Emergency Medicine Resident Simulation Curriculum for Pediatrics

(EM ReSCu Peds)

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Contents

Introduction

Purpose

Over 85% of pediatric patients access emergency care in general Emergency Departments (EDs) within the United States and, therefore, receive care from trainees and graduates of Emergency Medicine (EM) residency programs.[1] The Accreditation Council for Graduate Medical Education identifies pediatric medical resuscitation and pediatric trauma resuscitation as essential areas of practice which EM residents must be able to perform by the end of residency.[2] All EM residents and residency programs share the goal of optimizing the care of children whenever and wherever it is needed. However, differences in opportunities to care for acutely ill and injured children and/or access to education from Pediatric Emergency Medicine (PEM) specialists may exist across programs. These inequities in pediatric training could contribute to disparities in the quality of emergency care delivered to pediatric patients. This project aims to create a high quality, free, open-access, standard pediatric simulation-based curriculum that can be implemented across all U.S. EM residency programs. This work has the potential to improve the healthcare outcomes of the over 30 million acutely ill and injured children who seek ED care each year and enhance the training of EM residents in all programs.

Curriculum Development

Thank you for using this resource, a national PEM simulation curriculum for EM residents, in your EM training program. This curriculum was developed with the help and hard work of physicians and simulation experts across the United States and Canada. The formation of this group was facilitated by the American College of Emergency Physicians (ACEP) in collaboration with other organizations involved in the training of EM residents and/or emergency care of children. The president of ACEP invited the 9 other stakeholder organizations leaders to appoint a representative to this collaborative (see Table).

Table. Organizations Represented in the Collaborative

1. American Academy of Emergency Medicine
2. American Academy of Pediatrics
3. American College of Emergency Physicians
4. Council of Emergency Medicine Residency Directors
5. Emergency Medicine Residents' Association
6. International Network for Simulation-based Pediatric Innovation, Research, & Education
7. International Pediatric Simulation Society
8. Pediatric Trauma Society
9. Society for Academic Emergency Medicine
10. Society for Simulation in Healthcare

Next, the 10 stakeholder organizations agreed on a shared goal of creating a free, open-access, standard pediatric simulation-based curriculum for all EM residency programs. The next phase of the collaborative involved a modified Delphi process to generate consensus on prioritizing what content should be taught using simulation. The foundation for this process was a published consensus-derived comprehensive pediatric curriculum for EM residents. This process involved 73 participants from diverse institutions recruited through these 10 stakeholder organizations.[3] A team of PEM, EM, and simulation experts subsequently mapped the items that were identified as "definitely must be taught using simulation" to 15 cases (based on group consensus that 4-5 pediatric cases per year was a feasible goal for all U.S. programs). One to three primary authors from 16 institutions drafted comprehensive scenarios, using a standardized template, with supporting material, which was edited by 5 associate editors, who were selected as representatives from stakeholder organizations. Each case was piloted 2-3 times with EM residents from 32 programs across the United States. Participants and facilitators provided quantitative and qualitative feedback for each case and provided suggested edits, as appropriate. This feedback guided the iterative improvement of the cases that are published in this ebook. Based on the comprehensive feedback process, one case was subsequently split into 2 case scenarios resulting in 16 final cases.

Interprofessional Education

While these cases were developed with educational objectives specific to EM residents, the care for real and simulated patients in an ED requires interprofessional teamwork. The authors and editors have found that the curriculum is optimally employed using interprofessional team members. When this is not feasible, facilitators or residents should fill these roles, understanding that realism may be compromised.

Case Difficulty Level

The cases have varying levels of difficulty so that some may be more appropriate for junior residents while others involve multiple steps in the care of medically complex children which may draw upon multiple skill sets. Each case has a brief description of case alternatives that can be used to challenge more advanced learners (such as fourth year residents). Both of these features allow facilitators and educators to implement cases with residents across the learning and skill spectrums. We encourage facilitators to consider repetition of these cases when possible as repeated practice enhances learning.

Learning Objectives

Each case has 6-12 associated learning objectives. This is too many for any one simulation session, and we recommend selecting no more than four objects to focus on during any given case and debriefing session. We encourage you as the facilitator to determine which objectives you will focus on while preparing the simulation and allow these to serve as the foundation for your debriefing. The larger number of objectives is provided to allow for flexibility in the curriculum to best meet the needs of your learners and program. Each case has objectives related to medical evaluation, diagnostic plan development, communication with parents and caregivers, and teamwork. Depending on the goals of the session and the learners' needs, some objectives may be deferred and addressed during different simulation scenarios or during repeat iterations of the same case.

Debriefing

This curriculum was created for use by educators and simulationists with experience in scenario facilitation and debriefing. Specific debriefing points are included for each learning objective, but this is not a comprehensive tutorial on how to debrief. Many courses and resources are available if facilitators wish to gain more training in debriefing.[4-8]

Feedback on Cases and Curriculum

While these cases underwent multiple rounds of peer review, we anticipate suggestions for improvement. We value the feedback of facilitators and participants immensely and ask that brief surveys be completed by both groups following each session you run. Please see QR codes for facilitator and participant surveys listed within each case.

Thank you again for using this resource, the Emergency Medicine Resident simulation Curriculum for Pediatrics (EM ReSCu Peds).

SIncerely,

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References

1. Michelson KA, Lyons TW, Hudgins JD, et al. Use of a national database to assess pediatric emergency care across United States emergency departments. Acad Emerg Med 2018;25:1355–64. Pubmed

2. ACGME Program Requirements for Graduate Medical Education in Emergency Medicine. 2020.

3. Mitzman J , Bank I , Burns R, et al. A modified Delphi study to prioritize content for a simulation-based pediatric curriculum for Emergency Medicine residency training programs. AEM Education and Training. 2019;1(2):140-150. DOI

4. Sawyer T, Eppich W, Brett-Fleegler M, Grant V, Cheng A. More Than One Way to Debrief: A Critical Review of Healthcare Simulation Debriefing Methods. Simul Healthc. 2016;11(3):209-217. DOI

5. Grant VJ, Robinson T, Catena H, Eppich W, Cheng A. Difficult debriefing situations: A toolbox for simulation educators. Med Teach. 2018;40(7):703-712. DOI

6. Motola I, Devine LA, Chung HS, Sullivan JE, Issenberg SB. Simulation in healthcare education: a best evidence practical guide. AMEE Guide No. 82. Med Teach. 2013;35(10):e1511-e1530. DOI

7. Grant V, Cheng A (eds). Comprehensive Healthcare Simulation: Pediatrics. Switzerland: Springer International Publishing Switzerland, 2016.

8. Debrief2Learn website

Simulation Case 1

Anaphylaxis

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Setup

Chief complaint: Shortness of breath
Patient age: 6 years old
Weight: 25 kg

Brief Narrative Description of Case

A 6-year-old boy brought in by car with a parent presents with difficulty breathing, vomiting, rash, and facial swelling after eating at a restaurant. He has no previous allergic reactions.

The child should be quickly moved to a resuscitation area, placed on a cardiac monitor and given IM epinephrine. If IM epinephrine is administered quickly, he should show some improvement in a few minutes, but not completely resolved. If not promptly administered, he will become hypotensive and lethargic. Ideally, he should receive IV steroids, IV fluids, diphenhydramine, H2 blocker, and nebulizer on arrival. If all medications are administered, he will recover appropriately. If epinephrine is not given early, he will progress to hypotension and shock and need IV epinephrine infusion. There is an optional more difficult pathway for advanced learners where the initial IM epinephrine is not fully effective and the patient worsens, eventually needing multiple medications and an infusion of epinephrine.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Describe signs/symptoms of anaphylaxis **(comprehension)**
2. Perform early evaluation of a critically ill patient **(application)**
3. Construct and implement a plan to manage anaphylaxis **(application)**
4. Demonstrate focused history taking from a caregiver **(application)**
5. Explain diagnosis and management to caregivers **(synthesis)**
6. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

- Assign/assume team roles
- Obtain history from parent
- Perform primary assessment
- Administer supplemental oxygen
- Place patient on continuous cardiac monitor
- Obtain vascular access
- Perform focused physical exam
- Verbalize anaphylaxis
- Immediate IM epinephrine
- Give supplemental medications (fluids, diphenhydramine)
- Albuterol given via nebulizer
- Reassess patient after initial interventions

Recommended Supplies

- **Manikin:** child
- **Moulage:**
    - Urticarial rash is optional moulage
    - A photo of a child with urticaria can be shown as well
- **Resources:** PALS cards and/or color-coded length based tape
- **Manikin set up:**
    - Street clothing
- **Equipment**
    - IM syringe for injection (if manikin is capable)
    - IV set up
    - Nebulizer set-up
- **Medications**
    - IM epinephrine
    - IV steroid (methylprednisolone, dexamethasone), diphenhydramine, saline, ranitidine
    - Nebulized albuterol
    - IV epinephrine drip

Supporting Files

- Labs
- Photograph of child with anaphylaxis
- Normal CXR

Participants/Roles

- **Team leader:** Directs the case, gathers history
- **Team member (optional):** Examines patient
- **Team member (optional):** One team member may be assigned to the parent as the case progresses
- **Team member:** Assesses airway, places nebulizer, possible set up for intubation "just in case"
- **Nursing:** Gives medications, helps with monitoring
- **Patient:** Will need to voice the patient, describe the HPI
- **Family:** One parent with the patient to give history, HPI, ask questions

** Team roles may need to be adjusted in order to suit local practices and norms*

Prerequisite Knowledge

- **Faculty**
  - PALS protocols
  - General knowledge of emergency medicine
  - Knowledge of management of severe anaphylaxis
  - Simulation implementation and debriefing experience

- **Emergency medicine residents**
  - Any stage of training (preferably PGY-1 or 2 year)
  - Completed PALS certification
  - Some knowledge of management of anaphylaxis
  - Some knowledge of the approach to acute shortness of breath

Case Alternatives

- If epinephrine is not administered promptly, the patient will become fatigued to lethargic, and eventually hypotensive and in shock.
- If a greater challenge is desired, the patient does not improve with initial IM epinephrine, develop hypotension early, and not improve until a second dose of epinephrine is administered. Can become altered and need airway management.
- If the child becomes profoundly hypotensive and goes into cardiac or respiratory arrest, then IV epinephrine dose is required.

- Can be a difficult airway case as well for very high learners. This deviates from the core objectives (anaphylaxis management) so only to be used if the team is very successful with the primary objective.

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC3. Diagnostic Studies
PC4. Differential Diagnoses and Management
PC5. Pharmacotherapy
PC6. Observation and Reassessment
PC7. Disposition
PC10. Airway Management
PC15. Medical Knowledge
ICS1. Patient Centered Communication
ICS2. Team Management

Resources
1. Anagnostou K. Anaphylaxis in Children: Epidemiology, Risk Factors and Management. Curr Pediatr Rev. 2018;14(3):180-186. PMID: 29732976
2. Poowuttikul P, Seth D. Anaphylaxis in Children and Adolescents. Pediatr Clin North Am. 2019;66(5):995-1005. PMID: 26806049
3. Cheng A. Emergency treatment of anaphylaxis in infants and children. Paediatr Child Health. 2011;16(1):35-40. PMID: 22211074

Initial Presentation

ITEM	FINDING
Overall Appearance	An alert, anxious, distressed young boy who is very short of breath
HPI	Child was eating at a restaurant and suddenly became short of breath with lip swelling and rash, worsening over the next 20 minutes on the way here. No medications were given. **If the learners ask for specifics:** • The child has never had an allergy or similar reactions. • Was eating shrimp and fried rice and suddenly started coughing and became short of breath. Parents initially thought he was choking, but the child said no and continued to get worse, so they got in a car and brought him to the ED. • Rash noticed while in the car • No choking sensation or dysphagia but chest “feels tight” • There is no family history of food allergies. • They have not tried any medications or treatment yet.
Past Medical/Surgical History	None
Medications	None
Allergies	None
Family History	Non-contributory
Social History	Lives at home with parents, younger sibling

Stage 1

Begin Simulation (Stage 1 of 4)

Evaluation and initial stabilization:
Start of case to after first dose of IM epinephrine

CRITICAL ACTIONS

- Placement in resuscitation
- Exam including airway and lung assessment
- Placement on cardiovascular monitoring
- IM epinephrine given

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 110, **BP:** 90/60, **RR:** 22, **SpO_2:** 96% RA
General	Alert but anxious, in respiratory distress
HEENT	Lip swelling, eyelid swelling, facial urticarial rash Oropharynx is normal with no uvular or tongue swelling
Neck	Supple
Lungs	Tachypnea, retractions, diffuse expiratory wheezing, and decreased air movement
Cardiovascular	Sinus tachycardia, flush but brisk capillary refill
Abdomen	Soft, non-tender
Neurological	Alert, non-focal exam

ITEM	FINDING
Skin	Diffuse urticarial rash, mostly located on trunk, proximal arms, and face

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Epinephrine is given by IM injection for suspected anaphylaxis	Patient's heart rate increases by 20 beats per minute over next 1 minute. Respiratory rate decreases to 18 breaths/minute. Wheezing improves some (quieter or resolves depending on manikin capability). **Go to Stage 2.** **Challenge / Advanced Residents:** Minimal to no change with IM epinephrine. **Proceed to stage 3 instead of 2.**	If the learners are advanced, or if they identify anaphylaxis and give the initial IM epinephrine very quickly, skip **Stage 2** and use **Stage 3** which is the more difficult version of the case and requires multiple doses of epinephrine and more advanced care.
Oxygen placed on patient by mask or nebulizer	Any O_2 administration will increase the SpO_2 to 99-100%.	
Request IV placement		Nurse can place IV without difficulty, nurse may ask "Do you want any labs while I'm placing the IV?"
Place patient on cardiovascular monitoring		Live vital signs should not be shown to the learner until the patient is placed on a real time monitor.

Stage 2

After epinephrine is given through secondary interventions: If epinephrine is not given, see stage 3

CRITICAL ACTIONS

- Placement of an IV with medications (at least IV fluids, optional steroids, H2 blocker, diphenhydramine) and nebulized albuterol
- Advanced learners should set up difficult airway equipment anticipating possible decompensation

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 130, **BP:** 90/60, **RR:** 18, **SpO_2:** 96% RA (100% if on any oxygen)
Exam Changes	• Wheezing reduced after IM epinephrine • Overall rash, lip swelling, and respiratory distress all continue to improve gradually over 5 minutes after the IM epinephrine

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Nebulized albuterol is administered	Wheezing reduced, respiratory distress improves some	
IV fluids given	HR decreases 20	
Diphenhydramine given	Rash fades a little, child feels less itchy	
Steroids, H2 blocker given	No change	
After all secondary interventions OR after 10 minutes	**Go to Stage 4**	
If above medications are not given	Child will improve some with the IM epinephrine, but remain uncomfortable, mild respiratory distress, itchy, but will be clinically stable. Fluids, diphenhydramine, and albuterol will each make the child more comfortable.	If fluids or medications are not ordered, RN prompts, "Is there anything else you wanted me to give him?"

Stage 3

Worsening Condition (Optional): IV epinephrine drip initiation
This stage occurs either (1) if no epinephrine is given initially or (2) advanced learners/challenge scenario

CRITICAL ACTIONS

- Repeat or initial IM epinephrine progressing to IV epinephrine drip

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 130, **BP:** 68/45, **RR:** 24, **SpO_2:** 92% RA (100% if on any oxygen)
Exam Changes	• Some increase in respiratory distress, rash, and wheezing • Subjective lip swelling worsens • More tired appearing, fatigued

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Repeat IM epinephrine is administered (first IM epinephrine if not given before now)	• Heart rate increases by 10 • Subjective throat tightness improves some • BP increases to 74/50 • No other change	

Instructor Notes: Changes and Case Branch Points (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
3rd dose if IM epinephrine given	• HR increases by 10 • BP increases to 78/52 • No other changes	
IV fluid bolus of 20 mL/kg is given	HR decreases by 20	
IV steroid, diphenhydramine, H2 blocker given	No change	
Nebulized albuterol given	Mild improvement in wheezing, and respiratory distress	
IV epinephrine drip	BP improves to 90/60, rash and facial swelling improve some, HR increases to 150. Proceed to **Stage 4.**	Patient will remain in distress, lethargic appearing until IV epinephrine is started which will begin to improve all symptoms over 5 minutes
Intubation	If tube is successfully placed, the SpO_2 will rise and remain at 100% if oxygen is attached. RR at bagged rate	Teams may elect to intubate the patient; the difficulty of the airway placement / need for use of difficult airway devices can be included for more advanced learners. As this is not intended to be a difficult airway scenario, use caution in steering learners this way as it can take time and create a secondary discussion around difficult airways that is secondary to the primary learning objective around anaphylaxis management.

Instructor Notes: Changes and Case Branch Points (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Oxygen administered by mask or nebulizer	Any addition of oxygen (except nasal cannula) will result in SpO_2 rising to 99-100%	
Sedative given	Any sedative will cause the manikin to close its eyes and the patient to stop talking.	
Paralytic given	Patient will close eyes, stop breathing spontaneously, SpO_2 will drop quickly one minute later unless good BMV is maintained	

Stage 4

Case Conclusion: This stage occurs either after supplemental IV medications if early IM epinephrine given from stage 2 or after IV epinephrine is started from Stage 3.

CRITICAL ACTIONS

- Discussion around need for admission (if from stage 2 likely not needed, if from stage 3 should be admitted to ICU)
- **Discussion with family about anaphylaxis/allergic reactions. Outpatient treatment and follow up discussion.**

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 100, **BP:** 90/60, **RR:** 16 (or intubated), **SpO_2:** 100%
Exam Changes	• Rash improving • Lip swelling resolved • Lungs clear and no respiratory distress

Ideal Scenario Flow

The learners enter the room to find a 6-year-old boy in street clothes, anxious and in respiratory distress. They immediately placed him on a cardiovascular monitor and perform a quick assessment of ABCs. Noting wheezing, an urticarial rash, and lip swelling, they presume this is anaphylaxis and immediately administer IM epinephrine. Upon more thorough exam, they note his pharynx and tongue are OK, but he is wheezing with decreased air entry. Albuterol is administered by nebulizer, IV access is established, 20 m/kg of IV normal saline fluid, 2 mg/kg IV methylprednisolone, 1-2 mg/kg of IV diphenhydramine, and 0.5 mg/kg IV famotidine (or 1 mg/kg ranitidine) are given. Any x-ray, labs, or ECG ordered will be normal except sinus tachycardia on the ECG. The patient may gradually improve over 5-10 minutes with this treatment.

As an alternative for advanced learners, or learners that arrive at the initial diagnosis and give the IM epinephrine very quickly, Stage 3 can be used. Here, the IM epinephrine will be ineffective, and the patient will become lethargic and hypotensive over 3-5 minutes. Similar treatment as above should be done with the addition of a second and possible third IM epinephrine followed by initiation of an IV epinephrine drip which will improve the symptoms slowly. Teams may choose to intubate when he becomes altered. This patient should be admitted to the ICU for observation, weaning of the epinephrine, and ventilatory management if intubated.

Anticipated Management Mistakes

1. **Difficulty with recognizing anaphylaxis:** Early learners may have difficulty with recognizing anaphylaxis as the patient has no previous history leading to a delay in epinephrine use. The nurse in the case can point out things like the lip swelling and urticarial rash to prompt the team if needed.

2. **Focus on the wrong medications:** Learners may focus on the diphenhydramine and other secondary medications instead of given epinephrine immediately. The nurse can prompt / encourage the medication if not given early, but the case should progress to the worsening clinical scenario so they can see what happens if early epinephrine is not given.

Debriefing Points

Describe signs/symptoms of anaphylaxis (comprehension)

Anaphylaxis is potentially a life-threatening condition that requires quick recognition and prompt treatment as epinephrine can be lifesaving. It is important to recognize anaphylaxis before the patient decompensates and develops shock.

Anaphylaxis is highly likely when any 1 of the following 3 criteria is fulfilled:

- **Criterion 1** – Acute onset of an illness (minutes to several hours) involving the skin, mucosal tissue, or both (e.g., generalized hives, pruritus or flushing, swollen lips-tongue-uvula) and at least 1 of the following:
    - Respiratory compromise (e.g., dyspnea, wheeze/ bronchospasm, stridor, reduced peak expiratory flow, hypoxemia), OR
    - Reduced blood pressure (BP) or associated evidence of end-organ perfusion (e.g. decreased mental status, confusion, decrease urine output)
    - Note that skin findings are present in up to 90% of anaphylactic episodes. This criterion is helpful in making the diagnosis.
- **Criterion 2** – 2 or more of the following that occur rapidly after exposure to a likely allergen for that patient (minutes to several hours):
    - Involvement of the skin-mucosal tissue (e.g., generalized hives, itch-flush, swollen lips-tongue-uvula)
    - Respiratory compromise (e.g., dyspnea, wheeze/ bronchospasm, stridor, reduced peak expiratory flow, hypoxemia)
    - Reduced BP or associated evidence of poor end-organ perfusion (e.g. decreased mental status, confusion, decreased urine output)

  - Persistent gastrointestinal symptoms and signs (e.g., crampy abdominal pain, vomiting)

  - Note that skin manifestations are not present in up to 20% of anaphylactic episodes. Criterion 2 incorporates gastrointestinal symptoms in addition to skin symptoms, respiratory symptoms, and reduced BP. It is applied to patients with exposure to a substance that is a likely allergen for them.

- **Criterion 3** – Reduced BP after exposure to a known allergen for that patient (minutes to several hours):
  - Reduced BP in adults is defined as a systolic BP <90 mmHg or >30% decrease from that person's baseline.

  - In infants and children, reduced BP is defined as low systolic BP (age-specific) or >30% decrease in systolic BP.

  - Note that criterion 3 is intended to detect anaphylactic episodes in which only one organ system is involved and is applied to patients who have been exposed to a substance to which they are known to be allergic (e.g., hypotension or shock after an insect sting).

Demonstrate early evaluation of a critically ill patient (application)

- Learners should approach a critically ill patient in a standardized fashion. Airway, breathing, and circulation should be assessed immediately. Interventions such as airway repositioning/ adjuncts, bag valve mask ventilation, and CPR should be started concurrently, if required. After A, B, C have been addressed, the patient should be evaluated for disability and exposed for a thorough head to toe exam. In pediatrics, D also stands for "don't forget the dextrose" as a blood glucose level should be checked in any child with altered mental status.

- In this patient with obvious respiratory distress, airway and breathing are paramount. A quick evaluation including placement on continuous monitoring is important and early planning to begin addressing problems with airway and breathing must be started as quickly as they are identified.

- Alertness and airway are important early indicators of the severity of anaphylaxis.

- Understanding normal vitals in a child is important. For example, the systolic blood pressure (SBP) is generally above 70 + 2 times the age (5th percentile) and the mean is closer to 90 + 2 times the age in years. A shorter way to remember is 60-80-100 with the SBP being:
    - 60 mmHg for an infant
    - 80 mmHg for a child
    - 100 mmHg for an adolescent

Construct and implement a plan to manage anaphylaxis (application)

Epinephrine IM is the first and primary treatment for anaphylaxis.

- Dose: 0.01 mg/kg
- Standard adult dose is either 0.3 mg or 0.5 mg IM, and can be repeated in 3-5 minutes if needed
- IV infusion of epinephrine at 0.1 to 1 mcg/kg/min (maximum 10 mcg/min) can be started if needed after IM epinephrine
- Secondary treatment includes early administration of IV fluids to support early shock even before hypotension.
- 20 mL/kg IV normal saline boluses
- Bronchodilators by nebulizer can be helpful for wheezing
- Antihistamines such as diphenhydramine (PO or IV 1-2 mg/kg up to 25 or 50 mg) and ranitidine (1 mg/kg max; 50 mg) can be helpful for patient comfort and itching but do not help with the primary anaphylactic reaction.
- Steroids such as methylprednisolone (1-2 mg/kg IV) or dexamethasone (0.6 mg/kg IV or PO up to 12 mg)

Demonstrate focused history taking from a caregiver (application)

- Components of history taking: Past medical history, surgical history, family history, medications, allergies, social history, vaccination history

- For this scenario, obtaining an allergy history is important as well as:

  - Exposure or potential exposure to allergens
  - Timing of onset of symptoms and progression
  - Airway and breathing symptoms
  - Dizziness or altered mental status
  - Gastrointestinal symptoms

Explain diagnosis and management to caregivers (synthesis)

- Communicating effectively and supportively with families are important.

- Using easily understood language and common terminology are important when explaining a critical patient to their family.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep-

"Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Supporting Files

Lab Results

CBC

LABORATORY TEST	VALUE	UNITS
WBC	7 $\times 10^3$	$/mm^3$
Hemoglobin	13.5	g/dL
Hematocrit	38.8	%
Platelets	140 X 10^3	$/mm^3$

Supporting Files

Lab Results

Metabolic Panel

LABORATORY TEST	VALUE	UNITS
Sodium	135	mEq/L
Potassium	3.7	mEq/L
Chloride	98	mEq/L
Bicarbonate	24	mEq/L
BUN	18	mg/dL
Creatinine	0.6	mg/dL
Glucose	125	mg/dL

Supporting Files

Lab Results

Liver Panel

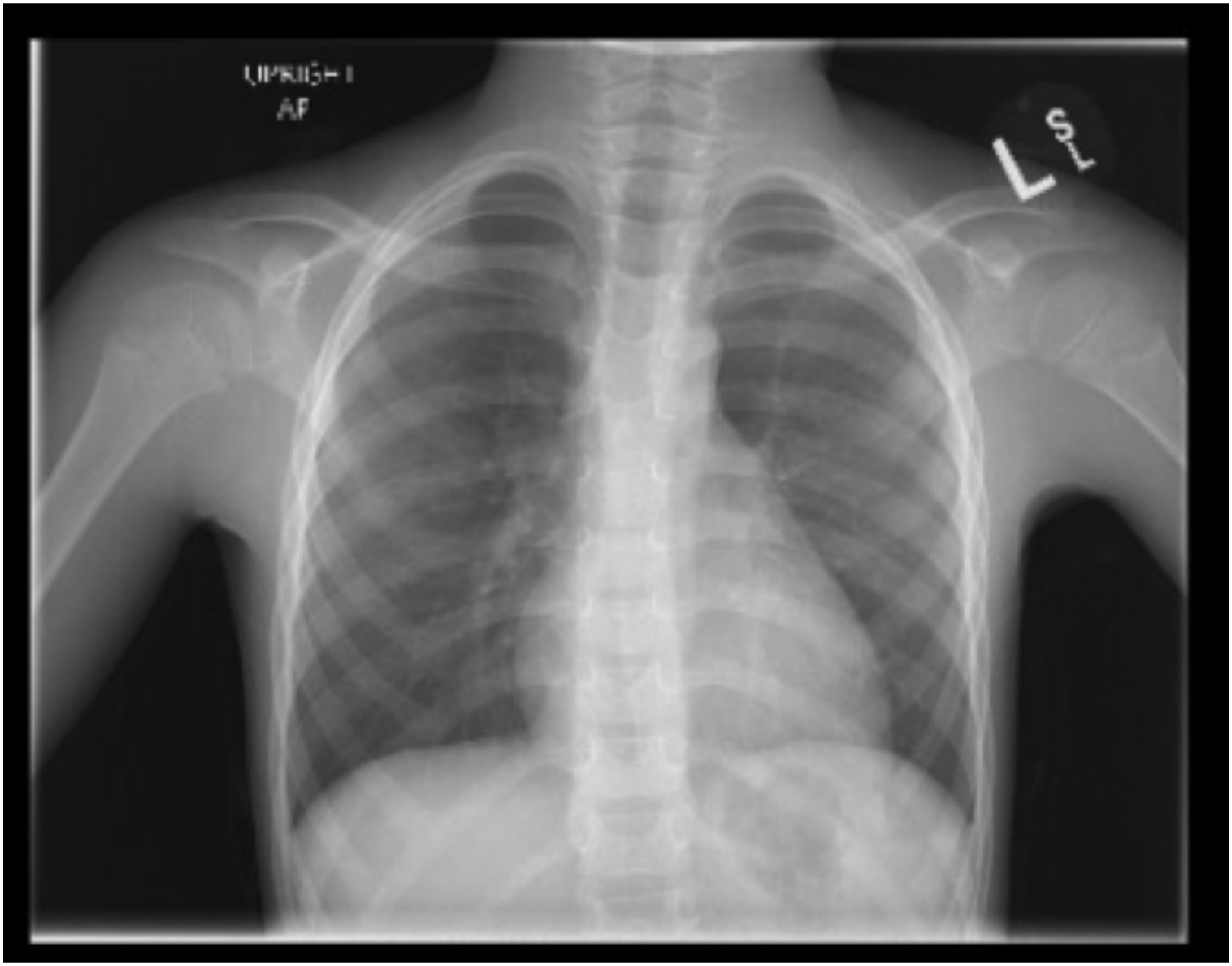
LABORATORY TEST	VALUE	UNITS
Albumin	305	g/dL
Alkaline phosphatase	140	U/L
ALT	30	U/L
AST	26	U/L

Supporting Files

Photograph of child

Supporting Files

Chest radiograph of child



Supporting Files

Notes

Photo: Child with anaphylaxis from the Anaphylaxis Campaign.

