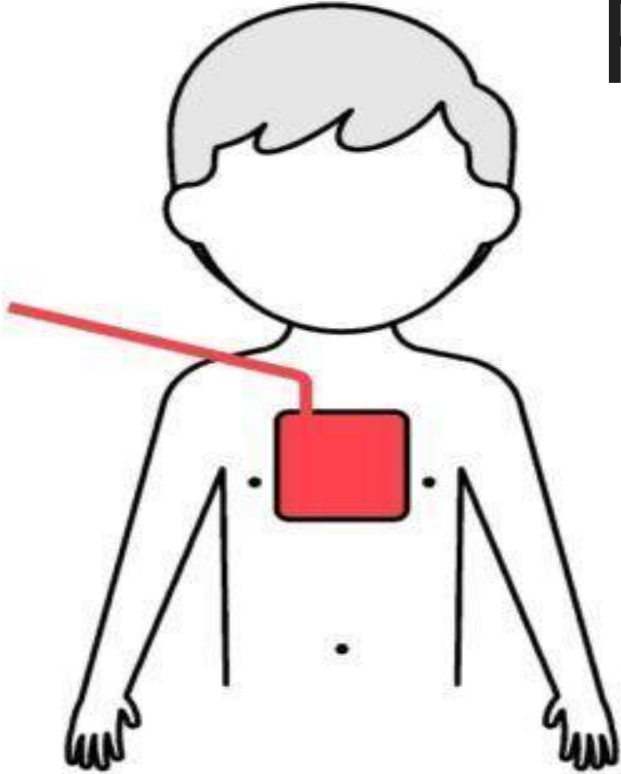
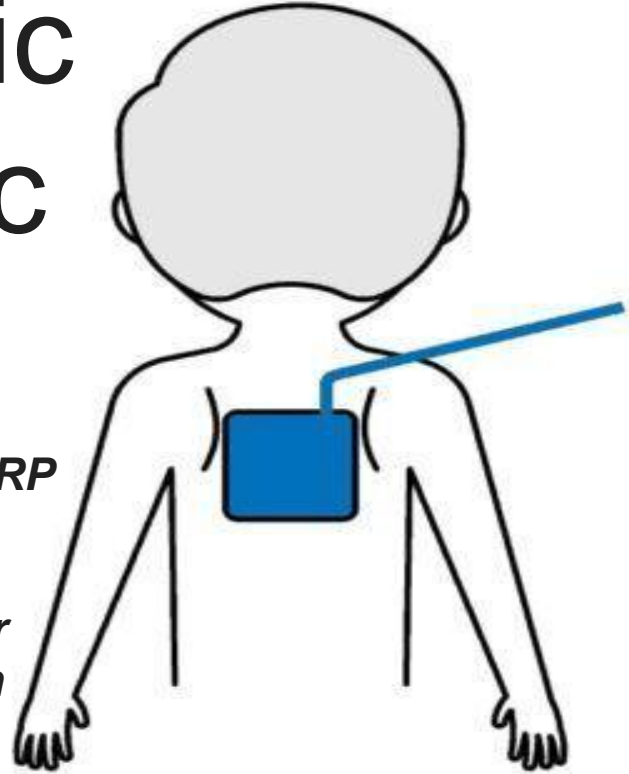


Pediatric Cardiac Arrest



*Chris Root, MD, NRP
EMS Fellow
UNM Health
Sciences Center
Flight Physician
UNM Lifeguard*



Disclosure

Dr. Root, faculty for this educational event, has received an educational grant from the National Association of EMS Physicians and the Stryker Corporation.

I have received compensation from the SSCOR corporation for performing technical writing.

All relevant financial relationships have been mitigated.

Goals

Understand the epidemiology of pediatric cardiac arrest

Discuss best practices for the management of out of hospital cardiac arrest

Provide strategies for improving your agency's response to pediatric cardiac arrest

Pediatric OHCA by the numbers

37 million EMS runs in the US annually

424,000 are for adult OHCA

7,000 are for Peds OHCA

1 Peds OHCA for every 10,000 EMS runs



Epidemiology and Outcomes from Out-of-Hospital Cardiac Arrest in Children: The ROC Epistry-Cardiac Arrest

Dianne L. Atkins, MD¹, Siobhan Everson-Stewart, MS², Gena K. Sears, BSN², Mohamud Daya, MD, MS³, Martin H. Osmond, MD CM, FRCPC⁴, Craig R. Warden, MD, MPH⁵, and Robert A. Berg, MD [on behalf of the ROC Investigators]⁶

¹University of Iowa Carver College of Medicine, University of Iowa Children's Hospital, Iowa City, IA

Atkins, DL. (2009). Epidemiology and outcomes from out-of-hospital cardiac arrest in children: the Resuscitation Outcomes Consortium Epistry-Cardiac Arrest. *Circulation*. 119(11):1484-91.

