How to Stay in the Saddle During a Rodeo: Pediatric Airway Pearls

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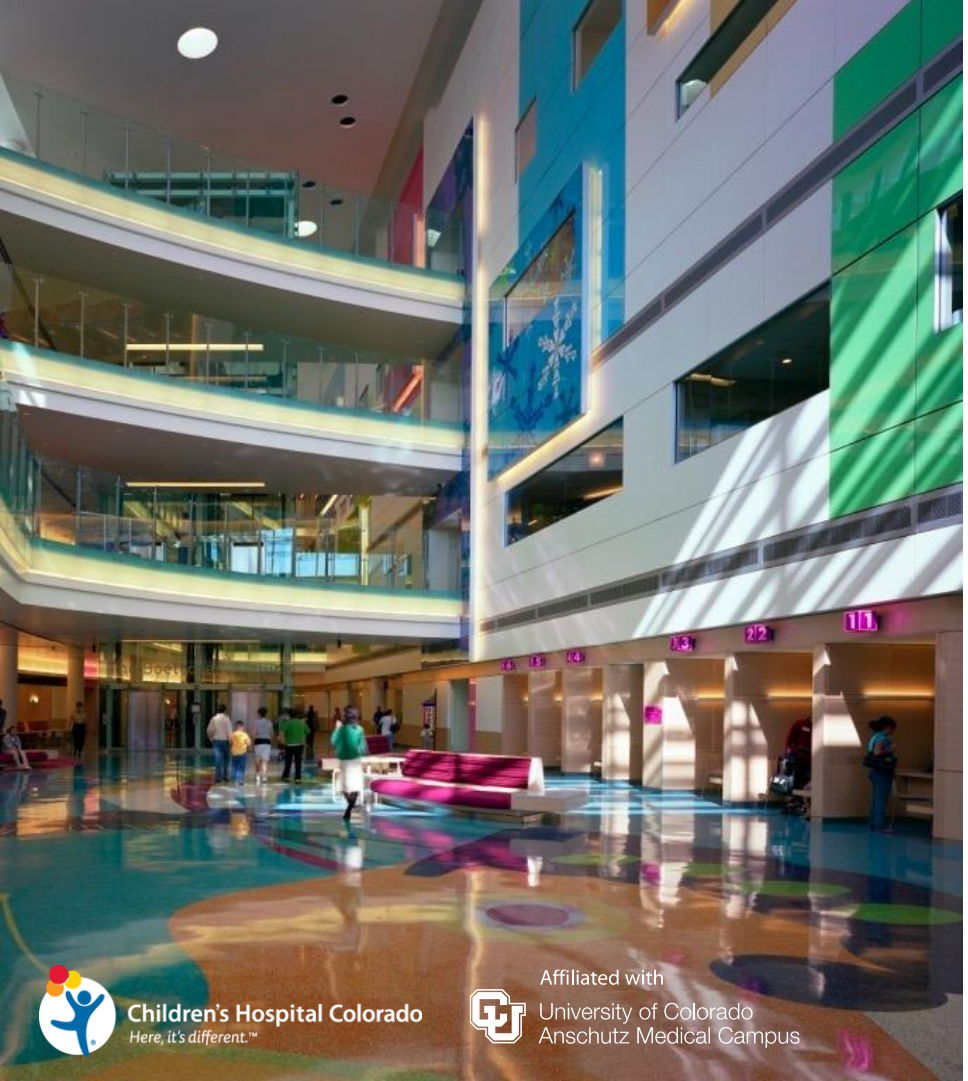

Financial Disclosure: I have no relevant financial disclosures with any commercial interest

Disclosure of Aspiration: Quality is not an act. It is a habit.

- Aristotle

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Get Your Spurs On: Time to Talk Objectives

- Discuss the clinically relevant differences between the pediatric and adult airway
- Identify predictors of a difficult pediatric airway
- Understand the common pitfalls made in pediatric airway management

Photo credit: www.theredlist.com

What Do You Do When . . .

You don’t encounter it often:

- 1 in 100 EMS patients is a child with respiratory distress
- 9 in 10,000 ED visits is a pediatric patient requiring advanced airway management

But the stakes are high:

- Unrecognized or inadequately treated respiratory failure is the leading cause of cardiopulmonary arrest
- Delay/Failure by minutes = increased morbidity and mortality

Hansen M, et al. Resuscitation 2015; American Heart Association 2010; Mort et al. Anesth Anal 2004

Must Consider Other Realities

- A crashing pediatric patient presents unique challenges that often lower the likelihood of success
- Adverse event occurs in 15-39% of pediatric intubations
- Younger patient = lower success
- The average urban EMS provider attempts pediatric intubation once every 3-5 years
    - Management of an adult airway is once every 20 days

Capone CA, et al. *Acad Emerg Med* 2021; Long, E et al. *Paediatr Anaesth* 2014; Pallin DJ et al. *Ann Emerg Med* 2016; Konrad et al. Anesth Analg 1998

Don’t Be Scared. You Just Need a Better Plan!