CXR: Normal radiograph. Image from Dr. Rebekah Burns.

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant (patient's parent)

Case Background Information

Your child is a typically healthy kid but suddenly became short of breath after eating shrimp fried rice in a restaurant. You initially thought he was choking, however he is able to speak in short phrases to you, only saying his "throat felt tight" and he "couldn't breathe". You think his lips might be more swollen than usual, and his face looks a bit red to you. He is otherwise healthy and has no allergies. This has never happened before. He has never had any medical problems or an allergic reaction before.

Who are the Learners?

The learners are emergency medicine residents of various stages of training (first, second, third, and possibly fourth year residents). First year residents typically are efficient at gathering a history and performing a physical exam on patients; however, they likely have limited medical knowledge and less familiarity with pediatric patients and procedures. Late second years, third years, and fourth years usually are much more comfortable with critically ill patients and have more knowledge regarding pediatric patients. For the purposes of this simulation, assume learners are in their first or second year of residency training.

Standardized Patient Information

Your 6-year-old is a healthy boy. Your family went out for dinner this evening, and shortly after eating fried rice with shrimp, your son began to cough frequently and breathe more rapidly. You thought he might be choking, but he was able to tell you that he felt like his "throat was closing" and he was "having trouble breathing". His lips looked more swollen to you and his face turned red. He's never had any food allergies before, but you were worried he might be having an allergic reaction. You got in the car and immediately drove to the hospital with him. On the way there he started complaining of itching, and you noticed a rash all over his body. Upon arrival to the ED, you are anxious about your son's appearance and increased work of breathing. Allow the team to assess your child and verbalize their thoughts to one another. Ask questions frequently, but remain calm and supportive.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT: "I think he is having an allergic reaction."
- AGE: 6 years old
- ADDITIONAL HISTORY: No additional HPI. Your child was fine earlier today.
- PAST MEDICAL HISTORY: None, goes to the doctor regularly, has all his vaccines.
- SOCIAL HISTORY: Lives at home with mother, father, older sister, and one dog. No one in the house smokes.
- FAMILY HISTORY: Older sister with asthma. Mother has no known medical diagnoses. Father has high blood pressure. Paternal grandfather with heart attack, but alive. Maternal grandmother with high blood pressure.
- PAST SURGICAL HISTORY: None
- MEDICATIONS: None
- ALLERGIES: No known allergies
- IMMUNIZATIONS: Up-to-date
- BIRTH HISTORY: Full term male born normal vaginal delivery. Normal pregnancy without complications. Unremarkable newborn course.

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:

- "This has never happened to him before, someone tell me what's going on!"
- "Why is he not getting better?"

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
If the residents do not give your child a breathing treatment of albuterol	"Why is he having such a hard time breathing? He sounds like when his sister is having an asthma attack!"
If the residents forget to give epinephrine (or have trouble with the dose)	"Is his throat closing up? Can't you just inject him with something?"
If the child becomes less responsive	"What is happening! Why is he acting like that? He looks so tired. Do something!"

Simulation Case 2

Cardiac Tamponade

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Updated August 27, 2020

Setup

Chief complaint: Difficulty breathing
Patient age: 8 years
Weight: 26 kg

Brief Narrative Description of Case

8-year-old female with viral respiratory illness and urinary tract infection develops acute onset of shortness of breath and hypotension due to onset of pericarditis with effusion resulting in medical cardiac tamponade.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Identify signs and symptoms of cardiac tamponade **(application)**
2. Demonstrate early evaluation of a critically ill patient **(application)**
3. Construct a broad differential for a child with fever, hypotension and respiratory distress **(synthesis)**
4. Construct and implement initial medical management for a pediatric patient with signs of shock and respiratory distress **(synthesis)**
5. Formulate a diagnostic plan to evaluate for causes of patient deterioration **(synthesis)**
6. Discuss when to use point-of-care ultrasound in the evaluation and treatment of a pediatric patient with undifferentiated cardiopulmonary distress **(evaluation)**
7. Interpret the sonographic findings of a pericardial effusion with cardiac tamponade. **(application)**
8. Demonstrate an emergent ultrasound-guided pericardiocentesis **(application)**
9. Demonstrate focused history taking from a caregiver **(application)**
10. Explain diagnosis and management to caregivers **(synthesis)**
11. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

- Assign and assume team roles
- Obtain history from the parent or guardian
- Perform primary assessment of the patient
- Place the patient on a cardiac monitor with continuous pulse oximetry
- Obtain a complete set of vital signs including heart rate, blood pressure, respiratory rate, oxygen saturation, and temperature
- Place the patient on supplemental oxygen (titrate to keep O_2 saturations >93%)
- Place two large bore peripheral intravenous (IV) lines
- Obtain an emergent portable chest x-ray
- Obtain an emergent ECG
- Send blood down for analysis including: Complete Blood Count (CBC) with differential, Complete Metabolic Panel (CMP), Lactic acid, Erythrocyte Sedimentation Rate (ESR), C-Reactive Protein (CRP), Thyroid Stimulating Hormone (TSH), Free thyroxine (T4), Blood cultures
- Administer a 20 mL/kg bolus of crystalloid IV 3 times.Initiate broad spectrum antibiotics after blood cultures have been drawn
- Perform a point-of-care, bedside CORE (Concentrated Overview of Resuscitative Efforts) Scan
- Recognize a pericardial effusion on bedside ultrasound
- Recognize cardiac tamponade on bedside ultrasound
- Determine that the patient requires an emergent pericardiocentesis for cardiac tamponade.
- Perform an ultrasound-guided pericardiocentesis at the bedside
- Obtain a cardiology consult/cardiothoracic surgery consult
- Admit the patient to the Pediatric Intensive Care Unit (PICU)
- Update the patient’s family

Recommended Supplies

- **Manikin:** child
- **Moulage:** none
- **Resources:** PALS cards and/or length-based tape (e.g., Broselow Tape)
- **Equipment**
  - Cardiac monitor
  - Cardiac defibrillator
  - Peripheral IV needles (20 and 22 gauge)
  - IO catheter and drill or Jamshidi
  - Blood collection tubes (rainbow)
  - Pediatric oxygenation and ventilation equipment, such as non-rebreather (NRB), bag-mask ventilation (BMV), tubing, oral-pharyngeal airway (OPA)
  - Pediatric intubation equipment, such as laryngoscope, endotracheal tube (ETT), stylet, end tidal carbon dioxide ($ETCO_2$) monitor, 10 mL syringe, ventilator
  - Continuous oxygen saturation monitoring
  - Oxygen source (wall tree or tank)
  - Yankauer suction catheter and suction vacuum set up/ canister
  - Ultrasound machine with 5-2 MHz phased array transducer, 5-1 MHz phased array transducer, and high frequency linear array transducer
  - Pericardial effusion task trainer
  - Pericardial needle and catheter set or substitute (central line kit, lumbar puncture kit, etc.)
  - Syringes (3 mL, 5 mL, 10 mL, and 60 mL)
  - IV fluids (normal saline, lactated ringers)
  - Code cart
- **Medications**
  - Vasopressor agents
  - IV antibiotics
  - Antipyretics (acetaminophen, ibuprofen)

Supporting Files

- Lab results
- ECG
- Chest x-ray (CXR) images
- Ultrasound images/video clips of pericardial effusion with

cardiac tamponade
- Ultrasound images/video clips of distended IVC

Participants/Roles

- Participants/Learners:
    - Team Leader
    - Airway Manager
    - Survey Physician
    - Medication Preparer
    - Medication Giver
    - Proceduralist
    - History Taker and Family Liaison
- Faculty or other embedded participants can play a nurse, respiratory therapist, or tech, if there are not enough learners to perform the above roles.
- Standardized patient (actor or faculty) to play patient's parent

** Team roles may need to be adjusted in order to suit local practices and norms*

Prerequisite Knowledge

- **Faculty**
    - PALS protocols
    - General knowledge of emergency medicine
    - Knowledge of management of cardiac tamponade
    - Simulation implementation and debriefing experience

- **Emergency medicine residents**
    - Any stage of training (preferably PGY-3 or greater for proceduralist)
    - Completed PALS certification
    - Use of point-of-care ultrasound (POCUS) and the CORE Scan
    - Ultrasound guided pericardiocentesis

Case Alternatives

- **Learners deviate from standard protocols or anticipated actions.**
    - The Sim RN or faculty facilitator can lead the participants

back down the right track with thoughtful and intentional questions.
  - Cardiology or Cardiothoracic Surgery can miraculously be walking by the room on their way out of the hospital and stop to see if the participants need any help.

- **Facilitators would like to increase the challenge of the case to target advanced learners.**
  - The patient's family member can have a syncopal event and not be available to provide any further information.
  - The patient can have a difficult airway.
  - The patient can develop disseminated intravascular coagulation (DIC) and start hemorrhaging.
  - The family member can tell everyone they are Jehovah's Witnesses and do not want any blood products.
  - The patient's father/mother can burst into the room and say "I do not authorize any of this! I want a mediator present for all medical decisions for my child!" (Parents are divorced.)
  - The patient can develop a pneumothorax or liver laceration depending on how the pericardiocentesis is performed.
  - The patient's aunt can burst into the room and say she is a medicolegal attorney and will be recording the entire encounter.

Resources

1. Wu TS. The CORE Scan: Concentrated Overview of Resuscitative Efforts. Critical Care Clinics. 2014;30:151-75. PMID: 24295844
2. Li S, Rossfeld Z, Basu B. Cardiac Tamponade in a Child with Fever of Unknown Origin. Hospital Pediatrics. 2017;7:692-696. PMID: 29089379
3. Alerhand S, Carter JM. What echocardiographic Findings Suggest a Pericardial Effusion is causing Tamponade? Am J Emerg Med. 2019;37:321-326. PMID: 30471929
4. Parnell, Sam. POCUS Pearls for Tamponade. JournalFeed.org (March 27, 2019).
5. Hatch N, Wu TS. Advanced Ultrasound Guided Procedures. Critical Care Clinics. 2014;30:305-329. PMID: 24606778
6. Barr L, Hatch N, Roque PJ, Wu TS. Basic Ultrasound Guided Procedures. Critical Care Clinics. 2014;30:275-304. PMID: 24606777
7. www.SonoSupport.com

Milestones

PC1 - Emergency Stabilization
PC2 - Performance of Focused History & Physical Exam
PC3 - Diagnostic Studies
PC4 - Diagnosis
PC5 - Pharmacotherapy
PC6 - Observation and Reassessment
PC7 - Disposition
PC8 - Multi-tasking (Task switching)
PC9 - General Approach to Procedures
PC10 - Airway management
PC11 - Anesthesia and Acute Pain Management
PC12 - Ultrasound - Diagnostic/Therapeutic
PC13 - Wound Management
PC14 - Vascular Access
MK – Medical Knowledge
PROF1 – Professional Values
PROF2 – Accountability
ICS1 – Patient Centered Communication
ICS2 – Team Management
PBLI – Practice Based Performance Improvement
SBP1 – Patient Safety
SBP2 – Systems-based Management
SBP3 - Technology

Initial Presentation

ITEM	FINDING
Overall Appearance	8-year-old female sitting up in bed with obvious tachypnea and respiratory distress, who is diaphoretic and pale
HPI	The patient is an 8-year-old female with a history of mild intermittent asthma and neurofibromatosis type 1 who presents to the Emergency Department with shortness of breath. She was brought in via private vehicle by her mother. She has been having daily fevers between 101°F to 105°F at home for the past week. This has been accompanied by a non-productive cough, nasal congestion, sore throat, general myalgias, and dysuria. She was seen by her PCP a few days ago and was diagnosed with bronchitis. She was started on amoxicillin pills. Her PCP called her mom yesterday to tell her that the urine cultures grew out *Staphylococcus epidermidis* and her PCP called in an additional antibiotic (cephalexin) to the pharmacy for them. She started her cephalexin yesterday. Today, she noticed a macular hand rash bilaterally. She also started having bilateral flank pain. She became increasingly short-of-breath despite albuterol treatments at home so her mom drove her to the ED. She has tried acetaminophen and ibuprofen at home for her fevers. She has multiple sick contacts at school.
Past Medical/Surgical History	Neurofibromatosis (Type I), asthma (mild)
Medications	Cephalexin, acetaminophen, ibuprofen, albuterol
Allergies	None
Family History	Mom and grandma with NF1
Social History	Lives with mother Father not involved No siblings No tobacco/drugs or alcohol Exposed to sick contacts (school)

Stage 1

Begin Simulation (Stage 1 of 6)

Initial presentation and primary evaluation:
Start of case through administration of crystalloid bolus

CRITICAL ACTIONS

- Recognize respiratory distress
- Obtain a complete set of vital signs
- Place the patient on supplemental oxygen
- Obtain a focused history
- Perform a focused physical exam
- Order 2 large bore peripheral IV's
- Recognize hypotension
- Order a 20 mL/kg bolus of crystalloid IVFs

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 38.3°C, **HR:** 140, **BP:** 77/42, **RR:** 62, **SpO_2:** 89% on RA
General	Well developed, well-nourished female who is lying in bed in obvious respiratory distress. Diaphoretic.
HEENT	Pupils equally round and reactive to light (PERRL), dry mucous membranes, strawberry tongue, uvula midline
Neck	Increased jugular venous distension (JVP), trachea midline, supple with good range of motion
Lungs	Tachypnea, clear to auscultation bilaterally, nasal flaring present, subcostal retractions present

Physical Exam (continued)

ITEM	FINDING
Cardiovascular	Tachycardic, normal S1 and S2 (no murmurs, rubs or gallops), distant heart sounds
Abdomen	Soft, non-tender, non-distended. No rebound. No guarding. No masses.
Back	No flank tenderness to palpation or percussion
Neurological	Alert, cooperative, cranial nerves 2-12 intact. Moves all extremities symmetrically. Strength is 4/5 throughout. No focal deficits.
Extremities	No cyanosis, clubbing, or edema
Skin	Café-au-lait spots on her back. Dark brown freckles in her armpits. Capillary refill is 4 seconds.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Orders cardiac monitor.	Patient is hypotensive, tachycardic, and tachypneic with hypoxia.	Nurse can ask “Do you want her on the monitor?”
Orders two large bore peripheral IV’s	Successful placement of PIVs	Nurse can ask “How many PIV’s do you want?”

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Places the patient on supplemental oxygen	With oxygen, the patient's oxygen saturation improves to 94%.	If oxygen is not administered quickly, the patient can say: "I can't breathe!" Nurse can ask: "How much oxygen do you want me to put her on?" and "How do you want the oxygen delivered?"
Administers a 20 mL/kg bolus of IVF's (crystalloid) for hypotension on the monitor.	Persistent tachycardia and hypotension despite IVF bolus. Vitals do not change. Go to **Stage 2**.	If the participants do not bolus IV fluids by 3 minutes into the case, the nurse can prompt or operator can decrease BP by 5% and increase heart rate by 5%.
If the participants try to obtain a comprehensive history and do not treat her with crystalloid and/or oxygen	Reduce the BP and oxygen by 5%, and increase the RR and HR by 5%.	

Stage 2

Reassessment:
Completion of 1st crystalloid bolus through completion of 2nd crystalloid bolus

CRITICAL ACTIONS

- Recognize abnormal physical exam findings
- Consider a broad differential
- Order a STAT portable CXR
- Order a STAT ECG
- Order the appropriate blood tests
- Order additional IVF bolus

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 38.3°C, **HR:** 140, **BP:** 77/42, **RR:** 62, **SpO_2:** 94%
Exam Changes	No changes in physical exam: The patient is still hypotensive, tachycardic, tachypneic, hypoxic, and febrile in respiratory distress.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Participants should note tachycardia, tachypnea, diaphoresis, pulsus paradoxus, muffled heart sounds, decreased capillary refill, and strawberry tongue.		If participants don't notice key findings, nurse will state: "What did you find on physical exam?" or "I thought her tongue looked odd" or "It's weird, I can't really hear her heart sounds very well."
Participants formulate a broad differential: Pneumonia, Sepsis, RAD, myocarditis, PTX, pleural effusions, PE, Kawasaki's Disease, pericarditis, pericardial effusion with tamponade perforated viscus, thyrotoxicosis, toxic ingestion		If the participants do not come up with at least 5 life threatening etiologies on their differential, the nurse can say "What else could this be?" Attending can intervene and guide with thoughtful and intentional questions if the participants go off track.
Order portable CXR	Radiology technician comes into the room and places the X-ray plate behind the patient and shoots the CXR. Participants will be shown the portable CXR images after completion.	If participants do not order the nurse can ask: "Do you want any imaging?" If CXR is ordered as a PA & LAT, the nurse will say: "I'm not comfortable sending this patient to radiology in her state."
Order ECG	RN or tech obtains an ECG. Participants will be shown ECG immediately after completion.	Nurse can ask: "Do you want an ECG?"

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Order blood work for analysis	RN or tech draws blood from the patient's peripheral IV.	Nurse can prompt: "I drew some blood with the IV starts. Do you want to order anything?"
Order additional 20 mL/kg bolus (bolus #2)	Go to **Stage 3.**	If participants do not order a second bolus, then drop BP 5% and increase HR by 5%.
Order broad spectrum antibiotics		If antibiotics are not ordered, the nurse can say: "She's febrile, tachycardic, and hypotensive. Do you think she could be septic?"
Order nebulized bronchodilator	Increase the HR by 5% if albuterol is ordered.	
Order nasopharyngeal viral studies or flu swab		Nurse should say "Do you really want me to swab her while she is in respiratory distress?"

Stage 3

Work-up:
Completion of second crystalloid bolus through review of CXR, ECG, and labs

CRITICAL ACTIONS

- Recognize cardiomegaly on CXR
- Recognize low voltage and electrical alternans on the ECG
- Interpret her blood test results correctly

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 38.3°C, **HR:** 136, **BP:** 90/55, **RR:** 60, **SpO_2:** 94%
Exam Changes	Minimal improvement in blood pressure and pulse. Still short of breath.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Patient's vital signs are improving slightly with second bolus of IV fluids and supplemental oxygen.	Vital signs improve by 5%.	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Participants should review the CXR and note that there is cardiomegaly and clear lung fields.	Increase HR and decrease BP by 5%.	If the participants do not correctly interpret the results, the nurse can say the following: "What do you think of her heart size?"
Participants should review the ECG and note that the patient is in sinus tachycardia with low voltage throughout and electrical alternans.	Increase HR and decrease BP by 5%.	"What do you think of her ECG? It looks kind of odd to me." "What do you think is going on with her heart?"
Participants are provided with the blood test results and note that the patient has leukocytosis with a left shift and bandemia, lactic acidosis, and an elevated ESR and CRP.	Increase HR and decrease BP by 5%.	"What did her blood tests show?"

Stage 4

Bedside ultrasound:
Review of CXR, ECG, and labs through bedside ultrasound

CRITICAL ACTIONS

- Perform a bedside point-of-care ultrasound
- Recognize a large pericardial effusion
- Recognize cardiac tamponade on bedside ultrasound

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 38.0°C, **HR:** 128, **BP:** 88/56, **RR:** 62, **SpO_2:** 95%
Exam Changes	The patient has worsening HR, BP, RR, oxygen saturation, and clinical status.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Patient is still complaining "I can't breathe. I don't feel good!" Patient is still tachycardic and hypotensive, requiring a 100% NRB mask to keep oxygen saturations >93%.	Continue to decrease BP and increase HR by 5%.	Nurse will say: "Are you going to order anything else for the patient?" Nurse will say "She is looking worse. What do you want to do?"

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Participants may administer another 20 mL/kg bolus of IVFs. (third IVF bolus for a total of 60 mL/kg).	Continue to decrease BP and increase HR by 5%.	If the participants do not administer another bolus of IV fluids, continue to drop the BP and increase the HR by another 5%.
Participants should perform a bedside point-of-care ultrasound (CORE Scan) Participants should scan her heart and note a large circumferential pericardial effusion (subxiphoid or parasternal views). Participants should note sonographic signs of cardiac tamponade (end-diastolic right ventricular collapse, right atrial collapse). Participants should scan the inferior vena cava (IVC) and note IVC dilation and lack of respiratory variation.	Continue to decrease BP and increase HR by 5%. Ultrasound images and video clips can be uploaded to a stimulus monitor or participants can use commercially available ultrasound simulators (e.g., SonoSim).	Nurse will say: "Do we need any other imaging?" If the participants try to order a computed tomography (CT) scan, the nurse will say: "I don't think she is stable enough to go to radiology right now. Is there anything else we can do for her at the bedside?" If the participants do not perform a CORE Scan, the nurse can say "Is there any other way we can see what is going on with her heart and lungs?" If the participants do not verbalize their ultrasound findings, the nurse should ask "What do you see on ultrasound?"
Participants should recognize that the patient has a pericardial effusion and cardiac tamponade.	Go to **Stage 5**.	

Stage 5

Pericardiocentesis:
Bedside ultrasound through pericardiocentesis

CRITICAL ACTIONS

- Recognize that the patient needs an emergent pericardiocentesis
- Perform an emergent bedside pericardiocentesis
- Place a call out to interventional cardiology or CT surgery
- Perform the pericardiocentesis under ultrasound guidance

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 38.0℃, **HR:** 155, **BP:** 74/58, **RR:** 8, **SpO_2:** 89% on 100% NRB
Exam Changes	Patient is deteriorating rapidly and unable to protect her airway.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Participants should call for immediate interventional cardiology, CT surgery and/or pediatric intensivist consult(s)	Consultants are not available.	If there is a delay in obtaining consults, the nurse can say "Is there anyone else I should call for you?"

Instructor Notes: Changes and Case Branch Points (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Participants may opt to intubate the patient.	If the participants intubate the patient, have the patient go into cardiopulmonary arrest due to the sudden drop in sympathetic drive.	Participants should be able to defibrillate the patient and get her back with epinephrine. Have her go back to pre-intubation vital signs after return to spontaneous circulation (ROSC).
Participants should prepare for and perform a bedside pericardiocentesis under ultrasound guidance (parasternal, apical, or subxiphoid approach) Participants may opt to perform the procedure under procedural sedation with oxygenation and ventilatory support given risk for decompensation with rapid sequence intubation.	Ultrasound images and video clips can be uploaded to a stimulus monitor or participants can use commercially available ultrasound simulators (e.g., SonoSim).	If the participants do not perform the pericardiocentesis under ultrasound guidance, the nurse should say "Do you want to use ultrasound guidance when you stick the needle into her chest?" If the participants decide to intubate her first, the RN may say "Do you think we have time to intubate her or should we sedate her quickly and get that fluid off her heart?"
Pericardiocentesis has been performed and 360 mL of thick serosanguinous fluid has been withdrawn emergently.	Temp 38.0C HR 125 BP 90/54 RR 20 (with bagging) O_2 Sat 100% on 100% FiO_2	Nurse can say "She's starting to stabilize. Where is she going to go next?"
	Go to **Stage 6**	

Stage 6

Case Conclusion:
Pericardiocentesis through signout to admitting team

CRITICAL ACTIONS

- Discuss with pediatric intensivist
- Transfer the patient to the pediatric ICU
- Update the family

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 38.0°C, **HR:** 125, **BP:** 90/54, **RR:** 20, **SpO_2:** 100% on 100% NRB
Exam Changes	Patient has improved color, decreased respiratory distress, and near normalization of vital signs after successful pericardiocentesis.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Participants can call PICU team or the PICU team can show up and say they heard there was a critical patient that needed admission. Participants should provide a succinct and direct hand-off to the admitting team including information such as what the patient presented with, what was done for the patient, the thought process behind the treatment, and what they are hoping to have happen next.	Consultants arrive for hand-off. Patient remains stable.	The consultant and admitting team can ask clarification questions if the consult or hand-off is not complete.
Participants should update the family.	Patient remains stable.	If the participants do not speak with mom, the nurse will say "Are you ready to talk to mom and dad?"

Ideal Scenario Flow

The learners enter the room to find a febrile female 8-year-old child in respiratory distress. They immediately place the patient on bedside cardiac monitors and recognize that the patient is in critical condition and imminent cardiopulmonary arrest. Supplemental oxygen is provided, peripheral IVs are placed, and IV fluid boluses are ordered. Blood is drawn and sent for analysis. The patient's oxygen saturation improves slightly with supplemental oxygen, but the respiratory distress does not resolve, and her hypotension is refractory to IV fluids. After completing a focused physical examination and obtaining a focused history, the providers begin prompt, aggressive resuscitation. A portable chest x-ray reveals an enlarged cardiac silhouette. An ECG shows sinus tachycardia with low voltage and electrical alternans. Point-of-care ultrasound (the CORE Scan) is performed and confirms the diagnosis of pericardial effusion with cardiac tamponade. The providers perform an ultrasound-guided pericardiocentesis. Blood test results are provided to the participants. The patient's vital signs and clinical status improve after emergent pericardiocentesis. The patient's case is discussed with the pediatric intensivist and arrangements are made to admit the patient to the pediatric intensive care unit. The family is updated. All questions are answered.

Anticipated Management Mistakes

1. **Participants do not act in a parallel fashion (e.g., take too long to perform a primary survey, resuscitation, history, or physical):** A faculty member or embedded participant could ask the team to reinforce team assignments, including the team leader role. This could focus individual team members on specific critical actions, while allowing the team leader to account for every task.