Age	Incidence
<1 yr	78/100,000
1-11 yrs	4/100,000
12-19	6/100,000
Adults	95/100,000

Incidence and Outcome of Out-of-Hospital Cardiac Arrest in the U.S.

	Annual number of cases	Annual number of fatalities	Survival, (%)
EMS assessed			
Overall	424,000	401,000	5.2
Children	9,500	8,800	4.4
EMS treated			
Overall	211,000	187,000	10.4
Children	7,700	7,000	5.4
Shockable rhythm			
Overall	42,000	30,000	28.3
Children	560	370	26.7
Bystander-witnessed, shockable rhythm			
Overall	24,000	16,000	31.7
Children	240	160	26.7

Age	Survival to discharge	Odds Ratio	95% CI
<1 yr	3.3%	0.71	0.4, 1.39
1-11 yrs	9.1%	2.11	1.21, 3.66
12-19 yrs	8.9%	2.04	1.24, 3.38
> 20 yrs	4.5%	1.0	

What causes cardiac arrest in children?

Respiratory Failure



Hypoxia, Hypercarbia, Acidosis



Impaired Cardiac Function

The Chain of Survival



Prevention



Recognition





What did we just see?

Compressions

1 rescuer: 30:2

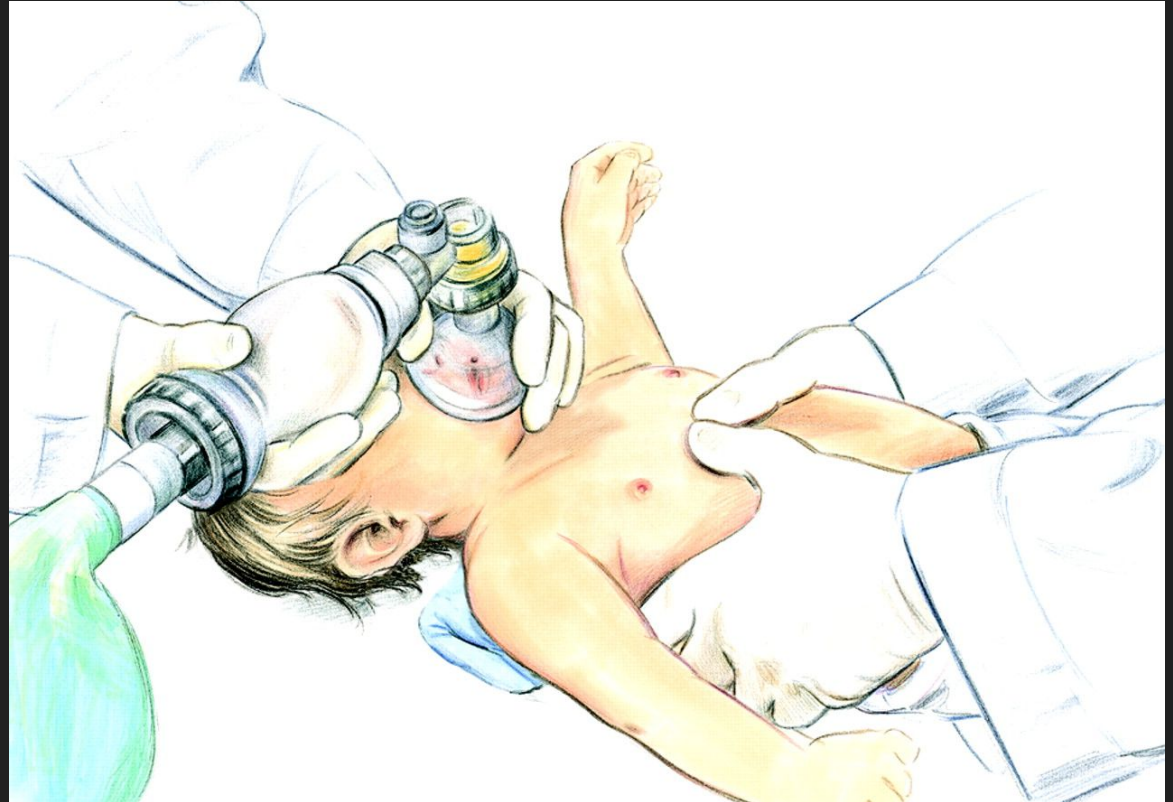
2 rescuers 15:2

Advanced airway:

Continuous

100-120 minute

$\frac{1}{3}$ - $\frac{1}{2}$ depth of chest



Allow full chest recoil

› [Crit Care Med.](#) 2010 Apr;38(4):1141-6. doi: 10.1097/CCM.0b013e3181ce1fe2.