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The Plan: Know Before You Start

1. Understand the differences, optimize the physiology
2. Examine the patient and situation
3. Identify your goals
   - What do I want to accomplish?
   - How critical is it to do something now?
   - Am I the one to do it?
   - Is this the place to do it?
4. Anticipate what could go wrong and have options ready

If You Climb in the Saddle, Be Ready for a Ride

<u>Bottom Line</u>

First Principle of Airway Management is to Learn the 7 Ps of Preparation:

Prior Proper Planning Prevents Piss Poor Performance

Photo credit: www.freepik.com

Oh, Baby. . . Let Me Count the Ways

Critical differences between the big and the small

Prominent Occiput

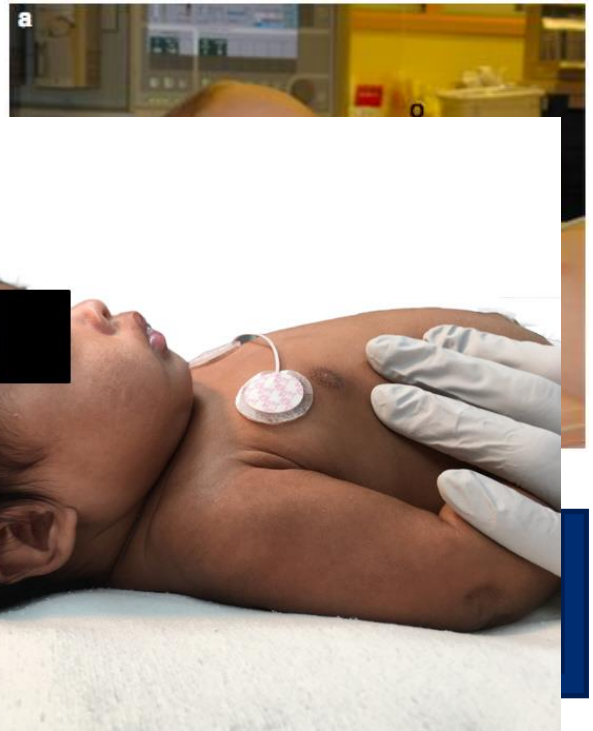

Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

Photo credit: Karsli C. *Can J Anesth* 2015

Result:

- Neck flexion causes UAO
- O/P/L axes not aligned, making laryngoscopy difficult

Management:

- Shoulder roll
- True sniffing position

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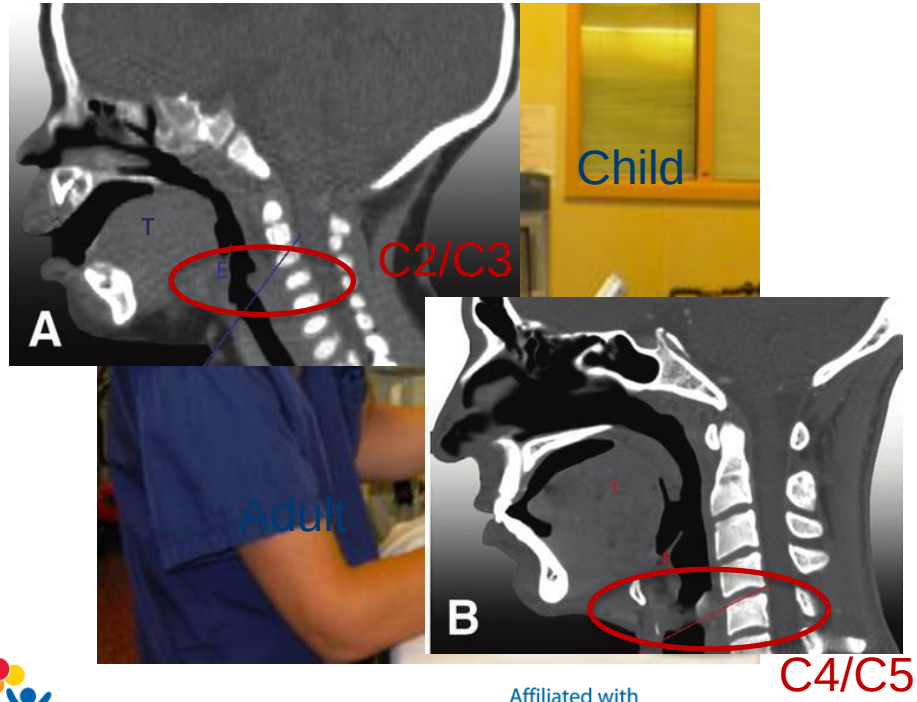
Cephalad Larynx



Result:

- Shorter distance between tongue and epiglottis creates acute angle
- Larynx seems more anterior

Management:

- Optimal positioning
- Gentle cricoid

Photo credit: Tumu AY et al. *Neurographics* 2014

Photo credit: Karsli C. *Can J Anesth* 2015

Floppy Epiglottis Angled Over Vocal Cords

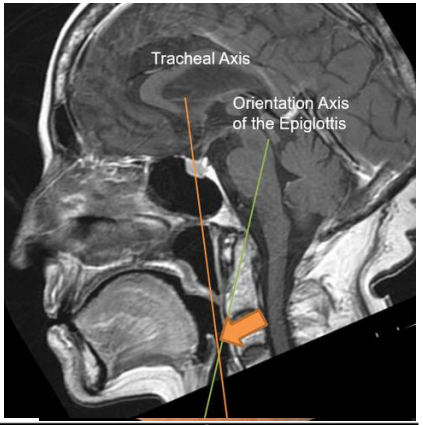
Result:

- More difficult to lift epiglottis and visualize VC
- ETT can get caught on anterior commissure of VC

Management:

- Gentle cricoid
- Straight blade in children under 3
- Hockey stick

Adult



Pediatric

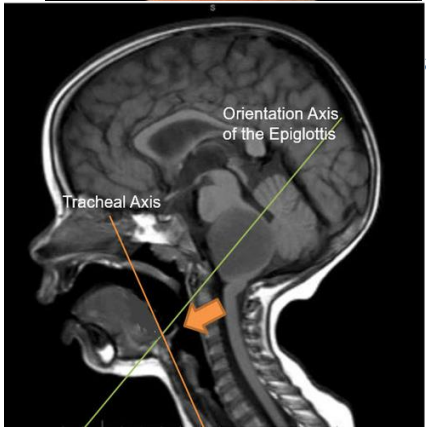


Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

Significant Soft Tissue and Large Tongue

Result:

- Increased risk of obstruction
- Difficult direct visualization

Management:

- OPA
- Lateral approach to direct laryngoscopy

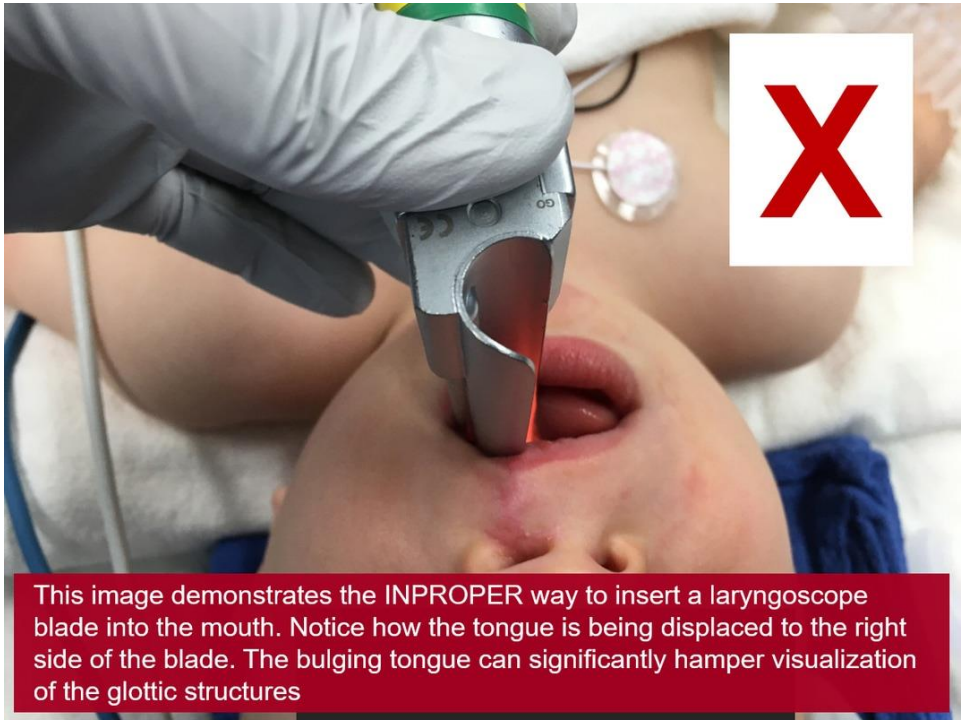


Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

Physiologic Immaturity

Result:

- Higher O_2 consumption
- Picture of inefficiency
- Higher RR

Management:

- Expect rapid desaturation during apnea
- Early O_2, preoxygenation
- Light sedation just prior to induction can be beneficial

Pediatric Principles in a Nutshell

Pediatric Airways:

- For multiple reasons, obstruct easier than adults
- Acute angles make visualization difficult
- Desaturate more quickly

Need to obtain effective oxygenation and ventilation quickly and reliably. The FIRST time

Adult Airway = Child's Play?

Photo credit: caparamedic.org


Looks Like
Your Throat
Could Use
Some Plastic:
Management Pearls

Case Example

An 18-month-old female with Down Syndrome and repaired VSD, now with 2 days of fever to 101°F, dry cough, and rapidly increasing difficulty breathing.

T 102.8°F | HR 205 | BP 80/53 | RR 70 | pO2 84% RA

Pale, dry, severe pan-retractions, nasal flaring, head bobbing, diminished breath sounds

Oh . . . And she just started daycare. A cute little place called "The Cootie Farm"

Case Example: Major Considerations

- Sepsis/shock: begin fluid resuscitation and antibiotics, have pressors drawn up and ready
- Consider cardiac complication
- Needs viral testing (including SARS-CoV-2)
- Consider Tamiflu early during flu season

And, of course, address her breathing

Simple nasal cannula?

Non-invasive Positive Pressure Ventilation (NIPPV) in Pediatrics

Increasing reliance on non-invasive means in pediatrics

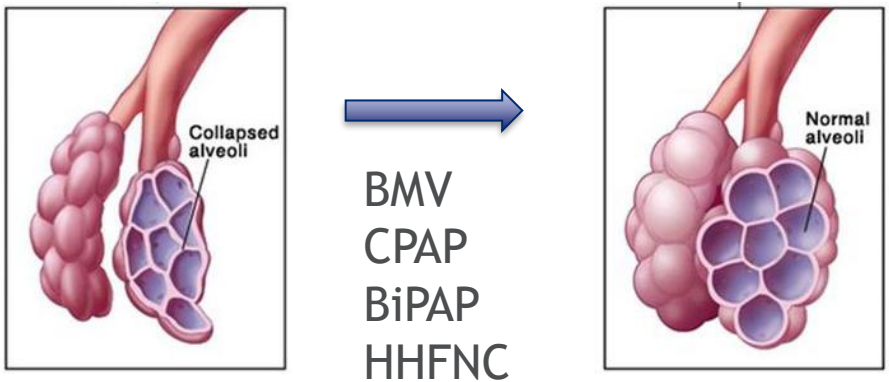


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Photo credit: medbullets.com

Non-invasive Positive Pressure Ventilation (NIPPV)

It DOES work in the hospital:

- Multiple studies show reduction in disease severity scores and intubation rates when used for bronchiolitis, asthma and lower respiratory tract disease

It MAY work in the field:

- Observational study of patients > 12 years: prehospital CPAP resulted in a decreased rate of intubation and decreased LOS in the ICU

Yanez, LJ et al. *Pediatr Crit Care Med* 2008;
Warner GS et al. *Prehosp Disaster Med* 2010

The Challenge:

Photo credit: incenter.medical.philips.com

Can
Causes

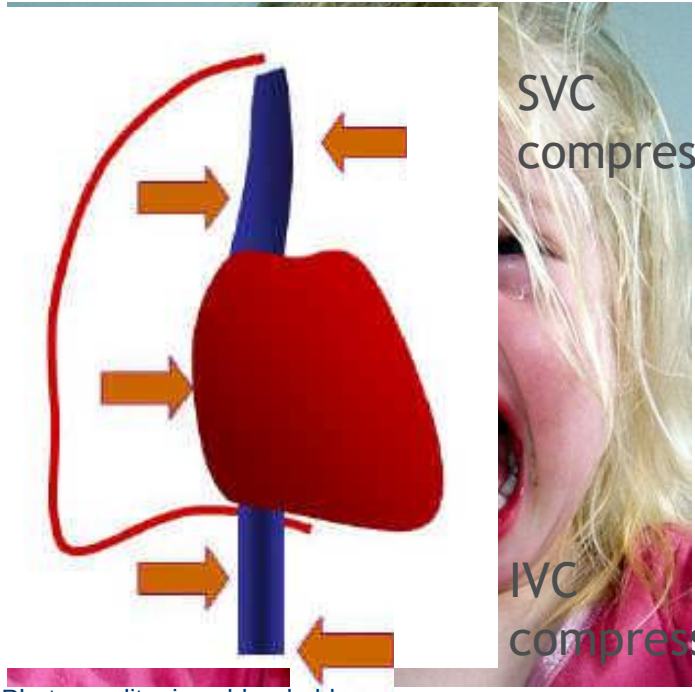

Photo credit: aic.cuhk.edu.hk

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Case Continuation

You place Janie on HHFNC at 16L/100%. Due to continued respiratory distress, you move her to scuba mask CPAP. Your next thought is:

- Should I give more fluids after she finishes this 3rd bolus?
- I should have been a banker.
- My next move is. . .

My Next Move Is: Prepare for the Worst!

We can anticipate difficulty in many cases. Help yourself!
Pediatric application of adult pneumonic:

L Look externally for indicators of of airway difficulty

E Evaluate mouth opening, neck space

M Mouth

O Obstruction signs

N Neck mobility

S Saturation

Brown CA et al. *The Walls Manual of Emergency Airway Management* 2022

Predicting Difficulty in the Pediatric Airway

Surgical corrections are often staged

Photo credit: craniofacial.org

Photo credit: cleftandcraniofacialcenterutah.com

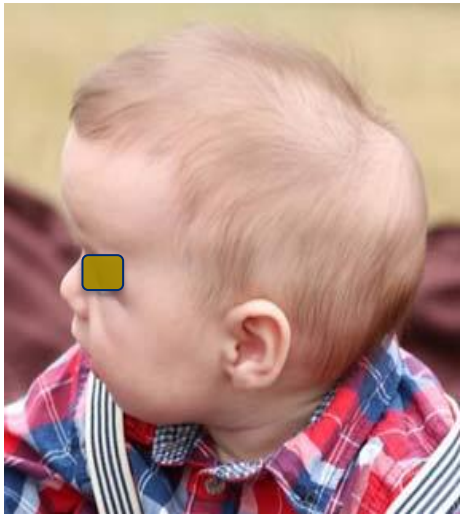

Photo credit: chkd.org

Predicting Difficulty in the Pediatric Airway

We can anticipate failure in some cases. Help yourself!

- L Look externally for indicators of of airway difficulty
- E Evaluate mouth opening, neck space
- M Mouth
- O Obstruction signs
- N Neck mobility
- S Saturation

Photo credit: midwestsinus.com

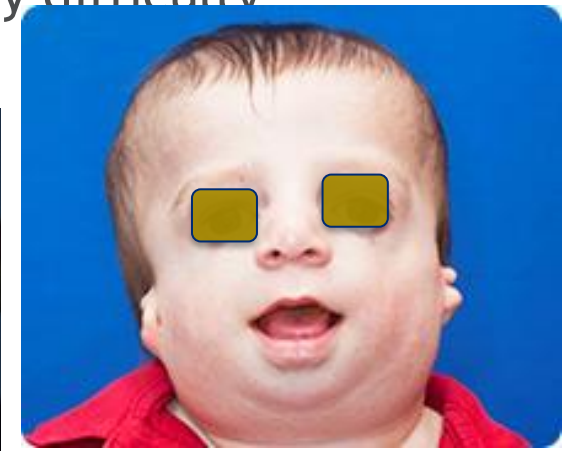

Photo credit: seattlechildrens.org

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Brown CA et al. *The Walls Manual of Emergency Airway Management* 2022

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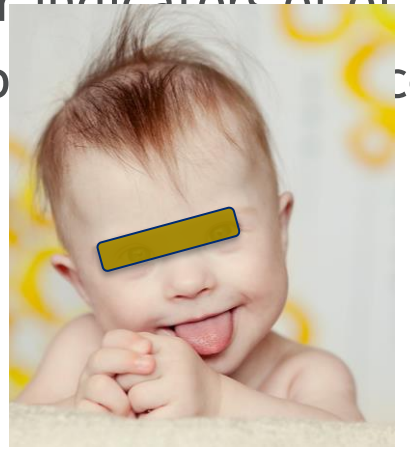

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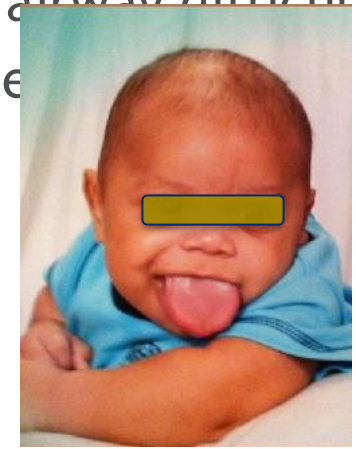

