Pediatric Trauma

ICEP EM Update, February 15th, 2018

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Assistant Professor of Clinical Emergency Medicine

Goal

Increase learner comfort and competence in caring for pediatric trauma patients.

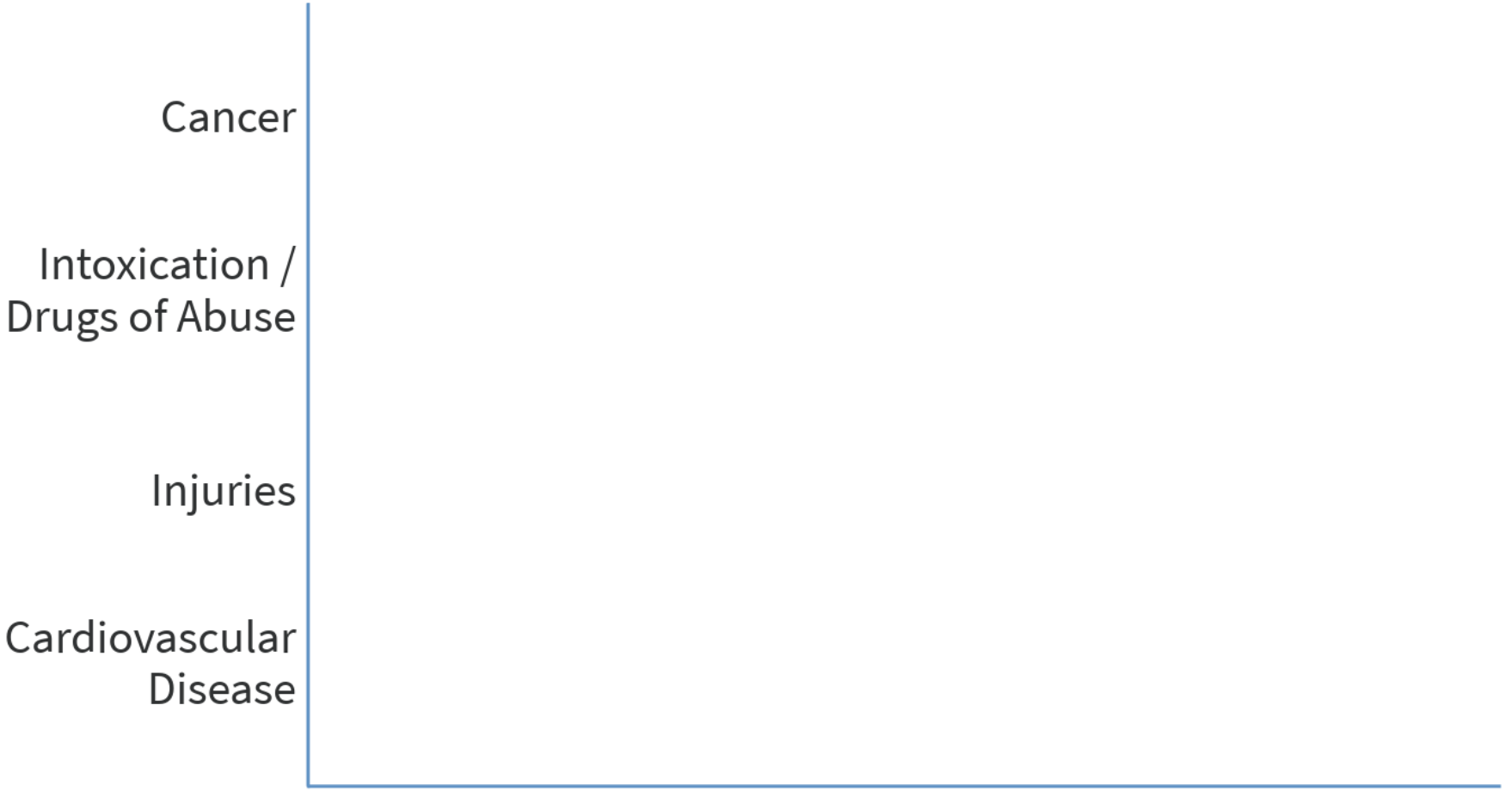
Objectives

- Describe the relevance of at least three anatomic and physiological differences in pediatric patients as compared to adults that are relevant to traumatic disorders
- Formulate a systematic approach to the evaluation of pediatric traumatic injury
- Describe at least three nuances in the management of pediatric trauma as compared to trauma in adults

Get your phones out!

Text ”GPOD” to 22333

What is the leading cause of death for patients 0-19 years old?



12,000 Lives

CDC Childhood Injury report, 2008

$300,000,000,000

CDC Childhood Injury report, 2008

What is the leading cause of unintentional injury death for patients 0-19 years old?

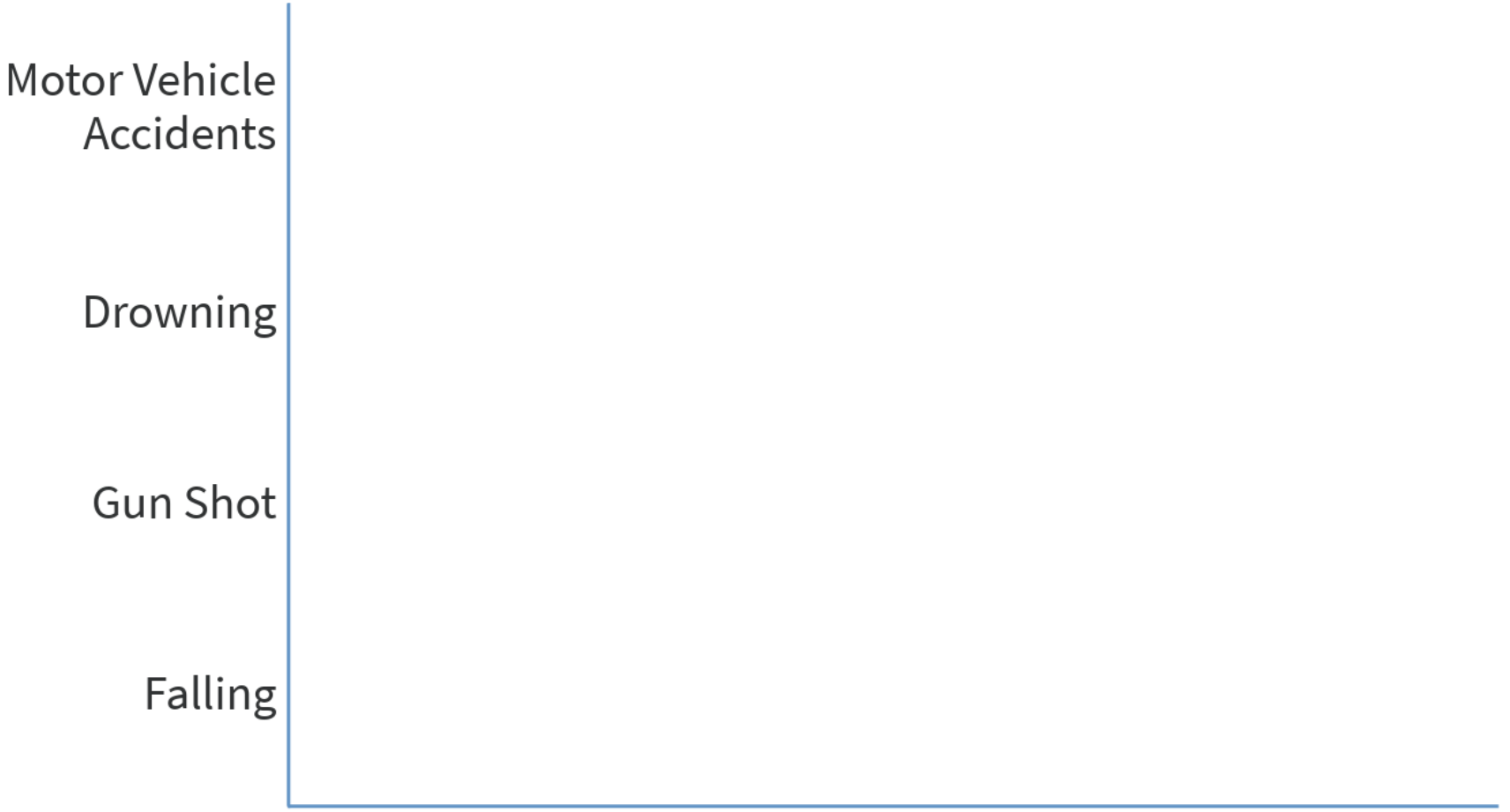
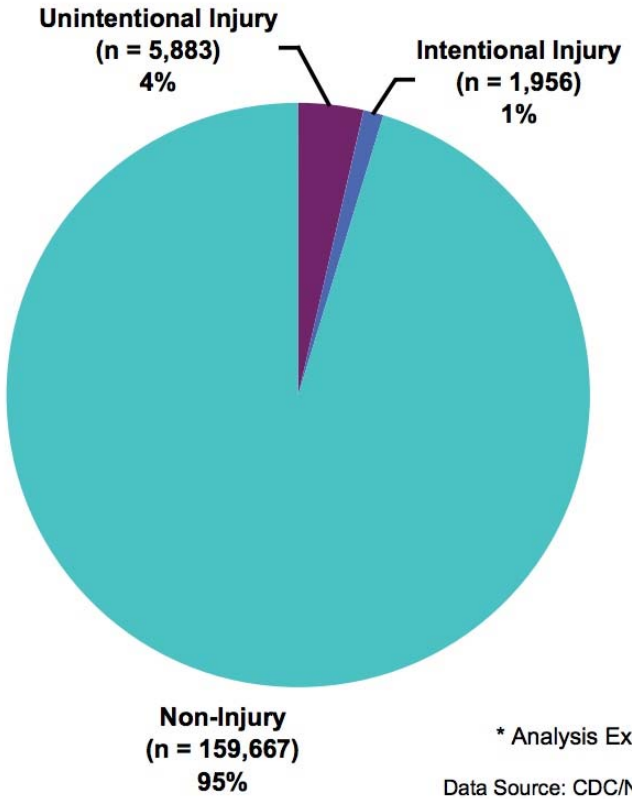


Figure 2: Cause of Death by Injury Status and Intent * among Children Less than 1 Year, United States, 2000 - 2005

