none"> • Subglottic stenosis, congenital 		

Classic Presentations



Tachypnea

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Reference ranges and milestones are guidelines, always follow local protocol. Each patient's individual clinical situation should always be taken into account.

	Weight in lbs	Weight in kg	Resp Rate	Heart Rate	Systolic BP
Preterm (<37 wks)	1.5 - 5.5	0.7 - 2.5	50-70	120-180	40-60
Newborn (37-42 wks)	5.5 - 9.5	2.5 - 4.3	40-60	100-170	50-70
Neonate (1-28 days)	7.5 - 11	3.4 - 5	30-50	90-160	60-80
Infant (1-12 months)	10 - 22	4.5 - 10	25-40	80-160	70-100
Toddler (1-3 yrs)	22 - 32	10 - 14.5	20-30	80-130	70-110
Preschooler (3-5 yrs)	32 - 42	14.5 - 19	20-30	80-110	80-110
School Age (6-12 yrs)	42 - 90	19 - 41	20-24	75-100	80-120
Adolescent (>13 yrs)	> 90	> 41	12-20	60-90	94-130

Pediatric Reference
Version A.1

Author and Publisher intend this reference to be free of errors and accurate but no guarantee can be made. Author and Publisher assume no responsibility for any outcomes that result from the use of this reference.