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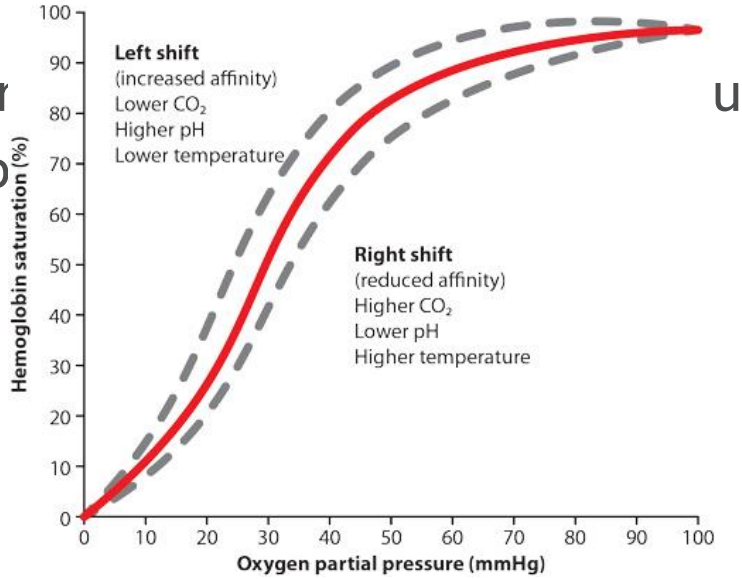

ulty

Kids:

1. Have lower safe apnea time
2. Are at higher risk for rapid hypoxemia if already desaturated

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Brown CA et al. *The Walls Manual of Emergency Airway Management* 2022

Case Continuation

As you continue to monitor, you notice that her respiratory rate has slowed to 12 bpm and her mental status has significantly declined. You begin providing bag-mask ventilation while thinking about next steps. You notice that the oxygen saturation is not improving.

Now What!?!

The Most Important Skill: BMV

- Rapid and effective means of oxygenation and ventilation
- Skill available to all provider levels
- Linked to improved survival over other means in many studies
- When something else isn't working. . . What do you return to?

Most under-rated skill in its importance. And difficulty.
Knowing how to troubleshoot is critical!

Harless, J et al. *Int J Crit Illn Inj Sci* 2014

Basics Aren't Always Basic

1. Improve positioning
   - Ramp and roll
   - Nook and Notch

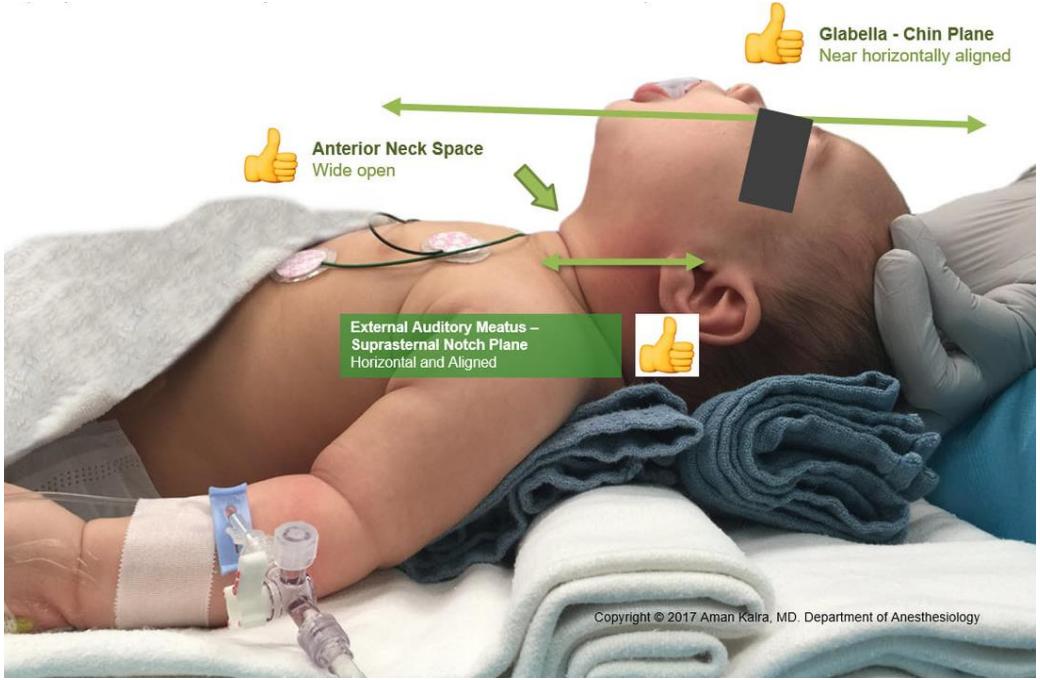


Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

Basics Aren't Always Basic

2. Verify equipment
- Appropriately sized
- Appropriately placed
- Cuff inflated

Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

Basics Aren’t Always Basic

3. Improve your technique
- Focus on the jaw thrust/chin lift
- Achieve a tight seal
- Classic C-E (one-person)

Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

”C” Ya Later

Learn a Better Technique:

- C-E becomes “V-clamp”
- 2-person whenever possible

Photo credit: Karsli C. *Can J Anesth* 2015

Basics Aren't Always Basic

4. Relieve obstructions

Late recognition of upper airway obstruction is very common

- Tracheal tug, stridor, snoring
- Paradoxical chest wall movement
- Capnography changes

Video credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

Karsli C. *Can J Anesth* 2015

Avoid These Common BMV Pitfalls:

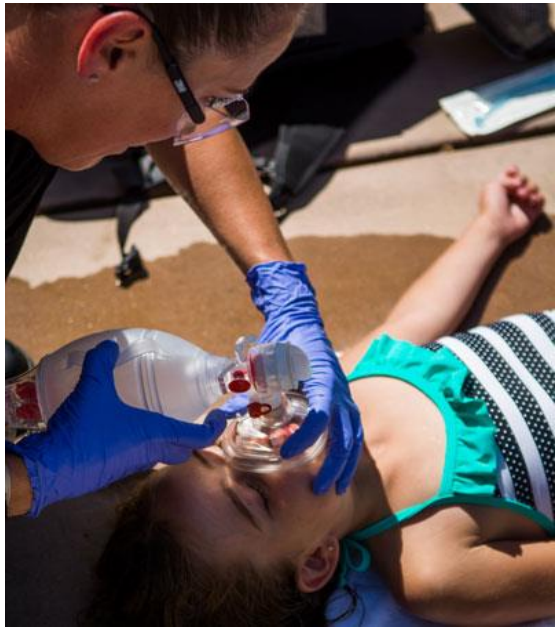
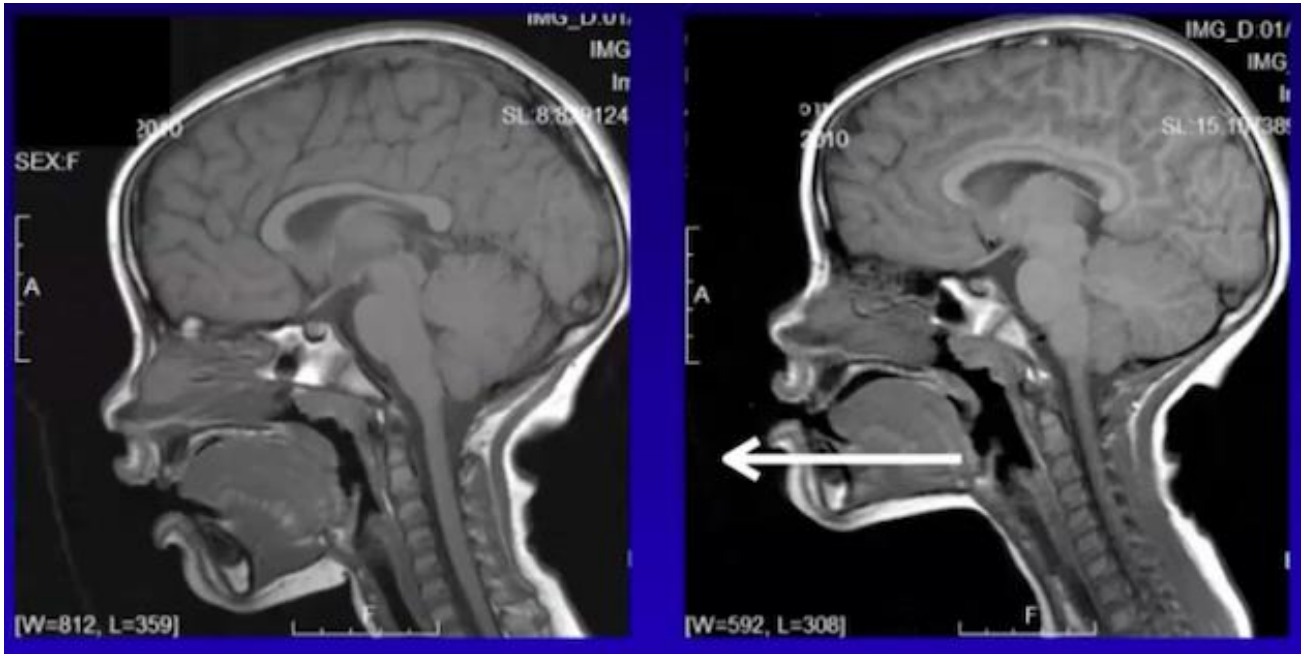


Photo credit: JEMS.com

Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

Never Underestimate the Impact of a Good Jaw Thrust!



Never Underestimate the Impact of a Good Jaw Thrust!

Video credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

Case Continuation

With technique improvement and effective jaw thrust, Janie's saturations rise to the low 90s. (insert breath of relief)

Because you Are the only person in the hospital with intubation privileges

It is apparent that advanced airway management is the next step.

How do you prepare?

Step 1: Never Squat with Spurs On

Pediatric Pre-intubation Checklist

Assess and Plan the Intubation

- ☐ Discuss any risk factors for anatomically difficult airway (including C-spine immobilization)
- ☐ Discuss any increased risk for desaturation
- ☐ Discuss any increased risk for hemodynamic instability
- ☐ State plan: Address risk factors, identify primary laryngoscopist and limits on attempts
- ☐ State back up plan: Call for institutional airway backup if needed (Anesthesia, ENT, ICU)

Prepare the Patient

- ☐ Appropriately position the patient (align external auditory meatus and sternal notch)
- ☐ Ensure all monitors in place (including end tidal carbon dioxide monitoring ready)
- ☐ Confirm working intravenous access
- ☐ Preoxygenate patient
- ☐ Prepare for apneic oxygenation (suggest 1-2 L/min/year of age)

Equipment, Personnel, and Pharmacy

- ☐ Ensure suction present and functioning
- ☐ Select appropriate size endotracheal tube (one size smaller available) and stylet

Get yourself a pre-intubation checklist

- Improves equipment selection
- Decreases desaturation events
- Decreases hypotension events

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Miller KA et al. *EMJ* 2022; Kerrey BT et al. *BMJ Qual Saf* 2015; Long E et al. *Pediatr Anesth* 2017

Give Yourself a Fighting Chance

Photo credit: MedicalAidMemoire.com

- Fill the tank
- Head up 20 degrees
- Have the equipment smorgasbord available in the correct sizes

Give Yourself a Fighting Chance

- Pre-oxygenation
- Consider nasal cannula for apneic oxygenation: low-flow O2 5LPM
- Consider delayed sequence intubation (DSI) as appropriate
  - Highly anxious children
  - Craniofacial abnormalities

Look familiar?

