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

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Professor of Pediatrics
Medical Director of EMS and CCT

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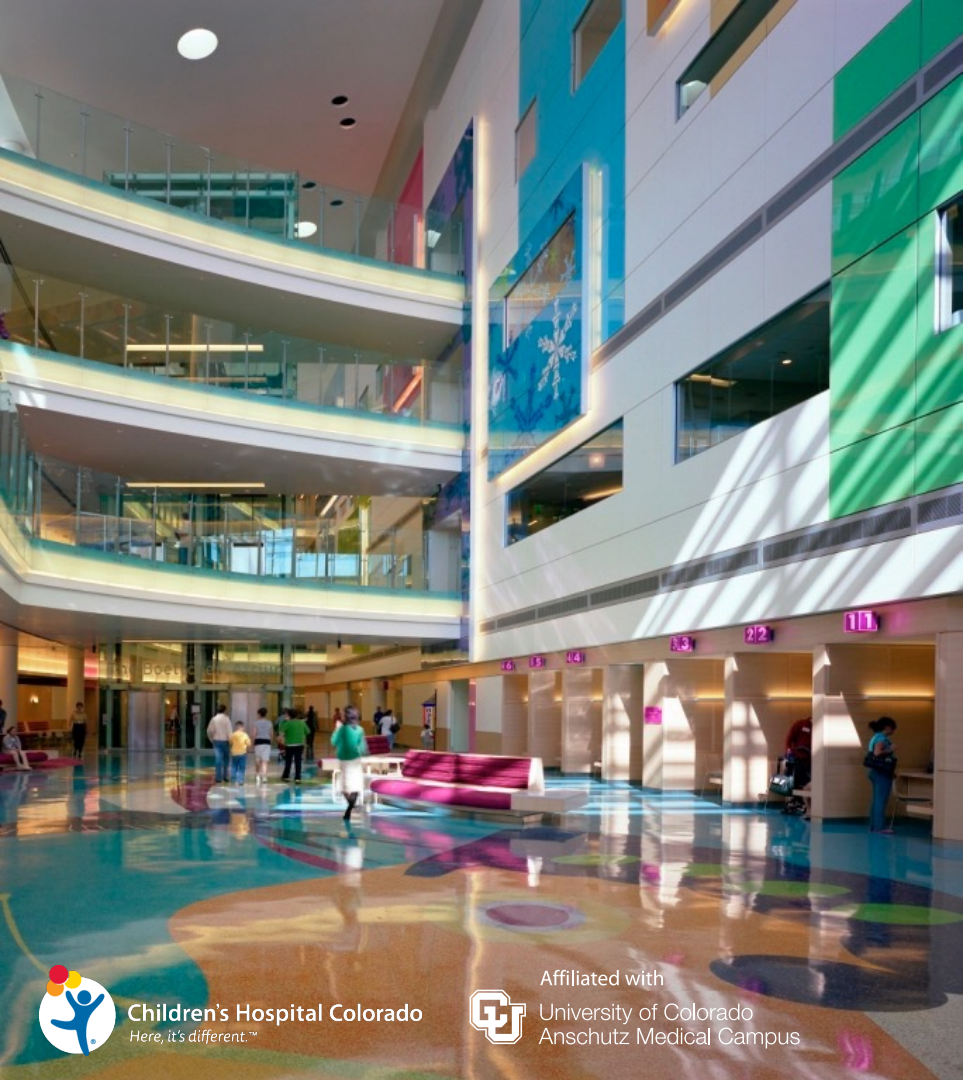

Financial Disclosure: I have no relevant financial disclosures with any commercial interest

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

- **Develop a plan** when approaching pediatric airway management
- **Identify predictors** of a difficult pediatric airway
- **Understand** the common **pitfalls** encountered during pediatric airway management

Photo credit: www.theredlist.com

What Do You Do When . . .

You don’t encounter it often:

- 2 in 1000 EMS patients is a child with respiratory failure
- 9 in 10,000 ED visits is a pediatric patient requiring advanced airway management

But the stakes are high:

- Leading cause of cardiopulmonary arrest in kids
- Delay/Failure by minutes = increased morbidity and mortality

Hanlin ER, et al. *Resuscitation* 2022; American Heart Association 2010; Mort et al. *Anesth Anal* 2004; Rodriguqez-Nunez A. *Resuscitation* 2023

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!