2. **Participants do not consider cardiac tamponade on the differential diagnosis:** During piloting, this occurred because the learners anchored on another diagnosis, did not perform an ultrasound, or perceived that classic tamponade exam findings were absent. In any of these situations, an embedded participant could explicitly suggest the use of bedside ultrasound.

3. **Participants hesitate to perform a pericardiocentesis:** Since the procedure ideally occurs near the end of the case, faculty can discuss this during debriefing.

Debriefing Points

Identify signs and symptoms of cardiac tamponade (application)

- Tachycardia, hypotension, muffled heart sounds

Demonstrate early evaluation of a critically ill patient (application)

- Focused primary survey
- Treat and think simultaneously

Construct a broad differential for a child with fever, hypotension and respiratory distress (synthesis)

- Vasculitis
- Infection
- Trauma
- Autoimmune
- Metabolic
- Iatrogenic
- Neoplasm
- Congenital

Construct and implement initial medical management for a pediatric patient with signs of shock and respiratory distress (synthesis)

- Peripheral IV's: 2 large bore IVs as central as possible
- Supplemental oxygen (nasal cannula, non-rebreather, positive pressure ventilation, intubation)
- Cardiac monitor with every five minutes automatic blood pressure readings
- Continuous oxygen saturation monitoring: ensure that there is a good waveform and that that probe is not on a cold extremity.
- Perform a POCUS: The CORE Scan for undifferentiated cardiopulmonary distress
- 20 mL/kg bolus (crystalloid). Reassess after IV fluids.
- Portable CXR: Do not send an unstable patient to radiology for PA/lateral
- ECG
- Draw and send blood for stat analysis.

Formulate a diagnostic plan to evaluate for causes of patient deterioration (synthesis)

- Think and act simultaneously.
- Perform tasks in parallel and not in series.
- Think at least three steps ahead of every other member on the team.
- Have backup plans for every step of assessment and treatment.
- Speak out loud and include team members in the decision-making process.

Discuss when to use point-of-care ultrasound in the evaluation and treatment of a pediatric patient with undifferentiated cardiopulmonary distress (evaluation)

- In undifferentiated patients, perform a POCUS early on to assess the heart, lungs, IVC, etc.
- Obtain useful data within minutes at the bedside.
- Act on each sonographic finding as you scan.

Interpret the sonographic findings of a pericardial effusion with cardiac tamponade (application)

- Hypoechoic or anechoic pericardial effusion.
- Visualize the effusion in the parasternal or subxiphoid view.
- Is the effusion circumferential? Is it loculated?
- Are you sure you aren't looking at a pericardial fat pad?
- Determine if there is end-diastolic RV collapse, RA collapse, and IVC dilation or decreased IVC variation with respirations.

Demonstrate an emergent ultrasound-guided pericardiocentesis (application)

- Subxiphoid approach puts the patient at risk for liver puncture.
- Consider a parasternal or apical 4 chamber approach.
- Perform the procedure under direct ultrasound guidance.
- Lumbar puncture or central venous access trays can be used in emergent situations.

Demonstrate focused history taking from a caregiver (application)

- Obtain the critical information first.

- Act immediately.
- Supplemental information can be obtained as the patient is being stabilized.
- Reassess regularly.

Explain diagnosis and management to caregivers (synthesis)

- Ensure that someone is updating the family regularly and frequently.
- Delegate this responsibility if necessary.
- Circle back with the family members and sit down to discuss with them what happened, what you were worried about, what was done, and what next steps will be.
- Always finish with, “Do you have any questions?” and “I am here for you if you think of any other questions later.”

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- “Airway status?”; Surveying provider- “Airway clear”; Leader- “Breath sounds?”; Surveying provider- “Breath sounds decreased on right”)

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Supporting Files

Lab Results

CBC with Differential

LABORATORY TEST	VALUE	UNITS
WBC	36.8×10^3	$/mm^3$
Hemoglobin	13.1	g/dL
Hematocrit	40.3	%
Platelets	485×10^3	$/mm^3$
MCV	84	fL/red
Neut %	74	%
Bands %	15	%
Lymph %	1	%
Mono %	0	%
Eos %	0	%
Baso %	0	%

Supporting Files

Lab Results

Comprehensive Metabolic Panel

LABORATORY TEST	VALUE	UNITS
Sodium	136	mEq/L
Potassium	4.8	mEq/L
Chloride	105	mEq/L
Bicarbonate	15	mEq/L
BUN	22	mg/dL
Creatinine	0.9	mg/dL
Glucose	90	mg/dL
Anion Gap	18	mEq/L

Supporting Files

Lab Results

Inflammatory Markers

LABORATORY TEST	VALUE	UNITS
ESR	52	mm/hr (normal <20)
C-Reactive Protein	21.5	mg/dL (normal <1)

Supporting Files

Lab Results

Arterial Blood Gas

LABORATORY TEST	VALUE	UNITS
pH	7.3	
pCO_2	32	mmHg
pO_2	89	mmHg
HCO_3	15	mEq/L

Supporting Files

Lab Results

Urinalysis

LABORATORY TEST	VALUE	UNITS
Specific Gravity	1.020	
pH	6.2	
Protein	Negative	
Glucose	Negative	
Ketone	Negative	
Bilirubin	Negative	
Urobilinogen	0	
WBC	0	cells per high power field (normal >5)
RBC	0	cells per high power field (normal >5)
Epithelial cells	2	cells per high power field (normal >5)

Supporting Files

Lab Results

Cultures

LABORATORY TEST	RESULT
Urine Culture	No growth at final
Blood Culture	No growth at final

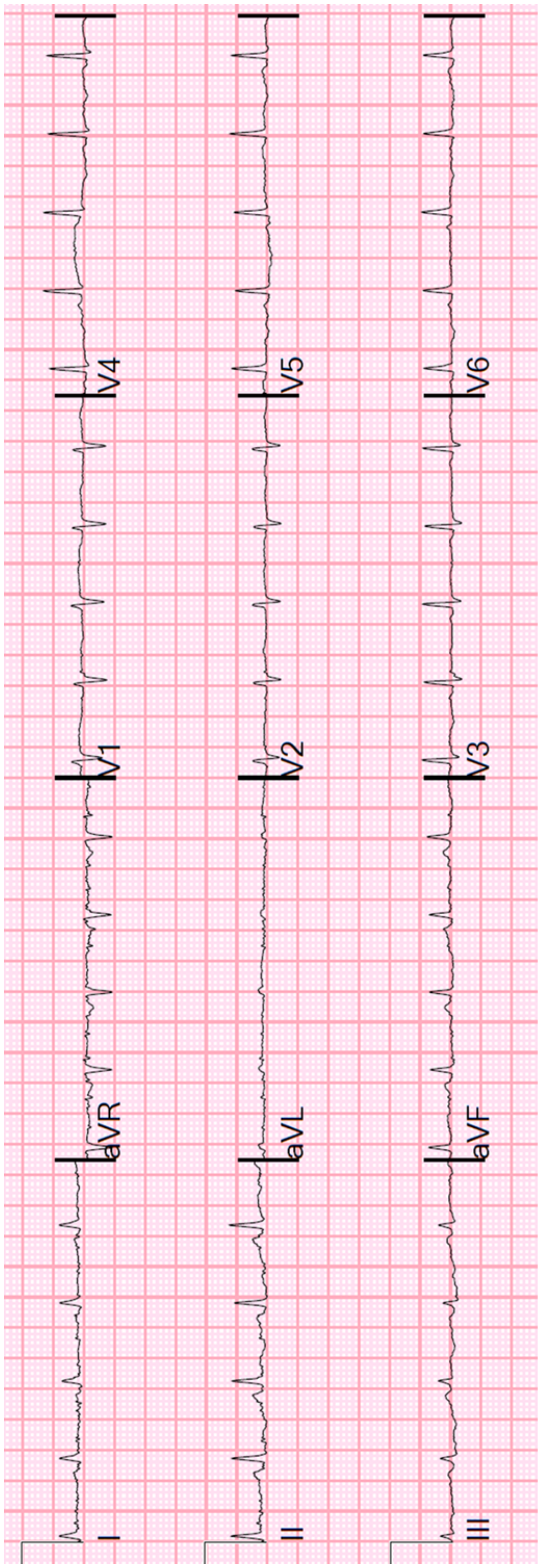
Supporting Files

Lab Results
Respiratory Virus Panel

LABORATORY TEST	RESULT
RSV	Negative
Influenza A	Negative
Influenza B	Negative
Parainfluenza	Negative
Sapovirus	Negative

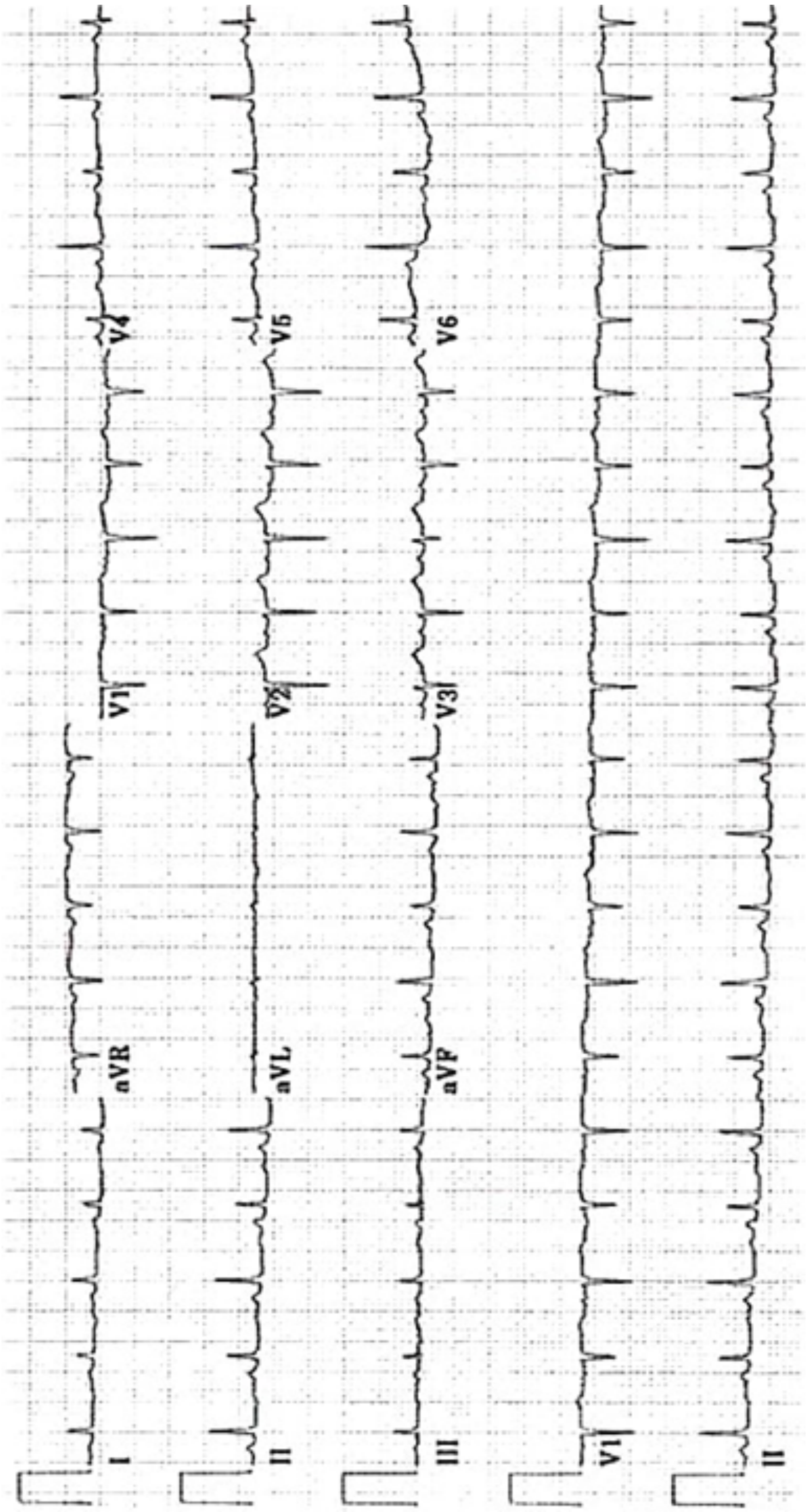
Supporting Files

ECG



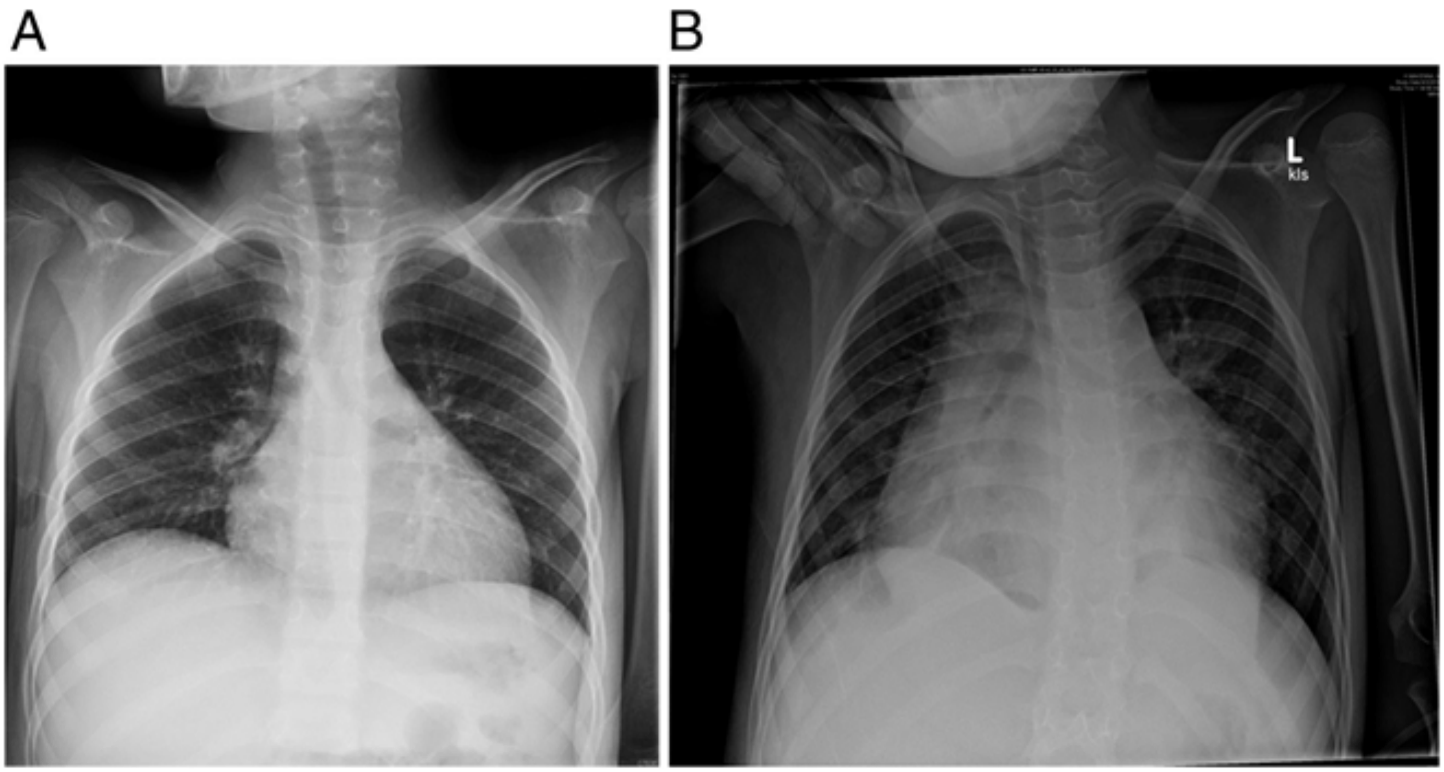
Supporting Files

ECG 2



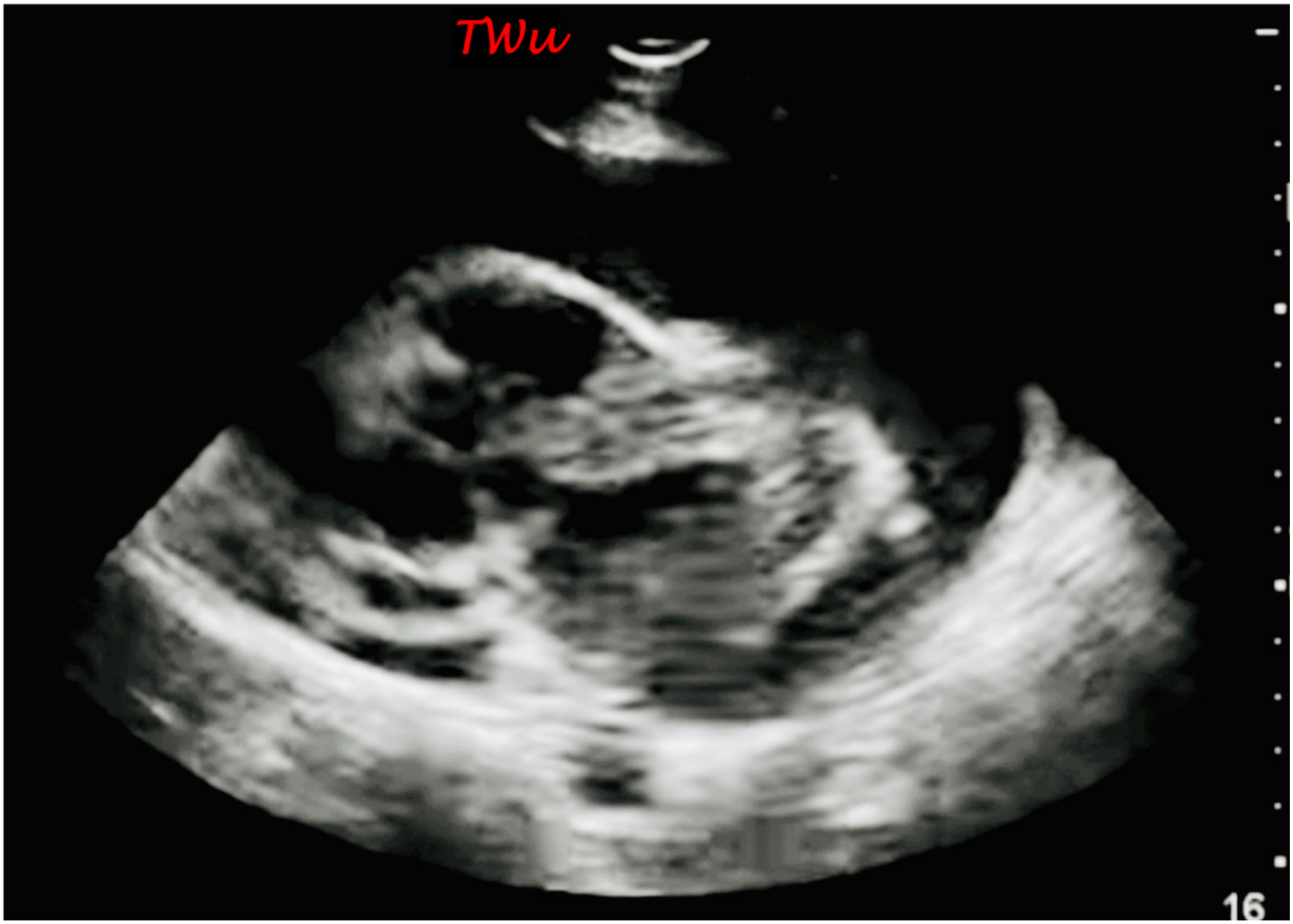
Supporting Files

Chest Radiograph
A. Prior chest XR
B. Chest XR at ED visit



Supporting Files

Point of Care Ultrasound 1



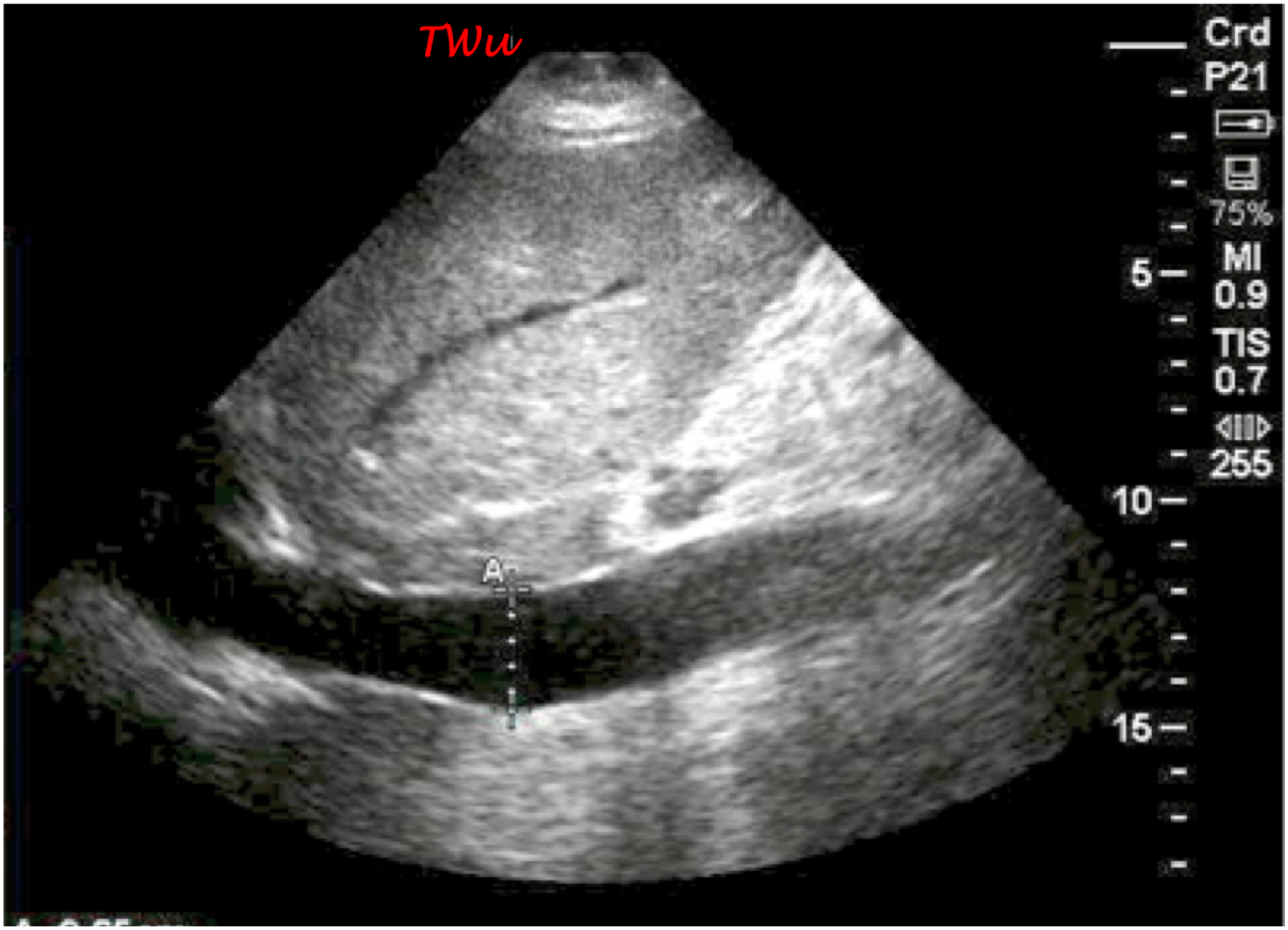
Video 1: Parasternal long axis view

Video 2: Parasternal short axis view

Video 3: Apical 4-chamber view

Supporting Files

Point of Care Ultrasound 2



Supporting Files

Notes

ECG 1 interpretation
Sinus tachycardia at 148 bpm, with diffusely low voltage, and T wave inversion in III, biphasic ST segment in aVF, flat ST segment in V3, and V4, with biphasic ST segments in V5 and V6. Normal R wave progression. Normal intervals. No PVCs or PACs. From **Dr. Smith's ECG Blog** posted August 21, 2015

ECG 2 interpretation
Sinus tachycardia at 120 bpm, low QRS voltage throughout, T wave inversion in I and flat in aVL. Biphasic ST segments in V4-V6. Electrical alternans. From **Life in the Fast Lane** by Ed Burns

Chest x-ray interpretation
No cardiopulmonary disease on a previous chest x-ray (A) and a significantly enlarged cardiac silhouette consistent with large pericardial effusion and clear lung fields during ED evaluation (B) Images from Dr. Teresa Wu

Point-of-care ultrasound interpretation
Parasternal short axis view of a large circumferential pericardial effusion with RV collapse indicating cardiac tamponade. Image from Dr. Teresa Wu, and **Sonosupport.com**.

- Video 1: Parasternal long axis view shows large pericardial effusion with collapse of right ventricular outflow tract. From Dr. Jason Deen.
- Video 2: Parasternal short axis view shows large pericardial effusion with RV collapse during systole. From Dr. Jason Deen.
- Video 3: Apical 4-chamber view shows large pericardial effusion with systolic compression of the right atrial free wall consistent with tamponade. From Dr. Jason Deen.

Point-of-care ultrasound interpretation
Long axis view of a dilated IVC secondary to cardiac tamponade from a pericardial effusion. Image from Dr. Teresa Wu, and **Sonosupport.com**

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the person running the simulated patient and serving as the voice of the simulated pediatric patient, AND for the embedded participant playing the role of the parent/guardian

Case Background Information

This 8-year-old female is brought in by her parent for fever, shortness-of-breath, and numerous other symptoms. For a few days prior, she has been managed by her primary care doctor (PCP).

Upon emergency department (ED) arrival, the treatment team should recognize that she is severely ill and immediately begin resuscitation. Provider actions will include intravenous (IV) fluids, oxygen, monitoring, diagnostic tests, and antibiotics. They may perform intubation and place a central line.

The patient will continue to be critically ill. Results from chest x-ray (CXR), electrocardiogram (ECG), and point-of-care ultrasound should allow the treatment team to recognize that she has cardiac tamponade. Ideally, they will perform a pericardiocentesis, and then transfer her care to the intensive care unit (ICU).

Who are the Learners?

Emergency medicine residents, pediatric emergency medicine residents, and undifferentiated medical students

- The learners are expected to be proficient in gathering a history and performing a physical exam. They are capable of formulating a list of diagnoses and ordering tests.
- Most learners will be able to perform common emergency department procedures such as:
    - Inserting a peripheral IV
    - Placing the patient on the cardiac monitor
    - Placing the patient on supplemental oxygen
    - Assisting ventilation
    - Intubating the patient
    - Performing point of care ultrasound
    - Establishing central venous access with a central line

- They will have variable experience regarding the diagnosis of cardiac tamponade and the performance of pericardiocentesis. They have likely read about those topics, but at their stage of training, it is uncommon to have firsthand experience with either in clinical practice.

Standardized Patient Information

Parent: Your overall demeanor is concerned. Your daughter has never been this sick before. You will be cooperative with the treatment team and openly answer their questions. If the team prepares for an invasive procedure (e.g., central line, pericardiocentesis), you will ask for a justification for the procedure ("Why does this have to be done?") and accept their explanation at face value.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT: "She's having difficulty breathing."

