Pediatric Assessment

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Outreach Education

Children's Hospital Colorado
Here, it's different.

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Disclosure

Planners, faculty, and others in control of content (either individually or as a group) have no relevant financial relationships with ineligible companies.

Objectives

Summarize the differences of pediatric vs adult physiology impacting patient assessment and triage

Develop systematic approach to pediatric assessment and triage

Report escalation of pediatric emergencies and knowledge of resources

Kids are not small adults!

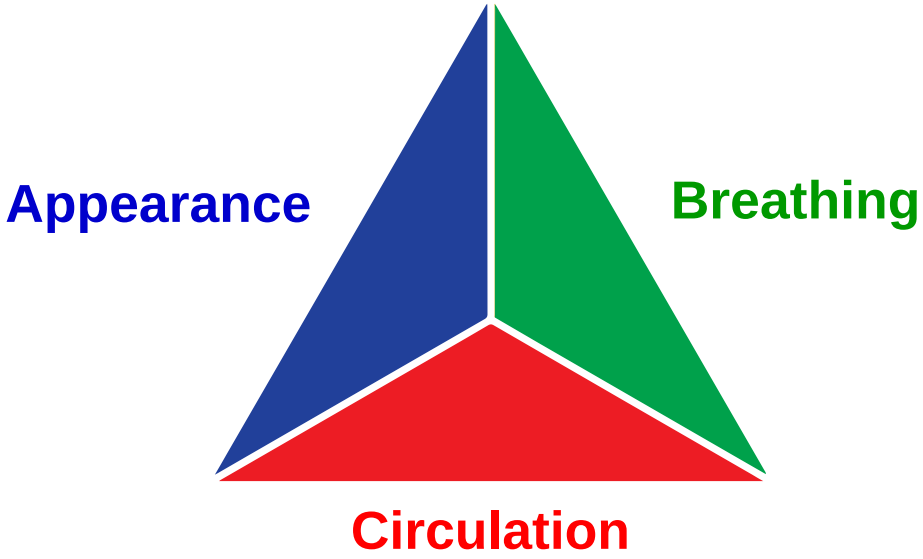
Adults

Kids

Pediatrics vs Adults

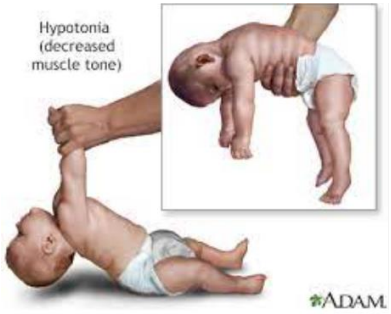
Differences	Implications
Greater BSA to body weight	Prone to hypothermia, dehydration
Higher metabolic rate	Prone to hypoxia, hypoglycemia
Higher fluid requirements	Prone to dehydration
Good vasculature and heart	Don’t see hypotension until late
Babies are nose breathers	Can’t breathe with secretions
Thin chest wall, weak IC muscles	Takes more effort to breathe

Sick or Not Sick: Pediatric Assessment Triangle



Source: American Heart Association (2020)

Appearance - TICLS



TONE – moving? limp?

INTERACTIVENESS –alert? not following?

CONSOLABILITY – by caregiver?

LOOK/GAZE – observant?

SPEECH/CRY – high pitched, hoarse, muffled?

Photo: Children's Hospital Colorado

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Floppy/Flaccid/Limp

Source: American Heart Association (2020)

Breathing

Position – extended neck or tripod?

Nasal flaring

Tracheal tug

Head bobbing

Retractions or abdominal breathing

Audible breath sounds: wheeze, stridor, grunting

Photo: Pearson

Photo: Stanford Medicine

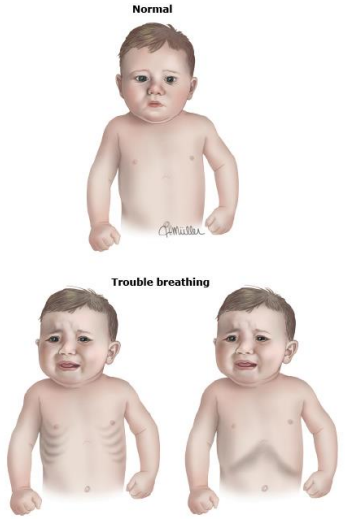

Photo: Up To Date

Slow RR, Abnormal Positioning
OR Sternal Retractions

Source: American Heart Association (2020)


Tracheal tug in 4 year old

Circulation

Skin color:

- Early: Pale
- Late: Mottled, Cyanotic

Mucous membranes

Bruising or purpura?