Photo credit: www.imgflip.com

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

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

The Plan: Know Before You Start

1. Examine the patient and the situation
2. Optimize the physiology
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

Oh, Baby. . . Let Me Count the Ways

Critical differences between the big and the small

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Prominent Occiput

Result:

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

Management:

- Shoulder roll
- True sniffing position

Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

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

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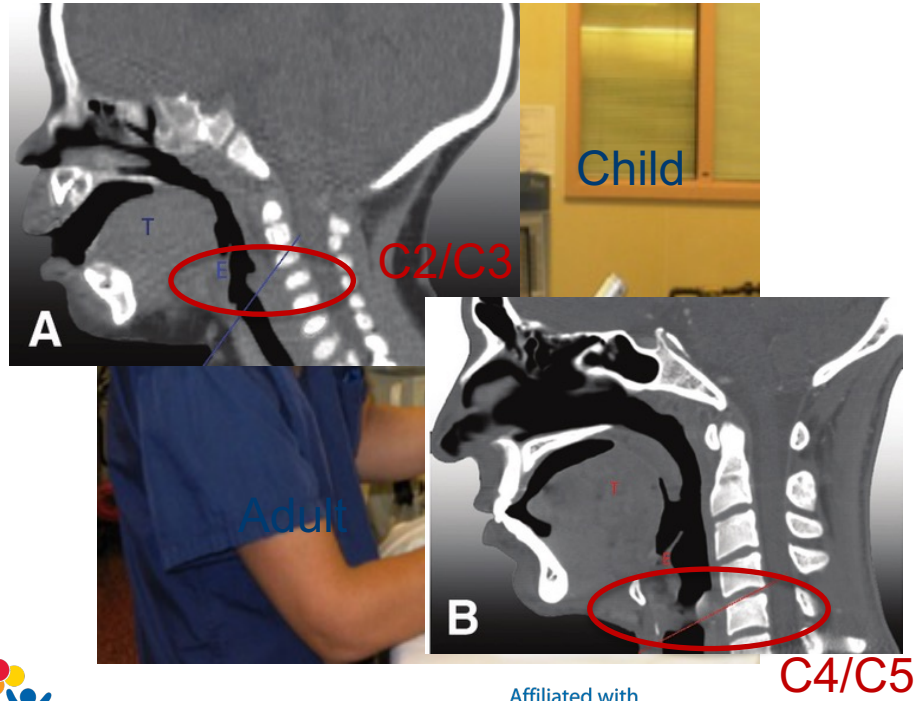
Cephalad Larynx



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

Epiglottis Angled Over Vocal Cords

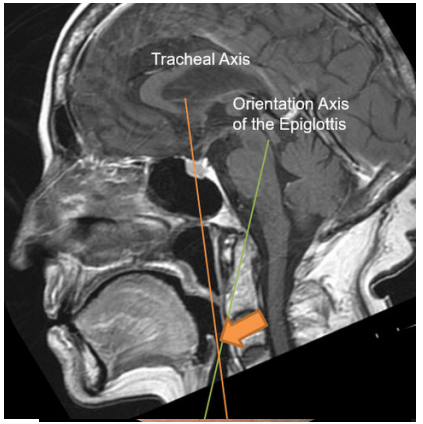
Result:

- 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 the ETT 10-15º

Adult



Pediatric

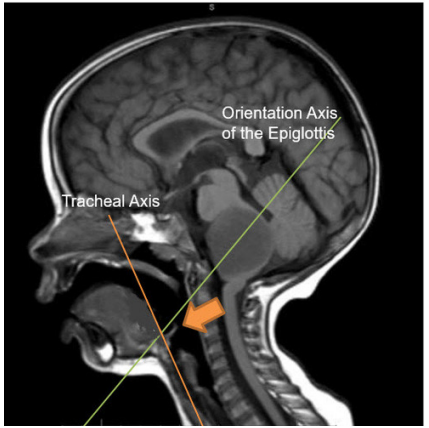


Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

Significant Soft Tissue and Large Tongue

Result:

- Increased risk of obstruction
- Difficult direct visualization

Management:

- OPA
- Lateral approach to direct laryngoscopy

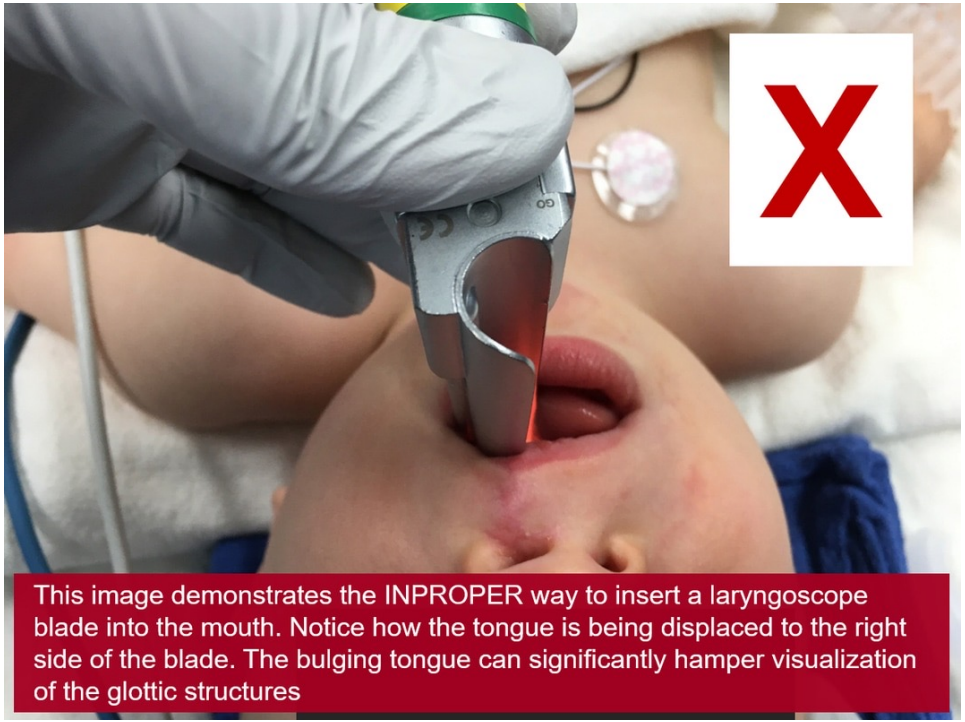


Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

Physiologic Immaturity

Result:

- Higher O_2 consumption
- Higher RR
- Picture of inefficiency

Management:

- Expect rapid desaturation during apnea
- 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"

Major Initial Considerations

- Sepsis/shock: begin fluid resuscitation and antibiotics, have pressors drawn up and ready (ref: 3pm talk!)
- Consider cardiac complication
- Consider Tamiflu early during flu season (its coming!)

And, of course, first address her breathing

Simple nasal cannula?

Non-invasive Positive Pressure Ventilation (NIPPV) in Pediatrics

Increasing reliance on non-invasive means in pediatrics

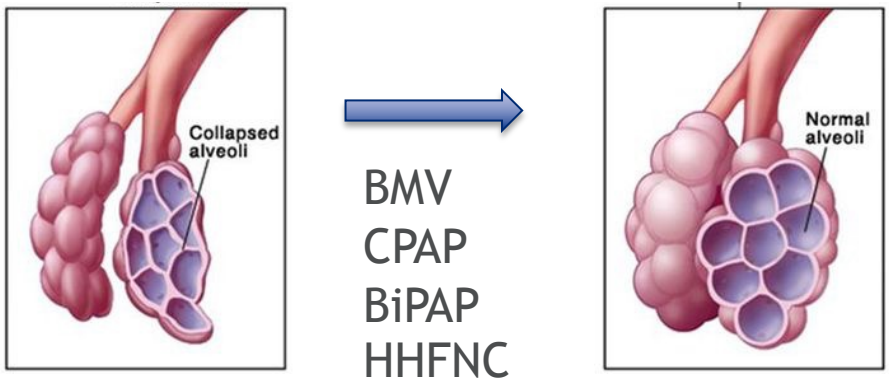


Photo credit: medbullets.com

Non-invasive Positive Pressure Ventilation (NIPPV)

It DOES work in the hospital:

- Reduction in disease severity scores
- Reduction in intubation rates

It MAY work in the field:

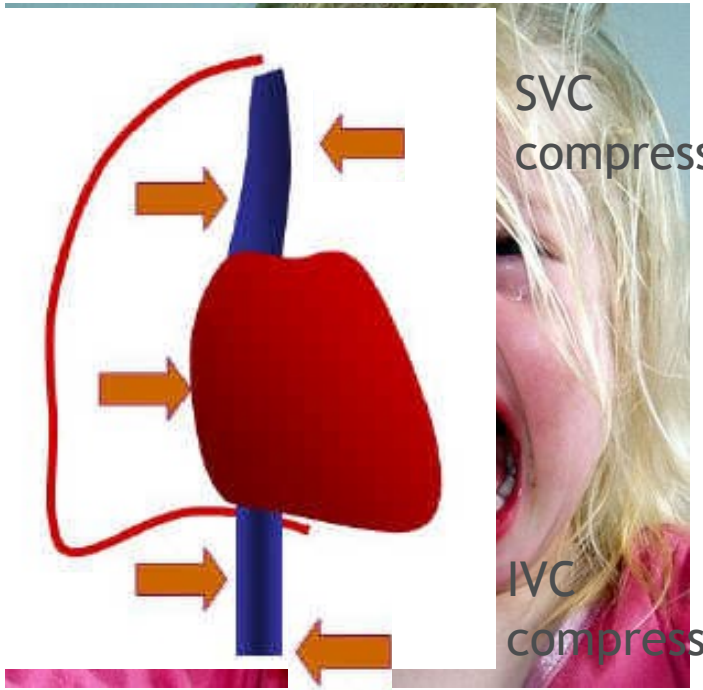
- Observational review of 8 studies (60% NICU) examining IFTs
- 0.3% required intubation during transport
- No information on hospital impact (LOS, intubation rates)

Yanez, LJ et al. *Pediatr Crit Care Med* 2008;
Baljit C et al. *Pediatr Crit Care Med* 2015

The Challenge:

Photo credit: incenter.medical.philips.com

Can
Causes



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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?
- Time for some acetaminophen?
- Ugh. I should have been a banker. Or a forest ranger.

- Better plan for my next move . . .

Refer to the Plan: Examine

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

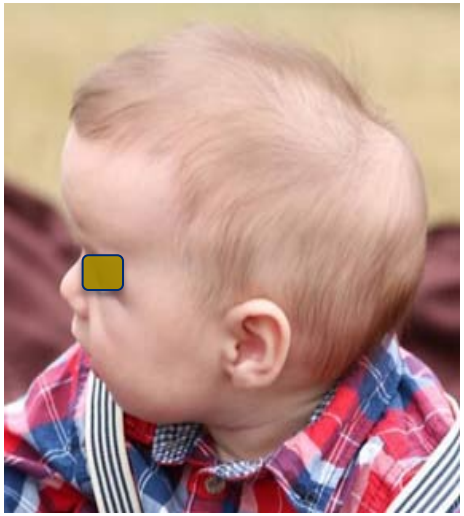

Photo credit: chkd.org

Predicting Difficulty in the Pediatric Airway

We can anticipate failure in some cases. Help yourself!

- L Look externally for indicators of of airway difficulty
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Photo credit: midwestsinus.com

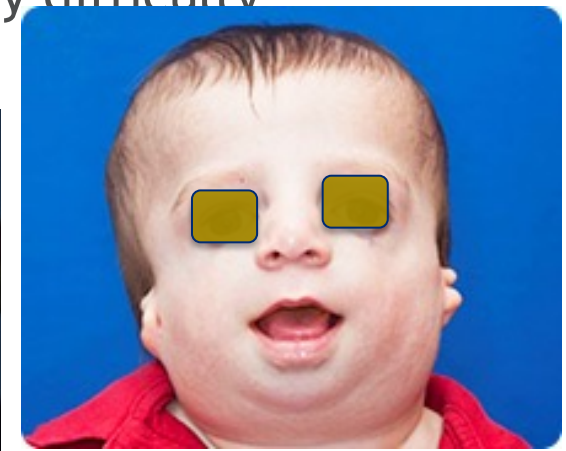

Photo credit: seattlechildrens.org

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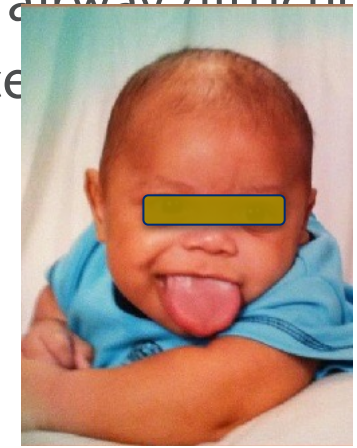