- AGE: 8 years old

- ADDITIONAL HISTORY:
    - She has been having daily fevers between 101°F to 105°F at home for the past week. This has been accompanied by a non-productive cough, nasal congestion, sore throat, body aches, and burning-with-urination.
    - She was seen by her PCP a few days ago and was diagnosed with bronchitis. A urine culture was sent. No other tests were done. She was started on amoxicillin pills.
    - Her PCP called her mom yesterday to tell her that the urine cultures grew out *Staphylococcus epidermidis*, and her PCP called in an additional antibiotic (cephalexin) to the pharmacy for them. She started her cephalexin yesterday.
    - Today, she noticed a red rash on both hands. She also started having bilateral flank pain.
    - She became increasingly short-of-breath despite albuterol treatments at home so you drove her to the ED.
    - You have given her acetaminophen and ibuprofen at home for her fevers.

- PAST MEDICAL HISTORY: Neurofibromatosis (Type I) and mild asthma
- SOCIAL HISTORY: She has multiple sick contacts at school. Lives with mother. Father not involved. No siblings. No tobacco/drugs or alcohol.
- FAMILY HISTORY: Mom and grandma both have Neurofibromatosis (Type I)
- PAST SURGICAL HISTORY: None
- MEDICATIONS: Cephalexin, acetaminophen, ibuprofen, albuterol
- ALLERGIES: No known allergies
- IMMUNIZATIONS: Up-to-date
- BIRTH HISTORY: Unremarkable. She was born full term, no medical complications (patient is 8 years old, ok if they don't ask about birth history)

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:

- "She looks really sick."
- "What do you think is going on with her?"
- "She looks really uncomfortable."

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
If the patient has not received supplemental oxygen	"Can you help her with her breathing?"
If the learners delay other initial resuscitative measures	"She looks really sick! What are you going to do for her?"
If half of the duration of the case goes by without the learners considering the diagnosis of tamponade	"What else do you think is going on?", "Is there another test you can do?"
If the learners recognize tamponade, but don't perform a pericardiocentesis	"How do you treat that?"
If the learners perform invasive procedures like central lines or pericardiocentesis	"What procedure is that?" or "Why do you have to do that?"

Simulation Case 3

Congenital Adrenal Hyperplasia & Adrenal Insufficiency Shock

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Updated August 18, 2020

Setup

Chief complaint: Vomiting
Patient age: 3 weeks old
Weight: 3 kg

Brief Narrative Description of Case

Patient is brought in by parents for vomiting. He is lethargic, ill-appearing, and severely dehydrated. Learners will need to establish that he is in hypotensive shock with poor perfusion. Intravenous access will be unable to be obtained, requiring intraosseous access. He is hypoglycemic and will require a glucose bolus. He is later found to be hyponatremic and hyperkalemic to alert providers of adrenal crisis.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Describe signs/symptoms of shock in a neonate **(comprehension)**
2. Construct a differential for shock in a neonate **(synthesis)**
3. Identify neonatal hypoglycemia **(comprehension)**
4. Construct and implement an initial management plan for a neonate in shock **(application)**
5. Interpret signs/symptoms of adrenal hyperplasia and adrenal crisis **(evaluation)**
6. Demonstrate intraosseous placement **(application)**
7. Demonstrate focused history taking from a caregiver **(application)**
8. Explain diagnosis and management to caregivers **(synthesis)**
9. Demonstrate teamwork and closed loop communication **(application)**
10. Optional: Identify signs/symptoms and treat hyperkalemia **(knowledge & application)**
11. Optional: Identify and treat ventricular tachycardia with pulses **(knowledge & application)**

CRITICAL ACTIONS

- Assign/assume team roles
- Obtain brief history from parent
- Establish basic airway maneuvers
- Place patient on continuous cardiac monitor
- Obtain a point of care glucose
- Administer glucose bolus
- Establish vascular access
- Recognize adrenal crisis and administer hydrocortisone
- Obtain a venous blood gas to establish electrolytes
- Obtain ECG for hyperkalemia on labs (advanced optional stage)
- Administer medications appropriate for hyperkalemia, such as calcium gluconate, albuterol, insulin/glucose, sodium polystrene (advanced optional stage)
- Perform synchronized cardioversion for ventricular tachycardia with pulses (advanced optional stage)
- Perform focused physical exam
- Recognize signs for adrenal crisis
- Explain diagnosis to parent and how it relates to the patient presentation

Recommended Supplies

- **Manikin:** Male neonate with male genitalia can be programmed to have the sunken fontanelle on exam
- Moulage (optional): Darkening of scrotum, cool extremities (take a paper towels wet them and place in the refrigerator then wrapping the arms/legs in those)
- **Resources:** PALS card and/or length-based tape (e.g., Broselow Tape)
- **Manikin set up:** Arms and legs placed in ice before simulation
- **Equipment:**
    - Intraosseous equipment including E-Z IO, needle, stabilizer, and connectors, saline flushes
    - Pediatric airway equipment of various sizes/airway cart
        - Simple facemask
        - Non-rebreather mask
        - Nasal cannula

        - Oxygen tubing
        - Suction
        - 3.5 uncuffed endotracheal tube, stylet, laryngoscope size 1 Miller/Mac
        - End-tidal monitoring device
- **Medications** (pre-calculated/pre-drawn):
    - D10W
    - Normal saline bags
    - Normal saline flush
    - Hydrocortisone
    - Ampicillin
    - Cefotaxime (or preferred antibiotics for presumed neonatal sepsis)
    - Calcium gluconate (advanced)
    - Sodium polystyrene (advanced)
    - Insulin (advanced)
    - Albuterol (advanced)

Supporting Files

- Point-of-care labs
- Electrocardiogram

Participants/Roles

- Participants/Learners:
    - Team Leader
    - Airway Manager
    - Survey Physician
    - Medication Giver
    - Family Liaison
- Faculty or other embedded participants can play a nurse, respiratory therapist, or tech, if there are not enough learners to perform the above roles.
- Standardized patient (actor or faculty) to play patient's parent

** Team roles may need to be adjusted in order to suit local practices and norms*

Prerequisite Knowledge

- **Faculty**
  - PALS protocols
  - General knowledge of emergency medicine
  - Simulation implementation and debriefing experience

- **Emergency medicine residents**
  - Any stage of training (preferably PGY-2 year; PGY-3 or 4 for advanced options)
  - Completed PALS certification

Case Alternatives

- If residents fail to recognize and treat adrenal crisis within 10 minutes of the case (e.g., residents continue to give normal saline boluses, administer antibiotics, consider pressors), stop the scenario.

- For advanced learners, the potassium (K) is extremely elevated to 10 mEq/L on VBG. Learners must obtain an ECG and administer appropriate medications to lower K, including Ca gluconate, albuterol, insulin/glucose, and/or sodium polystyrene (with Ca gluconate being required medication). If Ca gluconate is given within 5 minutes (i.e., very quickly, indicating proficiency in hyperkalemia management), then the patient can go into ventricular tachycardia with pulses. The team must cardiovert patient back into sinus rhythm.

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC3. Diagnostic Studies
PC4. Differential Diagnoses and Management
PC5. Pharmacotherapy
PC9. General Approach to Procedures
PC10. Airway Management
PC14. Vascular Access
PC15. Medical Knowledge
ICS1. Patient Centered Communication
ICS2. Team Management

Resources
1. Agus MSD, Dorney K. Endocrine Emergencies. In R. Bachur & K. Shaw (Eds.), Fleisher and Ludwig's Textbook of Pediatric Emergency Medicine. 2015; 7th ed., pp. 701-704.
2. Speiser PW, Azziz R, Baskin LS, et al. Congenital adrenal hyperplasia due to steroid 21-hydroxylase deficiency: An Endocrine Society clinical practice guideline. J Clin Endocrinol Metab 2010;95:4133. PMID: 20823466

Initial Presentation

ITEM	FINDING
Overall Appearance	3-week-old male lethargic, ill-appearing, shallow breathing
HPI	The patient arrives by private vehicle accompanied by a parent. "He has been acting very tired for the past week." If the learners ask for specifics: • He has been feeding poorly in the past few days, which is difficult to quantify since he's breastfed. • His diapers have been decreased, only 1 minimally wet diaper today. • His pediatrician called and left a message yesterday about an abnormal newborn screen. • ROS: Fatigues and tires at the breast easily. Tactile fever, but no cough, emesis, diarrhea, or rashes.
Past Medical/Surgical History	Born at 40-weeks gestation, unremarkable gestation/ delivery
Medications	None
Allergies	None
Family History	Non-contributory
Social History	No pet, no smokers, taken care of by mom at home

Stage 1

Begin Simulation (Stage 1 of 4)

Hypoglycemia:
Start of case through treatment of hypoglycemia

CRITICAL ACTIONS

- **Team leader assigns tasks**
- **Obtain brief history from parent**
- **Perform focused physical exam (ABCs)**
- **Perform basic airway maneuvers based on pediatric anatomy**
- **Place patient on continuous cardiac monitor**
- **Verbalize recognition of shock**
- **Obtain point-of-care glucose**
- **Obtain vascular access**
- **Verbalize recognition of hypoglycemia**
- **Administer D10W bolus at 5 mL/kg or D25 at 2 mL/kg**
- Administer normal saline bolus at 10-20 mL/kg
- Administer antibiotics (e.g., ampicillin 100 mg/kg/dose IV, cefotaxime 50 mg/kg/dose IV)
- **Discuss progress and plan of care with the parent**

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.5°C, **HR:** 190, **BP:** 50/28, **RR:** 35, **SpO_2:** 92% (tracing not consistently good)
General	Ill-appearing, lethargic, cries weakly

Physical Exam (continued)

ITEM	FINDING
HEENT	Sunken fontanelle, pupils equal round and reactive, full extraocular movements
Neck	Normal
Lungs	Clear to auscultation bilaterally
Cardiovascular	Tachycardic, no abnormal heart sounds, weak pulses, capillary refill >3 seconds
Abdomen	Normal, soft, non-distended, non-tender
Neurological	Cries weakly to painful stimuli, moves all extremities
Skin	Cold, no rashes or bruises
Other Relevant System	GU exam: Normal male genitalia, slightly increase pigmentation of scrotum

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Team performs basic airway maneuvers (e.g., patient placed in sniffing position, shoulder roll, placed on oxygen)	SpO_2 improves to 100%	
Team attempts intravenous line		Faculty/nurse verbalizes that attempt is unsuccessful
Team sends blood drawn for labs (including bedside electrolytes)		Labs other than bedside glucose will be pending until **Stage 2**.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Team places IO		IO is functional if placed in the appropriate location.
IO placement initiated without discussing with parent		Parent asks, “What are you doing to my child?” Parent will be satisfied with a direct/accurate explanation.
Participant requests finger stick blood glucose		Glucose level is 28 mg/dL.
Team gives 5mL/kg of D10 IV (or 2mL/kg of D25)	Patient cries more vigorously. Proceed to **Stage 2**.	
Team requests isotonic fluid boluses and empiric antibiotics.	Blood pressure decreases to 45/30	
Team requests vasopressors for hypotension	Blood pressure improves to 62/44	
Intubation	No change other than paralysis, O_2 sats will be 100% with oxygen	Team may elect to intubate the patient
Atropine is given prior to intubation	Heart rate increases by 10 for all stages	

Stage 2

Adrenal crisis:
10 minutes from the start of the case or after dextrose given for hypoglycemia through administration of steroids

CRITICAL ACTIONS

- Verbalize recognition of adrenal crisis
- Administer hydrocortisone 2 mg/kg IV bolus

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.5°C, **HR:** 180, **BP:** 55/30, **RR:** 40, **SpO_2:** 100% RA
Exam Changes	Pt slightly more active (more vigorous cry), but still hypotensive with poor capillary refill

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Point-of-care venous blood gas shows hyperkalemia, hyponatremia, metabolic acidosis		VBG/CBG: • pH 7.21 • pCO_2 35 mmHg • pO_2 60 mmHg • HCO_3 10 mEq/L • Lactate 25 mg/dL • Na 120 mEq/L • K 7.2 mEq/L

Team administers IV hydrocortisone	BP improves to 80/60, and tachycardia improves to 130. Proceed to **Stage 3**.	For advanced learners go to optional **Stage 4**.
Team continues to give isotonic fluid boluses and/or starts pressors	Patient becomes increasingly more hypotensive and tachycardic, but never loses pulses. Within 10 minutes of the case, stop the case.	The patient will remain in distress, lethargic appearing until IV hydrocortisone is given.

Stage 3

Case Conclusion:
Administration of steroids through signout to admitting team/facility

CRITICAL ACTIONS

- **Explain diagnosis to parent and how it relates to the patient presentation**
- Notify admission team

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.5°C, **HR:** 150, **BP:** 70/48, **RR:** 45, **SpO_2:** 100%
Exam Changes	Patient now vigorous and actively crying with improved color and capillary refill 2 seconds

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Point-of-care venous blood gas repeat shows improvement		VBG/CBG: • pH 7.30 • pCO_2 37 mmHg • O_2 100mmHg • HCO_3 17 mEq/L • lactate 16 mg/dL • Na 128 mEq/L • K 7.0 mEq/L
Team provides signout to admitting service, Pediatric ICU, and/or admitting facility	**Case ends**	

Stage 4 – Optional

Hyperkalemia:
After 2nd stage, repeat VBG shows K of 9.5 through administration of calcium gluconate or 10 minutes

CRITICAL ACTIONS

- Obtain electrocardiogram
- Administer calcium gluconate
- Perform cardioversion: If Ca gluconate is not administered within the first 5 min of this stage, patient will go into ventricular tachycardia with pulses. If Ca gluconate is not given within 10 minutes of the case, the case will be stopped.

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.5°C, **HR:** 180, **BP:** 48/25, **RR:** 30, **SpO_2:** 100%
Exam Changes	Increasing pallor/mottled appearance

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Peaked T waves on cardiac monitor	Patient more agitated and cries more	
Team obtains ECG	ECG shows sinus tachycardia, peaked T waves.	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Team fails to obtain ECG or notice peaked T waves	Within 5 minutes, case will be stopped.	
Team administers albuterol, sodium bicarbonate, insulin/glucose, or furosemide	Patient's peaked T waves resolve, and patient becomes responsive.	
Team administers calcium gluconate within <5 minutes	Patient remains stable. **Case ends.**	The assumption is that with such quick Ca gluconate administration, the team has proficiency in hyperkalemia management. **Or for advanced learners:** Patient goes into ventricular tachycardia with pulses.
Team administers calcium gluconate at 5–10 minute time point	Patient remains stable. **Case ends.**	The assumption is that the 5–10 minute time frame of Ca gluconate administration means that hyperkalemia management is not at proficient level, but still with some partial credit.
Team provides signout to admitting service, Pediatric ICU, and/or admitting facility	**Case ends**	No Ca gluconate within 10 minutes means the team is unlikely to implement hyperkalemia management.

Ideal Scenario Flow

The learners enter the room to find a thin, pale appearing patient who is lethargic but breathing. They immediately perform basic airway maneuvers (e.g., patient placed in sniffing position, placed on nasal cannula oxygen, shoulder roll placed), and patient's oxygen saturation improves to 100%. The team notices that the patient is hypotensive and tachycardic. Attempts to place IV access are unsuccessful, and the team must place an IO line and draw off a VBG. During **stage 1**, the team obtains a point-of-care glucose test and note that the patient is hypoglycemic. The team administers isotonic fluid boluses and glucose bolus which minimally improve the patient's hypotension and neurological status. During **stage 2**, the VBG then comes back and reveals hyponatremia, hyperkalemia, and metabolic acidosis. The team recognizes adrenal crisis and administers hydrocortisone. The patient regains normotension and tachycardia improves.

For advanced learners, the patient develops peaked T waves from hyperkalemia, confirmed on ECG. The providers administer hyperkalemia drugs, most critically calcium gluconate. Finally, if calcium gluconate is given very quickly, there is an option to move into ventricular tachycardia with pulses to add further challenge. Upon resolution, the providers arrange for patient admission to the floors/medical ICU.

Anticipated Management Mistakes

1. **Failure to obtain blood glucose:** Some learners may not immediately recognize the patient is hypoglycemic. The patient will continue to be lethargic despite isotonic fluid boluses. We may have the mother prompt the learners by saying the patient had not eaten for 6 hours.

2. **Failure to recognize adrenal crisis:** Some learners may think that the patient is in septic shock and continue giving fluids and adding pressors. Mom prompts at 5 min of stage 2 for learners saying that she had been unable to keep the patient's PMD appointment last week when the pediatrician had called saying that there was some abnormality with his newborn screening.

3. **Failure to give the correct steroid** (e.g., methylprednisolone): If the learner requests for a different steroid but still recognizes adrenal crisis, they will be prompted by the nurse saying there is no methylprednisolone in the rescue cart and suggest hydrocortisone. This should then be appropriately debriefed.

Debriefing Points

Describe signs and symptoms and manage shock in a neonate (comprehension)

- Brief: Initial assessment to determine the neonate is ill, short discussion about potential differentials of shock in a neonate and initial resuscitation measures

- Pediatric assessment triangle

- PALS algorithm

- Learners should approach a critically ill patient in a standardized fashion. Always check for responsiveness. If unresponsive, check for a pulse. If no pulse, start CPR and proceed to airway, breathing, and circulation. Interventions such as airway repositioning/adjuncts/ intubation should be considered if poor air movement or difficulty with BMV. After A, B, and C have been addressed, the patient should be evaluated for disability and exposed for a thorough head to toe exam. In Pediatrics, people often say that D also stands for "don't forget the dextrose" as a blood glucose level should be checked in any child with altered mental status.

- Learners should recognize abnormal vitals. The appropriate PALS algorithm for fluid-refractory hypotensive shock should include intravenous fluids and escalate to pressors and steroids.

Construct a differential for shock in a neonate (synthesis)

- Discuss how the case could be changed to demonstrate one of these other diagnoses instead.
    - For sepsis, the child may present with tachycardia, fevers, and hypotension. The correct management would be aggressive fluid resuscitation and early administration of empiric antibiotics. Blood cultures should be obtained prior to antibiotics administration.
    - Cardiogenic shock may manifest as clinical worsening (increased tachycardia, hypotension) with the

administration of fluids. Lung crackles and hepatomegaly may be appreciated on exam. Learners should recognize cardiogenic shock and stop fluids, and administer pressors immediately. Prostaglandin should be considered if there are concerns of congenital cardiac defects (e.g., coarctation of the aorta).
  - Adrenal crisis would manifest as fluid refractory hypotensive shock. Learners may administer fluids, antibiotics, and pressors without effect. Labs obtained would show hypoglycemia, hyponatremia, and hyperkalemia. This should prompt learners to administer steroids immediately. Physical exam features may indicate hyperandrogenism in the infant (enlarged clitoris in the female infant or hyperpigmented scrotum in the male infant).
  - Dehydration or electrolyte abnormalities can manifest as tachycardia, hypotension, and poor perfusion. Aggressive fluid hydration and electrolyte correction should be administered.
  - Hypoglycemia should be recognized early with a glucose check in an ill-appearing infant, and is defined as <47 mg/dL. Administration of glucose is indicated to correct.
  - Trauma should be suspected, especially nonaccidental trauma. Concerning physical exam signs may include bruising, bogginess on the scalp, or fractures. Management steps should follow the standardized ABCs.

Identify neonatal hypoglycemia (comprehension)

- Importance of a finger stick glucose test in any altered patient

- Hypoglycemia is the great mimicker.

- Neonates and other pediatric patients have minimal glucose stores and will become hypoglycemic with minimal insult.

- Short-term management of hypoglycemia consists of a bolus of dextrose-containing fluids. The mnemonic “Rule of 50” states that the product of the dextrose concentration and dose in mL/kg equals 50 (e.g., D10 at 5 mL/kg, D25 at 2mL/kg). A critical sample of blood should be drawn before glucose administration.

An infusion of dextrose-containing fluids should follow the bolus, and frequent glucose checks should be obtained to ensure appropriate resuscitation.

Construct and implement an initial management plan for a neonate in shock (application)

- Early administration of intravenous fluids is needed for shock (20 mL/kg boluses of isotonic crystalloid, to be repeated as necessary).
- Hypoglycemia or hypocalcemia should be corrected if found.
- If sepsis is a concern, blood cultures should be obtained prior to early administration of empiric antibiotics.
- Frequent reassessments should be done to monitor for improvement or worsening of shock. Consideration may be given to escalate to pressors if hypotension persists.
- Stress dose hydrocortisone for refractory shock (e.g., for adrenal crisis) may also be considered.

Interpret signs/symptoms of adrenal hyperplasia and adrenal crisis (evaluation)

- On physical exam, learners may appreciate hyperandrogenism in female infants (enlarged clitoris) and in males (hyperpigmented scrotum). Initial labs would show hypoglycemia, hyponatremia, and hyperkalemia. Administration of fluids, antibiotics, and pressors would not improve symptoms, so learners would need to recognize that hydrocortisone is indicated for adrenal crisis.

Demonstrate intraosseous placement (application)

- Intraosseous lines should be placed in critically ill children when IV access cannot be obtained quickly.
- Learners should be able to voice or show during the case the different sites that intraosseous lines can be placed. For children <6 years of age, placement in the proximal/distal tibia and distal femur are preferred over the humerus.

  - Proximal tibia
  - Distal tibia
  - Distal femur
  - Proximal humerus

Advanced Option: Identify signs/symptoms and treat hyperkalemia (knowledge & application)

- Learners should recognize hyperkalemia can cause arrhythmias.

- Identify peaked T waves on cardiac monitor.

- Management: Discussion with the team about next steps including the need for an ECG. ECG confirmation of peaked T waves indicates symptomatic hyperkalemia. Learners should discuss what medications would be indicated. The most urgent of these is calcium gluconate for cardiac protection. Other medications to lower K include furosemide, insulin and glucose combination, and albuterol. Kayexalate can be considered but is a slower-acting agent.

Optional: Identify and treat ventricular tachycardia (VT) with pulses (knowledge & application)

- As per the PALS algorithm, learners should immediately recognize wide-complex tachycardia.

- If the patient is in ventricular tachycardia with pulses but is unstable, synchronized cardioversion should be done, starting at 0.5-1 J/kg, titrated up to 2 J/kg as needed. If the patient is stable, and the rhythm is regular with monomorphic QRS complexes, a trial of adenosine can be considered or consultation with an expert recommended (e.g., cardiology) prior to the initiation of anti-arrhythmic medications such as procainamide or amiodarone.

Demonstrate focused history taking from a caregiver (application)

- Components of history taking: past medical history, surgical history, family history, medications, allergies, social history, vaccination history. For a neonate, it is especially important to ask about birth history, complications and medical care during pregnancy, results of the newborn screen, and family history related to genetic disorders.

- The differential for a neonate presenting with shock is broad (see above) so a comprehensive review of systems is important. It is important to note that neonates may not demonstrate fever when septic so the absence of infectious symptoms does not exclude septic shock.

Explain diagnosis and management to caregivers (synthesis)

- If personnel are available, one member of the team may stay with the family to gather history and explain interventions. Information should be relayed to the family using layperson's terms. The rationale for interventions such as IO placement should be explained preceding or at the time of occurrence, when possible.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Supporting Files

Lab Results

POC Glucose

LABORATORY TEST	VALUE	UNITS
Glucose	28	mg/dL

Supporting Files

Lab Results

Point of Care VBG/CBG for Standard and Advanced Case (Initial)

LABORATORY TEST	VALUE	UNITS
pH	7.21	
pCO_2	35	mmHg
pO_2	60	mmHg
HCO_3	10	mEq/L
Na	120	mEq/L
K	7.2	mEq/L
Cl	110	mEq/L
Glucose	29	mg/dL
Hct	36	%
Hgb	13	g/dL
Lactate	25	mg/dL
Base excess	-12	mEq/L

Supporting Files

Lab Results

Point of Care VBG/CBG for Standard Case (Post-Treatment with Hydrocortisone)

LABORATORY TEST	VALUE	UNITS
pH	7.30	
pCO_2	37	mmHg
pO_2	100	mmHg
HCO_3	17	mEq/L
Na	128	mEq/L
K	7.0	mEq/L
Cl	110	mEq/L
Glucose	80	mg/dL
Hct	36	%
Hgb	13	g/dL
Lactate	16	mg/dL
Base excess	-6	mEq/L

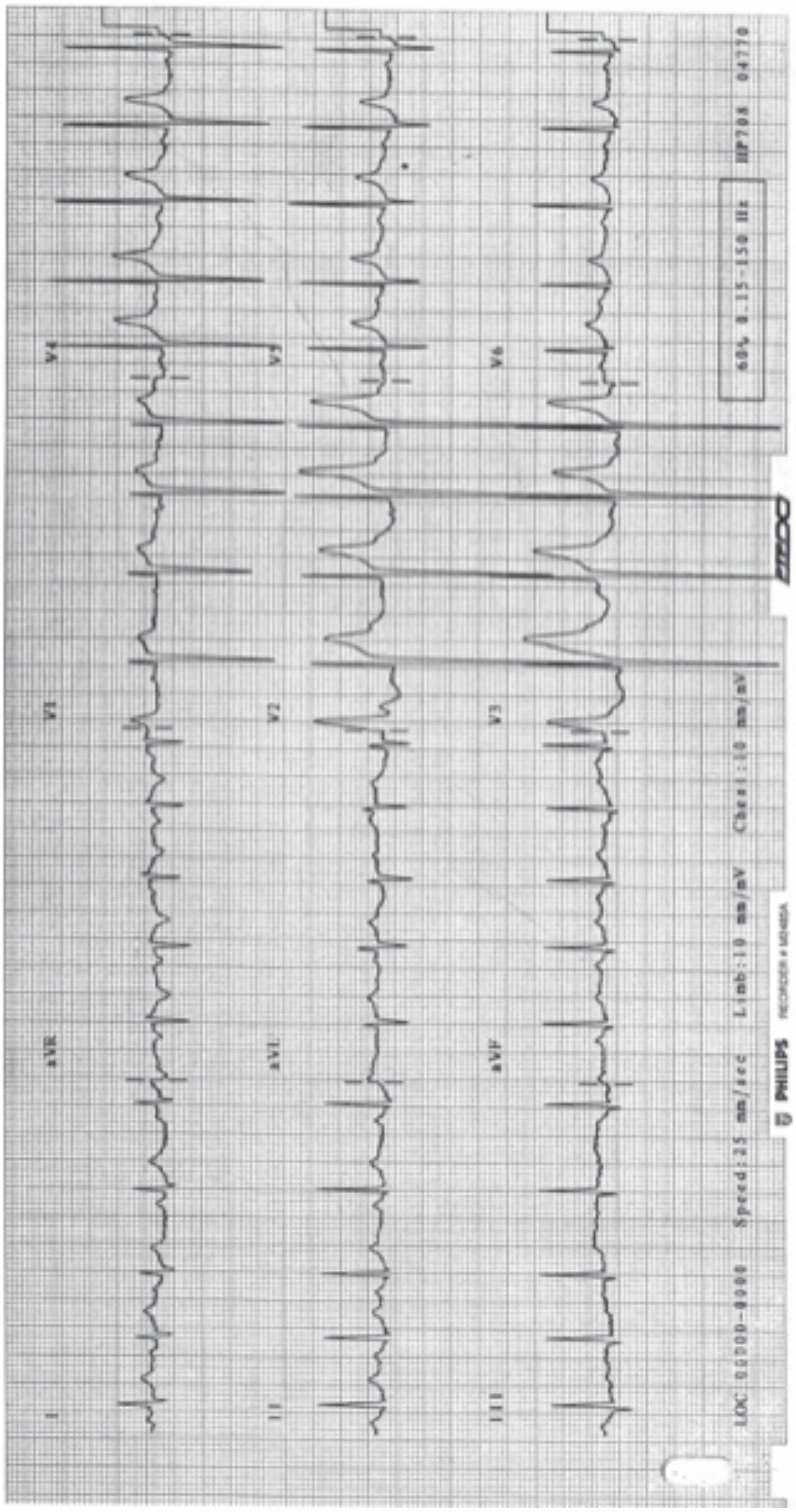
Supporting Files

Lab Results
Point of Care VBG/CBG (Advanced Case)