Mental status – LOC changes

Photo: BMJ

Photo: ResearchGate

Photo: Consultant 360

Photo: GrepMed

Altered Mentation

Source: American Heart Association (2020)

Putting together the ABCs

Concern(s)	Meaning	Interventions
Breathing	Respiratory Distress	Positioning, oxygen, suction, consider meds as applicable
Appearance + Breathing	Respiratory Failure	Positioning, oxygen (mask), suction, get advanced airway ready
Appearance + Circulation	Shock	Oxygen (NRB), access (IV/IO), labs, fluids, reduce oxygen demand / treat cause of shock
Appearance	Neurologic / Metabolic	Check blood sugar, labs, oxygen as needed, determine and treat cause
All 3 (ABC)	Cardiorespiratory Failure	Position, oxygen (bag mask), advanced airway, compressions

Respiratory Distress

Tachypnea
↑ Respiratory Effort
Abnormal Airway Sounds
Retractions
Accessory muscle use
Abdominal breathing

Can quickly progress

Respiratory Failure

Marked Tachypnea (early)
Apnea (late)
↑/↓ respiratory effort
Poor/absent distal air Movement
See saw breathing
Tracheal tug
Grunting
Nasal Flaring
Position of comfort

And then…

Cardiorespiratory Failure

Early
Tachycardia, cool/pale, decrease UOP

Late
Bradycardia, hypotension, cyanosis, unresponsive

What's Next?

Length-Based Tape

RED to head

Kilogram (kg) weight in pediatrics

- Medication doses
- Equipment

LENGTH-BASED TAPE

Weight	Laryn-goscope Blade	ET Tube (mm) +0.5 uncuffed	ET Tube Depth (cm)	Suction Cath. (Fr)	IV (ga)	NG (Fr)	Urinary Cath. (Fr)
3-5 kg	1 straight	3.0 Cuffed	3 kg 9-9.5 4 kg 9.5-10 5 kg 10-10.5	8	22-24	5-8	5
6-7 kg	1 Straight	3.0 Cuffed	10.5-11	8	22-24	5-8	8
8-9 kg	1 Straight	3.0 Cuffed	10.5-11	8	22-24	5-8	8
10-11 kg	1 Straight	3.5 Cuffed	11-12	10	20-24	8-10	8-10
12-14 kg	2 Straight	4.0 Cuffed	13.5	10	18-22	10	10
15-18 kg	2 Straight	4.5 Cuffed	14-15	10	18-22	10	10-12
19-23 kg	2 Straight or Curved	5.0 Cuffed	16.5	10	18-20	12-14	10-12
24-29 kg	2 Straight or Curved	6.0 Cuffed	17-18	10	18-20	14-18	12
30-36 kg	3 Straight or Curved	6.5 Cuffed	18.5-19.5	10-12	16-20	16-18	12

Photo: Armstrong Medical

PURPLE

SEIZURE		ICP	
Lorazepam (2 mg/mL)	1 mg (0.5 mL)	3% Saline	21-53 mL
(4 mg/mL)	1 mg (0.25 mL)	Mannitol (20% 0.2 g/mL)	10 g (50 mL)
Diazepam IV (5 mg/mL)	2 mg (0.4 mL)	(25% 0.25 g/mL)	10 g (40 mL)
Phenobarbital (65 mg/mL)	210 mg (3.2 mL)	Furosemide (10 mg/mL)	10 mg (1 mL)
(130 mg/mL)	210 mg (1.6 mL)	FLUIDS	
Phenytoin (50 mg/mL)	210 mg (4.2 mL)	Fluid Bolus	
Fosphenytoin (50 mg PE/mL)	210 mg PE (4.2 mL)	Crystalloid (NS or LR)	210 mL
Levetiracetam (100 mg/mL)	525 mg (5.25 mL)	Colloid/blood	105 mL
OVERDOSE/HYPOGLYCEMIA		Maintenance	
$D_{10}W$ (0.1 g/mL)	5.25 g (52.5 mL)	D5 1/2 NS + 20 mEq KCL/L	43 mL/HR
$D_{25}W$ (0.25 g/mL)	5.25 g (21 mL)	PAIN	
Naloxone (1 mg/mL)	1 mg (1 mL)	Fentanyl (50 mcg/mL)	10 mcg (0.2 mL)
(0.4 mg/mL)	1 mg (2.5 mL)	Morphine (2 mg/mL)	1 mg (0.5 mL)
Flumazenil (0.1 mg/mL)	0.1 mg (1 mL)	(4 mg/mL)	1 mg (0.25 mL)
Charcoal (25 g/120 mL)	10 g (50 mL)		
Glucagon (1 mg/mL)	0.5 mg (0.5 mL)		