Leaning during chest compressions impairs cardiac output and left ventricular myocardial blood flow in piglet cardiac arrest

[Mathias Zuercher](#)¹, [Ronald W Hilwig](#), [James Ranger-Moore](#), [Jon Nysaether](#), [Vinay M Nadkarni](#), [Marc D Berg](#), [Karl B Kern](#), [Robert Sutton](#), [Robert A Berg](#)

Affiliations + expand

PMID: 20081529 PMCID: [PMC3321356](#) DOI: [10.1097/CCM.0b013e3181ce1fe2](#)

[Free PMC article](#)

10% lean, 4lbs: 16 % lower cardiac index, 24% less myocardial blood flow
20% lean, 8 lbs, 27 % lower cardiac index, 33% less myocardial blood flow

Compressions



Compression take-homes

Not too fast not too slow

Allow full chest recoil

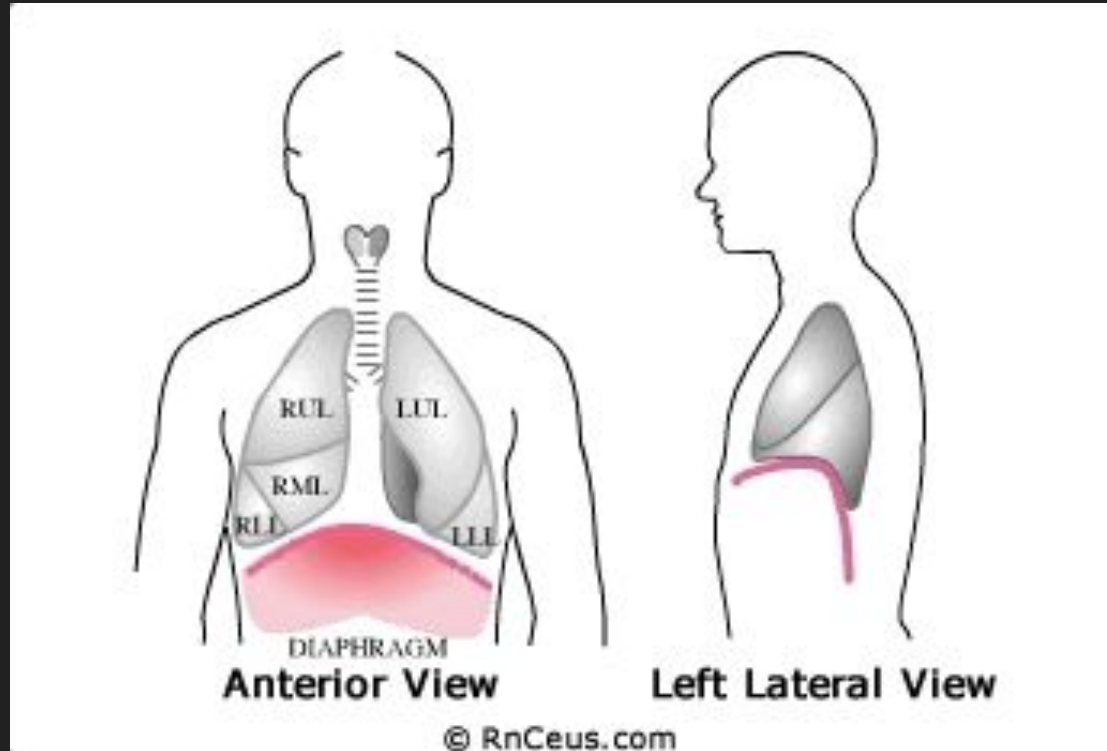
Use a metronome if possible

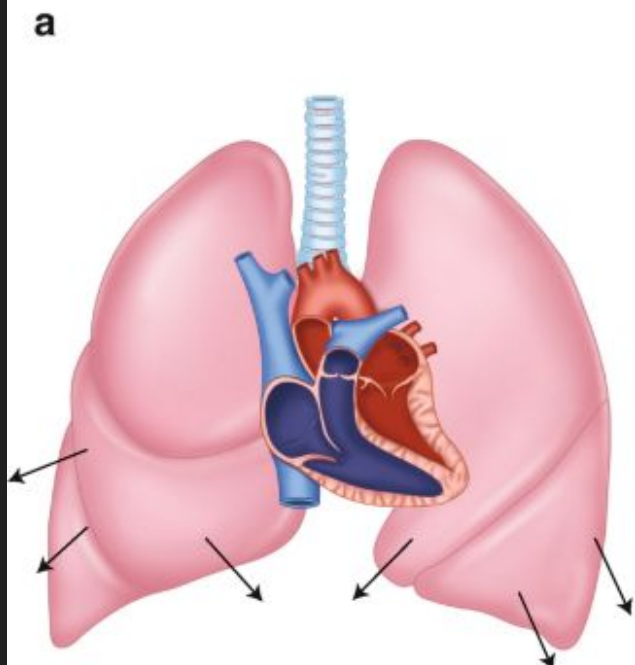
Ventilations





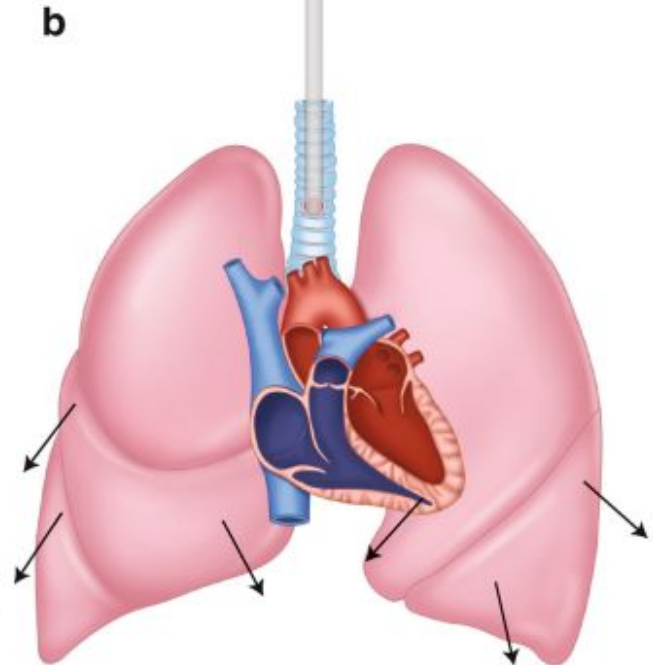
Normal respiration is driven by negative pressure





Pleural pressure: $-5 \text{ cm H}_2\text{O}$
Spontaneous Inspiration

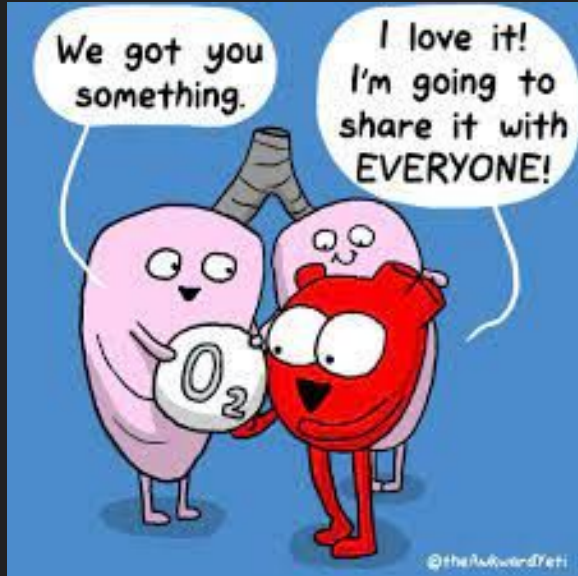
- Increase in RV preload
- Increase in LV afterload
- Increase in instantaneous cardiac output



Pleural pressure: $+5 \text{ cm H}_2\text{O}$
Positive pressure inspiration

- Decrease in RV preload
- Decrease in LV afterload
- Decrease in instantaneous cardiac output