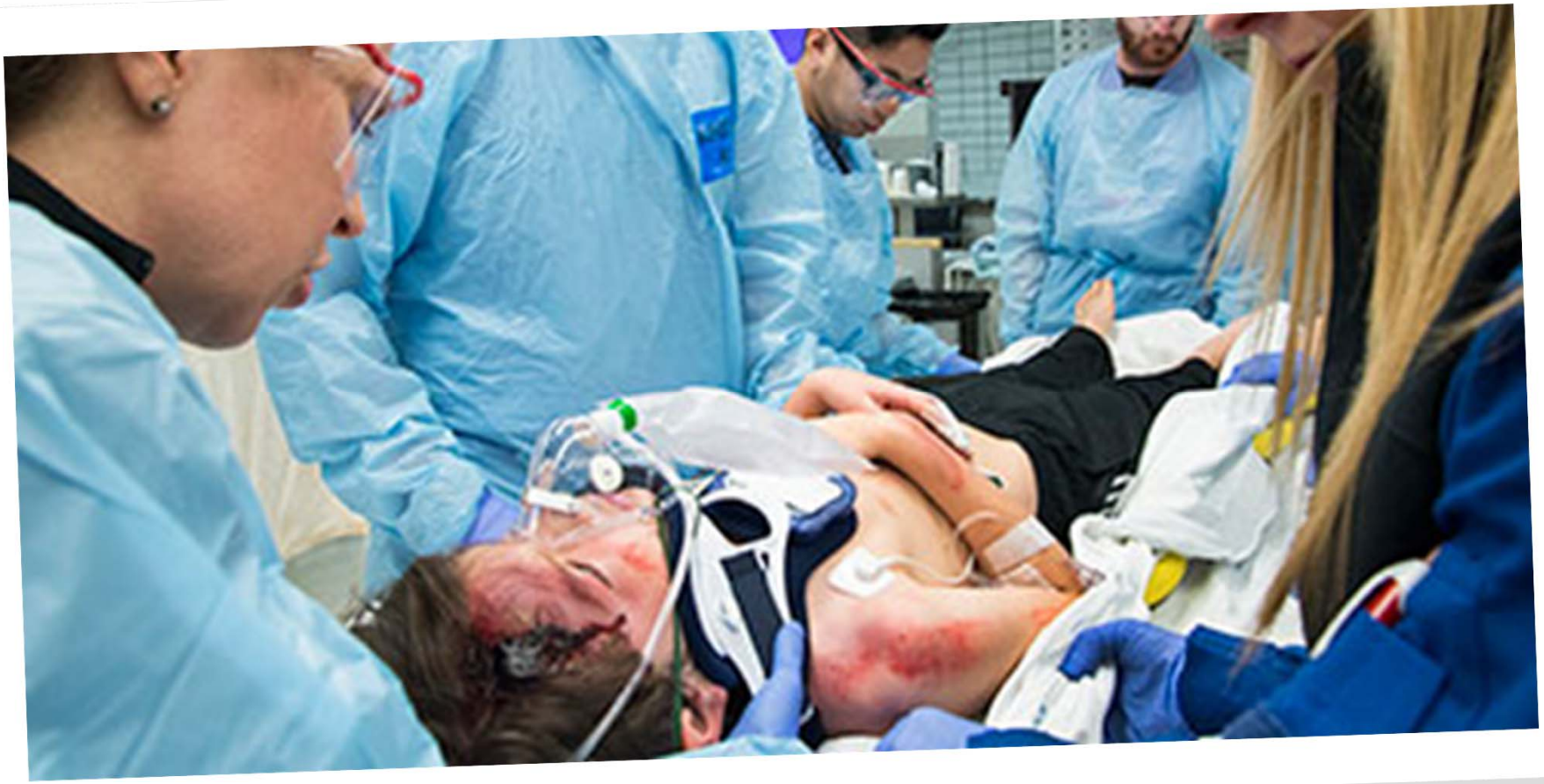


* Analysis Excluded Undetermined = 532 Deaths

Data Source: CDC/NCHS, National Vital Statistics System

- For children less than 1 year of age, two–thirds of injury deaths were due to suffocation.
- Drowning was the leading cause injury death for those 1 to 4 years of age.

https://lifesciencedaily.com/wp-content/uploads/2017/04/shutterstock_44



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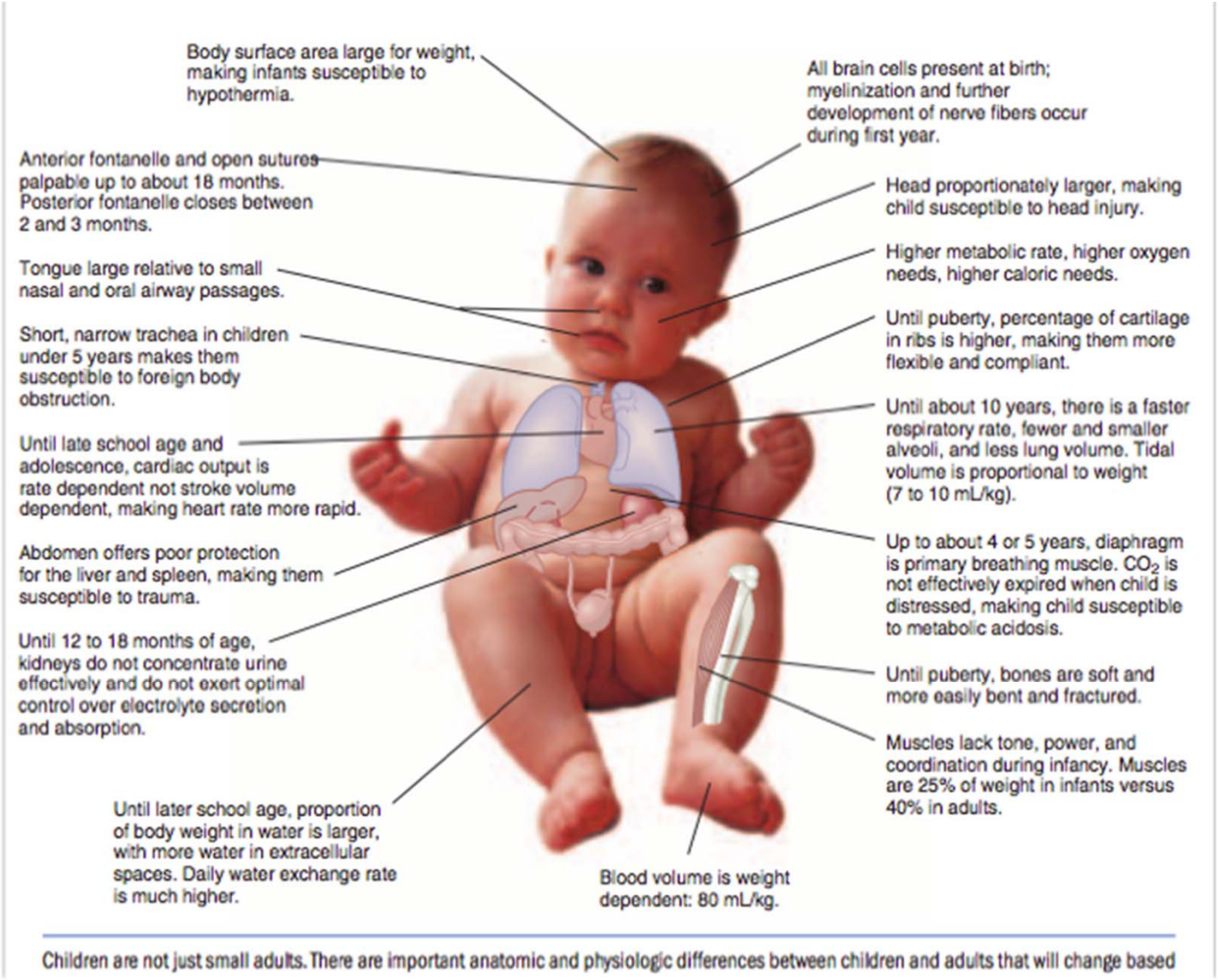
http://www.oddities123.com/hilarious-new-instagram-trend-kids-dressed-as-adults/



Children are not just small adults. There are important anatomic and physiologic differences between children and adults that will change based

Original source unknown.

ADVANCED TRAUMA LIFE SUPPORT®

ATLS®

STUDENT COURSE MANUAL

AMERICAN COLLEGE OF SURGEONS

Inspiring Quality:
Highest Standards, Better Outcomes

ACS Committee on Trauma

New to this Edition!
Mobile App

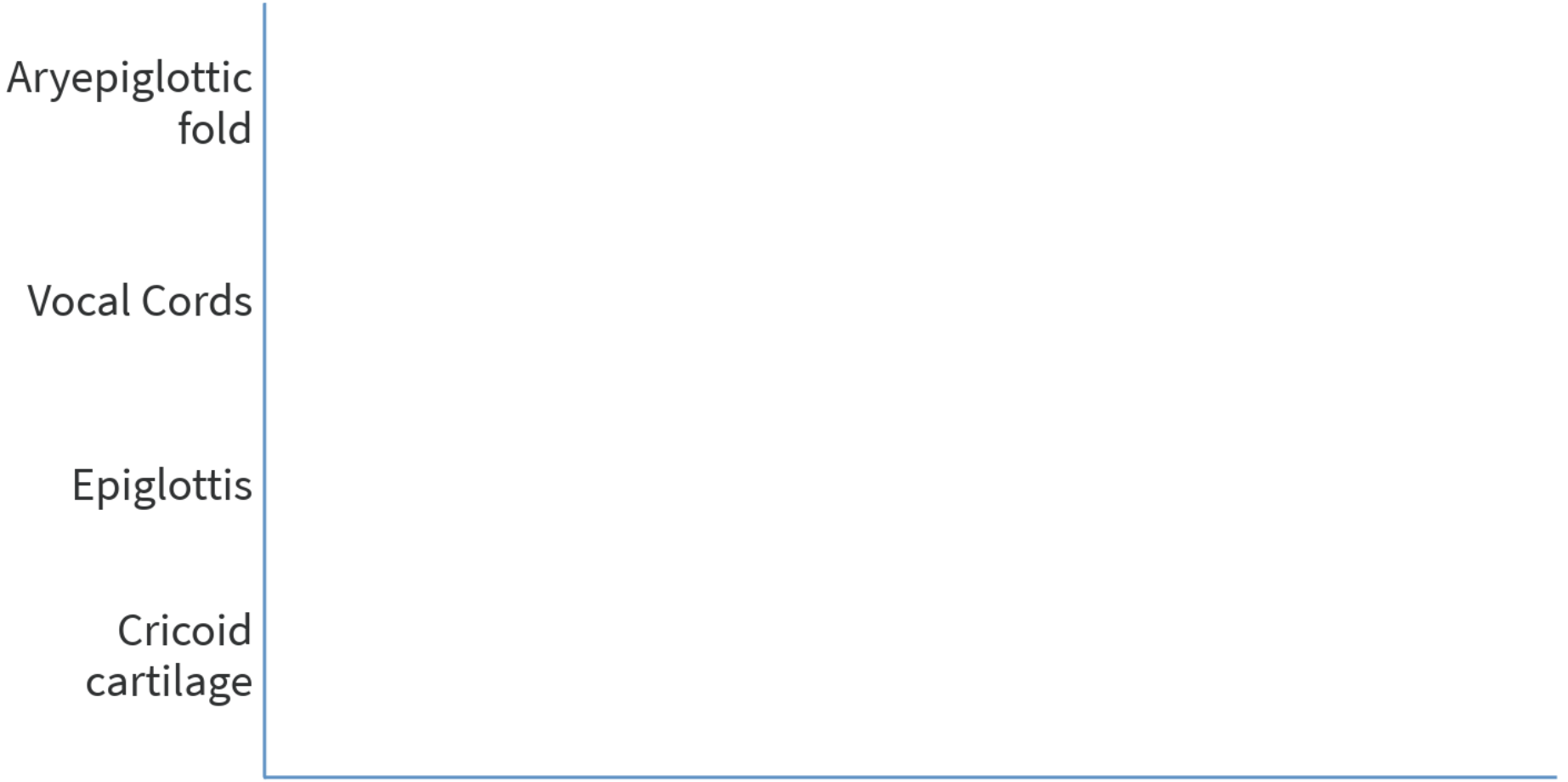
Trauma Evaluation

- Primary Survey
  - A →B→C→D→E
  - Address immediate life threats
  - Begin Resuscitation
- Secondary Survey
  - Head-to-toe, Xrays, imaging, re-evaluation
  - Remove backboard

Airway

maintenance with cervical spine protection

Where is the pediatric airway the narrowest?