EQUIPMENT		EQUIPMENT	
*E.T. Tube	4.0 Uncuffed/*3.5 Cuffed	Oxygen Mask	Pediatric NRB
E.T. Insertion Length	11-12 cm	*$ETCO_2$	Pediatric
Stylet	6 French	*Urinary Catheter	8-10 French
*Suction Catheter	8 French	*Chest Tube	14-20 French
Laryngoscope	1-1.5 Straight	NG Tube	8-10 French
BVM	Child	Vascular Access	20-24 Ga
Oral Airway	60 mm	Intraosseous (IO)	15 Ga
*Nasopharyngeal Airway	18 French	BP Cuff	Child
*LMA	2	*May not be included in Organizer System(s).	

Photo: HMP Global Learning Network

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A FULL Set of Vital Signs

Pediatric “normal” varies by age

Think about order!

Heart rate

Respiratory rate - a full minute!

Saturations

Temperature

Blood pressure

CHILDREN'S HOSPITAL COLORADO

OneCall 720-777-3999 | **Toll Free** 1-800-525-4871

PEDIATRIC VITAL SIGN NORMS

Age	HR Range	Respiratory Rate (Breaths/min)	Blood Pressure		Mean Arterial Pressure (mm Hg)
			Systolic (mm Hg)	Diastolic (mm Hg)	
Birth-28 days	100-205	40-60	67-84	35-53	45-60
1-12 months	100-180	30-53	72-104	37-56	50-62
1-3 yrs.	98-140	22-37	86-106	42-63	49-62
3-5 yrs.	80-120	20-28	89-112	46-72	58-69
5-11yrs.	75-118	18-25	97-115	57-76	66-72
12-18 yrs.	60-100	12-20	110-131	64-83	73-84

Hate the 60s

- Heart Rate **60** = bradycardia
- Respiratory Rate **60** = tachypnea
- Systolic Blood Pressure **60** = hypotension/uncompensated shock
- BGL **60** = borderline
  - 40-60 hypoglycemic

American Heart Association. | AMERICAN ASSOCIATION of CRITICAL-CARE NURSES

PALS

Vital Signs in Children

These 3 tables are reproduced or modified from Hazinski MF. Children are different. In: *Nursing Care of the Critically Ill Child*. 3rd ed. Mosby; 2013:1-18, copyright Elsevier.

Normal Heart Rates*

Age	Awake rate	Sleeping rate (beats/min)
Neonate	100-205	90-160
Infant	100-180	90-160
Toddler	98-140	80-120
Preschooler	80-120	65-100
School-age child	75-118	58-90
Adolescent	60-100	50-90

*Always consider the patient's normal range and clinical condition. Heart rate will normally increase with fever or stress.

Normal Respiratory Rates*

Age	Rate (breaths/min)
Infant	30-53
Toddler	22-37
Preschooler	20-28
School-age child	18-25
Adolescent	12-20

*Consider the patient's normal range. The child's respiratory rate is expected to increase in the presence of fever or stress.

Data from Fleming S et al. *Lancet*. 2011;377(9770):1011-1018.

Photo: Eastern Illinois University

Pain Scoring

Use the correct tool

- Pain is an abstract concept, hard for kids to number

Kids can withdraw from surroundings when in pain = misunderstandings

Treat pain:

- Fentanyl IV 1mcg/kg
  OR Intranasal 2mcg/kg

CRIES –

32-60 weeks gestation

CRIES Scale			
	0	1	2
Crying	None	High-pitched	Inconsolable
Requires O_2	None	<30% FiO_2 needed	>30% FiO_2 needed
Increased vital signs	Normal HR & BP	Increased HR & BP <20%	Increased HR & BP >20%
Expression	Normal	Grimace	Grimace & grunt
Sleeplessness	None	Wakes frequently	Awake constantly