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Brown CA et al. *The Walls Manual of Emergency Airway Management* 2022

Predicting Difficulty in the Pediatric Airway

"Quick and Dirty" When to Worry: The Secret Predictors

- Age < 1 year
- Cardiac anomaly
- Congenital ear malformations
- Cleft palate
- Low BMI
- Mallampati III or IV (if >4y)

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

Predicting Difficulty in the Pediatric Airway

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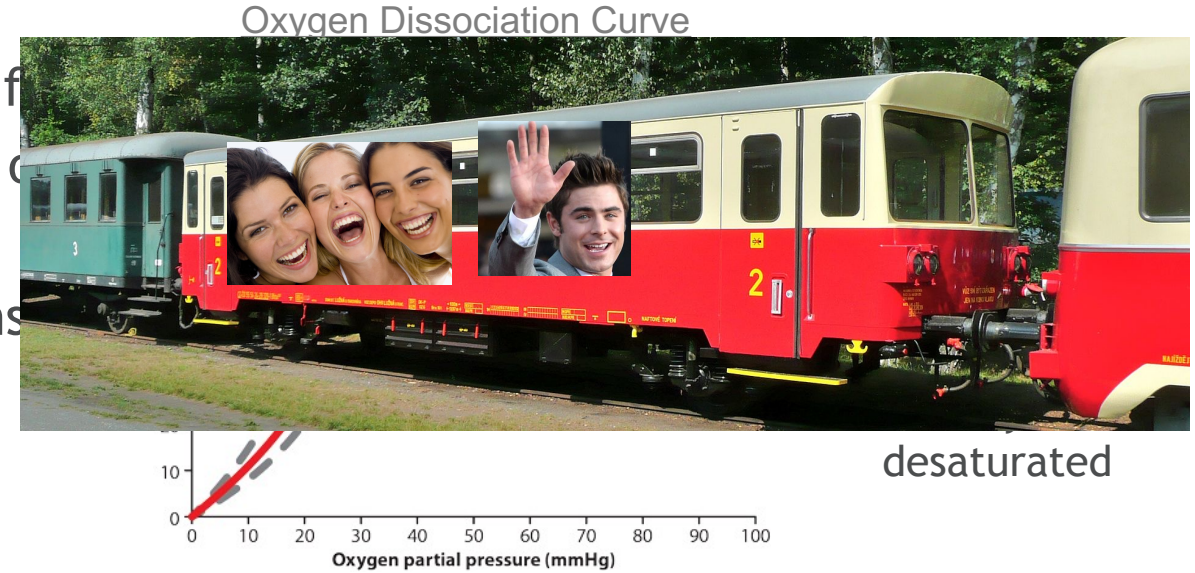

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Brown CA et al. *The Walls Manual of Emergency Airway Management* 2022

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

Troubleshoot that BMV! Why?

- 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.