Napolitano N et al. *Pediatr Crit Care Med* 2019;
Weingart SD et al. *Ann Emerg Med* 2012

Give Yourself a Fighting Chance

Examine

- Difficult airway predicted? (small jaw/mouth, large tongue, short neck, C-spine precautions?)
- History of difficult airway?
- High-risk desaturation, hypotension, hypercarbia? (increased ICP, pulmonary hypertension, shock)

Optimize

- Position patient (head up, sniffing position if no trauma)
- High-flow pre-oxygenation 2-3 minutes
- Apneic oxygenation nasal cannula
- Optimize intravascular volume and cardiac output (bolus, low-dose epinephrine, pressor drip as needed)
- Confirm IV access

Assemble

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Include consideration of the:

Anatomically difficult airway
AND
Physiologically difficult airway

Appreciate The Physiologically Difficult Airway

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†*

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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Pokrajac N et al. *Pediatr Emerg Care* 2020

When You Gotta Saddle Up Anyway

1200 pediatric emergent intubations across 8 institutions

Table 4 – Multivariable models for patients meeting at least one high-risk criterion.[a]

Outcomes	Adjusted Odds Ratio (95% CI)	*P*-value
Main Outcome		
Peri-intubation arrest[b]	75.1 (9.5, 593.7)	<0.0001
Additional Outcomes		
ECMO	7.1 (2.3, 22.3)	0.0008
Mortality	3.5 (1.9, 6.3)	<0.0001

CI – confidence interval.

ECMO – extracorporeal membrane oxygenation.

[a] Data were analyzed using generalized linear mixed models with risk group as a fixed effect, patient's age, reason for intubation, and 1st pass success as covariates, and site and first proceduralist nested in site as random effects.

[b] As no patients suffered peri-intubation arrest in the group that met no high risk criteria, 1 was added to all cells in the 2 × 2 contingency table of peri-intubation arrest and risk group to remove the first-order bias from the estimation of the log odds ratio.

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Dean P et al. *Resuscitation* 2023 (Epub ahead of print)

When You Gotta Saddle Up Anyway

4 things independently associated with peri-intubation arrest:

Table 5 – Multivariable models for individual high-risk criteria.[a]

High Risk Criteria	Adjusted Odds of Peri-Intubation Arrest (95% CI)	*P*-value
Post-ROSC	26.3 (9.9, 70.1)	<0.0001
Concern for cardiac dysfunction	21.8 (7.8, 60.4)	<0.0001
Persistent hypotension	6.4 (2.5, 16.2)	0.0001
Hypoxemia despite supplemental oxygen	5.7 (2.4, 13.3)	<0.0001
Primary metabolic acidosis with pH < 7.1	2.9 (0.8, 10.5)	0.1123
Status asthmaticus	1.0 (0.1, 8.7)	0.9801

CI – confidence interval.

ROSC – return of spontaneous circulation.

Physiologically difficult airways must be identified BEFORE intubation attempts

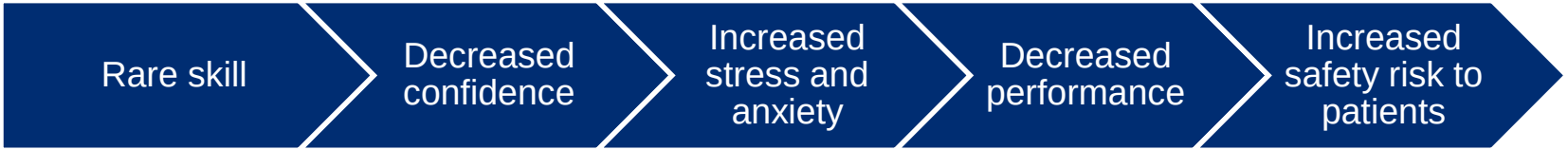
Dean P et al. *Resuscitation* 2023 (Epub ahead of print)

So Where Does That Leave Us?

The Plan: Know Before You Start

1. Consider the physiologically difficult airway
2. Consider the anatomically difficult airway
3. Identify your goals Shared mental model to address challenges
   - What do I want to accomplish?
   - How critical is it to do something now?
   - Am I the one to do it?
   - Is this the place to do it?
4. Anticipate what could go wrong and have options ready

Choose Your Weapons Carefully



Is intubation always the right answer?

The most common indications for intubation in pediatrics:

- Trauma
- Cardiac arrest
- Status epilepticus

Are we doing the right thing?

Choose Your Weapons Carefully

Some scenarios may support use of alternate tools:

- No strong evidence to support intubation over BVM or Supraglottic Devices for most acute situations
- Repeated attempts at intubation increase the risk of hypoxia/hypotension
- Each successive attempt decreased chance of successful intubation

Pepe PE et al. *Crit Care* 2015; Aufderheide TP, et al. *Circulation* 2004; Niebauer et al. *Pediatrics* 2011

Answers on the Horizon?

Two Questions:

1. Are we doing the right thing for ALL patients?
2. What is the safest, most reliable way to achieve the goal?

Is Videolaryngoscopy the Solution?

Depends upon what you read:

- Increases first-pass success by paramedics in pediatric cardiac arrest simulation
- Improves the glottic *view* in a C-spine stabilized pediatric simulation patient
- Improves intubation of neonates in an isolette
- 2 large observational PED studies: split opinion

Photo credit: bellmedical.com

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Szarpak L et al. *Am J Emerg Med* 2015; Madziala M et al. *Eur J Pediatri* 2017; Donoghue A et al. *Ann Emerg Med* 2022; Miller KA et al. *Ann Emerg Med* 2023

Beyond the DL: VL

Pros:

- Improves laryngoscopic view in the anticipated difficult airway compared to DL
- Faster time to successful ETI in difficult or after failed ETI
- Higher first-pass success in those with little intubating experience

Not So Pros:

- Same hypoxia, hypotension and airway trauma rates as with DL
- In the typical airway, no difference in 1st-pass success between VL and DL*
- Time to intubation often prolonged with VL

Video Laryngoscopy Summary

Likely most beneficial in:

- Trauma
- Cardiac arrest (but question why)
- Neonates
- Known difficult airway or multiple previous attempts (>2)
- Little experience (this is most of us!)
- Quality improvement adjunct

Hu X, et al. *J Clin Anesth* 2020; Okamoto H et al. *Resuscitation* 2019; Fiadjoe JE, et al. *Lancet Respir Med* 2016; Sun Y et al. Paediatr Anaesth 2014

(aka Just give drugs)

Case Conclusion: EMS

After optimizing the patient's condition and position, you successfully place an I-gel on the first attempt and achieve chest rise and see the pO2 rise to 97%.