AVOID HYPERINFLATION



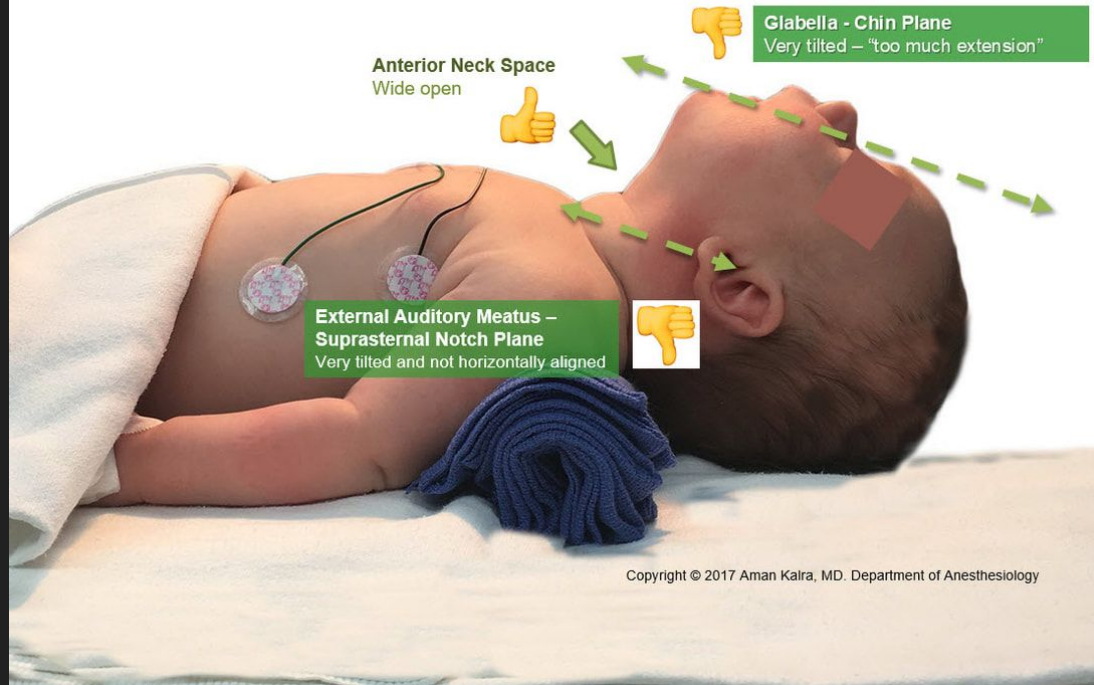
Select an appropriate size mask and BVM



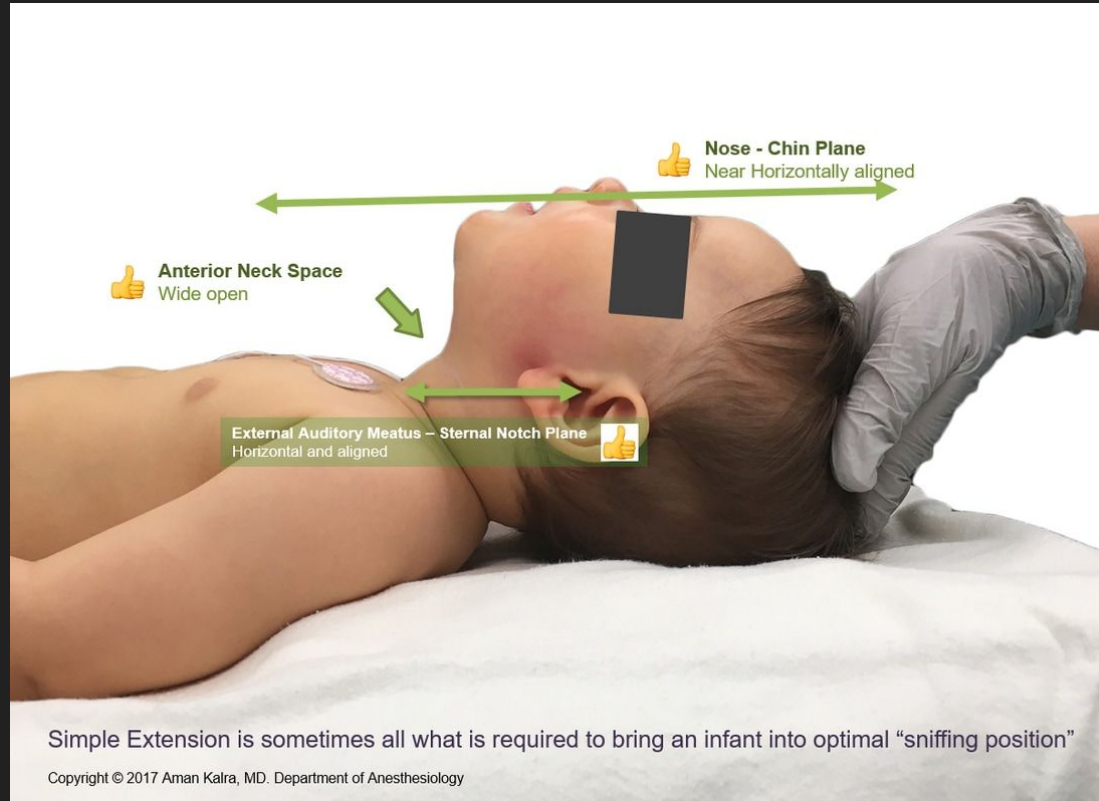
Positioning isn't part of airway management, it is airway management.

Step 2: Place a Shoulder Roll

Check if secondary markers meet criteria



Positioning isn't part of airway management, it is airway management.



Select appropriately sized adjuncts



What about tubes?

[JAMA](#). Author manuscript; available in PMC 2018 Aug 7.

PMCID: PMC6080953

Published in final edited form as:

NIHMSID: NIHMS982088

[JAMA. 2016 Nov 1; 316\(17\): 1786–1797.](#)

PMID: [27701623](#)

doi: [10.1001/jama.2016.14486](#)

Association Between Tracheal Intubation During Pediatric In-Hospital Cardiac Arrest and Survival

[Lars W. Andersen](#), MD, MPH, [Tia T. Raymond](#), MD, [Robert A. Berg](#), MD, [Vinay M. Nadkarni](#), MD, [Anne V. Grossestreuer](#), PhD, [Tobias Kurth](#), MD, ScD, and [Michael W. Donnino](#), MD, American Heart Association's Get With The Guidelines–Resuscitation Investigators

2294 patients, median age 7 months

68% were intubated during the arrest

36% of intubated patients survived vs 41% of non-intubated patients

What about tubes?

Observational Study > Resuscitation. 2021 Nov;168:191-198.

doi: 10.1016/j.resuscitation.2021.08.015. Epub 2021 Aug 18.