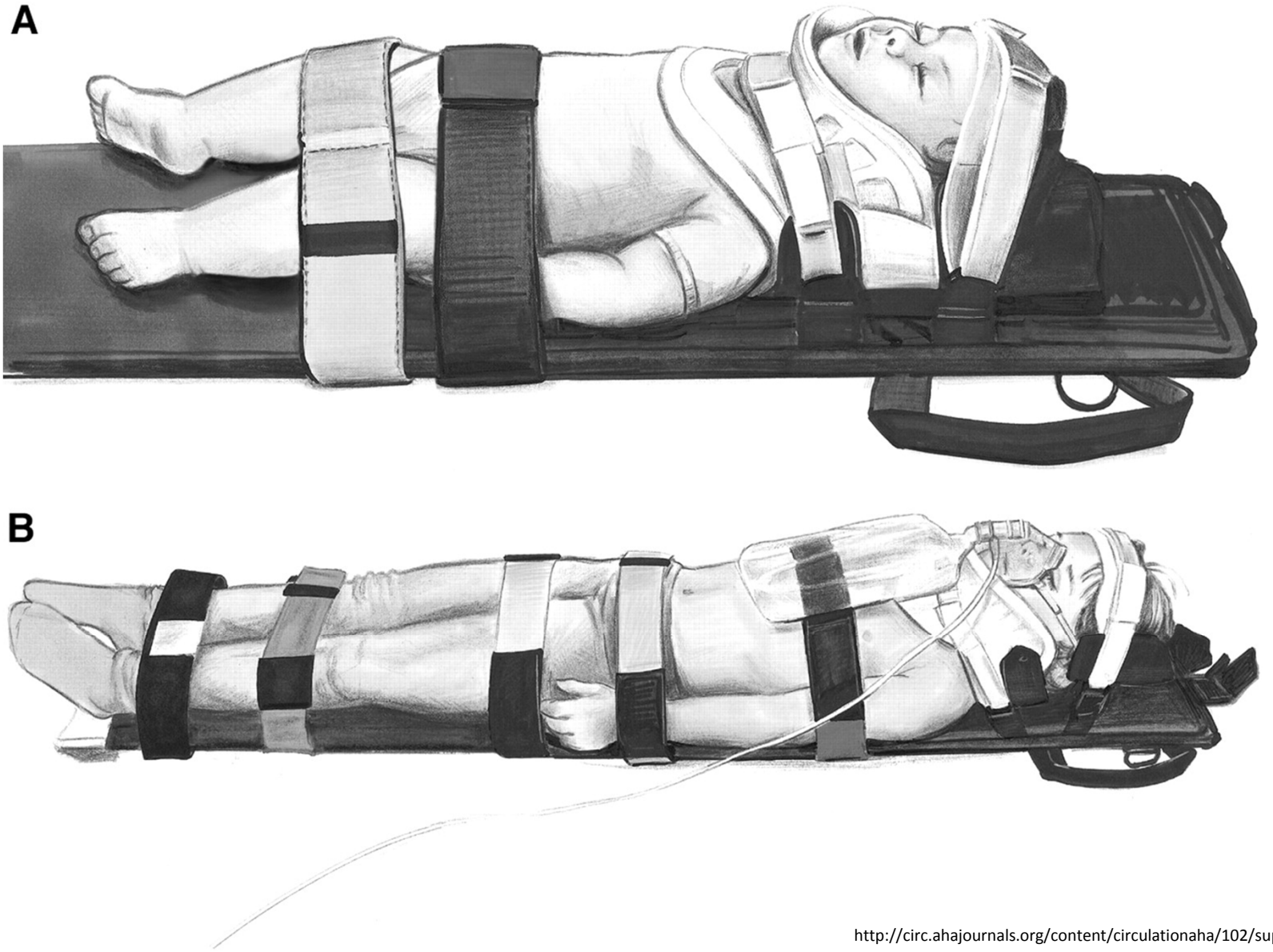


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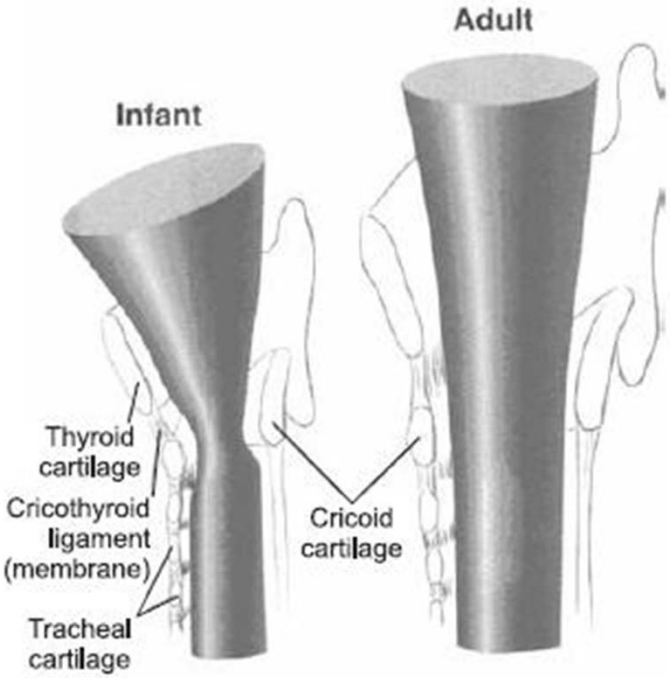
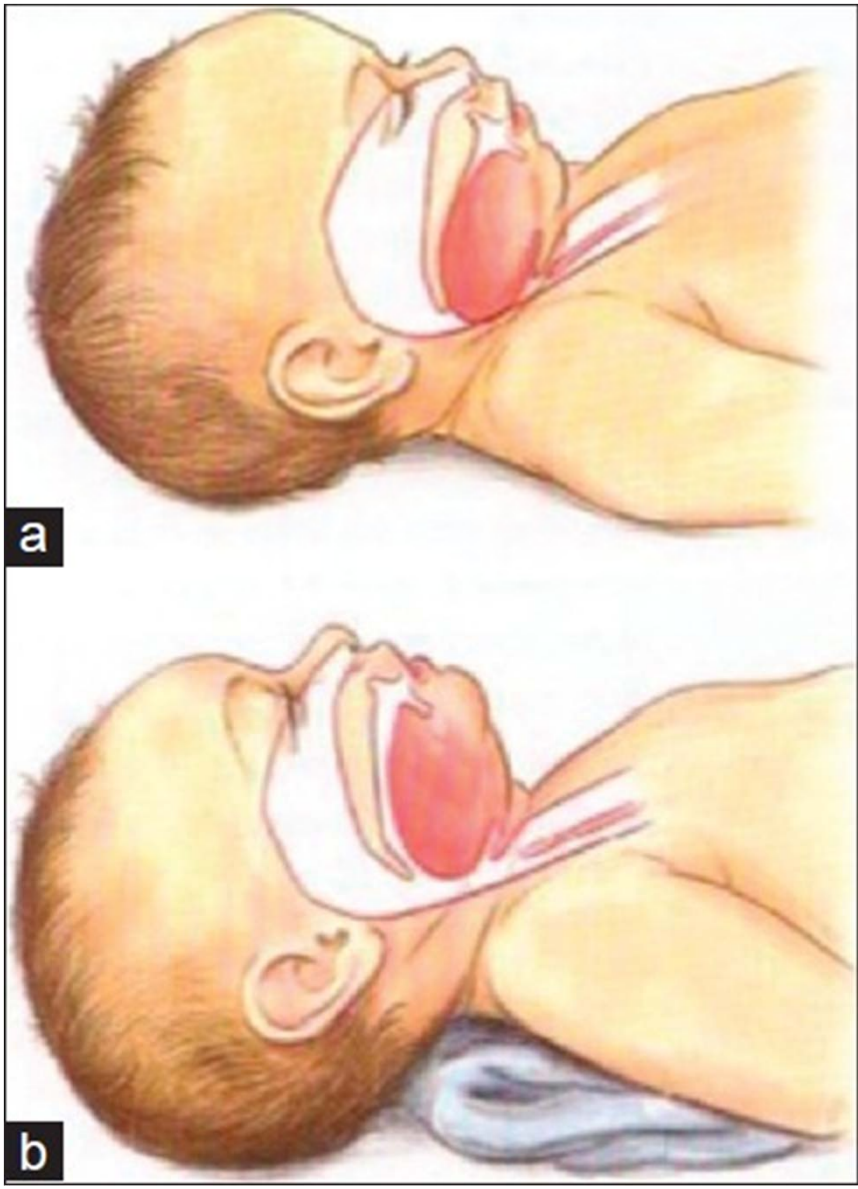
Figure 1. Comparison Of Infant And Adult Airway



From: Henretig, et al. Textbook of Pediatric Emergency Procedures



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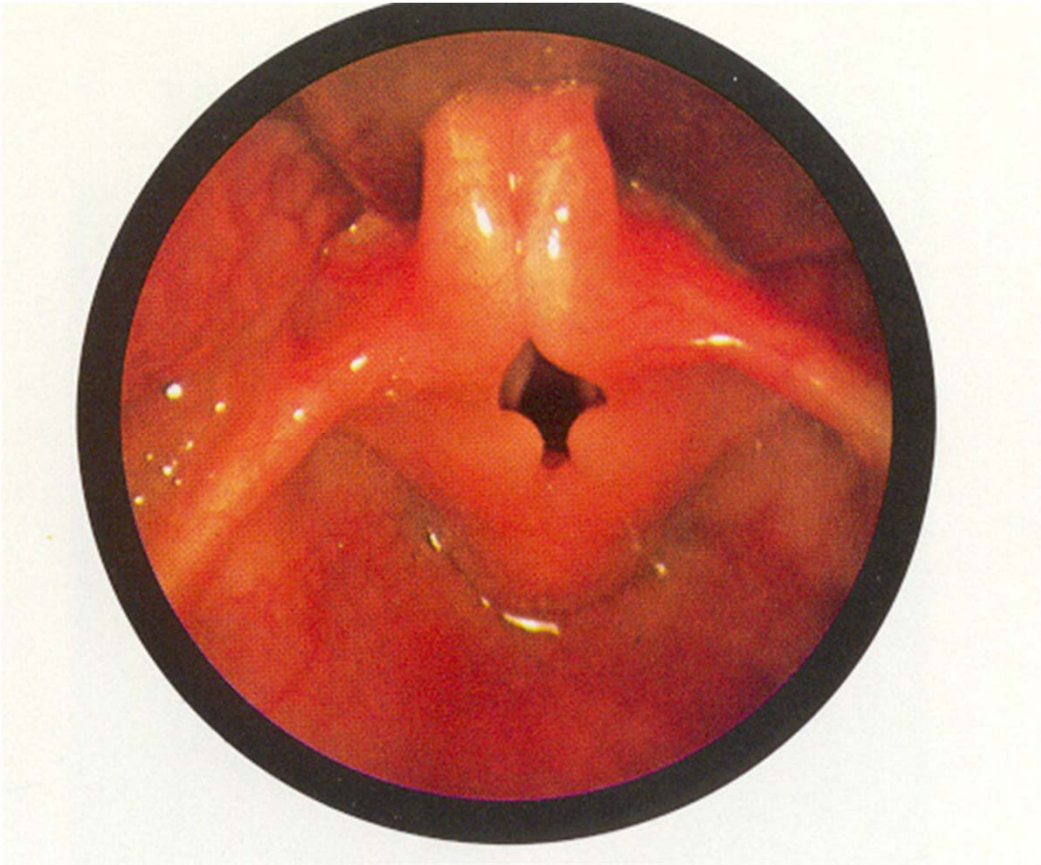
Airway Adjuncts
oral airway
nasal airway
RÜSCH
use once
CE 0124
FPnotebook.com

Pediatric

Adult

https://www.slideshare.net/markpbrady/emergency-airway-management-2014-mark-p-brady-pac

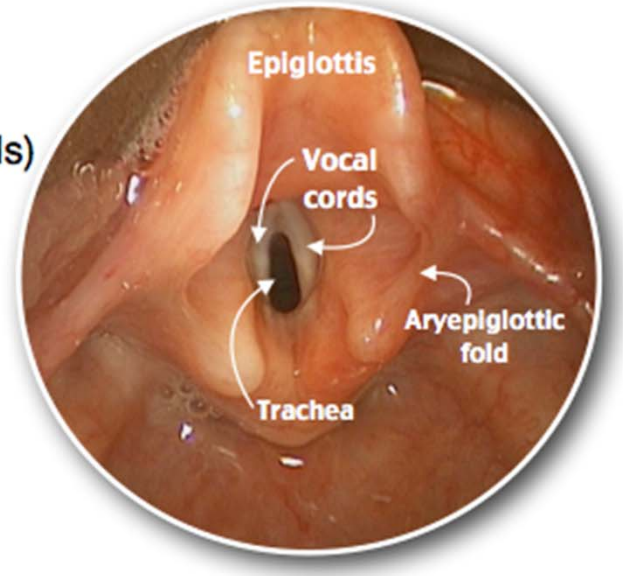



YOU SHALL NOT PASS!