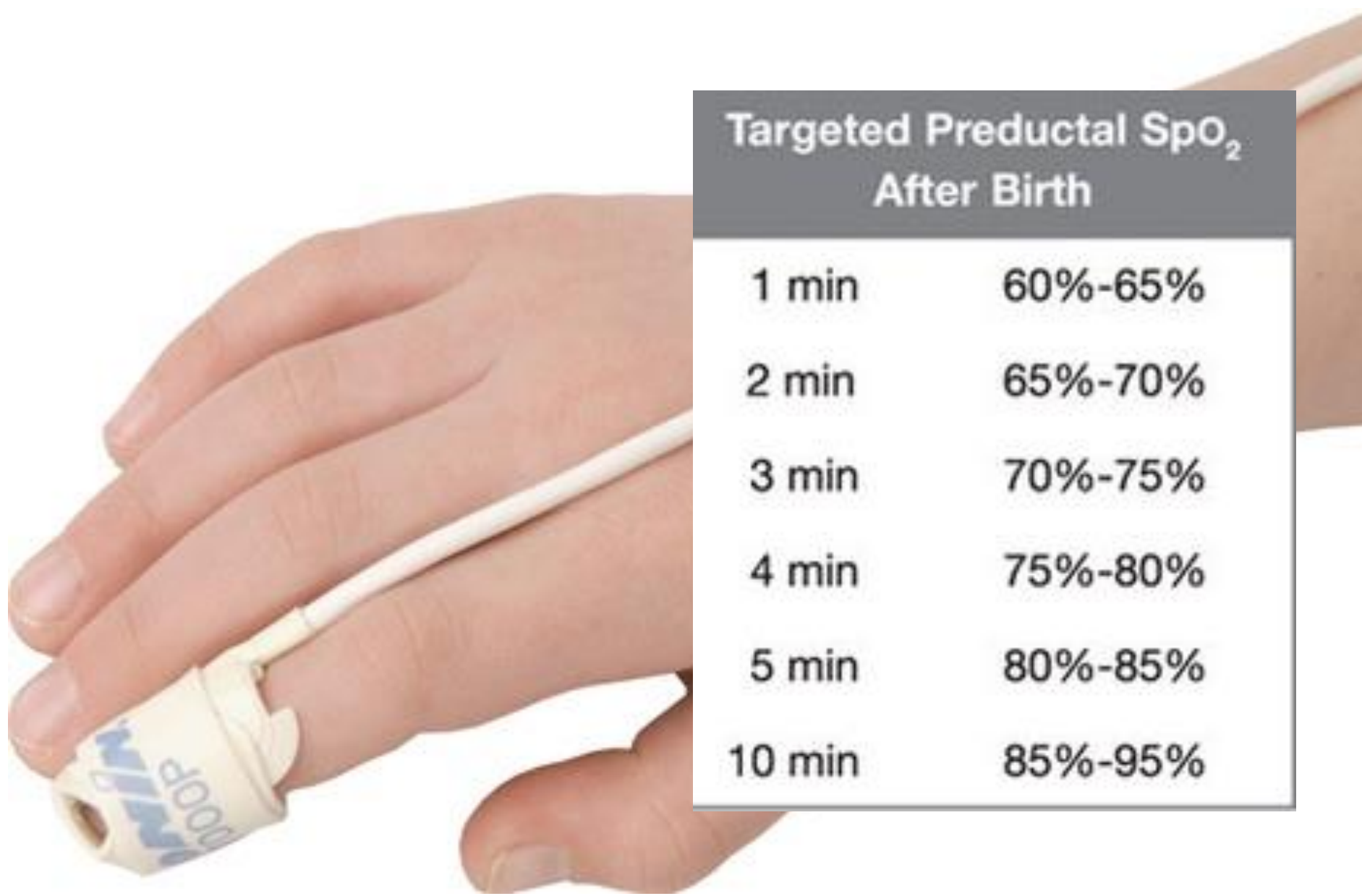




BEWARE...

*Kids that are out of ATP or
dominated by parasympathetic tone
won't be breathing fast*

Technology is your friend



Targeted Preductal SpO₂ After Birth

1 min	60%-65%
2 min	65%-70%
3 min	70%-75%
4 min	75%-80%
5 min	80%-85%
10 min	85%-95%





Pco₂ Above Baseline (in mm Hg)

+5: Hot hands

+10: Rapid bounding pulse, small pupils

+15: Engorged fundal veins, confusion or drowsiness, muscular twitching

+30: Depressed tendon reflexes, depressed extensor plantar responses, and coma

+40: Papilledema



Phuong Vo, Virginia S. Kharasch. (2014). Respiratory Failure. *Pediatrics in Review*. 35(11).

“During an acute asthma exacerbation, a PaCO₂ of 42 mmHg or greater, while technically “normal,” may suggest incipient respiratory failure.”





Ventricular Fibrillation



Tachycardia – Bradycardia – Asystole



Respiratory failure is not based on any
single finding





So what do we do about it?



Hammer J, (2013). Acute respiratory failure in children. *Paediatr Respir Rev.* 14(2):64.



Round 1	Room 1	Room 2
1700-1730	Team 1 (Team 4)	Team 2 (Team 3)
1730-1745	Debrief	Debrief
1745-1815	Team 3 (Team 1)	Team 4 (Team 2)
1815-1830	Debrief	Debrief
1830-1845	Wrap Up	Wrap Up

Round 2	Room 1	Room 2
1900-1930	Team 5 (Team 7)	Team 6 (Team 8)
1930-1945	Debrief	Debrief
1945-2015	Team 8 (Team 1)	Team 7 (Team 6)
2015-2030	Debrief	Debrief
2030-2045	Wrap Up	Wrap Up



"He who fails to plan is
planning to fail"

- Sir Winston Churchill

Thank You!

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- What is it? (challenge-response-capability of that response) not always linear
- Meeting metabolic demands vs not meeting
- Different pediatric demands
- Different capabilities to respond
- Peri-arrest state and the challenges of peds arrest
- So how do we know?
- What do we do about it?

A barky cough indicates subglottic tracheal obstruction, most commonly due to croup.

-A staccato cough suggests pneumonia caused by Chlamydia or Mycoplasma species.

-A dry, tight cough may occur in patients with wheezing due to asthma or bronchiolitis.

-A loose, wet cough may indicate tracheal secretions or bacterial pneumonia.

Unilateral wheezes may be appreciated if there is a foreign body in the lower airway.

A close-up photograph of a person's chest wall. A medical sensor, likely a strain gauge or similar device used for measuring chest wall compliance, is attached to the skin on the left side. The sensor consists of a small white circular pad with a blue metal disc on top. The skin is light brown and shows some minor blemishes. The person's arm is visible on the right side of the frame, and a portion of their hand is visible at the top. The background is a light-colored, possibly white, surface.

Chest Wall Compliance