FLACC –

< 3 years or nonverbal

FLACC Score			
CATEGORY	0 POINTS	1 POINT	2 POINTS
Face	Disinterested	Occasional grimace, withdrawn	Frequent frown, clenched jaw
Legs	No position or relaxed	Uneasy, restless, tense	Kicking or legs drawn up
Activity	Normal position	Squirming, tense	Arched, rigid, or jerking
Cry	No crying	Moans or whimpers	Constant crying, screams or sobs
Consolability	Content, relaxed	Distractible	Inconsolable

FACES –

3 – 12 years

Systematic Approach

Pediatric Airway Challenges

Same: C-spine stabilization, jaw thrust if needed

Large head, short neck under 2 yo

Larger tongue, larger floppy epiglottis, cricoid cone shaped, small diameter

- "Built-in" obstruction

Infants – obligate nose breathers

- Quick distress with secretions

Photo: Columbia Reports

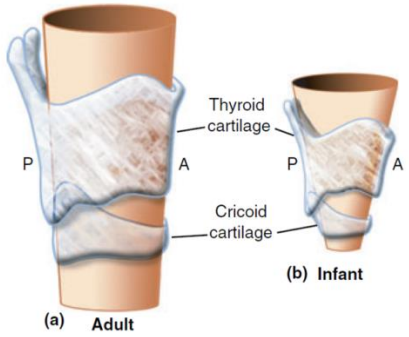


Photo: Open Anesthesia

Pediatric Airway Interventions

Shoulder Roll / Sniffing Position

- Head tilt chin lift

E-C clamp technique

Photo: Life with Gremlins

Photo: UCD Emergency Medicine

Suction - use saline!

“Deep suctioning”

Photo: Children’s Wisconsin

Photo: Anaesthesia, Pain & Intensive Care

Pediatric Breathing Challenges

Same: Intubate at GCS 8, significant respiratory failure, compensated shock, laryngeal reflex, impending herniation

Thin chest wall, cartilaginous sternum/ribs, poorly developed intercostal muscles

- Rapid RR, rely on diaphragm/abdominal muscles for respirations

Children have smaller lung capacity and higher oxygen consumption

- Increased RR first sign of distress, hypoxia risk

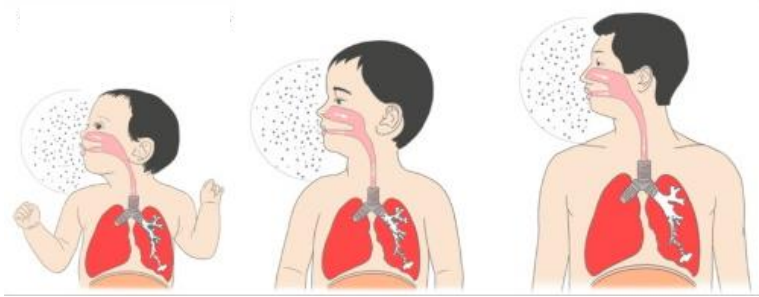


Photo: Science Direct

Age	Rate
Infant	30-53
Toddler	22-37
Preschooler	20-28
School Aged	18-25
Adolescent	12-20

Source: AHA / PALS

Pediatric Breathing Interventions

Upper vs lower airway
- Stridor vs wheeze

Airway adjuncts – nasal and oral
- Bring a bunch to the bedside

Oxygen – cannulas and masks
- NO “blow by”

Photo: Serphinity

Photo: Intersurgical

Photo: Children’s Health Ireland

Photo: Flexicare

Nasal canula –
Min: low
Max: Infant 3L,
Pediatric 6L

Photo: Medline

Simple mask –
Min: 6L
Max: 10L

Photo: Grayline

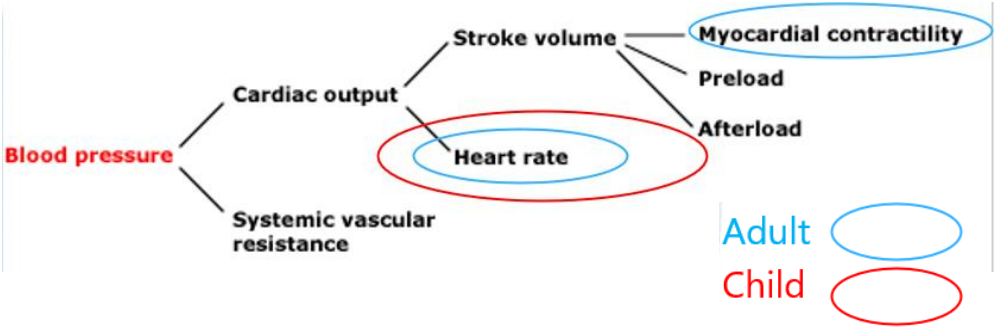
Non-Rebreather –
Min: 10L (keep bag inflated with breaths)
Max: 15L