Anatomical Differences Between Pediatric and Adult Airways

Pediatric airway

- Proportionally **smaller larynx**
- **Narrowest** portion is the **cricoid cartilage** (below vocal cords)
- **Epiglottis** is **longer** and **narrower**
- **Head** and **occiput** are proportionally **larger**
- **Tongue** is proportionally **larger**
- **Neck** is much **shorter**
- **Larynx** is more **anterior** and **cephalad**
- **Adenoids** are are **larger**
- Risk of **mainstem intubation** is much **higher** in pediatrics due to short trachea and bronchus



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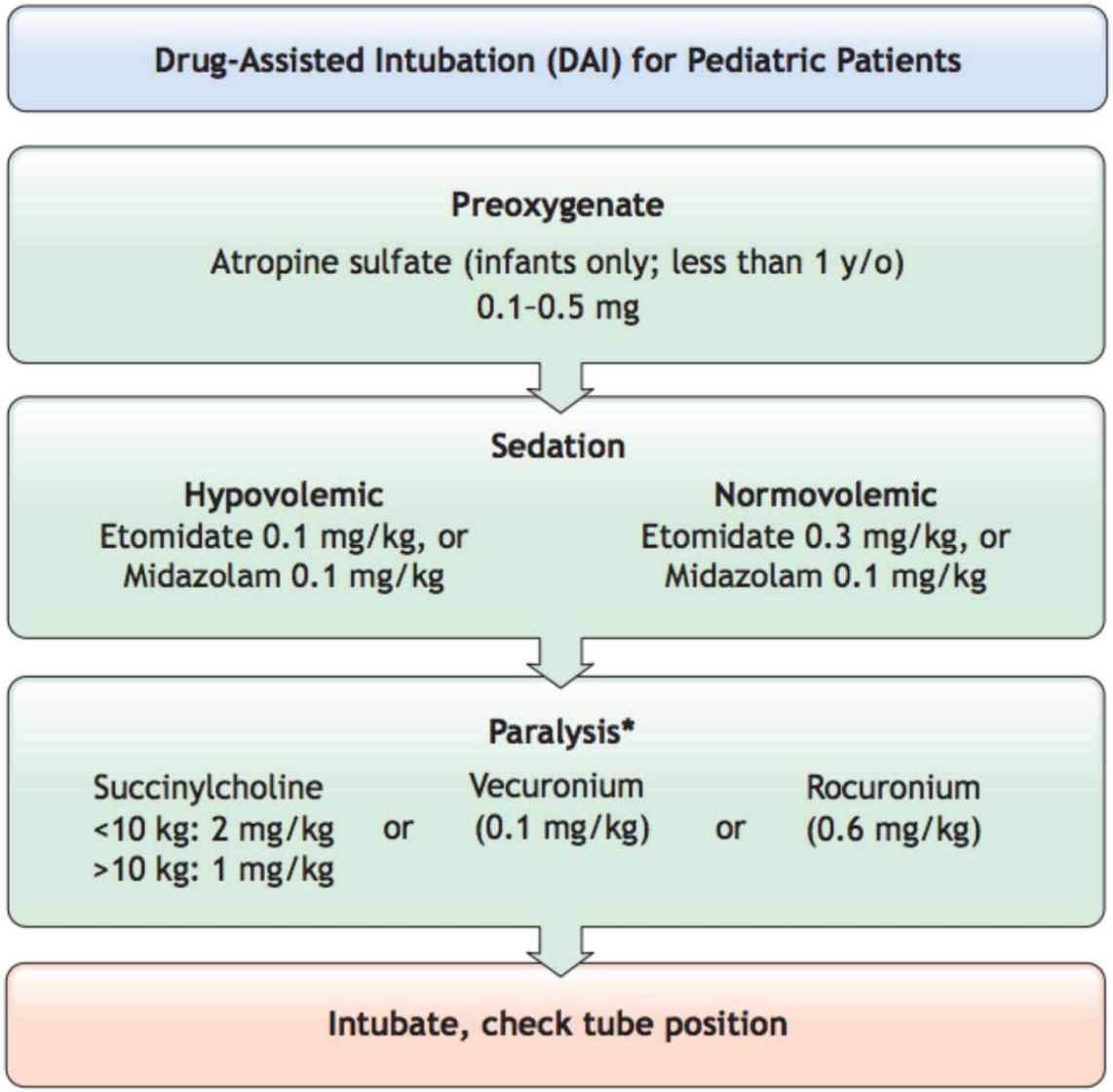

Advanced trauma life support (ATLS®): the ninth edition. 2013

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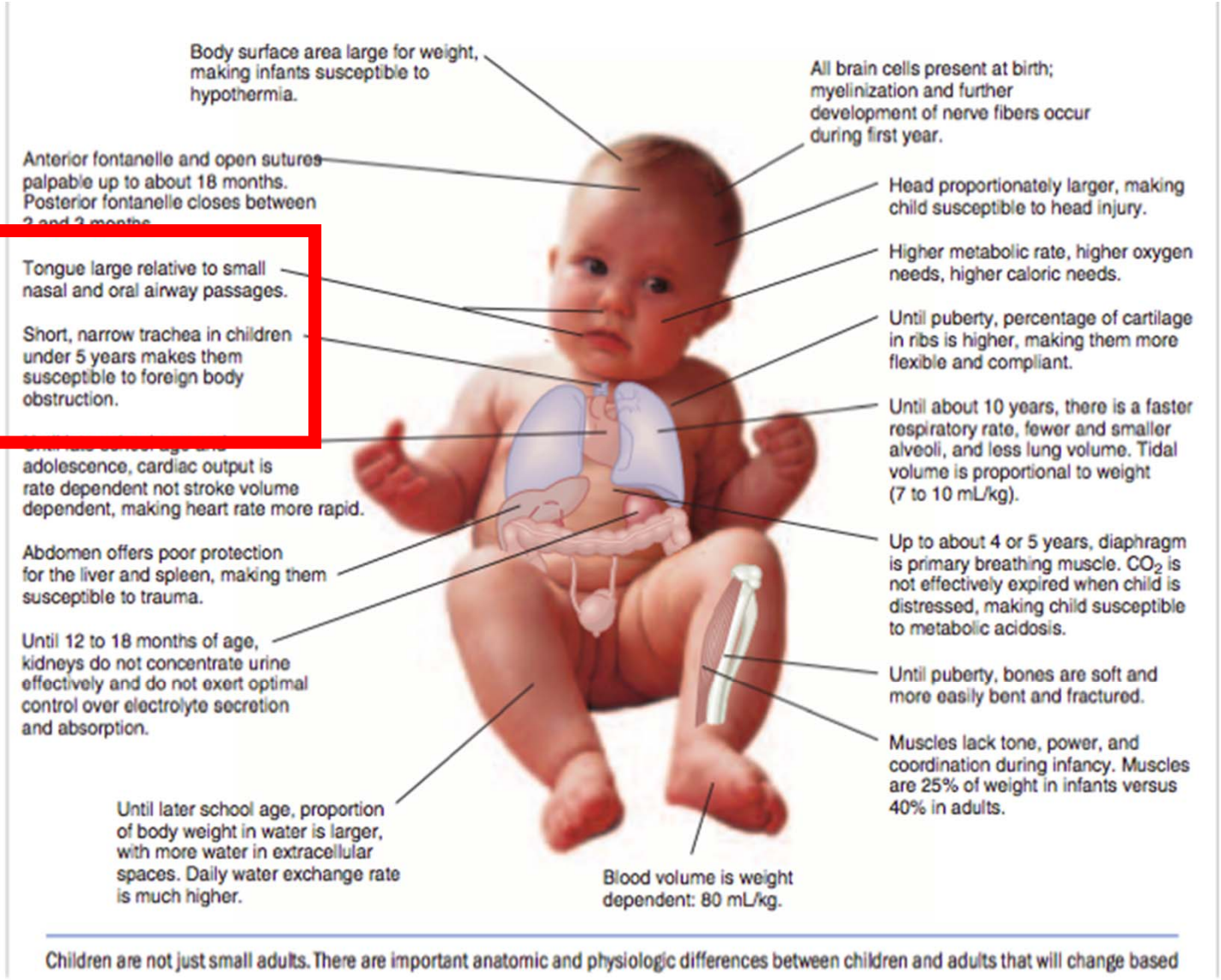
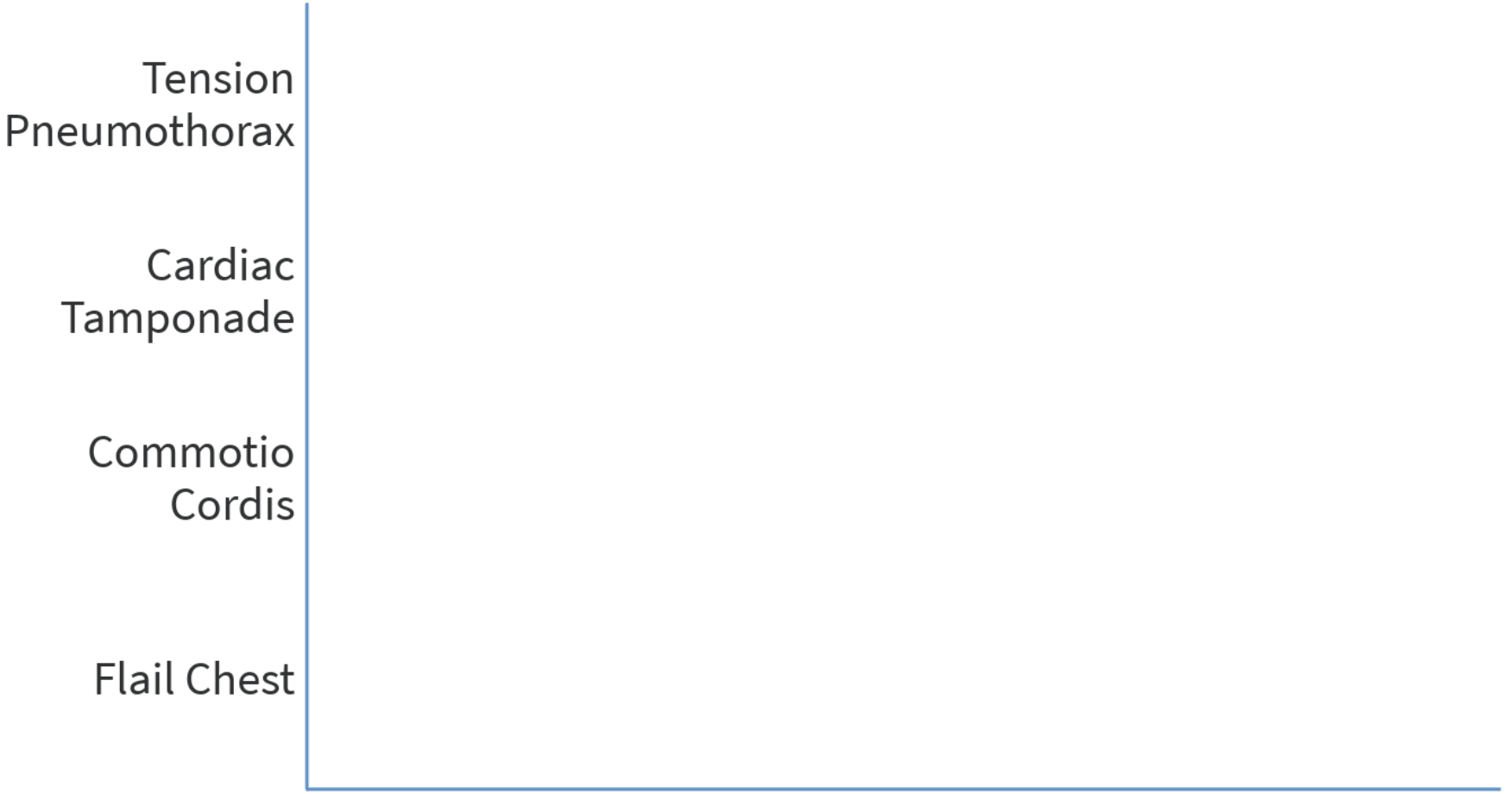


Children are not just small adults. There are important anatomic and physiologic differences between children and adults that will change based

Original source unknown.

What is the most common immediate life threatening injury in children?