LABORATORY TEST	VALUE	UNITS
pH	7.30	
pCO_2	35	mmHg
pO_2	100	mmHg
HCO_3	17	mEq/L
Na	129	mEq/L
K	9.5	mEq/L
Cl	110	mEq/L
Glucose	80 (after dextrose)	mg/dL
Hct	36	%
Hgb	13	g/dL
Lactate	25	mg/dL
Base excess	-9	mEq/L

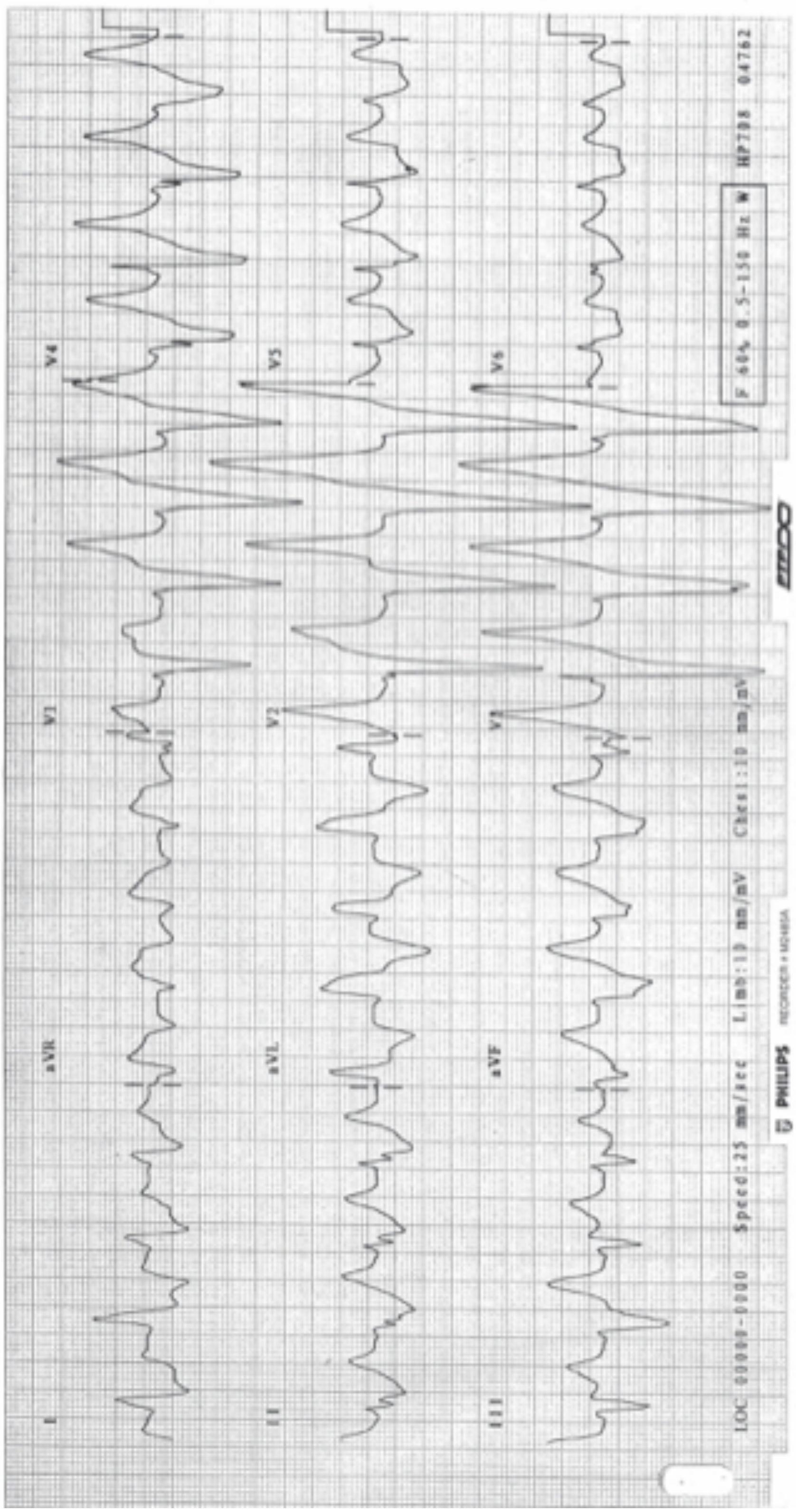
Supporting Files

ECG 1



Supporting Files

ECG 2



Supporting Files

Notes

ECG 1 Interpretation
Normal sinus rhythm. Image from Dr. Andrea Vo.

ECG 2 Interpretation
Normal sinus rhythm with widened QRS complex and peaked T waves. Image from Dr. Andrea Vo.

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant (patient's parent)

Case Background Information

Your son has congenital adrenal hyperplasia (CAH) and is going to be in adrenal crisis by the time he presents to the Emergency Department. This is a genetic condition that makes him unable to make certain types of hormones that are critical for his immune system, blood pressure, and metabolism. Typically this disorder is diagnosed through a screening process that all newborns receive. If not treated promptly, CAH can become life-threatening.

You are bringing him to the Emergency Department because you are worried that he hasn't been eating and just being listless and tired, with no wet diapers in the past 12 hours.

Who are the Learners?

Emergency Medicine residents

This case is specifically aimed at interns who are in their first year of specialty training and may have experience in gathering information from patients and families, and standard medical treatments and procedures. They may be less familiar with escalating medical therapies when first measures are not successful.

Standardized Patient Information

Your son has been increasingly more tired in the past few weeks. Since he was born a few weeks ago, he has never been that vigorous but recently he's been more lethargic. He never regained his birth weight and you have been taking him to the pediatrician for weight checks with the last one about a week ago. Today, he was just exceedingly tired and listless. You just remembered that the pediatrician tried calling you yesterday for something about an abnormal test he had done when he was born, and you tried calling back the pediatrician. However it is of course Sunday so the office was closed.

Your demeanor is frazzled and worried. You do not want to obstruct care but you also have no idea what has been going on and why he is suddenly so tired. You sporadically interrupt them if they are thinking out loud or discussing care with one another to ask questions about his care and what is happening.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT: "He is so tired and has been sleeping so much today."

- AGE: 3 weeks old

- ADDITIONAL HISTORY: You noticed that today your son has been sleeping almost all day. He woke up at 9 AM with a weak cry and was able to nurse for only 3 minutes before falling asleep again. Since he came home with you, you notice that he has been increasingly more tired and sleeping frequently. You have been bringing him into the pediatrician's office in the past 2 weeks because he's never fully regained his birth weight. You have been trying to alternate between breast and formula but he never seems to feed for more than 1 oz at a time. You also note that he has not had a wet diaper since last night (over 12 hours). He seems pale and mottled, and feels cool to you. No medications were given at home. There have been no recent coughs, congestion, vomiting, or diarrhea.

- PAST MEDICAL HISTORY: Born at 40-weeks' gestation. Spent 2 days in the hospital.

- SOCIAL HISTORY: Lives with both parents, no siblings. No pets. No smoke exposure. No travel.

- FAMILY HISTORY: Unremarkable

- PAST SURGICAL HISTORY: None

- MEDICATIONS: None

- ALLERGIES: No known allergies
- IMMUNIZATIONS: Received Hepatitis B vaccine and Vitamin K at birth
- FEEDINGS: Since birth, he has always been a poor feeder and takes less than 1 oz every 2 to 3 hours or stays only 5 min at the breast every 2-3 hours. Since last night, he has been feeding even less, about 1 oz every 4-5 hours or <5 min at the breast every 4-5 hours.
- WET DIAPERS: Only one wet diaper in past 12 hours
- BIRTH HISTORY: Born by spontaneous vaginal delivery at 37 weeks to a 30 yo G1P1 woman. Normal prenatal care, no complications during pregnancy or delivery. Discharged home from hospital on day 2 of life with mom.

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:

- "I don't know what I've been doing wrong. He's never been the greatest eater but today he's just been sleeping all day. I tried waking him up but he would just go back to sleep."
- "We've been taking him to the pediatrician to check his weight but he's just not feeding. We've been trying all different types of formula and breastfeeding."
- "I did receive a phone call from my pediatrician yesterday about an abnormal newborn screen he had done."

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
If they start drilling an intraosseous line without explanation	"What are you doing? Why does this have to be done?"
If they decide to intubate	"Why are you doing that?"
If they give glucose bolus or start pressors	"Did that work?"
If they diagnose him with adrenal crisis	"What's that?"
If they give hydrocortisone	"Why do you need to do that? Is that a steroid?"
If they express concern about peaked T waves and obtain an ECG	"What's going on? Is he going to die??"

Simulation Case 4

Congenital Heart Lesion

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Setup

Chief complaint: Tachypnea, poor feeding
Patient age: 10 days old
Weight: 3.5 kg

Brief Narrative Description of Case

You are working a shift in your Emergency Department (ED) when you hear an overhead announcement that a neonate is being brought in by EMS who is in distress. The nurses turn to you and ask which room to bring the baby into.

The anticipated interventions of the Emergency Medicine (EM) resident are designed to include the ACGME milestones listed by The Emergency Medicine Milestone Project, listed below in **bold**:

1. **Team management (ICS2):** Call for Peds/NICU/CICU help to care for the infant; utilization of TeamSTEPPS (see Debrief section) or other techniques for effective teamwork and communication used by your specific institution

2. **Performance of Focused History and Physical (PC2):** Assess the infant patient

3. **Emergency Stabilization (PC1)** and **Medical Knowledge (MK)**: Escalate care to address to following medical and procedural learning objectives:

4. **Airway Management (PC10):** Respiratory distress and hypoxemia requiring airway support and consideration of broad differential
    - **Pharmacotherapy (PC5), General Approach to Procedures (PC9), and Other Diagnostic and Therapeutic Procedures (PC14):** Closing of ductal dependent lesions that requires emergent opening with prostaglandin E1 (PGE1)
    - **Patient Centered Communication (ICS1):** Effectively and sensitively communicate with the guardian(s) that the infant is critically ill and will be transferred to the NICU or CICU for ongoing evaluation and management

A 10-day-old male who is brought in by EMS for concerns of fast breathing and poor feeding for the past 1-2 days. At first glance, the medical team may suspect an infant with bronchiolitis or sepsis but should soon entertain the diagnosis of a ductal-dependent cardiac lesion.

Overall topics included in this scenario include: Infant resuscitation, diagnosis and management of ductal dependent lesion presentation in infants, effective communication with parents, recognition of a sick child, basic airway maneuvers, including appropriate positioning based on pediatric anatomy, and bag-mask ventilation (BMV).

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Demonstrate early evaluation of a critically ill patient **(application)**
2. Describe signs and symptoms concerning for a ductal dependent cardiac lesion **(comprehension)**
3. Implement a plan to care for an ill infant with likely ductal dependent lesion **(application)**
4. Demonstrate focused history taking from a caregiver **(application)**
5. Explain diagnosis and management to caregivers **(synthesis)**
6. Demonstrate teamwork and closed loop communication **(application)**
7. Organize transfer to a higher level of care where needed resources are available **(synthesis)**

CRITICAL ACTIONS

General

- Elicit a team to help with tasks, specifically: Team lead, monitors and survey, airway, access, labs/medication administration, runner for help
- Acknowledge an ill infant in the ED with possible ductal dependent cardiac lesion and call for stat NICU/CICU/ pediatrics help
- Administer PGE1 and recognize likely complications of its administration

CRITICAL ACTIONS (continued)

- Effectively communicate with consultants
- Deliver the news to the parent that the infant is in critical condition and will be taken or transferred to a Cardiac Intensive Care Unit for ongoing management

Specific Roles

- **Team lead**
    - Assign team roles (monitors and survey, airway, access, labs/medication administration, runner for help).
    - Elicit helper to bring newborn warmer bed (or warm blankets), if not already located in ED bay
    - Instruct airway role to perform maneuvers (i.e., reposition airway, suction, start PPV)
    - Instruct monitors/survey role to apply leads and communicate exam
    - Get more history from the guardian and learn that the infant is eating poorly
    - Given this history, in the setting of an infant in distress and poor perfusion, consider cardiac closing of ductal dependent lesion and administer PGE1. Discuss dosing with pharmacy/NICU/CICU. Recognize risk of apnea with higher dose and consider intubation and mechanical ventilation.
    - Maintain normothermia and euglycemia
    - Treat presumed sepsis with fluids (gingerly) and antibiotics
    - Effectively give consultants (NICU/CICU/pediatrics) a recap of patient presentation and discussion of current concerns
    - Sensitively communicate with the guardian that the infant is critically ill and will be transferred to the Cardiac Intensive Care Unit (CICU) for ongoing management
- **Monitors and survey**
    - Place infant on bed (with radiant warmer if available), and fully expose the patient

CRITICAL ACTIONS (continued)

- Record infant's weight from bed scale (if available), use length-based tools available in your institution, ask guardian last weight
- Place pulse oximeter (pre- and post-ductal)
- Apply cardiac monitors, evaluate pulses, obtain 4-extremity blood pressures
- Place temperature probe
- Report loudly to group their initial impression of the infant

- **Airway**
  - Acknowledge respiratory distress and impending cardiorespiratory failure
  - Comment on patient's respiratory effort and cardiac exam
  - Demonstrate appropriate airway/breathing maneuvers (jaw thrust, chin lift, suction/PPV, CPAP)
- **Access**
  - Place IV or IO
- **Labs/Medication administration**
  - Obtain heel stick blood sugar level
  - Order labs/imaging when requested, including venous point-of-care labs, VBG, lactate, BNP, blood and urine cultures, CBC, CRP, BMP, CXR
  - Order ECG and echocardiogram ("are pending")
  - Administer PGE1, while identifying apnea risk and preparing for potential intubation
  - Administer normal saline
  - Administer antibiotics (ampicillin, gentamicin, acyclovir)
  - Order epinephrine 1:10,000, atropine, fentanyl, rocuronium or vecuronium
- **Runner for help**
  - Call stat NICU/CICU/Peds help
  - Get infant warming materials (bed, chemical mattress, hat, blankets)
  - Call radiology for x-ray if/when requested

Recommended Supplies

- **Manikin/Simulated actor:**
  - Neonate manikin that can be bag-mask ventilated and tolerate chest compressions
  - Simulated patient actor to play laboring mother
- **Moulage:** None
- **Resources:**
  - PALS algorithm, length based tape (e.g., Broselow) or other weight-based equipment, sizing and medication dosing reference
- **Manikin set up:**
  - Grey, lethargic, diaphoretic infant in respiratory distress
- **Equipment:**
  - Infant warmer bed with scale
  - Warm blankets, hat
  - Diaper
  - Monitors: Pulse oximetry, cardiac, temperature, blood pressure cuff
  - Rectal thermometer
  - Heel stick sampling kit, including alcohol wipe, lancet, portable blood sugar level reader
  - Bag valve mask, cardiorespiratory (CR) monitoring including $ETCO_2$, intubation supplies, code cart
  - Suction: Bulb and wall suction (set at 80-100 mmHg)
  - Oxygen source
  - IV/IO access equipment
- **Medications:**
  - Normal saline, epinephrine 1:10,000, prostaglandin (PGE1), atropine, fentanyl, rocuronium or vecuronium, ampicillin, gentamicin, acyclovir

Supporting Files

- Point-of-care labs
- Chest x-ray

Participants/Roles

- **Participants/learners:**
  - Team leader
  - Airway manager

  - Survey physician
  - Medication preparer
  - Medication giver
  - Family liaison/history taker

- **Embedded participant roles:**
  - Bedside nurse: Gets patient on monitor
  - Mom: Provides history
  - EMS: States uneventful transport. Thought heard wheezing, but did not give albuterol because of age. Gave blow-by oxygen for comfort.

Prerequisite Knowledge

- **Faculty**
  - NRP and PALS algorithms
  - General knowledge of emergency medicine
  - Simulation implementation and debriefing experience

- **Emergency medicine residents**
  - Any stage of training
  - Completed a required pediatric rotation in medical school

Case Alternatives

- If the participants do not resuscitate the infant (oxygen, fluids) and give PGE1, the patient decompensates into cardiorespiratory failure and requires cardiopulmonary resuscitation.

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC3. Diagnostic Studies
PC4. Differential Diagnoses and Management
PC5. Pharmacotherapy
PC7. Disposition
PC10. Airway Management
MK. Medical Knowledge
ICS1. Patient Centered Communication
ICS2. Team Management

Resources
1. Weiner GM, et al. Textbook of neonatal resuscitation (NRP). 2019.
2. Wing R. [The neonate in shock: When to think CARDIAC](). Brown Emergency Medicine (blog). 2015.

Initial Presentation

ITEM	FINDING
Overall Appearance	Grey, lethargic infant in distress on resuscitation bed
HPI	A 10-day-old male, who was born full-term via precipitous vaginal delivery, presents to your local hospital. He had been feeding well initially, though taking longer to finish his bottle more recently per mom. Over the past day or two the mom has noticed that he seems to be breathing faster and having difficulty feeding. He last fed <5 minutes prior to the ambulance arriving at the ED. He has had no noted apnea or cyanosis, though mom notes in general his color seems "off." He has not been vomiting. Normal stooling. Slightly fewer wet diapers. No fevers. Given his increased respiratory rate and poor color, mom called an ambulance, because she did not have a ride to the ED.
Past Medical/Surgical History	Full term, precipitous vaginal delivery, normal prenatal/ perinatal care, delivery at 38 6/7 weeks, GBS negative. Birth weight 7 pounds (3.18 kg).
Medications	Unknown
Allergies	Unknown
Family History	No known family history of congenital cardiac lesions
Social History	First infant to this single mother, no other caregivers in home

Stage 1

Begin Simulation (Stage 1 of 4)

Initial Assessment:
Start through assessment of pediatric triangle (color, respiratory effort and tone), followed by A, B, C, Ds

CRITICAL ACTIONS

- Assess ABCs
- Obtain vital signs
- Obtain IV access
- Place on oxygen
- Ask for POC glucose, labs

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 36.5°C, **HR:** 184, **BP:** bilateral upper extremities (BUE) 90/52; unable to obtain in lower extremities), **RR:** 78, **SpO_2:** 93% on room air for BUE; not picking up if probe on LE's
General	Awake infant in respiratory distress
HEENT	Eyes closed
Neck	Floppy/poor tone
Lungs	Airway intact, course throughout, grunting, tachypneic, subcostal and sternal notch retractions
Cardiovascular	Tachycardia, + murmur heard throughout, weak peripheral pulses (especially femoral)

Physical Exam (continued)

ITEM	FINDING
Abdomen	Soft, mildly distended, + hepatomegaly 3 cm below costal margin
Neurological	Moving all extremities, poor tone
Skin	Mottled lower extremities, cool to touch, capillary refill 4-5 seconds in lower extremities
Musculoskeletal	No obvious skeletal abnormalities

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Team takes newborn from nurse, finds and turns on warmer bed, brings neonate to warmer bed	Neonate remains grey with increased work of breathing	
Participants divide into roles		If no roles are delineated in group, nurse demands to know who is in charge.
Team lead delegates nurse to call stat NICU or pediatric consultants		Help is notified and is “en route.”
Patient weighed in warmer bed/scale; monitors applied to patient (pulse oximetry probe, cardiac monitors, temperature monitor, rectal temperature)		Weight: 3.5 kg

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Place on oxygen	SpO_2 does not increase with supplemental oxygen, if the probe is located on the LEs. It increases very slightly if the probe is on UEs.	
Obtain IV access	IV placed on first attempt, if attempted in the UE. Unsuccessful in lower extremities.	
Ask for labs (glucose, CBC, CRP, BMP, blood cx, urine cx, VBG, lactate, BNP)	Glucose 74 mg/dL Other labs pending Proceed to **Stage 2**.	
Call for respiratory backup, pharmacy, X-ray (as is available at your institution)		They are "en route."

Stage 2

Initial Interventions:
Completion of primary assessment through evaluation of chest x-ray

CRITICAL ACTIONS

- Attach ECG monitors
- Interpret POC labs
- Order NS bolus
- Order antibiotics
- Order chest x-ray

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 36.5°C, **HR:** 180, **BP:** 90/50 BUEs and 50/20 or unable to obtain in the BLEs, **RR:** 74, **SpO_2:** 93% on 100% FiO_2 via blow-by or NC, if probe on UEs, or SpO_2 70% if on LEs
Exam Changes	• Continues to have increased work of breathing and prolonged capillary refill with weak pulses • HR unchanged 180s

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Reassessment	Continued increased work of breathing, prolonged capillary refill, and weak pulses	
VBG result available	• pH 7.2 • pCO_2 30 mmHg • HCO_3 15 mEq/L • BE -8	
Order NS IV bolus, 5-10 mL/kg	No change in vital sign parameters if requested on pump or given slowly If fluid bolus is pushed, will see slight improvement in vital signs in lower extremities, if pulse oximetry probe on LE and BP cuff taken on LE. If asked, perfusion slightly better in LE.	Goal for fluid bolus is to increase preload to overcome the obstruction from the coarctation. If concerned about heart failure/cardiac lesion, reasonable to start with 5-10 mL/kg initial bolus to avoid precipitating significant pulmonary edema. Should always reassess. At any point if 20 mL/kg of IV fluid are given, the patient's oxygen saturation will drop to 89%. Increased preload will cause pulmonary edema and increase the liver size. BP will drop in UEs to 80/40.
Order broad spectrum antibiotics (ampicillin, gentamicin, acyclovir)	Antibiotics "being drawn up"	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Place orogastric tube	Successfully placed	
Order chest x-ray	Chest x-ray image provided and notable for cardiomegaly, decreased pulmonary markings, and OG tube in stomach. Proceed to **Stage 3**.	

Stage 3

Initiation of PGE1:
Review of CXR through initiation of PGE1 AND intubation

CRITICAL ACTIONS

- Order prostaglandin (PGE1)
- Request a stat cardiology consult
- Repeat NS IV bolus

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 36.2°C, **HR:** 175, **BP:** 74/36 (BUE), 50/20 (BLE), **RR:** at72, **SpO_2:** 93% on 100% FiO_2 (BUE); saturation reading is intermittent if problem is placed in the LEs because of poor perfusion
Exam Changes	More tired in appearance, grey coloring, poor pulses

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Ask if other labs have returned	CBC • WBC 8.9 x10^3/mm^3 • HgB 15.9 g/dL • Plt 255 x10^3/mm^3 BMP • Na 140 mEq/L • K 3.8 mEq/L • Cl 100 mEq/L • CO_2 16 mEq/L • BUN 40 mg/dL • Cr 1.0 mg/dL • Ca 9.0 mg/dL Lactate: 4.9 mmol/L LFT • ALT 50 U/L • AST 58 U/L • Total Bili 0.4 mg/dL • Direct Bili 0.2 mg/dL • Total Protein 7.0 g/dL • Albumin 4.0 g/dL	
Order prostaglandin (PGE1).	Should start at moderate end of dosing range and gradually increase until improvement in perfusion and BP and SpO_2 after 10-15 min. If start at high end of dose, the patient will develop apnea and flushing.	For any concern for a ductal dependent lesion where the duct closed, start PGE1 at a moderate dose (starting at 0.05 mcg/kg/min) to open it. The top end of range is 0.1 mcg/kg/min. For reference, 0.01 mcg/kg/min is the dose for maintaining a patent duct (like in the delivery room).

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Cardiology, Neonatology, or Pediatrics consulted	Leader should give a comprehensive "one-liner" on the patient that indicates significant concern for patient and requesting expert consultation.	• If verbalizes concern for congenital heart disease and/or ductal-dependent lesion, consultation should give appropriate recommendation for PGE1. • If verbalizes concern for sick neonate and has cardiac lesion on differential, would be appropriate for consult to discuss treatment with PGE1, as well as discussing treatment for other diagnoses on team's differential. • If verbalizes concern for sick neonate but does not have congenital heart disease/ductal dependent lesion on differential, consult should ask team if they have considered that diagnosis.
Repeat NS IV bolus: 5-10 mL/kg	• If prostaglandins started at moderate dose, bolus should result in continued improvement in VS parameters and perfusion. • BP in LE will become more similar to UEs (UEs 80s/40s and LEs 70s/30s)	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
1 minute after PGE1 started	• Patient becomes apneic • SpO_2 quickly goes to <70% if PPV is not initiated • HR decreases to <100 if PPV is not initiated within 30 seconds of becoming apneic	
Team proceeds with BMV	SpO_2 will go back to >93% with 100% FiO_2	
If atropine 0.02 mg/kg given	Increase in HR by 20 bpm from pre-administration HR	Atropine is sometimes given to decrease secretions and blunt vagal response to intubation.
Sedative given for emergent intubation (e.g., fentanyl 1-2 mcg/kg/dose)	No significant vital sign changes	
Paralytic medication given, per institution (e.g., vecuronium 0.1 mg/kg)	Patient becomes apneic and stops any spontaneous movements	Induction of paralysis time will depend on paralytic administered
Intubate with a 3.5 uncuffed ET tube using 0-1 laryngoscope blade to a depth of ~9-10.5 cm at the lip in coordination with medications given: +/-pre-med, sedative, paralytic	Vital signs post intubation: • T: 36.2°C (unchanged from prior) • HR: 150 • BP: 80s/40s UEs and 70s/30s LEs • RR: bagged rate • SpO_2 >93%	• Confirm presence of tube with end tidal CO_2, mist in tube, good chest rise and auscultation. • Repeat chest-xray.
Bedside cardiac ultrasound (if available)	Normal cardiac anatomy; LV function decreased, mitral valve regurgitation jet if color Doppler used.	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Team member updates mom on plan.	Mom verbalizes understanding and thanks team for care of her newborn. Proceed to **Stage 4.**	

Stage 4

Case Conclusion:
After fluid resuscitation and PGE1 administration
and calling for NICU/CICU/Pediatrics help

CRITICAL ACTIONS

- Discussion of patient with NICU and appropriate disposition stated

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 36.2°C, **HR:** 170, **BP:** 80/40 (BUE), 70/30 (BLE), **RR:** 65, **SpO_2:** 95% on 100% FiO_2 upper and lower extremities
Exam Changes	Improvement in perfusion and BP and work of breathing after 10-15 min after initiation of PGE1

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Call NICU/CICU/Peds; full summary given	Consultant accepts patient	Makes recommendation to start patient on PGE1 infusion. Start at low dose initially (0.01 mcg/kg/min), can increase up to 0.05 mcg/kg/min in consultation with NICU/CICU up to max dose of 0.1 mcg/kg/min.