Basics Aren't Always Basic

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

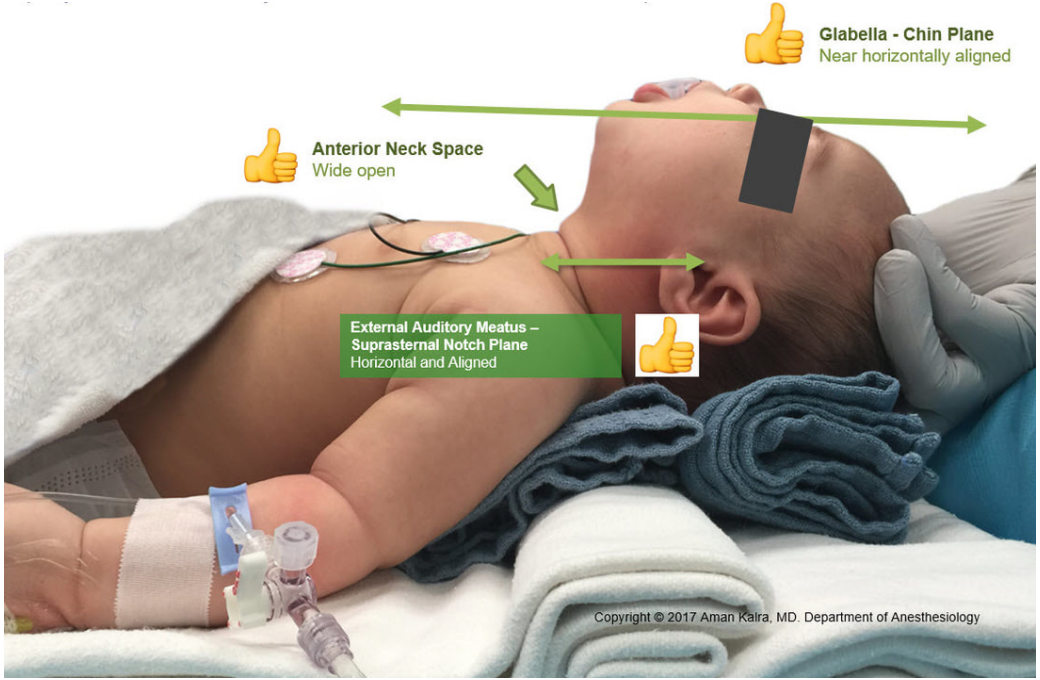

Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

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:

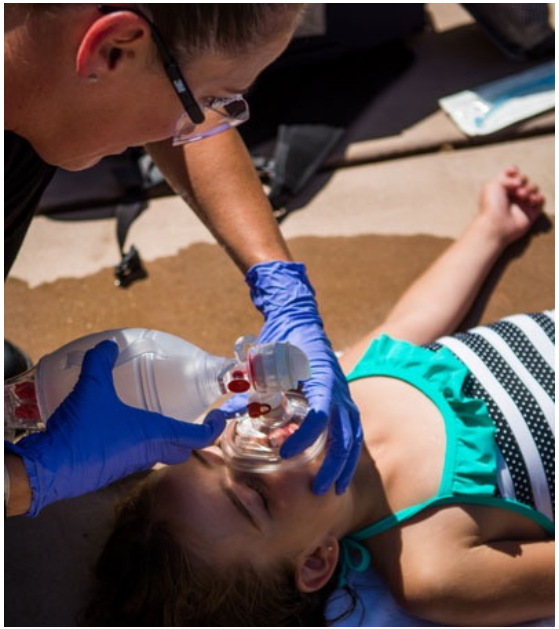

Photo credit: JEMS.com

Photo credit: Kalra A, Tufts Medical Ctr Anesthesia Dept

Never Underestimate the Impact of a Good Jaw Thrust!

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)

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

What do you choose?

How do you prepare?

The Plan: Know Before You Start

1. Examine the patient and the situation
2. Optimize the physiology
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

Give Yourself a Fighting Chance

Photo credit: MedicalAidMemoire.com

- Fill the tank
- Head up 20 degrees (NIPPV/SGA/DL)
- Have the equipment smorgasbord available in the correct sizes

Give Yourself a Fighting Chance

- Pre-oxygenation, simple mask x 3 minutes
- Apneic oxygenation: low-flow O2 5LPM
- Consider delayed sequence intubation (DSI) as appropriate
  - Highly anxious children
  - Craniofacial abnormalities

Look familiar?

How to remember this and more?

Napolitano N et al. *Pediatr Crit Care Med* 2019; Weingart SD et al. *Ann Emerg Med* 2012; Aroonpruksakul N. *Transl Pediatr* 2022

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

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

So Where Does That Leave Us?

Choose Your Weapons Carefully

Rare skill → Decreased confidence → Increased stress and anxiety → Decreased performance → Increased safety risk to patients

Is intubation always the right answer?

PEDI-PART
Pediatric Prehospital Airway Resuscitation Trial

Choice of tool and timing is the art of the airway

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

Video Laryngoscopy: A Brief Word

Likely most beneficial in:

- Trauma
- Cardiac arrest (adult data)
- Neonates
- Known difficult airway or multiple previous attempts (>2)
- Little experience (this is most of us!)
- Quality improvement adjunct
- Those who use it frequently

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

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


Thank You!
REACH
N127CH

So Long, Cowboy

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