Endotracheal intubation versus supraglottic procedure in paediatric out-of-hospital cardiac arrest: a registry-based study

Quentin Le Bastard ¹, Jade Rouzioux ², Emmanuel Montassier ¹, Valentine Baert ³, Morgan Recher ³, Hervé Hubert ⁴, Stéphane Leteurtre ³, François Javaudin ⁵; GR-RéAC

Affiliations + expand

PMID: 34418479 DOI: [10.1016/j.resuscitation.2021.08.015](https://doi.org/10.1016/j.resuscitation.2021.08.015)

1579 Children

85.8% were intubated during the arrest, 14.2% received SGA

7.7%% of intubated patients survived vs 14.3% of supraglottic patients

Airway and Breathing take-homes

Positioning is key

Adjuncts are helpful

Hyperventilation is bad

Intubation is likely harmful

Advanced interventions: Access



Are we using the correct site?

Review > [Prehosp Emerg Care](#). 2020 Sep-Oct;24(5):665-671.

doi: [10.1080/10903127.2019.1698682](https://doi.org/10.1080/10903127.2019.1698682). Epub 2020 Jan 7.

Tibial Intraosseous Insertion in Pediatric Emergency Care: A Review Based upon Postmortem Computed Tomography

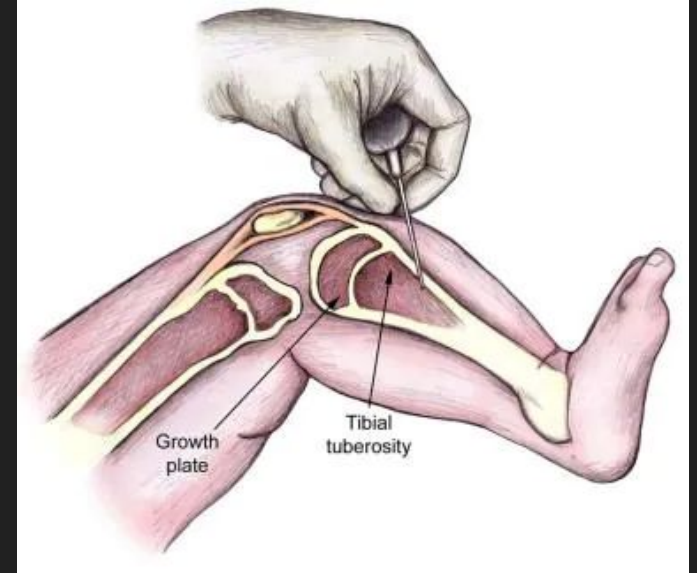
[H Theodore Harcke](#), [Riley N Curtin](#), [M Patricia Harty](#), [Sharon W Gould](#), [Jennie Vershovovsky](#),
[Gary L Collins](#), [Stephen Murphy](#)

PMID: [31774707](https://pubmed.ncbi.nlm.nih.gov/31774707/) DOI: [10.1080/10903127.2019.1698682](https://doi.org/10.1080/10903127.2019.1698682)