Ideal Scenario Flow

The patient will be brought back to the room. The nurse quickly asks for the physician to evaluate the patient because he doesn't look "well." The patient is noted to be tachypneic and tachycardic, and his color/perfusion is poor. He is awake, but not vigorous. The medical team should initially recognize an ill neonate and have on their differential diagnoses: sepsis, respiratory failure, cardiac disease, and metabolic disorder. On physical examination, they will note a murmur, decreased LE pulses, and hepatosplenomegaly. They should ask for IV access, general labs, a normal saline bolus, and a chest x-ray.

When considering congenital heart disease, the team should ask for an ECG, 4-extremity blood pressure measurements, chest x-ray, and pre- and post-ductal saturations. The team should recognize the potential for a ductal-dependent lesion and call for more assistance, either Cardiology/Neonatology/or Pediatrics, whichever is more likely. Either independently, or after consultation with experts, they should order prostaglandin E (PGE1; alprostadil). Their expert consultation should warn them that apnea is a PGE1 side effect and be ready to support breathing with BMV and intubation if necessary. If the team does not recognize apnea, the patient should go into cardiopulmonary arrest.

Disposition should be to the nearest NICU or CCU/CICU, depending on the discussion with the consultants.

Dosing for PGE1: Start at low dose initially (0.01 mcg/kg/min), can increase up to 0.05 mcg/kg/min in consultation with NICU/CICU up to max dose of 0.1 mcg/kg/min. Note that the team should start PGE1 empirically if there is a strong clinical suspicion for ductal-dependent congenital heart disease based on the initial evaluation. They should anticipate the side effect of apnea and learn that the risk increases with increasing doses of PGE1 infusion. The team should discuss intubation and mechanical ventilation early when ordering and administering PGE1.

Anticipated Management Mistakes

1. **Failure to consider a broad differential, including cardiac etiology:** The patient will decompensate quickly if treated with aggressive fluid resuscitation (>30 mL/kg) and/or do not support airway, breathing, and circulation with PGE1. The differential in a persistently hypoxic newborn is broad and includes: sepsis, persistent pulmonary hypertension, and congenital anomalies (e.g., congenital diaphragmatic hernia, congenital cystic adenomatoid malformation, tracheoesophageal fistula, and congenital cardiovascular anomalies).

2. **Failure to obtain access with IV:** The participants must obtain access to administer PGE1 and resuscitation. If unable to obtain a peripheral IV, must obtain IO access.

3. **Failure to initiate PGE1 or only at the lower dosing range**: Patient will continue to deteriorate.

4. **Initiating PGE1 at higher doses:** This increases the risk of apnea. Team should discuss this and be prepared to intubate.

5. **Fluid resuscitation at 20mL/kg or above will increase preload:** This will result in further cardiac failure and increase pulmonary edema and venous backup into liver, causing further enlargement of liver.

Debriefing Points

Demonstrate early evaluation of a critically ill patient (application)

Learners should approach a sick infant in a standardized fashion. The pediatric triangle and airway, breathing, and circulation should be assessed immediately. Interventions such as airway repositioning/ adjuncts, BMV, and CPR should be started concurrently, if required. After A, B, C have been addressed, the patient should be evaluated for disability and exposed for a thorough head to toe exam, and a blood sugar level should be obtained. Labs/imaging should be ordered and antibiotics and fluids administered in a timely fashion.

Describe signs and symptoms concerning for a ductal dependent cardiac lesion (comprehension)

Learners should recognize the symptoms of poor feeding and poor perfusion in a neonate as evidence of shock and to keep cardiogenic shock from a closing ductus arteriosus at the top of their differential.

Learners should recognize that different blood pressure values obtained pre-ductus arteriosus (usually right upper extremity) and post-ductus arteriosus (reliably the lower extremities) is suggestive of a coarctation.

Implement a plan to care for an ill infant with likely ductal dependent lesion (application)

The learners should promptly assess ABCDEs: Keep airway patent, supplement as appropriate with oxygen, ventilate the patient if necessary, support circulation by administering prostaglandin (PGE1) to reopen a closing ductus arteriosus and administer small fluid boluses with frequent reassessments between interventions, assess for disability, and maintain euglycemia and euthermia.

The learners should also identify appropriate consultants to discuss the case with and determine appropriate disposition based on their local resources.

The learners should also learn to anticipate adverse effects from the medications or interventions that are necessary for the care of an ill infant with a likely ductal-dependent lesion. They should consider interventions to mitigate these effects.

Demonstrate focused history taking from a caregiver (application)

The parental history should be focused during the initial evaluation on possible newborn etiologies of cardio-respiratory failure. Assign a participant to get a thorough history from the mother in a sensitive manner.

Explain diagnosis and management to caregivers (synthesis)

If personnel are available, assign one member of the team to stay with the mother to gather history and explain interventions. Update the mother on the baby's status, interventions that have been done, and what next steps are (admission to the NICU/CICU). Avoid using medical jargon.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The

sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Develop a plan to transfer an infant to a higher level of care where needed resources are available (synthesis)

Give an organized and thorough patient sign-out to the transferring team (NICU/CICU/Peds/transport team). Be specific about the presenting scenario, initial evaluation, labs/imaging obtained, and what interventions were done with an update on how the patient has responded to said interventions.

Supporting Files

Lab Results

Complete Blood Count

LABORATORY TEST	VALUE	UNITS
WBC	8.9 x10^3	/mm^3
Hemoglobin	15.9	g/dL
Platelets	255 x10^3	/mm^3

Supporting Files

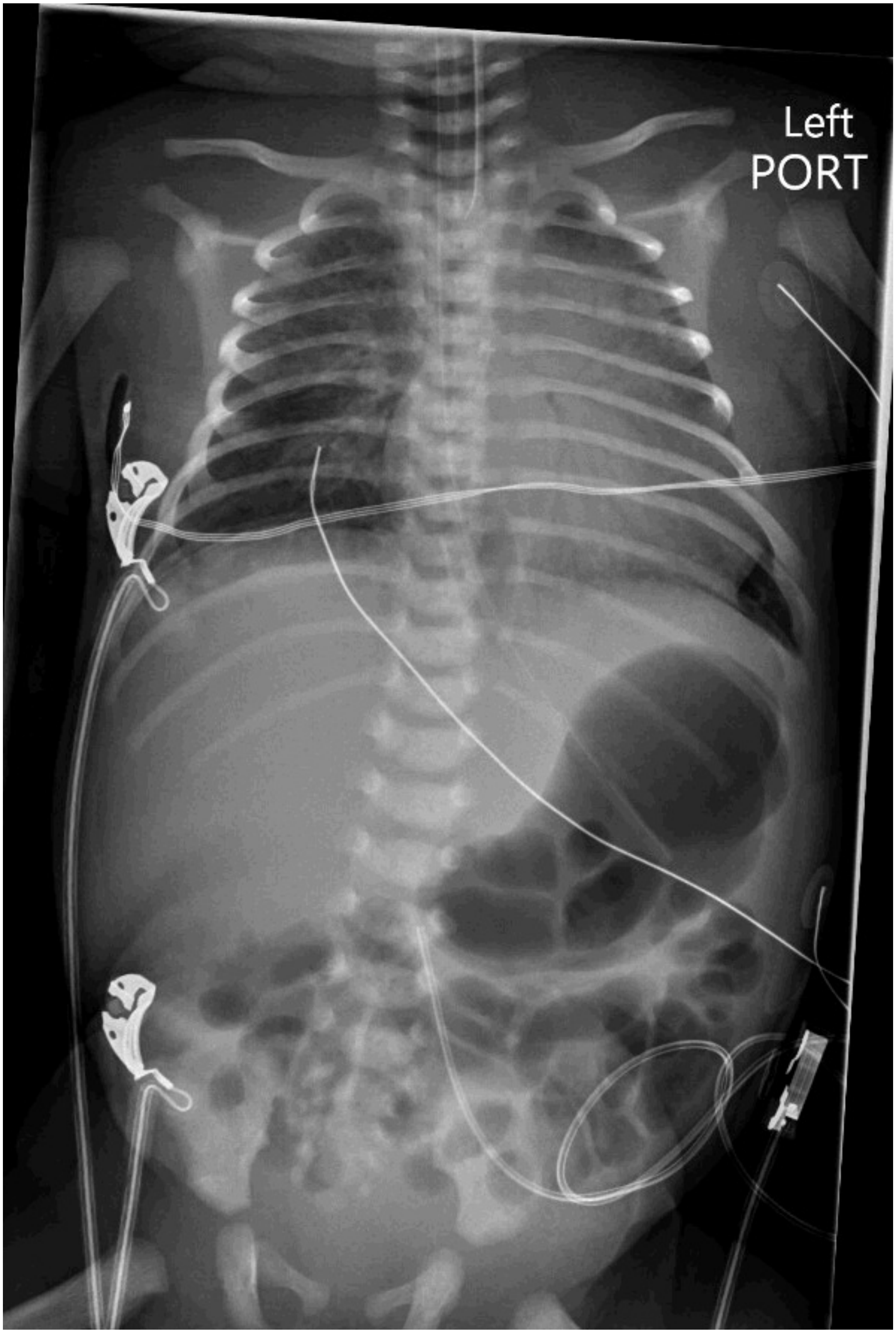
Lab Results
Basic Metabolic Panel and Others

LABORATORY TEST	VALUE	UNITS
Sodium	140	mEq/L
Potassium	3.8	mEq/L
Chloride	100	mEq/L
Bicarbonate	16	mEq/L
BUN	40	mg/dL
Creatinine	1.0	mg/dL
Calcium	9.0	mg/dL
Lactate	4.9	mmol/L
AST	50	U/L
ALT	58	U/L
Total bilirubin	0.4	mg/dL
Direct bilirubin	0.2	mg/dL
Total protein	7.0	g/dL
Albumin	4.0	g/dL

Pending labs
Blood and urine cultures, CRP, BNP, coagulation profile

Supporting Files

Chest x-ray



Supporting Files

Notes

Chest x-ray interpretation

Post intubation film showing orogastric tube, leads, temperature probe, and high-riding ET tube. There are also some patchy opacities in the lung fields and possible cardiomegaly. Image from Dr. Leah Carr.

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant playing the mother of her newborn baby, who is coming in with poor feeding and fast breathing

Case Background Information

The case is a 10-day-old male who is brought in by EMS for concerns of fast breathing and poor feeding for the past 1-2 days. The medical team entertains a broad differential including the diagnosis of a congenital heart lesion (i.e., closing of duct with dependent lesion), metabolic, sepsis, and pulmonary etiologies.

Who are the Learners?

Emergency Medicine interns and residents: They have little prior experience resuscitating babies, but do have significant experience in gathering information from patients and family members.

Standardized Patient Information

Over the past few days your 10-day-old son has been breathing faster and does not want to eat (breast milk or bottle). He last ate for <5 minutes just prior to the ambulance arrival. He seems tired. He has not stopped breathing or turned blue, but his color seems "off" to you. No vomiting, normal stooling, fewer wet diapers (3 per day instead of 6), no fevers. Given his fast breathing and poor color, you called an ambulance because you did not have a ride to the ED.

Meanwhile, the infant is being attended to by the medical team. The baby is grey and mottled with tachypnea. The patient is supported with airway and breathing maneuvers (including supplemental oxygen, positive pressure ventilation, and intubation), fluids, antibiotics, and a medication, PGE1, to treat the cardiac lesion before being signed out to the NICU team.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you? Or "what happened?"): Fast breathing and difficulty with eating.

- AGE: 10 days old

- ADDITIONAL HISTORY: Prenatal care limited to first trimester. You moved and did not find a new OB to get care with. Baby is estimated to be at or near term.

- PAST MEDICAL HISTORY: Ex- full term, precipitous vaginal delivery, normal prenatal/ perinatal care, delivery at 38 6/7 weeks, GBS negative, birth weight 7 pounds

- SOCIAL HISTORY: Lives with 2 parents, first baby

- FAMILY HISTORY: Does not know

- PAST SURGICAL HISTORY: None

- MEDICATIONS: None

- ALLERGIES: No known drug allergies

- IMMUNIZATIONS: Up-to-date

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:

- "How is my baby? I want to hold my baby. Can someone tell me what's going on?"

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
If participants do not recognize that the baby's color is more grey	"Why does his skin color look different?"
If participants do not recognize fast breathing	"Why is he breathing so quickly?"

Simulation Case 5

Diabetic Ketoacidosis

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Setup

Chief complaint: Vomiting and lethargy
Patient age: 8 years
Weight: 30 kg

Brief Narrative Description of Case

The patient's parents brought her in for vomiting, and "tiredness." The whole family has had the flu for the past week and all three children were home from school with fever, myalgias, diarrhea. She had a negative COVID-19 swab at a community testing site yesterday. Her siblings seem to be feeling better, but she hasn't improved yet. She is somnolent, ill-appearing, and severely dehydrated. She is in early hypotensive shock with poor perfusion. Intravenous access attempts will be minimally effective (22g only x 1). She is hyperglycemic, and there is difficulty obtaining additional vascular access. She is hypokalemic (DKA plus diarrhea) and acidotic, which should prompt recognition of DKA with complications.

Management will require IV access (IO), appropriate fluid resuscitation, insulin drip, potassium replacement and admission/transfer.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Describe signs/symptoms of shock in a child **(comprehension)**
2. Demonstrate early evaluation of a critically ill patient **(application)**
3. Interpret signs/symptoms of DKA including hyperglycemia and acidosis **(evaluation)**
4. Construct and implement an initial management plan for a child in DKA **(application)**
5. Consider risks of aggressive fluid administration in the setting of DKA such as cerebral edema **(evaluation)**
6. Manage hypokalemia and hyperglycemia in the setting of insulin administration **(application)**
7. Demonstrate focused history taking from a caregiver **(application)**
8. Effectively communicate diagnosis and management to

caregivers and respond appropriately to their concerns **(synthesis)**

9. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

- Assign/assume team roles
- Obtain brief history from parent
- Place patient on continuous cardiac monitor
- Obtain a point of care glucose
- Establish vascular access – consider IO or ultrasound guided peripheral IV (USGPIV)
- Obtain a venous/capillary blood gas to establish electrolytes/pH level
- Perform focused physical exam/Primary Survey
- Verbalize diagnosis of DKA
- Initiate appropriate fluid resuscitation for severe DKA
- Initiate appropriate medications (insulin, potassium)
- Communicate effectively with PICU +/- Endocrine consultants
- Explain diagnosis to parent(s) and how it relates to the patient's presentation
- Effectively manage anxious family members

Recommended Supplies

- **Manikin:** Any model to reflect age of patient (8 years old)
- **Moulage:** None
- **Resources:** PALS card and/or length-based tape (e.g., Broselow), local DKA pathways/procedures, if applicable
- **Manikin set up:** IV line available x 1 in place with drainage bag
- **Equipment:**
    - Point of care tester (for glucose/VBG/K+)
    - Intraosseous equipment including E-Z IO, needle, stabilizer, and connectors; saline flushes
    - ECG machine
    - Cardiac monitor
    - Continuous oximeter
    - Pediatric airway equipment of various sizes/airway cart

    - Simple facemask
    - Non-rebreather
    - Nasal cannula
    - Oxygen tubing
    - Suction
- **Medications:** normal saline, IV insulin, sodium bicarbonate, mannitol, hypertonic saline, ondansetron (ODT or IV), D10 ½ NS (optional)

Supporting Files

- Point-of-care labs (VBG/CBG, glucose, electrolytes)
- First ECG showing sinus tachycardia with signs of hypokalemia
- Second ECG (if insulin started without checking/giving potassium) showing Torsades de Pointes

Participants/Roles

- Participants/Learners:
    - Team Leader
    - Airway Manager
    - Survey Physician
    - Bedside RN
    - Medication Preparer
    - Medication Giver
    - +/- Family Liaison
    - Consultant (PICU or Endocrine)
- Embedded participants can play a nurse, respiratory therapist, or tech.
- Standardized patient (actor or faculty) to play patient's parent

** Team roles may need to be adjusted in order to suit local practices and norms*

Prerequisite Knowledge

- **Faculty**
    - PALS protocols
    - General knowledge of emergency medicine
    - Simulation implementation and debriefing experience

- **Emergency medicine residents**
  - Any stage of training (PGY-1,2 for basic case, PGY3+ advanced case)
  - Completed PALS certification

Case Alternatives

- If residents fail to recognize DKA within 5 minutes of the case (e.g., gives normal saline boluses, +/- administers antibiotics, +/- gives pressors), the patient will become more lethargic (cerebral edema) and will need emergent airway management.

- If intubation is performed, the patient will become more acidotic and hypotensive.

- For advanced learners, the initial ECG will show u-waves and a wide QRS. If this is not recognized, the patient will develop torsades (and ultimately ventricular tachycardia if not recognized). (See **Stage 2**)

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC3. Diagnostic Studies
PC4. Differential Diagnoses and Management
PC5. Pharmacotherapy
PC9. General Approach to Procedures
PC14. Vascular Access
PC15. Medical Knowledge
ICS1. Patient Centered Communication
ICS2. Team Management

Resources
1. Kuppermann N, Ghetti S, Schunk JE, et al. Clinical Trial of Fluid Infusion Rates for Pediatric Diabetic Ketoacidosis. N Engl J Med. 2018;378:2275-2287. PMID 29897851
2. Wolfsdorf J, Glaser N, Sperling MA. Diabetic ketoacidosis in infants, children, and adolescents: A consensus statement from the American Diabetes Association. Diabetes Care. 2006;29:1150-1159. PMID 16644656
3. Wolfsdorf J, Craig ME, Daneman D, et al. Diabetic ketoacidosis. Pediatr Diabetes. 2007;8(1):28-43. PMID 17341289

Initial Presentation

ITEM	FINDING
Overall Appearance	An 8-year-old girl is laying on her bed. Her very anxious mother is at her bedside. She is awake and answering questions appropriately but is clearly miserable, clutching her vomit bag and complaining that her stomach hurts. She has tacky mucous membranes. Note: If using a low fidelity mannequin, the team is to refer to the facilitator. If using a high-fidelity mannequin, the team is to refer directly to the mannequin for feedback.
HPI	The patient is volunteering very little; she is mostly complaining of generalized abdominal pain (although unable to help pinpoint a specific location for the pain) and anxious about vomiting – although she doesn't while the medical team is bedside. The mother has limited medical knowledge – and is very anxious that her child will need surgery as she had a friend whose child recently needed stomach surgery. The vomiting and nausea are upsetting her tremendously. Mom will voluntarily share history that the entire family had a cold last week, and everyone improved except the patient who seems worse. Any other history needs to be elicited – and mom will respond to the best of her abilities. She is anxious to help. **If the learners ask for specifics:** Mom will be unclear if she is drinking or peeing more (she just isn't sure) - but definitely thinks she has lost weight – although mom is convinced this is due to the vomiting and diarrhea (both of which are non-bloody and vomiting is non-bilious, if asked). No recent travel.

Initial Presentation (continued)

ITEM	FINDING
Past Medical/Surgical History	None
Medications	No chronic daily medications – mom has given her daily ibuprofen and cough syrup for her "flu" over the last few days
Allergies	None
Family History	None – If ever specifically asked, mom comments that maternal grandmother has problems with her sugars
Social History	No pets No smokers 2 siblings and 2 parents at home

Stage 1

Begin Simulation (Stage 1 of 3)

Hyperglycemia (initial recognition):
Evaluation to identification of DKA

CRITICAL ACTIONS

- **Team leader assigns tasks**
- **Obtains brief history from parent**
- **Performs primary survey**
- **Request patient placement on continuous cardiac monitor**
- **Performs focused physical exam**
- **Verbalizes recognition of shock**
- **Obtains point-of-care glucose (high)**
- **Obtains vascular access**
- IO or ultrasound-guided peripheral IV preferred, if peripheral access is unsuccessful
- **Verbalizes recognition of hyperglycemia**
- **Obtains point-of-care VBG/CBG and electrolytes (abnormal)- if extended electrolytes are ordered (Mg+, PO4-, they are not available during case)**
- **Verbalizes hypokalemia on POC testing OR obtains ECG showing hypokalemia-related changes**
- **Discusses progress/plan of care with the family**

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 98.5°F, **HR:** 130, **BP:** 90/60, **RR:** 35, **SpO_2:** 99% on RA, **Wt:** 30 kg
General	Tired appearing, but arousable and alert and oriented x 3. If residents specifically ask, there is a fruity odor to her breath.
HEENT	Unremarkable except tacky mucous membranes. Eyes are normal and not sunken.
Neck	Unremarkable – no stiffness
Lungs	Clear – but if residents ask, there is Kussmaul breathing (deep rapid breathing) – (Some manikins can do this)
Cardiovascular	Tachycardia only, no muffled heart sounds
Abdomen	Non-distended, patient complains of overall discomfort but no point tenderness
Back	No CVA tenderness
Neurological	Alert and oriented, but very tired. GCS 14, otherwise normal exam
Skin	Dry with cool extremities, capillary refill is delayed 4 seconds No edema

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Placed on monitors	Vitals are displayed on monitors	Failure to do so within 5 minutes will result in rapid deterioration of patient down cerebral edema pathway
Team attempts/asks for intravenous line x 2	Initial attempt results in one 22G peripheral IV	If residents fail to get second access, patient's mental status will start to deteriorate
IV fluid bolus (normal saline 10-20 mL/kg)	Bolus started	Residents will initially order bolus of 20 mL/kg but reduce to 10 mL/kg over first hour after getting blood glucose level Practice variation exists with management of DKA (fluid quantities and rates, insulin drip dosing). Learners should follow local standards and practices.
POC glucose obtained	Result will be 392 mg/dL– should prompt residents to immediately consider DKA. An elevated blood glucose level should prompt discussion to either decrease the IVF rate (to 10 ml/kg) vs keep same (* point for discussion in debrief based on new and old studies- still controversial)	If no POC glucose ordered, RN prompt "Do you want any POC tests?"

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Asks for IVF to be adjusted to 10 mL/kg following glucose result	Fluid volume will be adjusted	Nursing staff can prompt with question, “Do you need me to adjust the fluid rate at all?” Mom will ask why fluid rate was adjusted and Resident will mention that there is a potential for risk of cerebral edema. Mom will be content with this answer If learners do not decrease fluid rate, the patient will still be fine, but can bring up as a point of discussion the different management options and the controversial nature of the subject.
VBG	pH 7.04 pCO_2 14 mmHg pO_2 40 mmHg O_2 sat 75% BE -24 mEq/L	
POC serum electrolytes (K+)	Potassium level is 3.1 mEq/L	If learners don’t order POC potassium, the lab will result during **Stage 2**.
Urine ketones		Learners are told the urine will be collected with the next void.

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
CBC ordered		Learners are told results will be available in the standard time for site. They may order antibiotics.
Insulin ordered (0.05-0.1 U/kg/hr)		When insulin is ordered, RN should prompt with, "it will take a couple of minutes to come from pharmacy." If no POC K+ has been ordered, RN verbalizes need to hold insulin until potassium resulted. Should residents fail to check potassium, can consider ECG changes on monitor (torsades de pointes) and prompt that pathway after insulin started.
ECG ordered after POC labs checked	ECG #1 provided (sinus tachycardia with signs of hypokalemia)	
Ondansetron ordered	Medication is given, and this provides patient and mom with a lot of comfort	Consideration of hypokalemia already and potential for prolonged QTc
If learners do not verbally identify DKA in first 10 minutes	Increase BP from 90/60 to 150/100 and HR will drop to 80	Cerebral edema will occur if delay in case progression

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Patient intubated	If intubated, patient will deteriorate with HR increasing to 150, BP dropping to 70/50, and new VBG/CBG will be 6.9/25/2	
Team member states concern for DKA and summarizes next steps	Proceed to **Stage 2**.	If this does not occur by 10 minutes, RN asks, "What do we think is happening?"

Stage 2

DKA Stabilization:
Identification of DKA through start of insulin drip and IV fluids

CRITICAL ACTIONS

- **Verbalize recognition of DKA, complicated by hypokalemia**
- **Administer 10 mL/kg normal saline for moderate dehydration**
- **Reassess perfusion status following initial bolus**
- **Reassess mental status following initial bolus**
- **Reassess glucose level following initial bolus**
- Begins IV insulin AFTER saline bolus is completed (0.05-0.1 units/kg/hour)
- **Begins IV potassium for K<3.5 mEq/L (0.5 mEq/kg over 1 hour) – can be given peripherally as bolus**

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 98.5°F, **HR:** 121, **BP:** 98/70, **RR:** 28, **SpO_2:** 98%
Exam Changes	• No significant changes to exam – including neurological status • Capillary refill remains prolonged, but not worsening

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Potassium bolus ordered (0.5 mEq/kg over 1 hour)	Infusion	Potassium bolus should be ordered either as a bolus or in the 2-bag system IVF. If not given prior to or in conjunction with starting insulin, Torsades should develop.
Participants formulate a broad differential: 10 minutes after insulin infusion ordered	Insulin arrives from pharmacy and infusion started. Proceed to **Stage 3**.	If the participants do not come up with at least 5 life threatening etiologies on their differential, the nurse can say "What else could this be?" Attending can intervene and guide with thoughtful and intentional questions if the participants go off track.
Initial 10 mL/kg bolus completed	Capillary refill normalizes No prolonged cap refill. Defer 2nd bolus. Start maintenance IVF + K.	Practice patterns vary here: **Option 1:** Insulin infusion started with second NS bolus of 10 mL/kg **Option 2:** Insulin infusion started with 2-bag system containing potassium

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Maintenance fluids ordered	RN or tech obtains an ECG. Participants will be shown ECG immediately after completion.	If no comment about additional IVF, RN may prompt with "That first bolus is done, do you want any more?" Example: 1.5 x mIVF + 0.5 mEq/kg mEq KCl See **Stage 3** regarding 2-bag system.
If no K+ ordered as bolus or in maintenance fluids	K+ levels drop significantly to K 1.5 mEq/L, and torsades will ensue.	Management of torsades with a pulse: • Cardioversion with a "K-run"- 1 mEq/kg of K to quickly improve K level is required • Once K run is completed, K level increase to 2.5 mEq/L and cardioversion completed- patient will return to sinus.
PICU consult and/or Endocrine Consult	The PICU team agrees to open up a bed but asks the ED to manage for the next hour or two. Proceed to **Stage 3**.	

Stage 3

Case conclusion and disposition:
Time 1 hour after arrival through reassessment (physical exam and labs)

CRITICAL ACTIONS

- **Verbalize need for repeat neuro checks for cerebral edema evaluation**
- **Verbalize need for q 2 hour electrolyte/glucose monitoring**
- **Orders VBG + electrolytes STAT if worse in any way**
- **Explains diagnosis to parent and how it relates to the patient presentation**
- Consults PICU and/or Endocrine for admission (if not done in Stage 2)

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 98.2°F, **HR:** 111, **BP:** 110/88, **RR:** 22, **SpO$_2$:** 99%
Exam Changes	The patient remains alert and oriented. She still has not urinated. Her cap refill is now <3 sec.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
TIME ADVANCE Instructors: please state "time has advanced 1 hour since the patient arrived at the ED." Repeat neurological exam	Mental status improving	
Repeat blood glucose	POC glucose 300 mg/dL	
If a second NS bolus was ordered		RN prompt "Second bolus completed"
Adjust IVF (2-bag method) – Start the 2-bag method based on the POC glucose obtained now at 300 mg/dL	Discuss 2-bag method of management (details of this discussion are outlined in the debriefing points below) **Two-bag method for DKA management:** Given her body weight of 30 kg – • Maintenance IVF rate is 70 mL/kg/hr • 1.5x maintenance IVF rate is 105 mL/hr Because the patient's blood glucose is 300 mg/dL, the 2-bag method would warrant: • **Bag 1:** NS at 1.5x maintenance x 75%) = 79 mL/hr of Bag 1 • **Bag 2:** D10 NS at 1.5x maintenance x 25%) = 26 mL/hr of Bag 2	**NOTE:** Practice points differ between various centers. You may use your local centre practice and protocols.