Breathing and ventilation

Respiratory Rate

Normal Respiratory Rate by Age (breaths/minute) Reference: PALS Guidelines, 2015	
Age	**Normal Respiratory Rate**
Infants (<1 y)	30-53
Toddler (1-2 y)	22-37
Preschool (3-5 y)	20-28
School-age (6-11 y)	18-25
Adolescent (12-15 y)	12-20

1-2-3-4 rule

1 x ETT = (age/4) + 4 (formula for ***uncuffed*** tubes)

2 x ETT = NG/ OG/ foley size

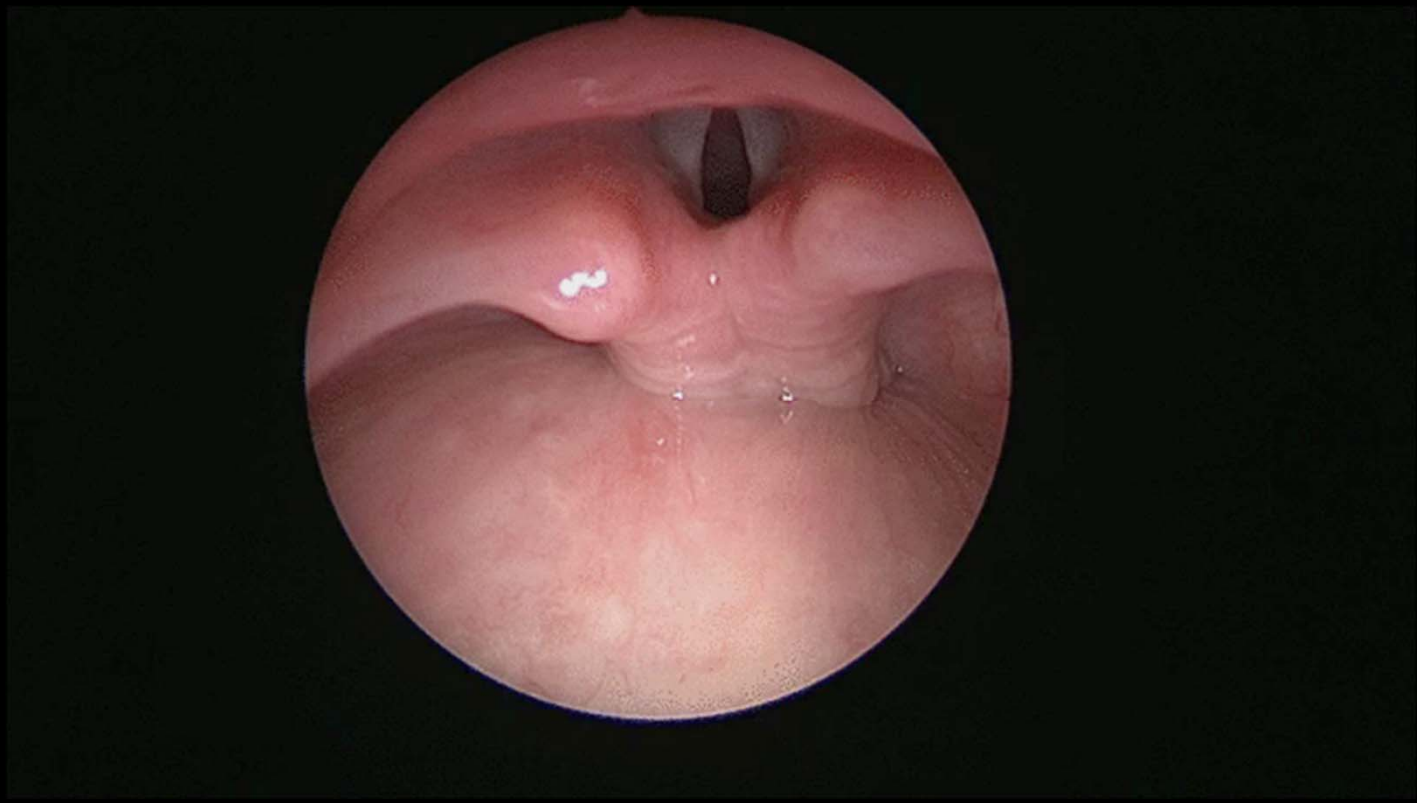
3 x ETT = depth of ETT insertion

4 x ETT = chest tube size (max, e.g. hemothorax)

So for example, a 4-year-old child would get intubated with a ___ ETT inserted to depth of ___ cm (3x ETT), a ___Fr NG/OG/foley (2x ETT), and a ___Fr chest tube (4x ETT).

https://umem.org/educational_pearls/1400/

- Normal Vital signs
- Chest tube sizes
- Thoracostomy



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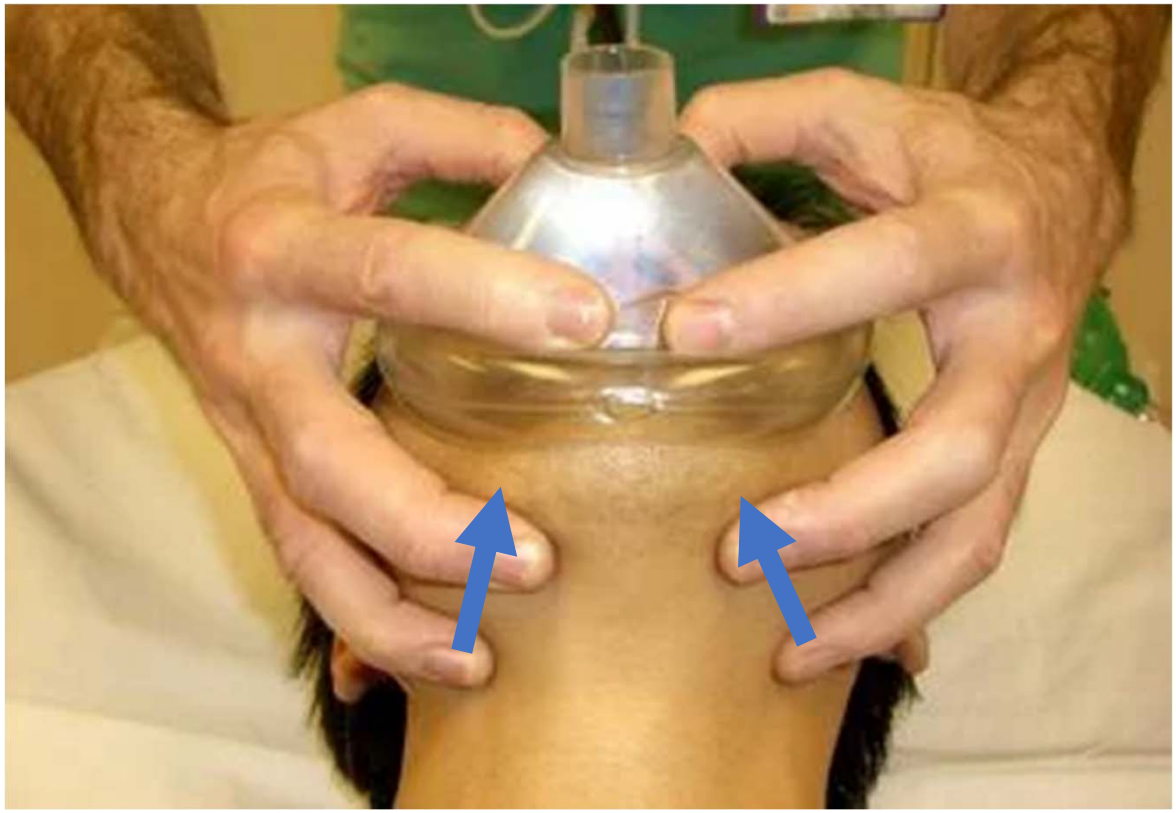


PERCUTANEOUS TRANSLARYNGEAL VENTILATION

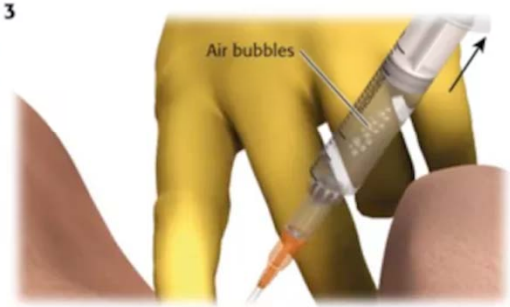
1

Hyperextend the patient's neck if possible. Locate the cricothyroid membrane with your nondominant hand.

2

Attach a 14-gauge angiocatheter to a saline-filled syringe. Insert the needle through the skin, subcutaneous tissue, and membrane directed at a 30° to 45° angle caudally.

3



Aspirate the syringe as you advance the needle; air bubbles will be seen in the syringe when the trachea is entered.

4

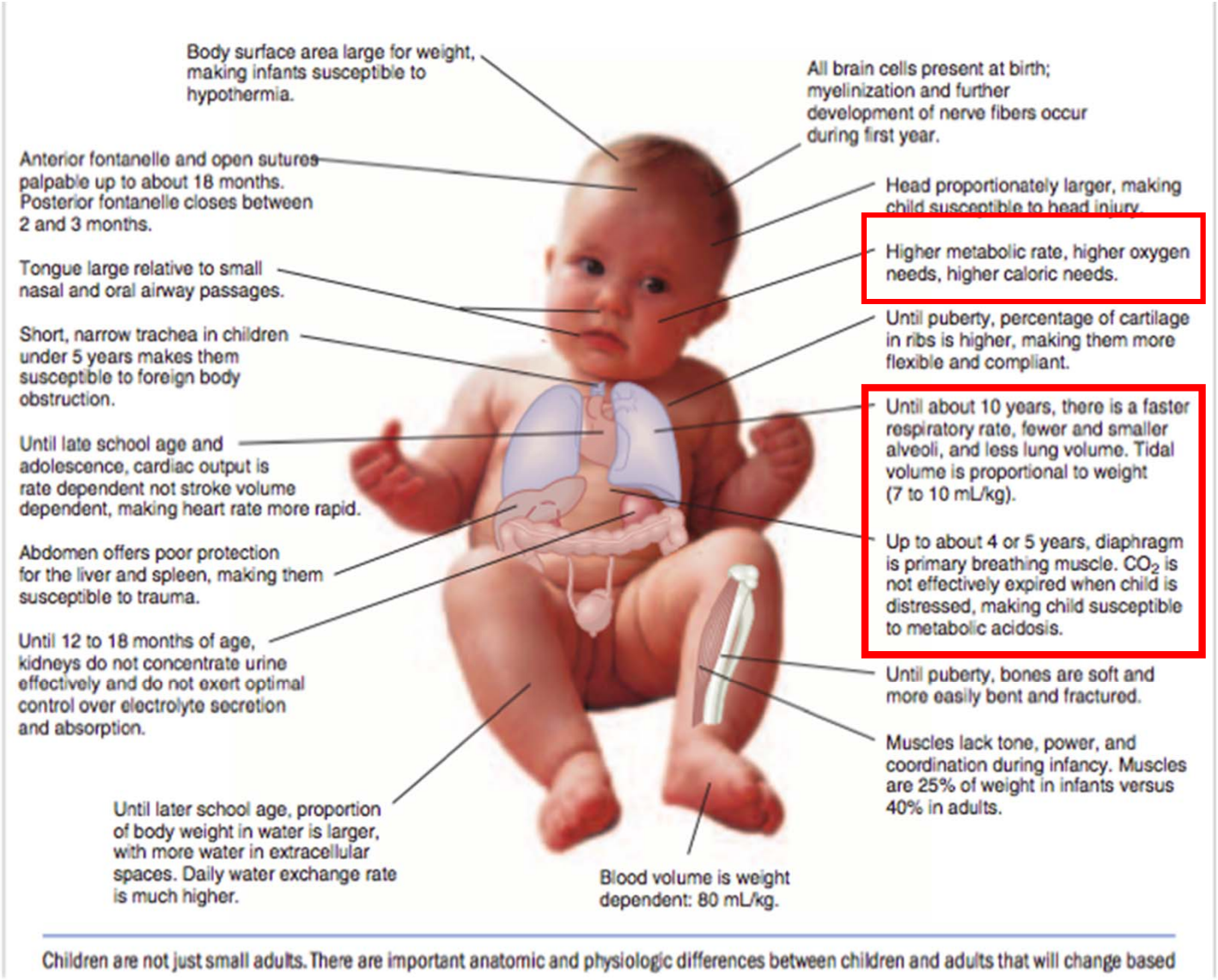
Once the trachea is entered, advance the catheter over the needle until the hub is flush with the skin.

5

Remove the needle.

6

Attach the oxygen supply and begin to ventilate the patient.