-40% of Tibial IOs incorrectly placed on perimortem CT

-In infants < 6 mo old successful tibia placement is a coin toss

Distal Femur vs Proximal tibia



Distal Femur vs Proximal tibia

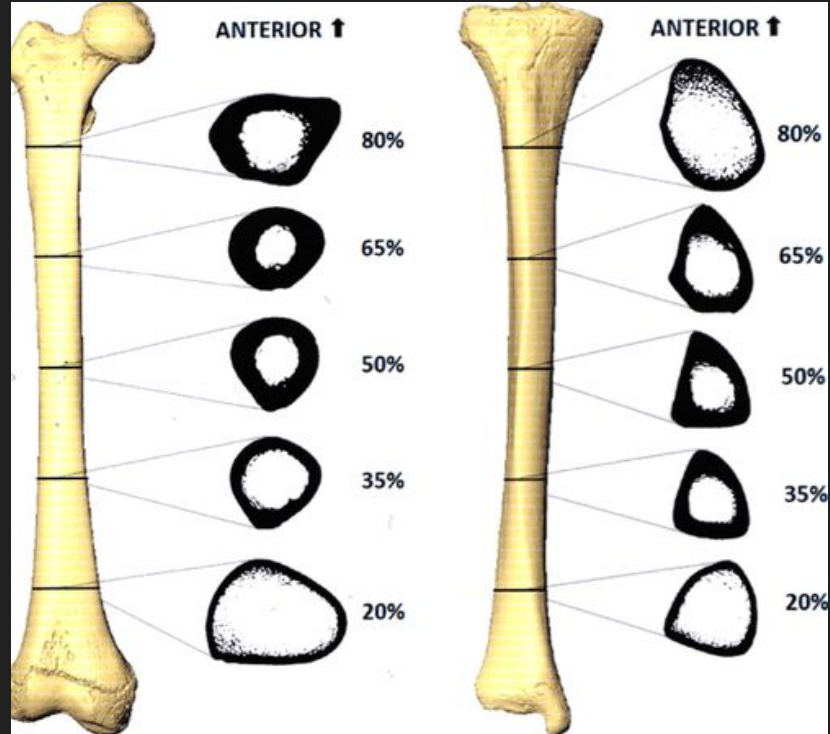
AR The Anatomical Record

Developmental Biology | **Free Access**

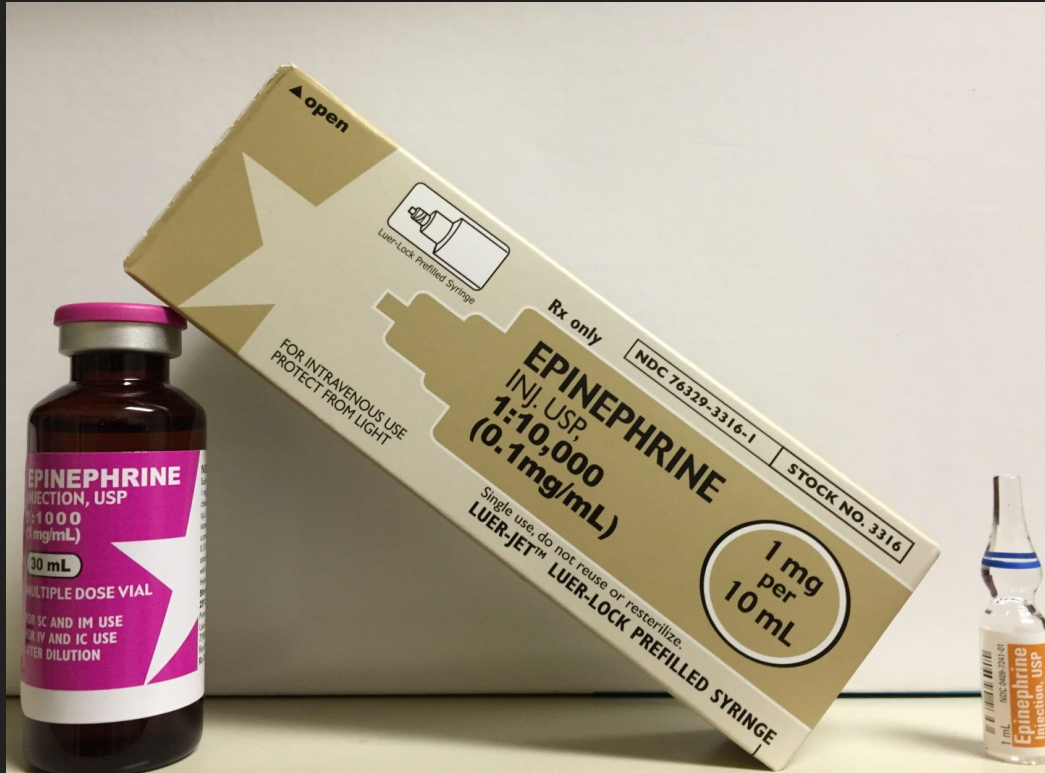
Development of Cortical Bone Geometry in the Human Femoral and Tibial Diaphysis

James H. Gosman ✉, Zachariah R. Hubbell, Colin N. Shaw, Timothy M. Ryan

First published: 27 March 2013 | <https://doi.org/10.1002/ar.22688> | Citations: 61



Advanced interventions: Drugs






INTERMEDIATE

- ▶ **Epinephrine 0.1 mg/mL (OLD NAME 1:10,000): 0.01 mg/kg (0.1 mL/kg) up to maximum of 1 mg per dose IV/IO every 3 - 5 minutes**
- ▶ Administer **20 mL/kg Normal Saline or Lactated Ringers** bolus

GO TO NEXT PAGE

Cognitive Aids




Pedi STAT
 James M Kempema MD PA

UPDATE

54 RATINGS AGE CHART DEV

4.4 17+ #5 James M

★★★★★ Years Old Medical

What's New Version History



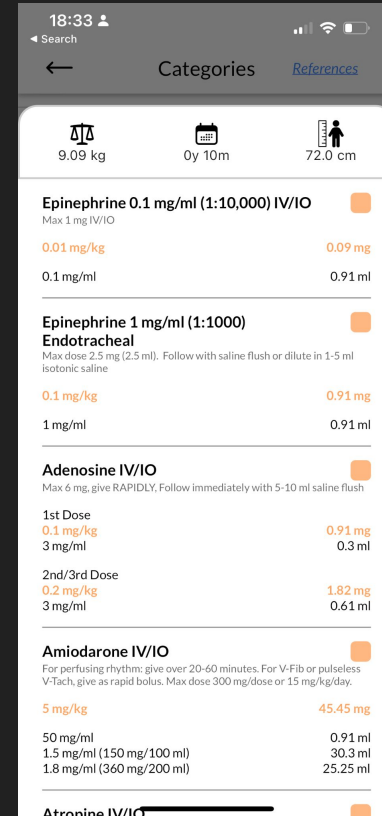
Broselow



*65% of the time,
it works every time.*



Pedistat



Handtevy



*NOTE: The Diazepam IV dose is HALF (1/2) the volume of the listed Diazepam IM / IN dose.
PEC 2014, Vol 18