Pediatric Circulation Challenges

Capillary refill
- More dependent on room-temp

Blood pressure – repeat q15 min
- Kids compensate… hypotension is late

End organ function
- Mental status – parents may notice first!
- Ask about wet diapers



Age	Systolic BP
Term Neonate (0-28 days)	<60
Infants (1-12 months)	**<70**
Children (1-10 years)	<70 + (age in years x 2)
Children > 10 years	<90

Source: AHA / PALS

Pediatric Circulation Interventions

IVs:

Saphenous

AC/hand

Head

IOs:

Stabilize leg, slight external rotation

Proximal tibia: tibial tuberosity flat, 1-3cm below knee joint

Rapid Fluid Administration:

3-way connector

Pull/push: pull from IVF bag into syringe, push in from syringe

Pediatric Shock

Identification – 3 things at once

- Oxygen - NRB
- Monitor – keep cycling BP!
- Access – IV/IO, don't delay

20 ml/kg isotonic boluses – load them up

- Hepatomegaly, rales/crackles – go slower

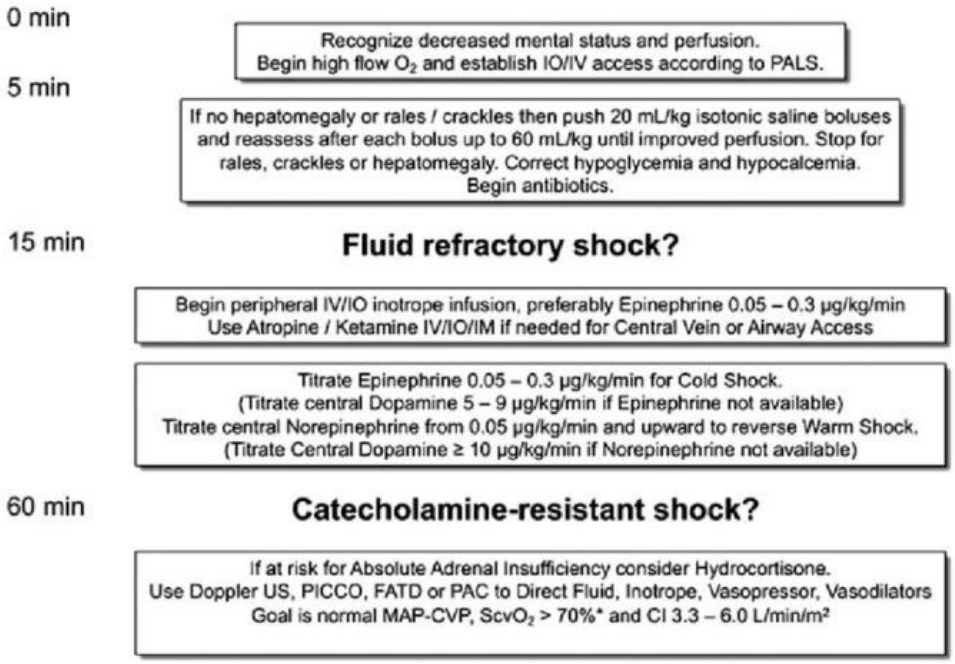
"Do not delay inotropes" – PIV, double up

- Epinephrine
- Norepinephrine
- Dopamine

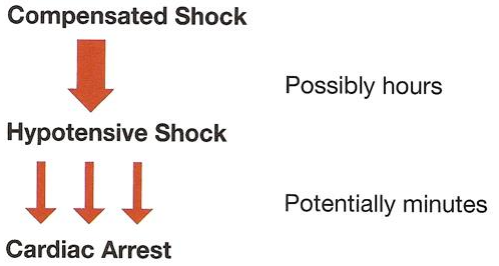
Consider hydrocortisone

Compensated: normotensive

Uncompensated: AMS, hypotension



Algorithm of management of shock in infants and children by American College of Critical Care Medicine



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Pediatric Disability – Da Brain, Dextrose

Same: Mental status – Awake Verbal Pain Unresponsive

Fontanelles! (6-18 months)

Mental status - what's normal?