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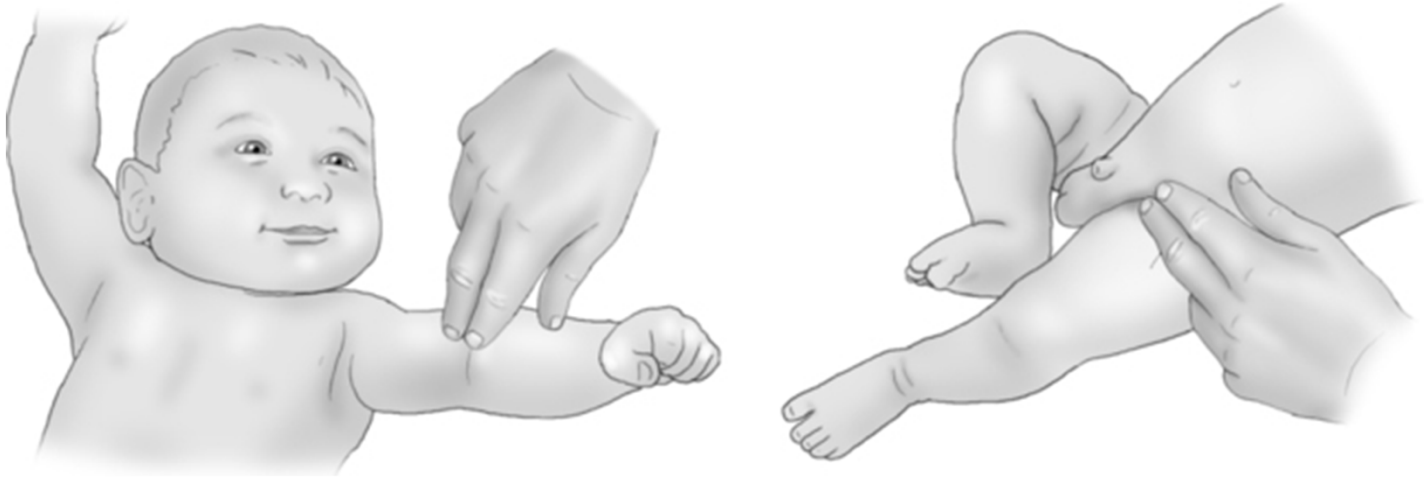
Circulation
with hemorrhage control



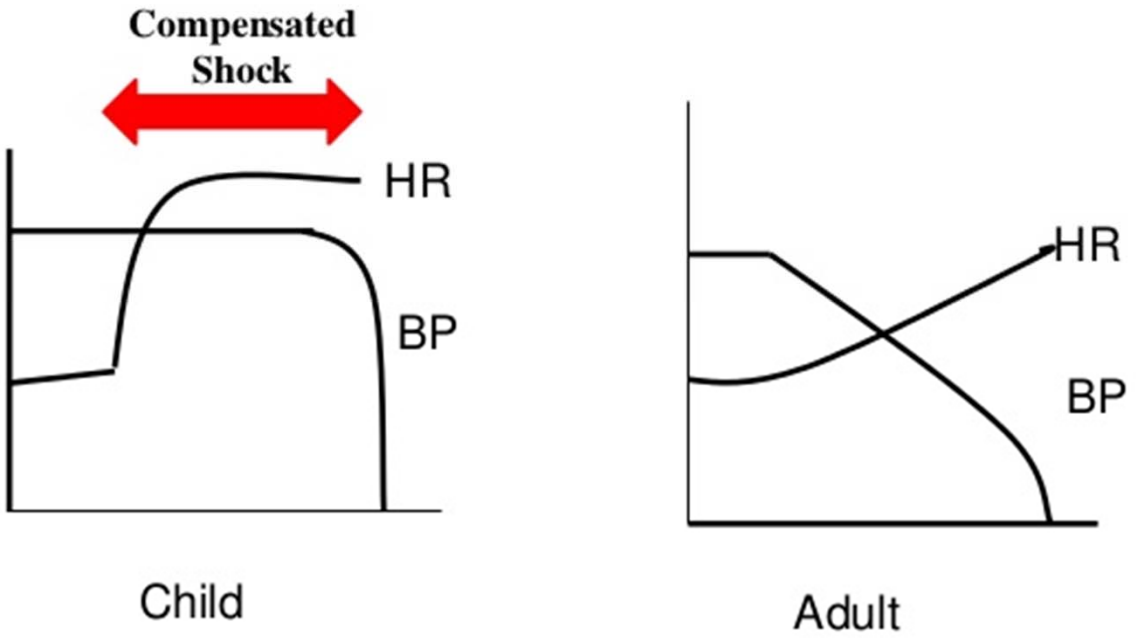
https://clinicalgate.com/wp-content/uploads/2015/06/B9780323100298000125_f12-04-9780323100298.jpg

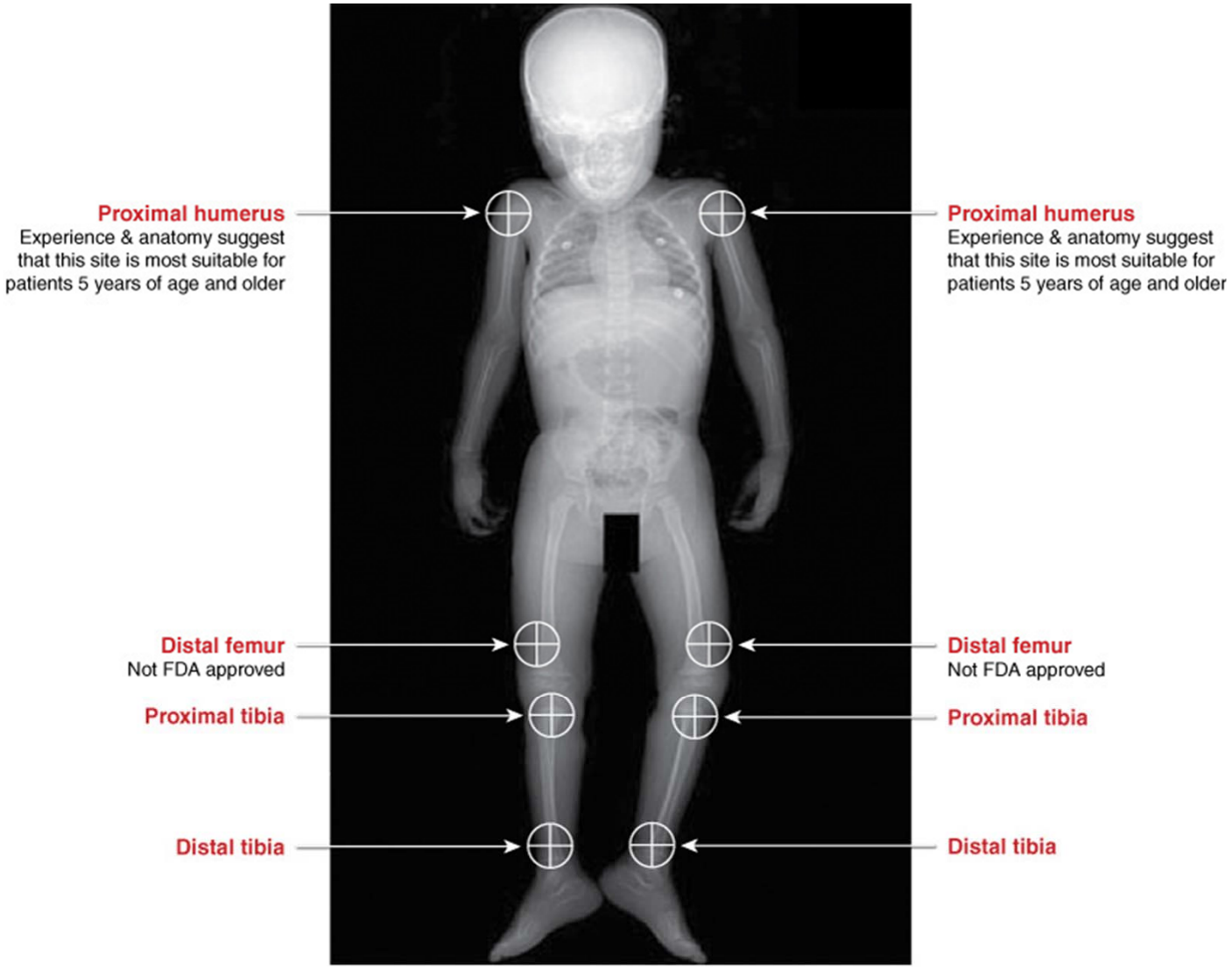
Infant (1-12 mo)	72-104	37-56	<70
Toddler (1-2 y)	86-106	42-63	<70 + (age in years x 2)
Preschooler (3-5 y)	89-112	46-72	<70 + (age in years x 2)
School-age (6-9 y)	97-115	57-76	<70 + (age in years x 2)
Preadolescent (10-11 y)	102-120	61-80	<90
Adolescent (12-15 y)	110-131	64-83	<90

Heart Rate

Normal Heart Rate by Age (beats/minute) Reference: PALS Guidelines, 2015		
Age	**Awake Rate**	**Sleeping Rate**
Neonate (<28 d)	100-205	90-160
Infant (1 mo-1 y)	100-190	90-160
Toddler (1-2 y)	98-140	80-120
Preschool (3-5 y)	80-120	65-100
School-age (6-11 y)	75-118	58-90
Adolescent (12-15 y)	60-100	50-90