- You concentrate on the squeeze-release-release, watch your EtCO2 and use a ventilation timer
- Your partner begins to chart
- The child gets diagnosed with COVID-19, but recovers well

OR

Case Conclusion: Hospital-based

After optimizing the patient's condition and drawing up RSI drugs, you successfully place an ETT with VL on first attempt and achieve chest rise and see the pO2 rise to 97%.

- You place the child on a ventilator, draw a blood gas and watch your EtCO2
- You chart on your day off ☹
- The child gets diagnosed with COVID-19, but recovers well

Case Conclusion

And you all live happily ever after (whew!)

Photo credit: techcommgeekmom.com

Summary

- Understand the unique anatomical and physiologic differences in children and you will increase your chances of success in pediatric airway management
- Embrace the 7 Ps. Know your options, know your plan.
- Embrace your goal: adequate oxygenation and ventilation. Intubation is not always the answer
- Know your airway toolbox: optimal drugs, techniques and equipment

Be an expert at BMV

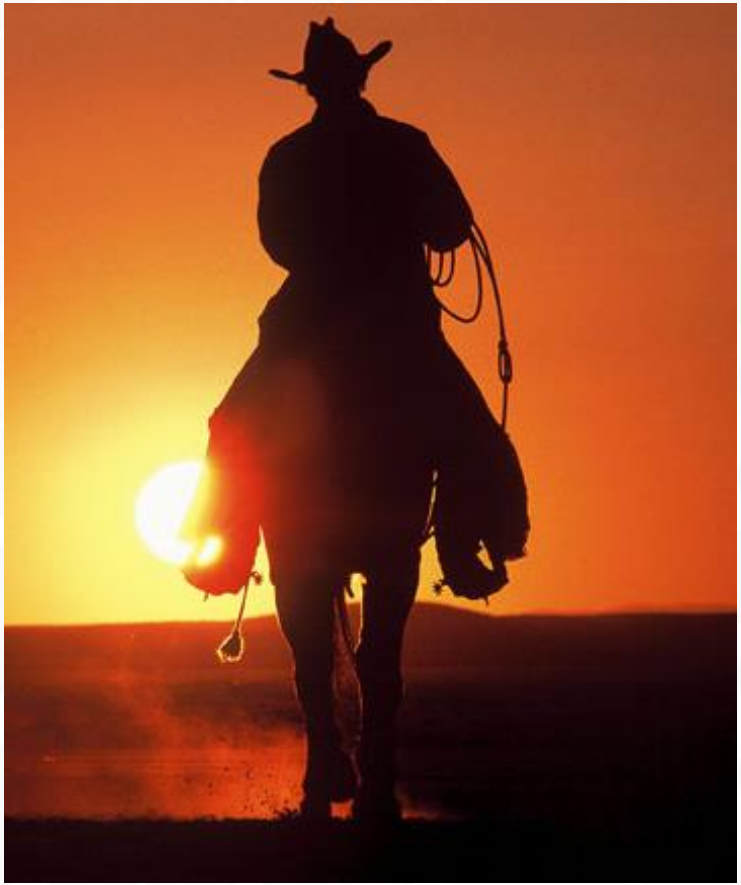
Remember This Above All Else

For every amazing save you make with a complex airway maneuver, you'll save 100 more by doing the basics well

Photo credit: fortune.com

So Long, Cowboy

Reach out to me: Maria.Mandt@childrenscolorado.org



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Thank You!

Drugs Preferred by Children Everywhere

- Atropine
  - < 1year of age
  - Septic shock or hypovolemic shock
  - Patients < 5 years of age receiving succinylcholine or any child receiving a second dose of succinylcholine
- Ketamine: what's not to love?
- Rocuronium vs succinylcholine

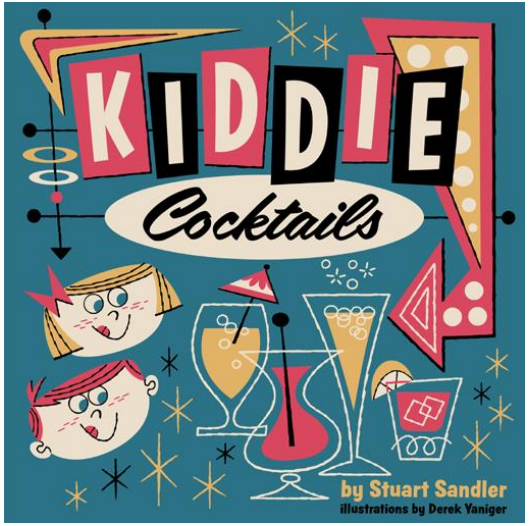

Photo credit: Book cover illustration by Derek Yaniger

Jones P, et al. *Ped Crit Care Med* 2013;
Conway JA, et al. *Crit Care Med* 2020;

Kiddy Cocktails Preferred by Children(‘s)

For most RSI circumstances:

- Atropine (if < 1 year), Ketamine, Rocuronium

For patient with catecholamine depletion or cardiac dysfunction:

- Atropine (if < 1 year), Etomidate, Rocuronium

Photo credit: Don LaVange

What? No Narcs?

- RSI with opioids in children is generally not recommended
- Increased risk of hypotension, early respiratory depression that interferes with preoxygenation
- Provide analgesia as part of post-intubation care

How About Those Neonates?

Give ‘em drugs!

Photo credit: Waking Time

- Median success rate is doubled with premedication, regardless of experience
- Successfully intubated in half the time
- Fewer changes in baseline heart rate

In our system: fentanyl/rocuronium

Le CN, et al. *J Perinatol* 2014; Bottor LT *Adv Neonatal Care* 2009