- You may need the parents

Dextrose – less liver capacity to store glycogen

- Increased risk for hypoglycemia

Head trauma – majority of pediatric trauma deaths

Think about ingestion!

Modified Glasgow Coma Scale for Infants and Children

	Child	Infant	Score
Eye opening	Spontaneous	Spontaneous	4
	To speech	To speech	3
	To pain only	To pain only	2
	No response	No response	1
Best verbal response	Oriented, appropriate	Coos and babbles	5
	Confused	Irritable cries	4
	Inappropriate words	Cries to pain	3
	Incomprehensible sounds	Moans to pain	2
	No response	No response	1
Best motor response*	Obeys commands	Moves spontaneously and purposefully	6
	Localizes painful stimulus	Withdraws to touch	5
	Withdraws in response to pain	Withdraws to response in pain	4
	Flexion in response to pain	Abnormal flexion posture to pain	3
	Extension in response to pain	Abnormal extension posture to pain	2
	No response	No response	1

Pediatric Disability Interventions

Check GLUCOSE!

Rule of 50s:

- 50 = D50 x 1ml/kg
- 50 = D25 x 2ml/kg
- 50 = D10 x 5ml/kg
- 50 = D5 x 10ml/kg

Suspected Increased ICP:

- Head midline, elevate 30
- Maintain normotension
- Do not excessively hyperventilate – EtCO2 35
- Consider Mannitol, Hypertonic
- Sedation

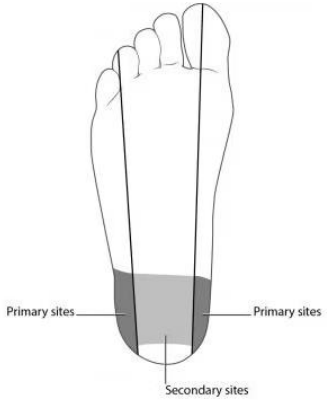


Photo: Medscape

Photo: CHOP

Pediatric Exposure Interventions

Clothes off – look under diaper too

- Then bundle them back up

Aim for normothermia

Warm: Blankets, Warmed IVF, Bair Hugger

Cool: Remove layers, Wet washcloths, Cooling blankets, antipyretics

Photo: Wyoming Department of Health

Case Study

Sam

- 5 days old
- Uncomplicated pregnancy and birth, first baby
- Presents to ED with poor feeding, fast breathing, lethargy, mottled skin, delayed cap refill
- T 38, HR 220, BP 60/46, RR 65, Sats 95 (cool extremities)

Pediatric Assessment Triangle (plus vitals):

Appearance

Breathing

Circulation

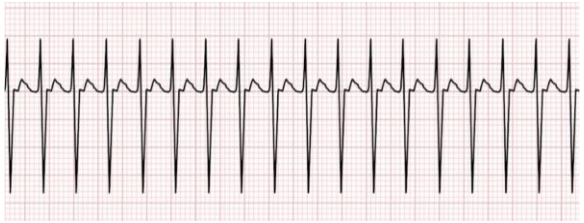
Situational Awareness

- Alterations in Appearance (lethargy), Breathing (tachypnea) and Circulation (mottled skin, cool extremities)

A + B + C = Cardiorespiratory Failure

Further Assessment:

- EKG strip
- Crackles, liver down 2cm
- Pulses thready



Next Steps

High flow O2

Access - IV/IO

- What med?

Labs

- Glucose

Fluids

- Anything different?

Weight, kg	Adenosine, mL
2	0.07

0 min

Recognize decreased mental status and perfusion.
Begin high flow O_2 and establish IO/IV access according to PALS.

5 min

If no hepatomegaly or rales / crackles then push 20 mL/kg isotonic saline boluses and reassess after each bolus up to 60 mL/kg until improved perfusion. Stop for rales, crackles or hepatomegaly. Correct hypoglycemia and hypocalcemia. Begin antibiotics.

15 min

Fluid refractory shock?