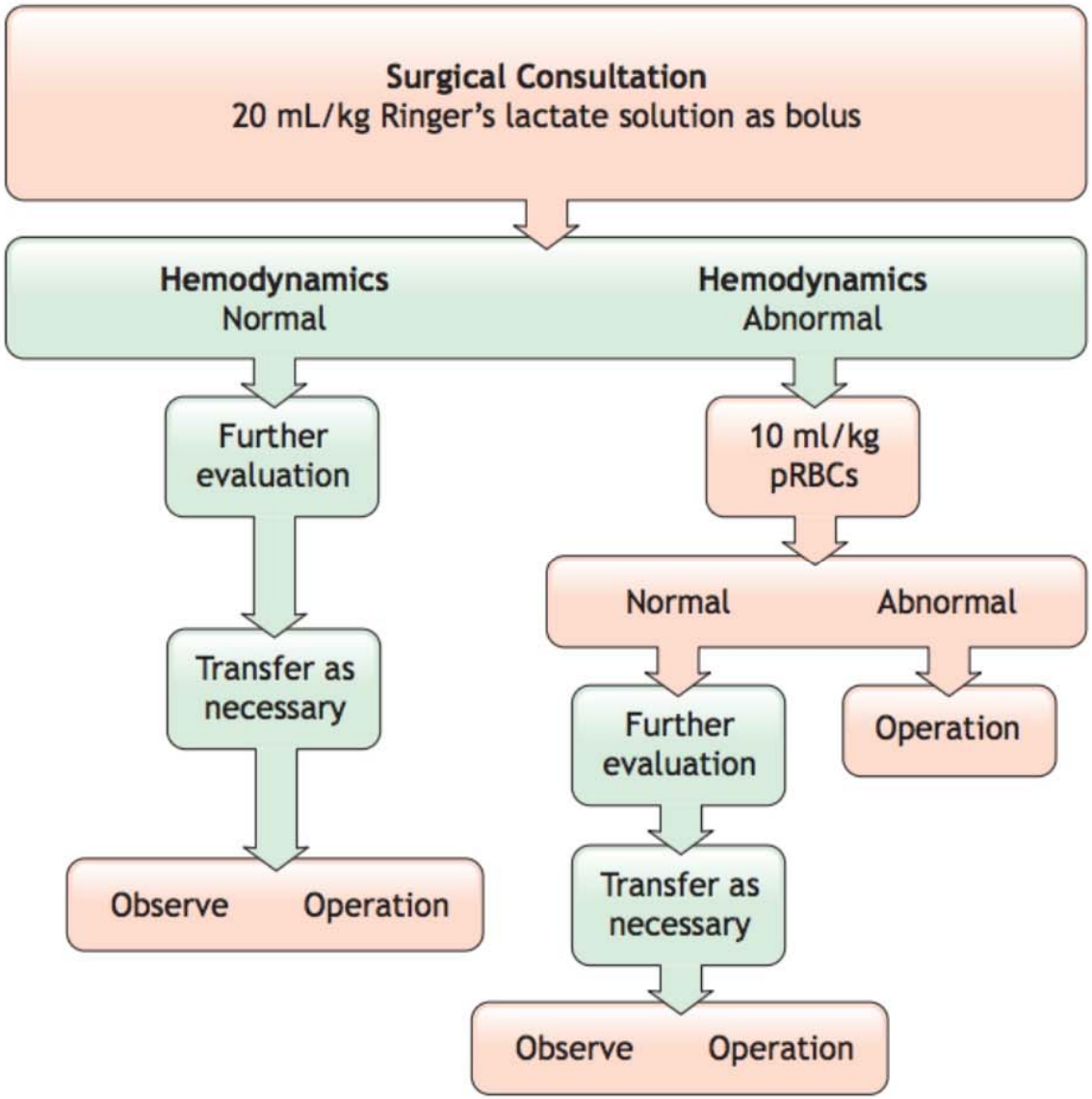
Haemodynamic Response to Hypovolaemia





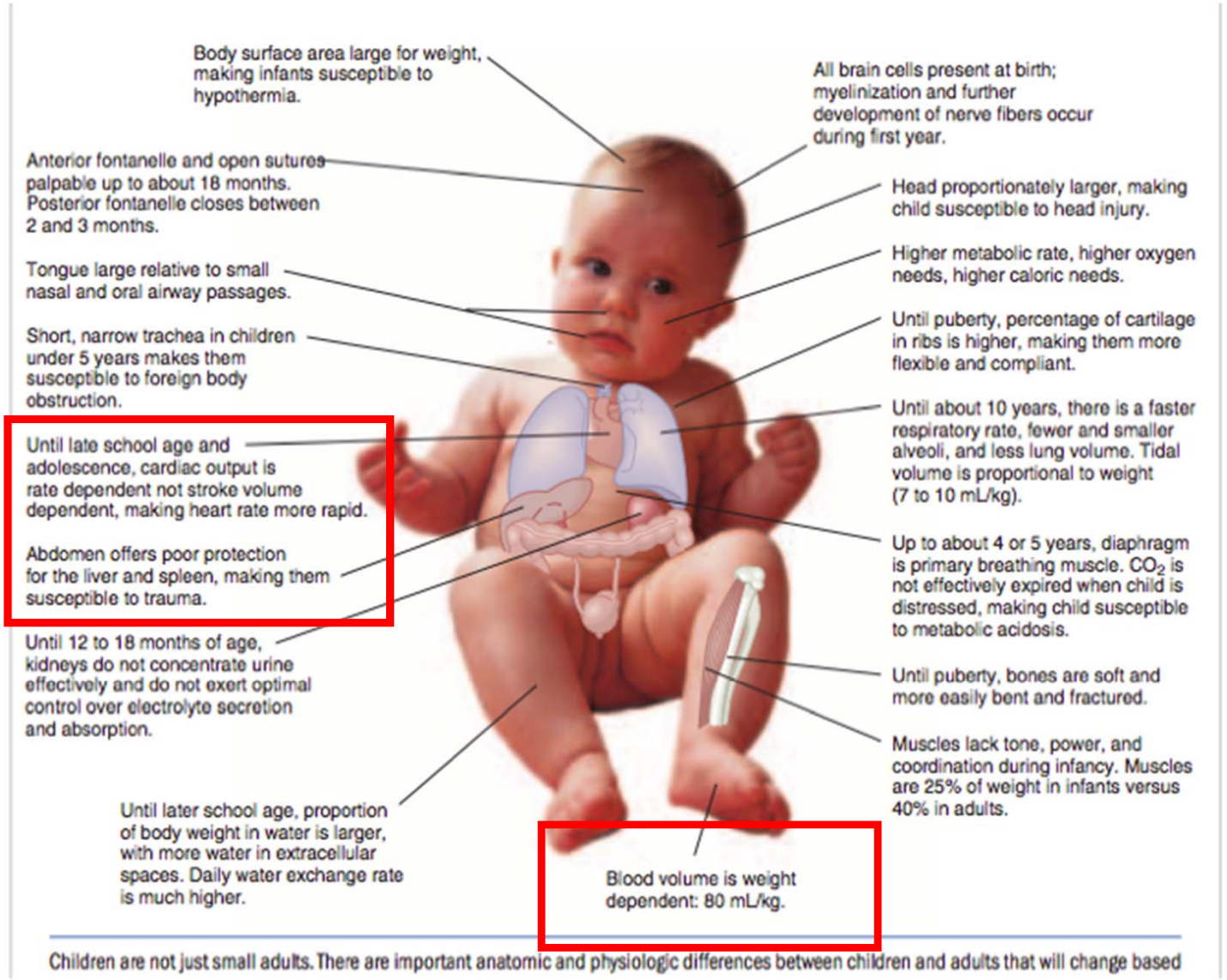
Source: Tintinalli JE, Stapczynski JS, Ma OJ, Cline DM, Cydulka RK, Meckler GD: *Tintinalli's Emergency Medicine: A Comprehensive Study Guide, 7th Edition*: http://www.accessmedicine.com


Intraosseous Needles
Long EZ-IO
15 ga x 4.5 cm
Adult EZ-IO
15 ga x 2.5 cm
>40 kg
Peds EZ-IO
15 ga x 1.5 cm
FPnotebook.com



■ **FIGURE 10-7 Resuscitation Flow Diagram for Pediatric Patients** with normal and abnormal hemodynamics.

Advanced trauma life support (ATLS®): the ninth edition. 2013



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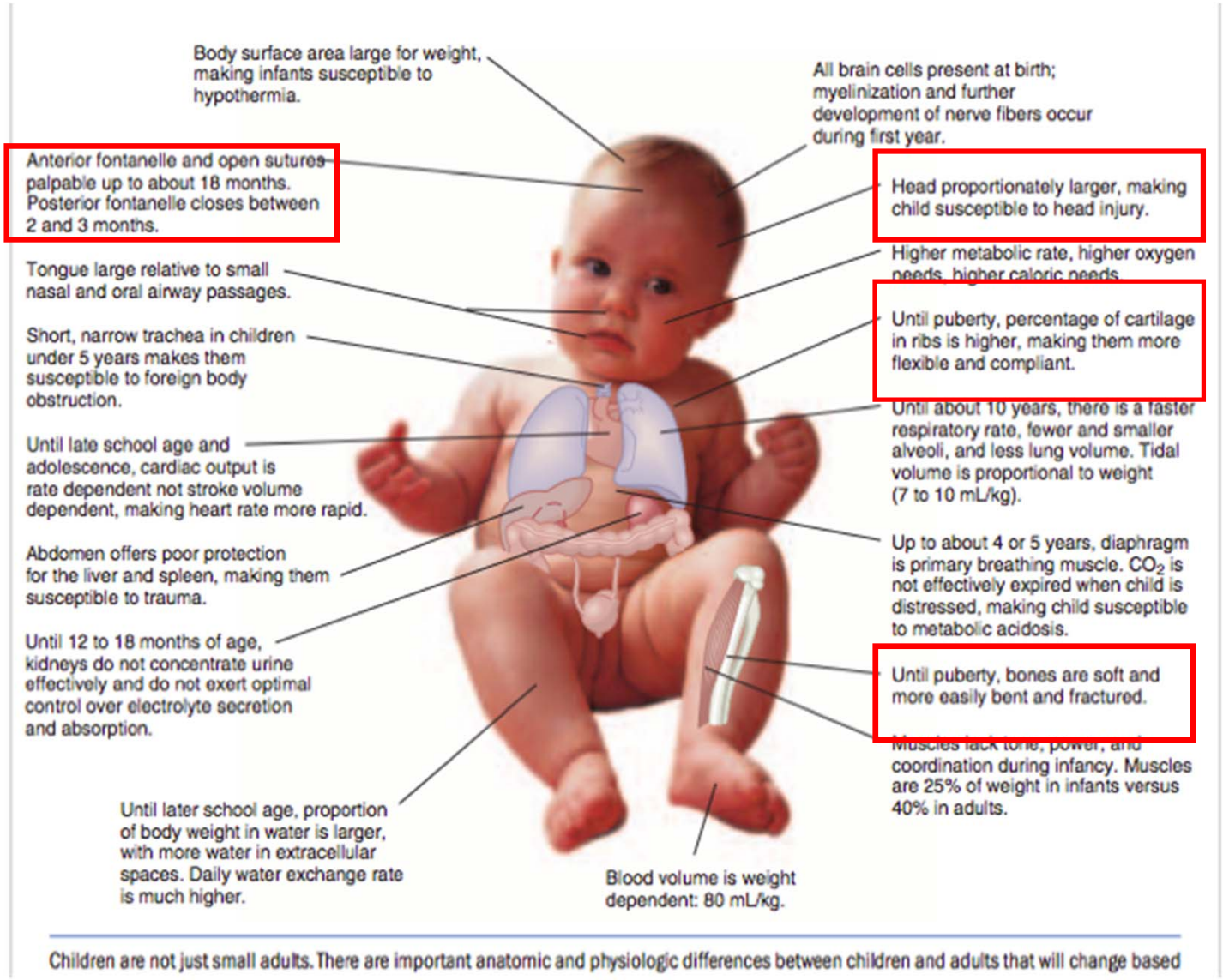
Disability & Neurologic assessment



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Original source unknown.

Type of Response	Score*	AGE-RELATED RESPONSES		
		>1 Year	*<1 Year*	
Eye-opening response	4	Spontaneous	Spontaneous	
	3	To verbal command	To shout	
	2	To pain	To pain	
	1	None	None	
		>1 Year	*<1 Year*	
Motor response	6	Obeys commands	Spontaneous	
	5	Localizes pain	Localizes pain	
	4	Withdraws to pain	Withdraws to pain	
	3	Abnormal flexion to pain (decorticate)	Abnormal flexion to pain (decorticate)	
	2	Abnormal extension to pain (decorticate)	Abnormal extension to pain (decorticate)	
	1	None	None	
		>5 Years	*2-5 Years*	*0-2 Years*
Verbal response	5	Oriented and converses	Appropriate words, phrases	Babbles, coos appropriately
	4	Confused conversation	Inappropriate words	Cries but is consolable
	3	Inappropriate words	Persistent crying or screaming to pain	Persistent crying or screaming to pain
	2	Incomprehensive sounds	Grunts or moans to pain	Grunts or moans to pain
	1	None	None	None

Modified from James HE, Trauner DA. The Glasgow Coma Scale. In: James HE, Anas NG, Perkin RM, editors. Brain Insults in Infants and children. Orlando: Grune & Stratton; 1985, p. 179-82.
*Scoring: severe, <9; moderate, 9-12; mild, 13-15.