- Epi 1:1,000 IM 1 mg/mL
- Epi 1:10,000 IV 1 mg/10 mL
- Amiodarone 150 mg/3 mL
- Bicarb 8.4% 50 mEq/50 mL
- D₂₅W 0.25 g/mL
- Normal Saline Bolus 0.9%
- Lorazepam 2mg/mL
- Diazepam 10 mg/2 mL
- ETT U=Uncuffed C=Cuffed

Drawing up meds



Shocks



Advanced intervention take-homes

Consider the Distal femur for IO access

Use a reference when dosing meds

Set yourself up for success

How do you get to Carnegie Hall?



Low-fidelity sim is better than no sim



Use Of A Low Resource Model For Group Cardiopulmonary Resuscitation Training: Knowledge Gains And Attitude Changes

Matthias Goldstein, Benjamin Goldstein, Joel Novograd, Inayzha Wallace, Leah Goldstein, Kailah Carden, Towson University, Baltimore, MD
Student Health Services/ Health Center, Towson University, Towson MD, USA

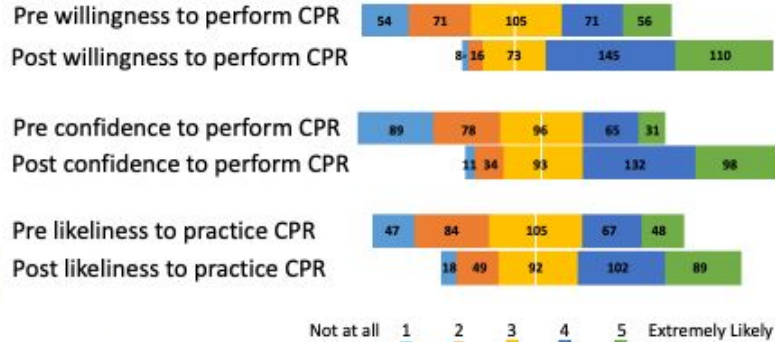


Figure 1 - Attitudes

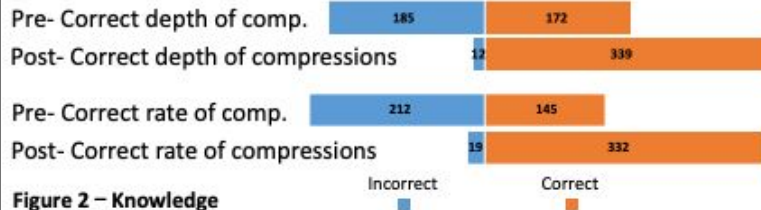


Figure 2 - Knowledge

Every peds case has at least two patients



Parental presence during resuscitation

Stewart, 2019 . Parents' experience during a child's resuscitation: getting through it

- All parents are individuals with differing needs
- Parents felt a sense of overwhelming chaos during their child's resuscitation
- Parents who were not present recalled enhanced fear, and high anxiety

Parental presence during CPR

McAlvin and Carew-Lyons, 2014 . Family presence during resuscitation and invasive procedures in pediatric critical care: a systematic review

- **Parents present during resuscitation would do so again, recommend being present to others and would not have changed anything**
- **Parents not present reported more distress and felt they had failed in their role as the child's protector**
- **Parents felt their presence was helpful to their child and beneficial to themselves**

Parental presence during CPR

Mark, 2021 . Family presence during paediatric resuscitation and invasive procedures: the parental experience: an integrative review

- Being present during resuscitation and invasive procedures is described as natural, obligatory, a must matter beyond choice, and a natural aspect of loving someone, desiring to be present during rough times
- 3 months after the event, parents had no traumatic memories and would choose to be present again

Take care of the patient then take care of yourself

This is a potentially once in a career traumatic event.

You don't just walk it off.





**Crisis Support Team Dispatch Telephone
Through Santa Fe Control: 505-827-9384**

505-827-9384

505-827-9384

First responders can call this dispatch number 24/7/365 to get in touch with the emergency medical services critical stress team who can offer critical incident stress debriefing and counseling services.

Final take-homes

The basics of good CPR are what matter most

Use every resource available to reduce the cognitive load in the moment

A little practice and preparation go a long way

Take care of the patient and then take care of yourself

Resources for Further Learning

[Pediatric Cardiac Arrest with Dr. Robert Berg, OPEN Pediatrics](#)

[Handtevy System](#)

[EMS For Children Improvement and Innovation Center](#)

[AHA 2020 Emergency Cardiac Care Guidelines](#)

@ChrisRootMD

Chriswroot@salud.unm.edu