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Repeat VBG/CBG + electrolytes are completed 1 hour post arrival to ED		pH 7.10 pCO_2 17 mm Hg pO_2 40 mmHg O_2 sat 75% BE -18 mEq/L Glu 300 mg/dL Na 133 mEq/L K 3.3 mEq/L (if K was replaced) Cl 112 mEq/L
Discussion with mother about DKA, expectations, admission needs, and immediate management plan	Mom will be appropriately anxious and continues to have poor understanding; NOT aggressive or difficult	

Ideal Scenario Flow

The learners enter the room to find a patient who is dry, uncomfortable, and tired appearing – she is mildly somnolent but fully arousable. They immediately place the patient on a bedside monitor and recognize that the patient is in early hypovolemic shock. Access needs to be obtained and might be difficult; the residents can place an IO and an IV fluid bolus should be ordered. Initial blood work should also be ordered at this time – including point of care glucose – the result of which should immediately prompt the residents to move down the DKA management pathway. After completing a physical examination and obtaining an appropriate history, the learners should note that the patient appears to be worsening – her blood pressure has decreased slightly and remains tachycardic. At this point they discuss the risk of cerebral edema with aggressive fluid management. Patient's perfusion status remains stable and BP is still above 5% for her age range so conservative management should continue. Insulin is ordered and potassium is measured. Potassium returns 3.1 mEq/L, which should prompt the learners to recognize the need to give potassium (either as a bolus or incorporated into maintenance fluid) prior to the initiation of the insulin drip (regardless of whether they additional IVF). Patient remains stable and starts to hemodynamically improve as the second bolus starts. No signs of cerebral edema are noted on 1 hr neuro check. She is admitted to ICU, the endocrine team is consulted and will follow the patient in the unit. Prior to the end of the case, DKA diagnosis is explained to the patient and her mother, and DKA education is started.

Anticipated Management Mistakes

1. **Inadequate IV access:** Learners may be hesitant to perform IO/ultrasound-guided peripheral IV (USGPIV) access. Some may be unfamiliar with it or may be concerned that it is painful or frightening for parents to watch. However, with need for IVF, IV insulin, and potassium, access is critical. Furthermore, in critically ill patients, anticipating a need for access is crucial. While IO access and USGPIV are becoming more mainstream, it may be helpful to have a nurse prompt with "we do this all the time". If learners fail to recognize how ill the child is, a nurse may prompt with "she seems pretty sick, I worry she may get worse quickly."

2. **Intubation of a patient in DKA:** It would be unlikely in a patient with a fairly normal mental status for intubation to be considered. However, some learners may bring an element of simulation artifact ("it is sim so this is going to go downhill fast") to the case. In this scenario, intubation leads to worsening acidosis, and PEA requiring CPR and epinephrine. If the conversation heads toward intubation, it may be helpful to discuss the risk/benefit of intubation in an acidotic patient who is relying on respiratory compensation. It is actually quite dangerous to intubate a patient such as this unless the patient is severely obtunded and not maintaining respiratory effort or protecting their airway. It is very hard to be able to compensate as well as the patient can with a ventilator.

3. **Excessive fluid resuscitation:** Some of our learners may provide aggressive fluid resuscitation in an attempt to normalize heart rate and blood pressure. Concerns for cerebral edema increase with aggressive fluid management. This however, is controversial. Please refer to the Kuppermann et al. trial as a point of discussion.

Debriefing Points

Describe signs/symptoms of shock in a child (comprehension)

Shock is the state where blood flow to tissues/organs flow does not adequately meet the demand. Children are more susceptible to cardiovascular compromise from shock because of both physiologic differences (compared with adults) and their limited reserve.

- In general, hypotension is a late finding in pediatric shock. Assessment of perfusion status (e.g., capillary refill) may give an early indication: delayed capillary refill suggests “cold shock” (cardiovascular or hypovolemic source) and very brisk capillary refill suggests “warm shock” (e.g., anaphylactic or distributive etiology)
- Another early sign of shock in children is tachycardia and decreased capillary refill, compared to a low blood pressure.

Demonstrate early evaluation of a critically ill patient (application)

In general, the evaluation of a critically ill child requires quick assessment of the pediatric triangle (appearance, breathing, color) in conjunction with the primary survey with an emphasis on the clinical status

- **Appearance:** Mental status, level of arousal, and changes in speech/cry
- **Work of breathing:** Note presence of abnormal breath sounds, retractions, nasal flaring, grunting, apnea
- **Circulation to skin:** Note presence of pallor, delayed capillary refill, mottling, cyanosis

Primary survey:

- **Airway:** Does the patient have a patent airway?
- **Breathing:** Auscultate for bilateral breath sounds
- **Circulation:** Assess for presence/absence of pulses and degree of peripheral perfusion, cardiac sounds, liver distension
- **Disability:** Report Glasgow Coma Scale, examine pupils, D * for dextrose
- **Exposure**: Allow for adequate visualization of the patient

Interpret signs/symptoms and laboratory changes of DKA including hyperglycemia and acidosis (evaluation)

- Hyperglycemia >200 mg/dL
- Acidosis: Venous pH <7.3 or HCO_3- <15 mEq/L
- Glucose and Ketones in urine or ketonemia (BOHB >1 mmol/L)
    - Mild DKA (pH: 7.2-7.3) (HCO_3-: 10-14 mEq/L)
    - Moderate DKA (pH: 7.1-7.2) (HCO_3: 5-9 mEq/L)
    - Severe DKA (pH: <7.1) (HCO_3-: <5 mEq/L)

Construct and implement an initial management plan for a child in DKA (application)

- The initial step in DKA treatment is assessment of dehydration status, weight, and mental status.
- The second step in DKA treatment involves blood testing.
    - Point of Care (POC) tests:
        - Blood glucose level
        - Blood beta-hydroxybutyrate (may not be available POC in all locations)
        - Urine ketones (may be found on urine dipstick)
    - Lab testing:
        - Blood glucose level (for more accurate values)
        - Serum electrolytes (including bicarbonate – allows for anion gap calculation)
        - BUN/creatinine
        - Complete blood count
        - pH/pCO_2
        - Calcium, phosphorous, magnesium
- The third step includes medications:
    - Saline (see detailed discussion below)
    - Insulin
    - +/- Potassium
    - +/- D10
    - Avoidance of bicarbonate (lack of benefit and potential for harm)

Consider risks of aggressive fluid administration in the setting of DKA such as cerebral edema (evaluation)

Cerebral injury (or cerebral edema) is rare. Its clinically significant incidence is between 0.3-0.9% of episodes in children with DKA.

(Many or most others with DKA will have subclinical cerebral edema without neurological signs). It is more common in children with DKA than adults, and those with the most severe DKA are at highest risk for the cerebral complications. It may be present prior to DKA treatment or during it (between 3-12 hours after treatment begins). The cause is not completely understood. Early work thought it may be the rate of fluid administration but this is being challenged with current lines of research.

"Clinical Trial of Fluid Infusion Rates for Pediatric Diabetic Ketoacidosis": June 14, 2018 -- N Engl J Med 2018; 378:2275-2287 (DOI: 10.1056/NEJMoa1716816)

- Risk factors for cerebral injury in DKA:
  - Severely acidotic on original presentation
  - High BUN on presentation (suggests greater hypovolemia)
  - Low pCO_2
  - Insufficient rise of sodium level when DKA treatment starts
  - Younger age (<3-5 yrs old) on presentation (because diagnosis is often delayed)

- Identifying cerebral edema (cerebral edema risk tool):
  - Positive if any of the following:
    - 1 diagnostic criteria
      - Abnormal verbal or motor response to pain
      - Posturing (decorticate or decerebrate)
      - Double vision or cranial nerve palsy (III, IV, VI)
      - Abnormal respiratory pattern (Cheyne-Stokes, apnea, grunting, tachypnea)
    - 2 major criteria
      - Age-inappropriate incontinence
      - Abnormal, fluctuating or declining mental status after therapy begins (including agitation)
      - Abnormal heart rate sowing (declining by more than 20 beats) that is not explained by sleep or improved intravascular volume status
    - 1 major (above) plus 2 minor criteria (minor criteria listed below)
      - Vomiting*
      - Headache*
      - Lethargy or irritability*
      - Elevated blood pressure (e.g., diastolic BP >90 mmHg)

        - *Especially if begins/resumes after DKA treatment initiated
      - 1 major plus 1 minor criteria (if age <5 years old)

- Management of cerebral edema: Treatment should begin as soon as cerebral edema is suspected.
    - Treat increased ICP:
        - Avoid drugs that increase ICP
        - Elevate head of the bed 30 degrees
        - Hyperosmolar therapy:
            - First line treatment: Mannitol 0.5-1g/kg IV over 10-15 minutes. May repeat in 30 minutes.
            - Second line treatment: Hypertonic saline 2.5-5 mL/kg over 30 minutes
        - Neurosurgery consult for possible ICP measuring
    - General Principles:
        - IV saline to improve intravascular compromise
        - 10-20 mL/kg normal saline or lactated ringers
        - Ensure adequate airway and assist ventilation as needed
        - Supplemental oxygen as needed to maintain a normal O_2 level
        - Avoid intubation if possible
        - If intubation is necessary, hyperventilate to maintain the pCO_2 they had before they decompensated. Reduce this over several hours.

Manage hypokalemia and hyperglycemia with potential of hypoglycemia in the setting of insulin administration (application)

Patients in severe DKA may also need supplemental IV potassium. Since the goal of insulin administration is closure of the anion gap, supplemental dextrose may be needed when the serum glucose level falls below 250.

When adding dextrose for glucose <250 mg/dL, you may use the "2-bag method".

- First, calculate the maintenance rate using the standard formula:
    - 4 mL/kg/hr for the first 10 kg body weight
    - 2 mL/kg/hr for the second 10 kg body weight
    - 1 mL/kg/hr for the remaining weight
    - In this case (pt weighs 30 kg): 70 mL/hr

- Second, multiply this by 1.5x.
    - In this case: 105 mL/hour
- Finally, determine which percentage of which bag to give.

- **Two-Bag Method of IV Fluids in Hypoglycemia**

Supplies

- 1 bag normal saline
- 1 bag D10 NS
- 1 bag D12.5 NS
- PRN dextrose

SCENARIO	IV FLUID BAG(S)
If blood glucose is **>300** mg/dL	1 bag • NS at 1.5x maintenance
If blood glucose is **251-300** mg/dL	2 bags • Bag 1: NS at 1.5x maintenance x 75% • Bag 2: D10 NS at 1.5x maintenance x 25%
If blood glucose is **201-250** mg/dL	2 bags • Bag 1: NS at 1.5x maintenance x 50% • Bag 2: D10 NS at 1.5x maintenance x 50%
If blood glucose is **151-200** mg/dL	2 bags • Bag 1: NS at 1.5x maintenance x 25% • Bag 2: D10 NS at 1.5x maintenance x 75%
If blood glucose is **<150** mg/dL	1 bag • D10 NS at 1.5x maintenance x 100% o Stop normal saline infusion o Order D12.5 to have available o Contact Endocrinology team
If blood glucose is **<100** mg/dL	1 bag • Bag 1: D12.5 NS at 1.5x maintenance x 100% o Hold insulin drip for 30 minutes until blood glucose is >150 mg/dL o Contact Endocrinology team

If blood glucose is **<70** mg/dL	1 bag • Bag 1: D12.5 NS at rate (mL/hr) x 100% • Administer supplemental dextrose as bolus • Contact Endocrinology team

- **Hypokalemia in the setting of DKA**

Hypokalemia on presentation signifies a profound total potassium deficit. Caution with IV insulin and bicarbonate therapy is warranted, because it could further drop the potassium levels. Davis et al. 2016 presented a case of profound hypokalemia associated with DKA (Pediatr Diabetes Feb; 17 (1): 61-65). In this case, the patient's potassium level was 1.3 mEq/L. 0.3 mEq/kg KCl over 1 hour was initiated and insulin held until potassium level was 2.7 mEq/L.They reported that their institution had a policy which prevented them from giving a more aggressive replenishment of 0.5 mEq/kg over an hour potassium via a peripheral line. They opted to avoid risks associated with central line placements. Additionally, 30 mEq/L potassium acetate and 30 mEq/L potassium phosphate were given at 1.5X maintenance.

PFCCS (Pediatric Fundamental Critical Care Support) recommends a conservative IV potassium replacements regimen:

- If **K+ 3.0-3.5 mEq/L**, administer 0.25 mEq/kg KCL over 1 hour.
- If **K+ 2.5-3.0 mEq/L**, administer 0.5 mEq/kg over 2 hours.
- If **K+ <2.5 mEq/L**, administer 0.75 mEq/kg over 3 hours, with checking of the K level half-way through this infusion.

Demonstrate focused history taking from a caregiver (application)

Evaluation of a critically ill child should include obtaining a history from all possible sources including EMS, old records (if time), and especially caregivers. Paying attention to details such as trauma or recent illness may give hints toward identifying the underlying pathophysiology. A history of polyuria, polydipsia, increased hunger and weight loss may suggest undiagnosed diabetes. Children may present with DKA after a mild illness so a review of systems should also include evaluation for infection symptoms.

Effectively communicate diagnosis and management to caregivers and respond appropriately to their concerns (synthesis)

Compassionate, understandable communication with caregivers is critical, as they are strong partners in the treatment of their children. This should not impede lifesaving treatment, but if at all possible, a member of the treatment staff should be assigned to help communicate with parents. Failure to provide a communication liaison may result in anxious parents that may obstruct care. When not actively resuscitating (as in this case), the physician should be able to communicate with patients throughout the child's care. For complicated concepts, like DKA, it is important to ensure the caregivers understand the explanations being given to them.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example:

Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Supporting Files

Lab Results

Initial Point of Care Testing

LABORATORY TEST	VALUE	UNITS
Glucose	392	mg/dL
Beta-hydroxybutyrate	8	mmol/L
Urine dipstick	No urine yet	

Supporting Files

Lab Results

CBG/VBG Initial

LABORATORY TEST	VALUE	UNITS
pH	7.04	
pCO_2	14	mmHg
pO_2	40	mmHg
O_2 sat	75	%
BE	-24	mEq/L
Potassium	3.1	mEq/L

Supporting Files

Lab Results
Complete Blood Count

LABORATORY TEST	VALUE	UNITS
WBC	13.0×10^3	$/mm^3$
Hematocrit	38	%
Platelets	320×10^3	$/mm^3$

Supporting Files

Lab Results

Basic Metabolic Panel and Others

LABORATORY TEST	VALUE	UNITS
Sodium	132	mEq/L
Potassium	3.1	mEq/L
Chloride	108	mEq/L
Bicarbonate	4	mEq/L
BUN	18	mg/dL
Creatinine	0.9	mg/dL
Glucose	392	mg/dL
Anion Gap	20	mEq/L
Albumin	3.5	g/dL
Calcium	9.2	mg/dL
Magnesium	2.0	mg/dL
Phosphorus	4.2	mEq/L

Supporting Files

Lab Results

CBG/VBG if intubated

LABORATORY TEST	VALUE	UNITS
pH	6.9	
pCO_2	25	mmHg
pO_2	60 (VBG), 100 (CBG)	mmHg
O_2 sat	80% (VBG), 100% (CBG) Poor perfusion	%

Supporting Files

Lab Results

Subsequent Point of Care Testing after 1 Hour of Treatment

LABORATORY TEST	VALUE	UNITS
Glucose	300	mg/dL

Supporting Files

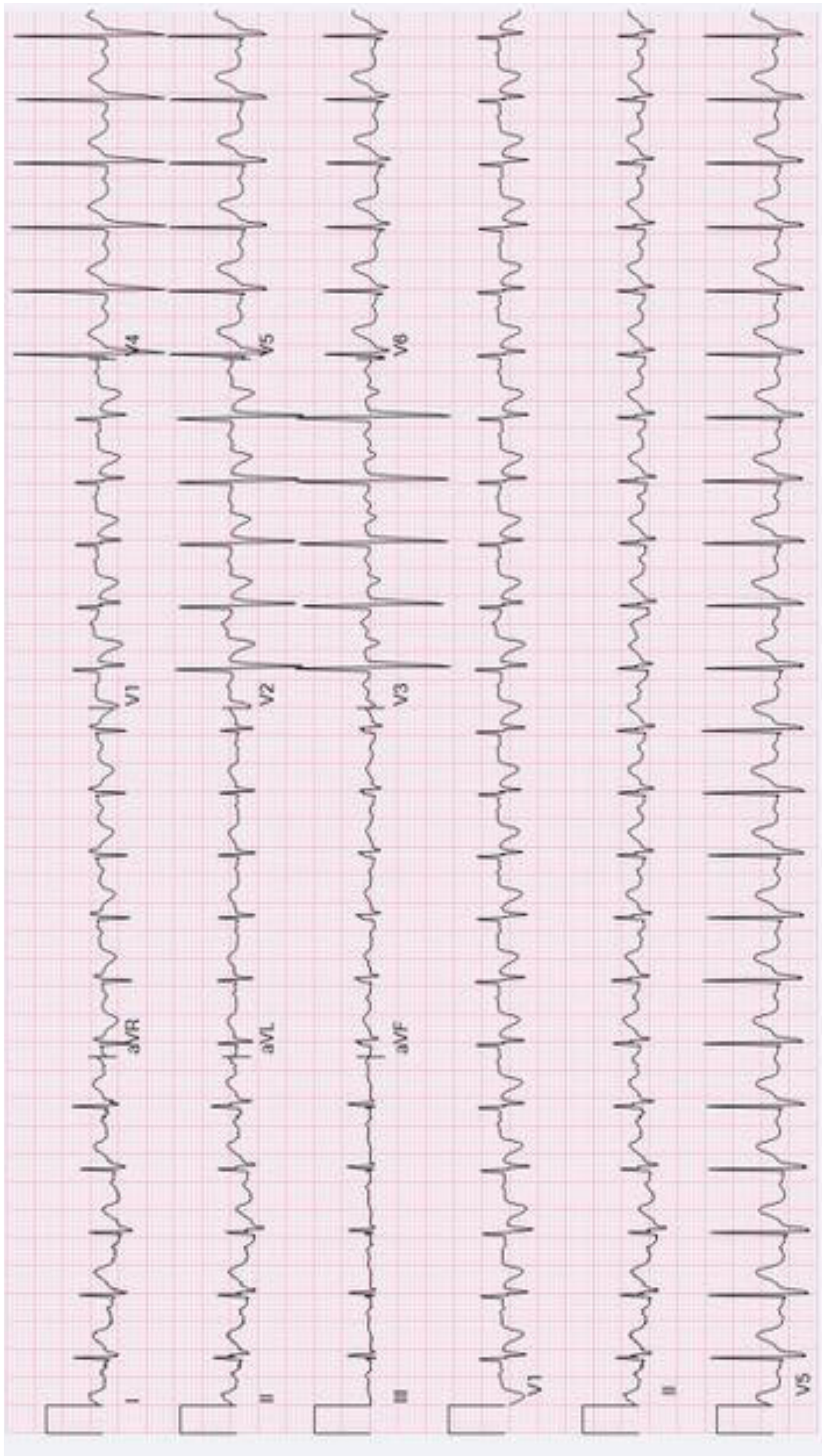
Lab Results

CBG/VBG Initial

LABORATORY TEST	VALUE	UNITS
pH	7.10	
pCO_2	17	mmHg
pO_2	40	mmHg
O_2 sat	75	%
BE	-18	mEq/L
Glucose	300	mg/dL
Sodium	133	mEq/L
Potassium	3.3 (if repleted)	mEq/L
Chloride	112	mEq/L

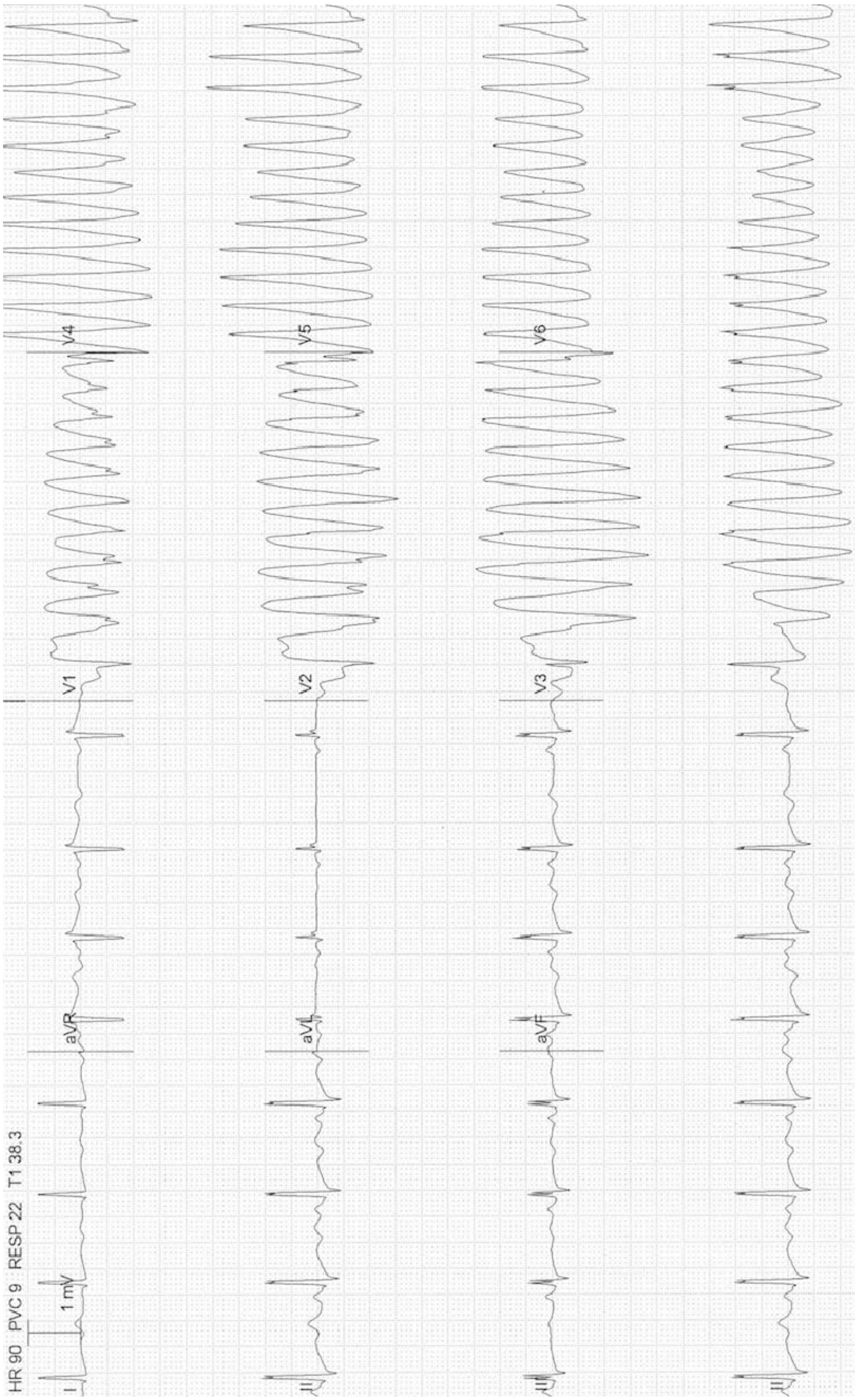
Supporting Files

ECG 1



Supporting Files

ECG 2



Supporting Files

Notes

ECG 1 interpretation
ECG with signs of hypokalemia. Image from Dr. Ilana Bank.

ECG 2 interpretation
ECG with torsades de pointes. Image from Dr. Ilana Bank.

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participants playing the role of the patient and mother

Case Background Information

You are bringing your daughter to the ED for vomiting and "tiredness."

Over the past week the whole family has had the "flu," with intermittent fevers, myalgias and fevers. Her 3 siblings, however, are all feeling better – but she doesn't seem to be back to herself. Additionally, for the last 2 days she has been complaining of stomach aches with "too many to count" episodes of vomiting (NB/NB). You took her to an urgent care earlier in the day and they told you that some children take longer to recover from illnesses than others. You're not satisfied with that response.

Who are the Learners?

Emergency medicine residents

This case is specifically aimed at first and second year residents who should have experience in gathering information from patients and families, and standard medical treatments and procedures. They may be less familiar with escalating medical therapies when first measures are not successful.

Standardized Patient Information

Mother: Your demeanor is overall anxious and concerned. You are a nervous parent with limited medical acumen. Interrupt the doctors often with questions – but do not be belligerent or aggressive. You are especially concerned about her stomach-ache and really want to know if she will need surgery. If given space, tell the team about your friend's daughter who has a stomach-ache and then needed surgery, and then ask repeatedly "is this the same thing?" Her nausea is making you very anxious and want it managed quickly. Something is VERY wrong with your child and you know it. You keep giving her Motrin and Robitussin, but it is not making her any better.

Patient: She doesn't contribute much. She is awake, tired appearing, not moving a lot on the bed, but intermittently rubs her stomach, clutches her vomit bag (if offered one) and talks about feeling like she might throw up. When examined, she cannot specifically tell them where your pain is - "it's everywhere." She is alert and oriented if asked. She is also thirsty if asked.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT: "My stomach hurts."
- AGE: 8 years old
- ADDITIONAL HISTORY: I had a cold last week, my whole body hurt and since then I feel crummy.
- PAST MEDICAL HISTORY: None
- SOCIAL HISTORY: None, no recent travel. They have never left California.
- FAMILY HISTORY: Grandma has trouble with sugars - offer only if specifically asked
- PAST SURGICAL HISTORY: None
- MEDICATIONS: None
- ALLERGIES: No known allergies
- IMMUNIZATIONS: Up-to-date
- BIRTH HISTORY: Unremarkable. She was born full term, no medical complications (patient is 8 years old, ok if they don't ask about birth history)

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things MOM could say without being asked:

- "All the vomiting has made her lose weight. She keeps eating but is so skinny. I think it's the vomiting."
- "Everyone else got better, why isn't she getting better?"
- "She is such a healthy child, she is never sick and never complains. I know something is wrong."

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
If residents are not picking up on DKA	You could offer that your daughter wet her bed two nights ago. "She never wets her bed."
If the residents continue not picking up on the diagnosis	You can offer the family history of "sugar problems".