Figure 6a. Patient 10, evidence of spinal cord oedema at the level of C2 (encircled)

Pediatric C-spine injury

- 1-2%
- Most common finding is isolated sensory deficit (may be transient)

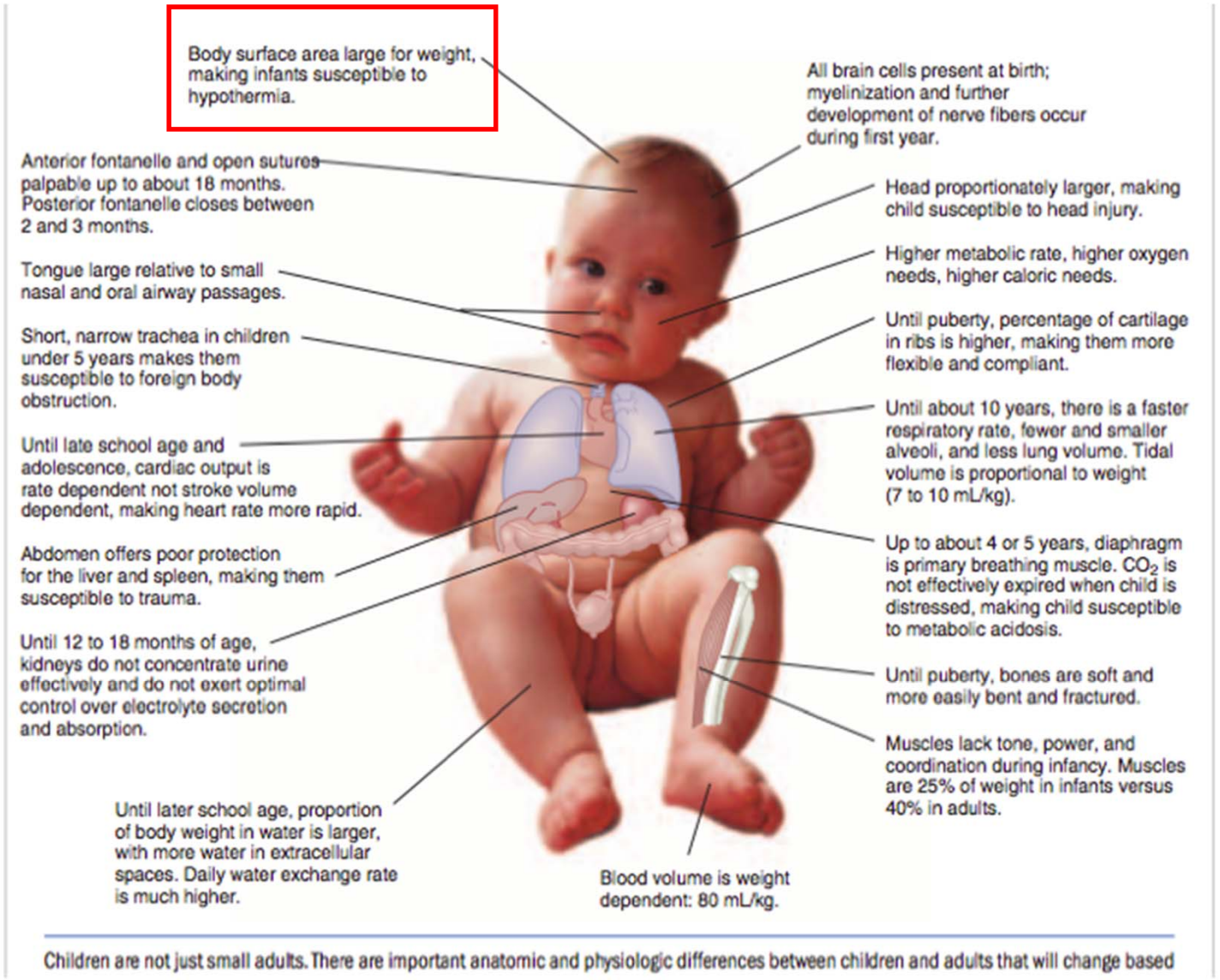
Screening for cervical injuries

Eight Variable that are sensitive for pediatric cervical spine injuries

1. Altered mental status (GCS < 15)
2. Focal neurological findings (signs or symptoms)
3. Complaints of neck pain
4. Torticollis
5. Substantial injury to the torso
6. Diving injury
7. High risk MVC injuries
   - Head on collision, rollover, ejection from vehicle, death, speed > 55 mph
8. Predisposing conditions for cervical injury
   - Down's, OI, h/o CSI or cervical surgery, Ehlers-Danlos, Marfan's, etc.

Annals of Emer Med. 2010. doi:10.1016/j.annemergmed.2010.08.038

Exposure & Environmental control



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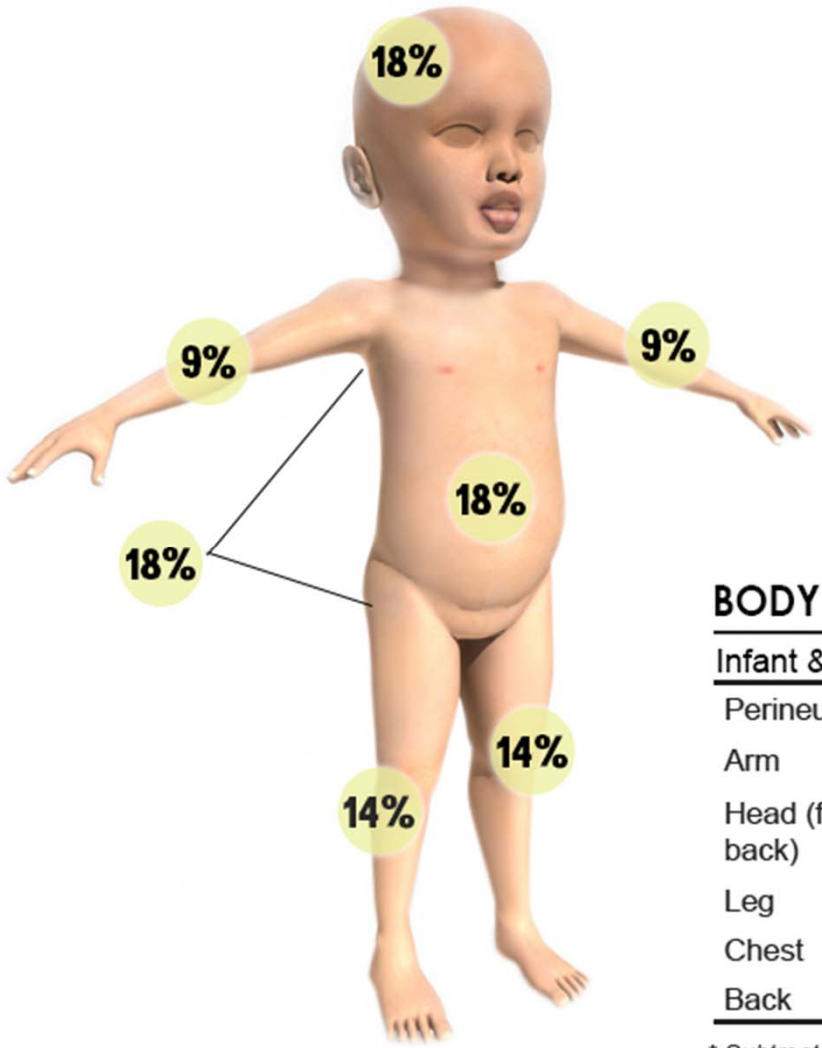
Original source unknown.


30
20
10
0
10
20
30
°C
100
80
60
40
20
0
20
°F



BODY SURFACE AREA

Infant & Child	BSA
Perineum	—
Arm	9%
Head (front and back)	18%
Leg	14%
Chest	18%
Back	18%

** Subtract 1% from the head area for each year over age 1*

bsa.png bsa_child.png

Burn Reference
Version C.1

Palm Method

Pediatric

1%
Entire Palmar Surface

0.5%
Palm Only

Adult

0.8%
Entire Palmar Surface

0.5%
Palm Only

Use of the hand as a measurement tool is acceptable to measure burn surface areas which are <15% (or >85% measuring nonburned area). Several studies have shown adult palmar surface is closer to 0.8%[1,3,4]. A common misinterpretation is the palm only (no fingers) is 1% when it is actually closer to 0.5%[1,2,3,4]. In pediatrics the entire palmar surface is closer to 1%[1,2].

1. Amirsheybani HR, Crecelius GM, Timothy NH, Pfeiffer M, Saggers GC, Manders EK. The natural history of the growth of the hand: I.Hand area as a percentage of BSA. *Plast Reconstr Surg*. 2001; 107: 726-33.
2. Nagel TR, Schunk JE. Using the hand to estimate the surface area of a burn in children. *Pediatr Emerg Care*. 1997; 13: 254-5.
3. Perry RJ, Moore CA, Morgan BD, Plummer DL. Determining the approximate area of a burn: An inconsistency investigated and re-evaluated. *BMJ*. 1996; 312: 1338.
4. Rossiter ND, Chapman P, Haywood IA. How big is a hand? *Burns*. 1996; 22: 230-1.

https://clinicalgate.com/wp-content/uploads/2015/02/B9781437727920000385_f038-002di-97814377279202.jpg

Prognostication: What can we do?

- Pediatric Trauma Scale
- Revised Trauma Scale
- BIG score

Pediatric Trauma Score

Assessment Component	SCORE		
	+2	+1	-1
Weight	Weight >20 kg (>44 lb)	10-20 kg (22-44 lb)	<10kg (<22 lb)
Airway	Normal	Oral or nasal airway, oxygen	Intubated, cricothyroidotomy, or tracheostomy
Systolic Blood Pressure	>90 mm Hg, good peripheral pulses and perfusion	50-90 mm Hg, carotid/femoral pulses palpable	<50 mm Hg, weak or no pulses
Level of Consciousness	Awake	Obtunded or any loss of consciousness	Coma, unresponsive
Fracture	None seen or suspected	Single, closed	Open or multiple
Cutaneous	None visible	Contusion, abrasion, laceration <7 cm not through fascia	Tissue loss, any gunshot wound or stab wound through fascia
Totals			
Adapted with permission from Tepas JJ, Molitt DL, Talbert JL, et al: The pediatric trauma score as a predictor of injury severity in the injured child. Journal of Pediatric Surgery. 1987;22(1)15.			

*PTS > 8 should have 0 % mortality.
All injured children with PTS < 8 should be triaged to an appropriate pediatric trauma center.

The BIG Score

Predicting mortality in pediatric polytrauma

BIG score = BASE DEFICIT + (2.5 x INR) + (15 – GCS)

Results

50/621 (8%) of the study patients died. Independent mortality predictors were the BIG score (OR 11, 95% CI 6-25), prior fluid bolus (OR 3, 95% CI 1.3-9), and prior intubation (OR 8, 95% CI 2-40). The area under the receiver operating characteristic curve was 0.95 (CI 0.93-0.98), with the optimal BIG cutoff of 16. With BIG <16, death rate was 3/496 (0.006, 95% CI 0.001-0.007) vs 47/125 (0.38, 95% CI 0.15-0.7) with BIG ≥16, ($P < .0001$). In patients requiring admission to the ICU, the BIG score remained predictive of mortality (OR 14.3, 95% CI 7.3-32, $P < .0001$).

Conclusions

The BIG score accurately predicts mortality in a population of North American pediatric patients with blunt trauma independent of pre-hospital interventions, presence of head injury, and hypotension, and identifies children with a high probability of survival (BIG <16). The BIG score is also associated with mortality in pediatric patients with trauma requiring admission to the ICU.

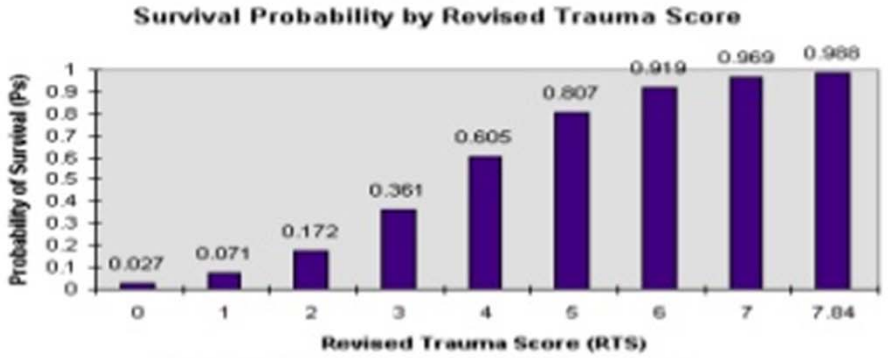
Mortality increases significantly if BIG score > 16

J Pediatr. 2015 Sep;167(3):593-8 (PMID: 26118931)

REVISED TRAUMA SCORE

RTS = 0.9368 GCS + 0.7326 SBP + 0.2908 RR

GCS	SBP	RR	Coded Value
13-15	>89	10-29	4
9-12	76-89	>29	3
6-8	50-75	6-9	2
4-5	1-49	1-5	1
3	0	0	0



Krongdai.unh@mahidol.ac.th

Questions?

References

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- **Advanced trauma life support (ATLS®): the ninth edition** ATLS Subcommittee; American College of Surgeons' Committee on Trauma; International ATLS working group.J Trauma Acute Care Surg. . 2013
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- https://www.ebmedicine.net/topics.php?paction=showTopicSeg&topic_id=132&seg_id=2659
- https://www.pedscases.com/pediatric-vital-signs-reference-chart