Begin peripheral IV/IO inotrope infusion, preferably Epinephrine 0.05 – 0.3 µg/kg/min
Use Atropine / Ketamine IV/IO/IM if needed for Central Vein or Airway Access

Titrate Epinephrine 0.05 – 0.3 µg/kg/min for Cold Shock.
(Titrate central Dopamine 5 – 9 µg/kg/min if Epinephrine not available)
Titrate central Norepinephrine from 0.05 µg/kg/min and upward to reverse Warm Shock.
(Titrate Central Dopamine ≥ 10 µg/kg/min if Norepinephrine not available)

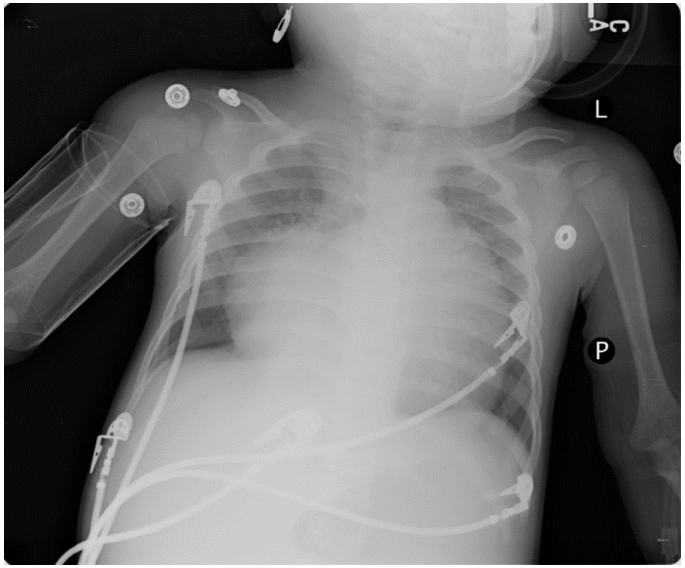
60 min

Catecholamine-resistant shock?

If at risk for Absolute Adrenal Insufficiency consider Hydrocortisone.
Use Doppler US, PICCO, FATD or PAC to Direct Fluid, Inotrope, Vasopressor, Vasodilators
Goal is normal MAP-CVP, $ScvO_2$ > 70%* and CI 3.3 – 6.0 L/min/m²

Infant Cardiogenic Shock

- Could just be SVT
- Early queues:
  - BP was 60/46 (narrow)
  - Crackles, hepatomegaly
  - Mottled, cool
- Prostaglandin (PGE1) 0.05 mcg/kg/min until duct dependent defect excluded
  - PDA closing – can uncover coarc or other things…
  - Pulses and BP in all 4 extremities, call cardiology
  - What side effect do you anticipate?

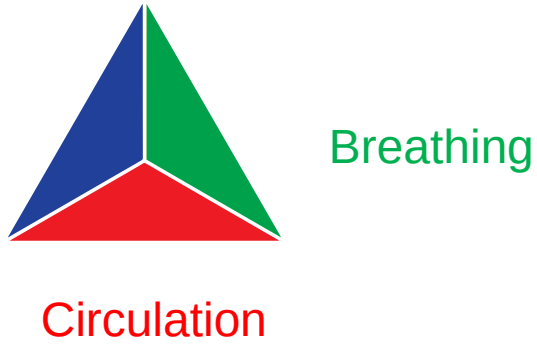


Case Study

Elin

- 9 years old, no PMHx
- Hard hit/fall at soccer game, no LOC
- Presents to ED with parents 3 days later: tired, irritable, didn't recover well from recent cold
- T 37, HR 100, BP 100/60, RR 20, Sats 95

Pediatric Assessment Triangle (plus vitals):



Situational Awareness

- Alteration in Appearance (lethargy)

A = Neurologic / Metabolic

Concern(s)	Meaning	Interventions
Breathing	Respiratory Distress	Positioning, oxygen, suction, consider meds as applicable
Appearance + Breathing	Respiratory Failure	Positioning, oxygen (mask), suction, get advanced airway ready
Appearance + Circulation	Shock	Oxygen (NRB), access (IV/IO), labs, fluids, reduce oxygen demand / treat cause of shock
Appearance	Neurologic / Metabolic	Check blood sugar, labs, oxygen as needed, determine and treat cause
All 3 (ABC)	Cardiorespiratory Failure	Position, oxygen (bag mask), advanced airway, compressions

Next Steps

More history:

- More thirsty – getting over cold
- Abdominal pain – maybe a little worse than usual stomachaches, her cold?
- Irritable – 9-year-old girl, always been sassy

Get a glucose, blood gas, urinalysis

- **450, pH 7.22 and bicarb 12, urine +ketones**

Pediatric DKA is different, better look at the Clinical Pathway!

https://www.childrenscolorado.org/health-professionals/clinical-resources/clinical-pathways/

Pediatric DKA

ASAP:

- 2 PIVs, NPO, CR monitor, neuro checks q1 hr
- NS 10-20/kg over 1 hour, no more than 40/kg
- Check electrolytes
- **DO NOT BOLUS INSULIN**
- Start regular insulin 0.1 unit/kg/hr
  - Start at 0.05 if signs of cerebral edema

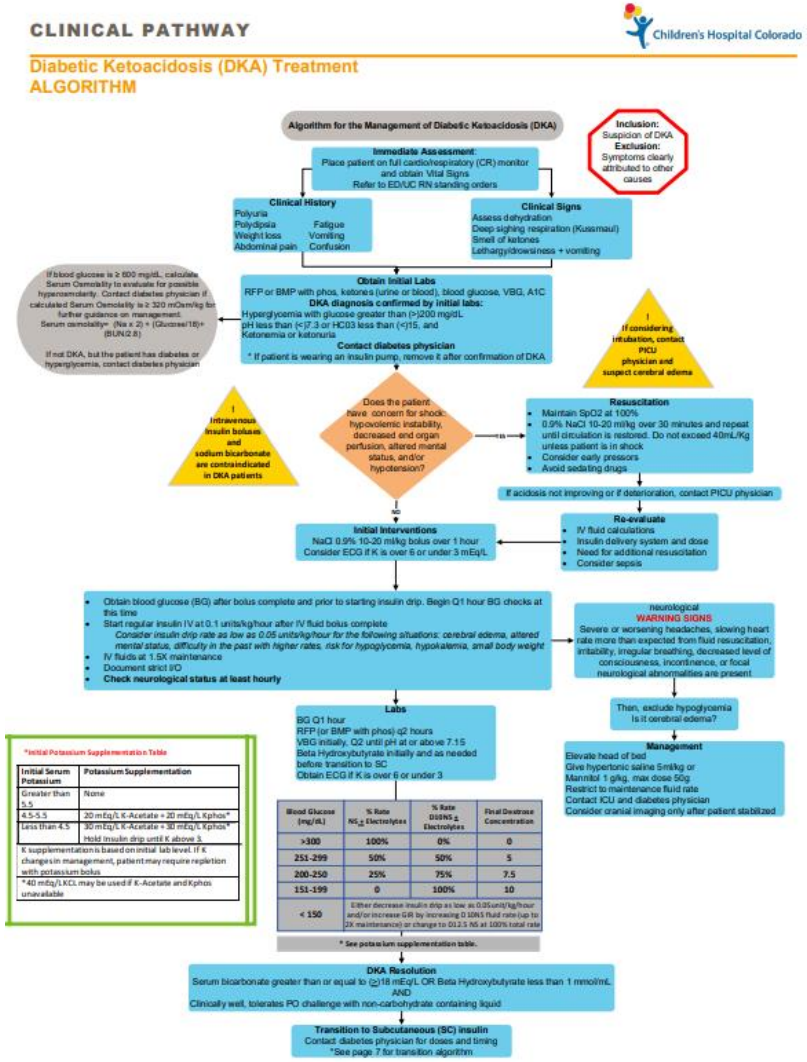
BACKGROUND | DEFINITIONS

Diabetic ketoacidosis (DKA) is a life-threatening medical emergency requiring immediate evaluation and treatment. Please notify the diabetes physician on call through One Call for all patients with known or suspected DKA.

Diabetic ketoacidosis (DKA) is a life-threatening condition. Almost 1 in 100 children with DKA will develop clinically significant cerebral edema, which has a mortality rate of 21-24%. Those with severe DKA have a much higher mortality and risk of complications. Meticulous attention to the details of therapy and the child's clinical course can decrease this risk. A patient who is unresponsive to vocal commands or presents with hypotension is rare and requires immediate critical care in a hospital. Urgent critical care and diabetes consultation should be obtained.

DKA is defined by:

- Hyperglycemia with glucose greater than 200 mg/dL, and
- pH less than 7.3 or HCO_3- less than 15 and
- Ketonemia or ketonuria



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Sam Elin (& Avi) Will

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Take Away Points

- Keep in mind pediatric differences
- Use validated tools and a systematic approach
- Basic interventions save lives
- Early recognition of decompensation is key
- Know your resources:

  CHCO OneCall 720-777-3999

  CHCO Pathways

  https://www.childrenscolorado.org/health-professionals/clinical-resources/clinical-pathways/

Thank you

Questions?

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