Simulation Case 6

Foreign Body Aspiration

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Updated August 18, 2020

Setup

Chief complaint: Cough and wheezing
Patient age: 10 months
Weight: 10 kg

Brief Narrative Description of Case

Mother brings a 10-month-old child to the Emergency Department with a complaint of sudden onset of cough. She was in the kitchen and briefly left the infant with her 3-year-old sibling who was playing with her toys. She returned to find the child coughing along with "wheezing." If asked, what mother is actually describing is stridor from the upper airway foreign body. Child will initially be stable with intermittent stridor but will develop increasing breathing difficulty leading to hypoxia. Foreign bodies may not be radio-opaque and x-rays will not reveal diagnosis. Participants will need to recognize the need for emergency airway intervention. Child will become increasingly hypoxic and distressed and require attempted intubation with an endotracheal tube. Team will not be able to remove the foreign body or advance an endotracheal tube. Once an advanced airway has been attempted, the child will improve clinically only briefly and will ultimately need a needle cricothyroidotomy to secure the airway because of a foreign body completely obstructing the airway. Participants are required to discuss diagnosis with family and why intubation is necessary. Mother will be upset and feel responsible for the child's condition and will require reassurance. Final steps will be consultation with surgery, otolaryngology (ENT), or pulmonary service for foreign body removal and subsequent admission of the child to PICU.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Describe the signs/symptoms of an upper airway foreign body **(comprehension)**
2. Demonstrate early evaluation of a critically ill patient **(application)**
3. Discuss the limitations of radiologic studies in the diagnosis of airway foreign bodies **(comprehension)**
4. Demonstrate management upper airway obstructions including

intubation and needle cricothyroidotomy **(application)**
5. Demonstrate focused history taking from a caregiver **(application)**
6. Explain diagnosis and management to caregivers **(synthesis)**
7. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

- Recognize stridor secondary to upper airway foreign body
- Recognize impending airway compromise
- Manage airway, including bag-mask ventilation and attempted intubation
- Perform needle cricothyroidotomy
- Prompt consultation with appropriate services for foreign body removal
- Admit to Pediatric ICU or OR setting
- Discuss diagnosis and management with parents

Recommended Supplies

- **Manikin:** Intubatable infant, ideally should have the ability to perform needle cricothyroidotomy, but task trainer may be used
- **Moulage:** Small toy (e.g., Lego) for foreign body in airway lodged above vocal cords
- **Resources:** Pediatric reference card such as PALS card and/or length-based tape (e.g., Broselow Tape)
- **Manikin set up:** Dressed in infant clothing
- **Equipment:** Pediatric Airway Equipment, McGill forceps, NRBM mask, bag-valve mask, needle cricothyroidotomy kit
- **Medications:** Racemic epinephrine, albuterol, RSI medications, sedation medications, dexamethasone or methylprednisolone

Supporting Files

- Normal infant chest x-ray
- Photograph of airway foreign body

Participants/Roles

- Team leader
- Airway manager
- Survey physician
- Medication preparer
- Medication giver
- Family liaison/history taker
- Standardized patient (actor or faculty) to play patient's parent (only 1 parent needed)

Faculty or other embedded participants can play a nurse, respiratory therapist, or tech, if there are not enough learners to perform the above roles.

** Team roles may need to be adjusted in order to suit local practices and norms*

Prerequisite Knowledge

- **Faculty**
    - PALS protocols
    - General knowledge of emergency medicine
    - Simulation implementation and debriefing experience

- **Emergency medicine residents**
    - Any stage of training
    - Familiarity with needle cricothyroidotomy

Case Alternatives

- If attempt intubation early on, have the child's oxygen saturation improve, and the nurse can question why providers are wanting to intubate the patient.

- If facilitators would like to increase the challenge of the case to target advanced learners, have the learners attempt foreign body removal.

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC4. Differential Diagnoses and Management
PC7. Disposition
PC9. General Approach to Procedures
PC10. Airway Management
MK. Medical Knowledge
PROF1. Professional Values
ICS1. Patient Centered Communications
ICS2. Team Management

Resources

1. Nickerson C. Inhaled foreign body. https://litfl.com/inhaled-foreign-body/ Chris Nickson, Last update 2019.
2. Passàli D, Lauriello M, Bellussi L, et al. Foreign body inhalation in children: an update. Acta Otorhinolaryngol Ital. 2010;30:27–32. PMID: 20559470
3. Na'ara S, Vainer I, Amit M, et al. Foreign Body Aspiration in Infants and Older Children: A Comparative Study. Ear Nose Throat J. 2020;99:47-51. PMID: 30974996
4. Rovin JD, Rodgers BM. Pediatric Foreign Body Aspiration. Pediatr Review. 2000;21:86-90. PMID: 10702322
5. Needle cricothyrotomy. WikiEM. https://wikem.org/wiki/Needle_cricothyrotomy. Last update 2020.

Initial Presentation

ITEM	FINDING
Overall Appearance	Mother sitting in room, holding infant in her arms. Infant is having intermittent stridor.
HPI	Mother reports a story of her child having a sudden cough that resolved and now having "wheezing". She brought her daughter to the ED because she started coughing when she was in the other room and now has intermittent "wheezing" (actually stridor, but she thinks it is wheezing). She was fine when she first woke up, and this is very atypical for her. You are worried she is sick. If asked, will describe events of the child playing with her sibling and developing a sudden onset of cough when she was out of room. She was in the kitchen and briefly left the infant with her 3-year-old sibling, who was playing with her toys. Mother will state child "wheezing" but when questioned will actually describe stridor.
Past Medical/Surgical History	None, born at 38 weeks by spontaneous vaginal delivery
Medications	None
Allergies	No known drug allergies
Family History	None
Social History	Attends daycare

Stage 1

Begin Simulation (Stage 1 of 5)

Initial Presentation:
Start through end of primary survey (initial examination)

CRITICAL ACTIONS

- Team leader assigns tasks
- Obtain relevant history from parent
- Perform primary survey
- Place patient on continuous cardiac monitor
- Perform focused physical exam
- Recognize stridor

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 110, **BP:** 90/52, **RR:** 26, **SpO_2:** 96% on RA
General	Awake and alert infant held by parent or lying on stretcher
HEENT	Intermittent stridor. Foreign body visualized at cords on initial inspection. Cannot be removed.
Neck	Supple
Lungs	Clear to auscultation bilaterally
Cardiovascular	Regular rate and rhythm, no murmurs
Abdomen	Soft, non-tender, non-distended

Physical Exam (continued)

ITEM	FINDING
Neurological	Non-focal, moves all extremities
Skin	Warm, dry, capillary refill < 2 sec

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Following initial exam	Intermittent stridor. SpO_2 will drop to 88%, but then return to normal range once stridor resolves.	Mother will state “This is the wheezing I was talking about, are you going to give him any treatment?”
During intermittent stridor	Saturation decrease to 88%	
Participants request chest x-ray		Images provided to participants.
Participants request racemic epinephrine	No change in exam	Medications will be available.
After exam and imaging (if requested)	Proceed to **Stage 2**.	

Stage 2

Airway compromise:
After initial exam (and any imaging ordered) through preparation for intubation

CRITICAL ACTIONS

- Recognize airway difficulty and need for intubation
- Establish vascular access

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 125, **BP:** 90/52, **RR:** 34, **SpO_2:** 88%
Exam Changes	Stridor is now constant and child having increasing respiratory difficulty and distress

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Child returns from x-ray department or portable x-ray is completed.	Stridor constant and SpO_2 declines	Nurse or mother will draw attention to patient, if team not recognizing
Racemic epinephrine nebulizer ordered	No effect	
Albuterol MDI or nebulizer treatment	No effect	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Steroids given orally or intravenously	No effect	
Order blood glucose	Blood glucose (point of care) 101 mg/dL	
Order venous blood gas	Venous blood gas: pH 7.40 PO_2 35 mmHg PCO_2 45 mmHg	
Additional lab orders	Pending when asked	
Orders arterial blood gas	No effect	Nurse questions why do we need to this painful procedure

Stage 3

Intubation:
Teams calls for airway equipment

CRITICAL ACTIONS

- Intubation must be attempted and once deemed unsuccessful, needle cricothyroidotomy must be attempted.

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 130, **BP:** 90/52, **RR:** 42, **SpO_2:** 84%
Exam Changes	Cyanosis present with continuous stridor

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Intubation attempted	Will be unable to place ET tube due to foreign body obstruction. Proceed to **Stage 4.**	
Attempt to remove foreign body	Unable to remove foreign body or removal causes trauma leading to significant edema	Use image provided, if foreign body unable to be placed in manikin

Stage 4

Cricothyroidotomy:
Intubation attempt through cricothyroidotomy

CRITICAL ACTIONS

- Perform needle cricothyroidotomy

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 130, **BP:** 90/52, **RR:** 42, **SpO_2:** 84%
Exam Changes	No changes

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Needle cricothyroidotomy attempted	Hypoxia and cyanosis will improve following procedure. Proceed to **Stage 5**.	Jet ventilation can be performed as a temporary measure.

Stage 5

Case Conclusion

CRITICAL ACTIONS

- Surgical, ENT or pulmonary consultation (depending on local practices)

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 130, **BP:** 90/52, **RR:** assisted, **SpO_2:** 100% O_2 after needle cricothyroidotomy
Exam Changes	• Cyanosis resolves • Stridor resolves

Ideal Scenario Flow

The learners enter the room to find a child is coughing. During the initial exam, the child will have intermittent stridor. They immediately place the patient on bedside monitors. Learners will recognize that the patient is hypoxic and having increased respiratory difficulty. Supplemental oxygen is provided. The child's respiratory distress improves slightly but does not resolve. After completing a physical examination, obtaining an appropriate history, and ordering imaging, the providers note that the child's respiratory status has continued to worsen and ultimately endotracheal intubation is required. Learners will not be able to remove the foreign body despite efforts. Intubation will not be successful due to the foreign body obstructing the airway. Needle cricothyroidotomy will need to be performed which will provide adequate ventilation. The child will then require an appropriate surgical consultation and admission to PICU.

Anticipated Management Mistakes

1. **Failure to recognize the need for intubation:** Some of our learners do not immediately recognize that the patient requires prompt airway management, leading to delay in diagnosis. We found it helpful to allow the pulse oxygenation to continue to drop despite supplemental oxygen to prompt the need for attempted intubation. Also have the nurse or mother express the need for an additional step: "Are you going to do something?"

2. **Team attempts removal of foreign body:** Use image of foreign body provided instead of placing in manikin. When team visualizes foreign body, tell them it cannot be moved. If the team removes foreign body, the case may need to pause to replace or option of upper airway edema from trauma during removal could be added to make the team have to progress to needle cricothyroidotomy

3. **Apprehension to perform needle cricothyroidotomy:** Have nurse show team equipment is available once intubation fails.

Debriefing Points

Describe the signs/symptoms of an upper airway foreign body (comprehension)

In infants, several conditions can cause respiratory distress. Common causes include bronchiolitis, reactive airway disease, gastroesophageal reflux, congenital abnormalities, or foreign bodies. Unlike adults and older children, infants and young children are unable to provide a history of foreign body aspiration or manifest typical choking signs. Instead, caregivers and providers must rely on other non-specific presentations. Common complaints from parents may be non-specific, and what is described as wheezing may not actually be wheezing. Infants may have intermittent stridor or cyanosis. Partial obstruction makes the diagnosis difficult. The classic triad of new onset cough, wheezing and asymmetric breath sounds is not present in the majority of patients. The majority of aspirated foreign bodies in children are located in the bronchi. The most common presenting symptom is cough. In infants and young children, an increased respiratory rate may be present with respiratory distress.

Airway foreign bodies led to 17,000 emergency department visits in children <14 years old. Leading cause of accidental infantile deaths and 4th among preschool children. Peak occurrence is 1-2 years old with 80% <3 years old. In western nations, peanuts account for half of all organic ingestions. Classic triad of paroxysmal cough, wheezing and decreased air entry seen in only <40% of patients. Cough (72%) is the most frequent symptom. Expiratory stridor is a unique finding. Laryngotracheal foreign bodies are uncommon but likely life-threatening.

Demonstrate early evaluation of a critically ill patient (application)

Learners should approach a critically ill patient in a standardized fashion. Airway, breathing, and circulation should be assessed immediately. After A, B, C have been addressed, the patient should be evaluated for disability and exposed for a complete head to toe exam. If a child is found to have a complete obstruction, back blows and chest compressions should be started immediately in the infant in order to dislodge the foreign body.

Discuss the limitations of radiology in the diagnosis of airway foreign bodies (comprehension)

Radiographs may not be helpful in the diagnosis of an airway foreign body. Only about 10% of aspirated objects are radio-opaque. CT scan is another option. However, bronchoscopy may be more appropriate and should be performed if foreign body aspiration is suspected even if radiographic studies are normal.

Demonstrate management upper airway obstructions including intubation and needle cricothyroidotomy (application)

Removal of foreign bodies is often performed under rigid bronchoscopy. This helps to prevent mucosal damage and distal advancement of the object. If a child is unstable and requires airway management then progression to intubation is acceptable. Needle cricothyroidotomy involves placing a needle through the cricothyroid membrane followed by a catheter. This is only a temporary airway (<45 minutes) that should be performed in a can't intubate, can't ventilate situation. This procedure is recommended in children 5 years and under. This is not the same as a surgical cricothyroidotomy. The obstruction needs to be above the level of the cricothyroid membrane for it to be useful.

Relative contraindications are (1) inability to identify landmarks, (2) tracheal transection or severe trauma, and (3) underlying tumor, abscess/infection, or anatomical abnormality.

Equipments should include:
- 12-14-gauge angiocatheter
- 3 mL syringe x 2
- Adapter to 7.0 ETT or 3.0 ETT
- Pediatric bag valve mask

Procedure [YouTube video]:
- Prep and drape for sterile technique as time permits
- Locate cricothyroid membrane
- Aiming caudally, pierce membrane with angiocatheter at an angle of 30-45 degrees
- Attach 3 mL syringe filled with saline
- Advance while aspirating; bubbles should indicate in airway
- Advance catheter and remove needle; hub to skin

- Attach 3-0 ETT adapter to angiocath or if not available attached 3 mL syringe with 7-0 ETT adapter
- Attach bag valve mask and ventilate

Demonstrate focused history taking from a caregiver (application)

The history should be focused during the initial evaluation on possible etiologies of difficulty breathing. Inquiry about recent illnesses/infection symptoms, potential exposure to ingestions or toxins, potential trauma is pertinent. Especially in infants and young children, it is important to assess recent oral intake and potential losses as they are at high risk for hypovolemia and hypoglycemia. Past medical history assessment should include questioning about birth history and any prenatal complications. Medications and allergies should be inquired about, just like for all patients. If the patient is breast fed, the mother's medications should also be reviewed.

Explain diagnosis and management to caregivers (synthesis)

If personnel are available, one member of the team may stay with the family to gather history and explain interventions. Information should be relayed to the family using layperson's terms. The rationale for invasive interventions such as IV placement, BMV, intubation, and needle cricothyroidotomy should be explained preceding or at the time of occurrence, when possible.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

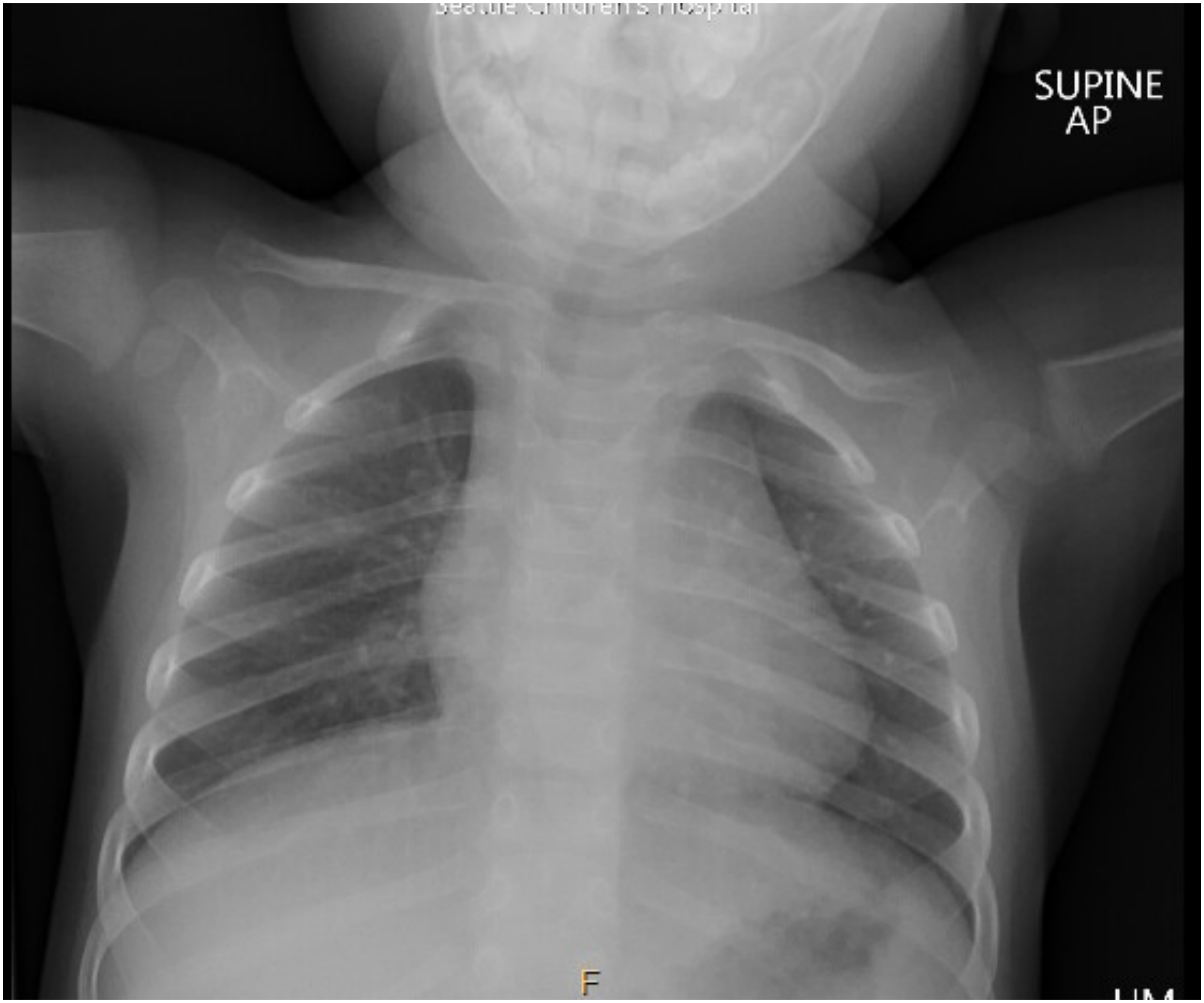
- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Supporting Files

Chest X-Ray (AP/Lateral)

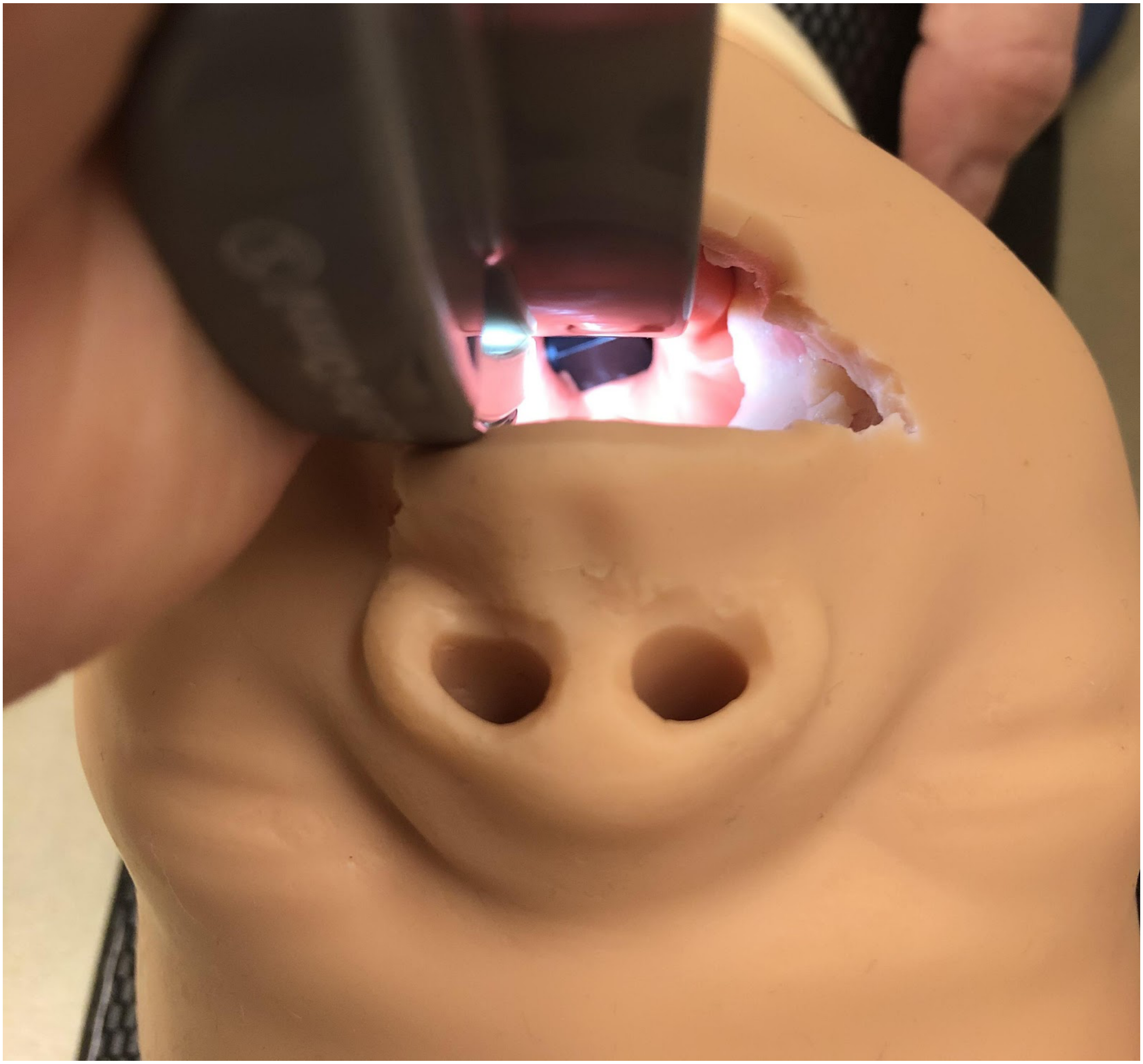


Supporting Files

Chest X-Ray (Lateral)

Supporting Files

Airway Visualization



Supporting Files

Notes

CXR interpretation
Normal chest x-ray. Images by author Dr. Rebekah Burns.

Airway visualization
Image of foreign body that can be used, if unable to actually place object in manikin. Image by author Dr. C Sampson.

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant playing the patient's parent

Case Background Information

Your daughter has choked on a small toy that is stuck in her airway. This is causing her to have stridor, which is a noise made when the upper airway is obstructed. This can quickly lead to difficulty breathing or cause her to stop breathing.

You are bringing your daughter to the Emergency Department because she has been "wheezing" intermittently since the coughing episode started and you are very concerned. You were not in the room when she choked on the toy so you are unsure of what happened.

Who are the Learners?

Emergency medicine residents

This case is specifically aimed at interns who are in their first year of specialty training and may have experience in gathering information from patients and families, and standard medical treatments and procedures. They may be less familiar with escalating medical therapies when first measures are not successful.

Standardized Patient Information

You brought your daughter to the Emergency Department because she started coughing when you were in the other room and now has intermittent "wheezing" (actually stridor, but you think it is wheezing). She was fine when she first woke up, and this is very atypical for her. You are worried she is sick.

Your demeanor is concerned but relatively calm. You do not want to obstruct care but want to know what is happening. Do not interrupt them if they are thinking out loud or discussing care with one another but ask questions when possible if they don't explain what they are doing.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you"): "She has been coughing and wheezing this morning."
- AGE: 10 months old
- ADDITIONAL HISTORY: You first noticed the coughing around 9 AM this morning. She woke up at 7:00 AM normally and had a normal breakfast. At 9 AM, she was playing with her 3-year-old brother. You went briefly to the kitchen to prepare milk for the child. You heard loud coughing and choking. At first, you didn't think much of it because she occasionally coughs. The coughing stopped but now the child has intermittent stridor that you describe as "wheezing". She has not had fever, congestion, emesis, or recent illness. She has not received any medications. There are no medications other than acetaminophen and ibuprofen at home. She has not had any falls or injuries at home.
- PAST MEDICAL HISTORY: Born at 38-weeks' gestation. Spent 2 days in the hospital.
- SOCIAL HISTORY:Lives with both parents. 1 cat. No smoke exposure. Mother watches child at home with sibling. No travel.
- FAMILY HISTORY: Brother was admitted for RSV at 12 months of age
- PAST SURGICAL HISTORY: None
- MEDICATIONS: None
- ALLERGIES: No known allergies
- IMMUNIZATIONS: Up-to-date
- BIRTH HISTORY: Born by spontaneous vaginal delivery at 38

weeks to a 34-year-old G2P2 woman. Normal prenatal care, no complications during pregnancy or delivery. Discharged home from hospital on day 2 of life with mom and dad.

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things MOM could say without being asked:

- "I have never seen her cough like this before. Why is she wheezing? Does she have RSV?"
- "She is usually healthy and never gets sick."

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
When the stridor sounds start	"Why is she wheezing again?"
When she becomes hypoxic (turns blue and O_2 saturation begins to decline)	"Is she getting sicker?"
If they start using a bag mask to help your child breath without telling you what they are doing	"Is she not breathing?!"
If they start to intubate	"Is she going to die?!"

Simulation Case 7

Multisystem Trauma

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Chrissy Chan, MD

Updated August 19, 2020

Setup

Chief complaint: Pedestrian hit by a car
Patient age: 6 years old
Weight: 20 kg

Brief Narrative Description of Case

This scenario occurs in a community Emergency Department that is not a Level 1 Trauma Center. This patient is a 6-year-old girl who was struck by a car and has a combination of intracranial bleeding, pulmonary contusion, solid-organ intra-abdominal injury, and a distal extremity fracture. Ideally, the learners should recognize all of the injuries and treat them in order of priority, prior to transfer to a trauma center. Treatment should be done in a timely manner before the complications of hypoxemia and hypotension occur.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Demonstrate the evaluation of a pediatric patient with blunt trauma using a standard systematic approach **(application)**
2. Describe signs/symptoms of blunt multisystem trauma **(comprehension)**
3. Construct and implement initial medical management plan for a child with blunt multisystem trauma **(application)**
4. Construct and implement initial medical management plan for a child with traumatic brain injury **(application)**
5. Demonstrate airway management of a sick child using appropriate adjuncts, bag-mask ventilation (BMV), and endotracheal (ET) intubation **(application)**
6. Use fluids and/or blood in emergent resuscitation **(application)**
7. Explain diagnosis and management to caregivers **(synthesis)**
8. Develop a plan for transfer to a trauma center for definitive management **(synthesis)**
9. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

- Assign/assume team roles
- Obtain history from parent
- Perform primary and secondary surveys
- Place patient on continuous cardiac monitor
- Obtain vascular access
- Perform assisted oxygenation
- Perform assisted ventilation by bag-mask ventilation (BMV)
- Administer intravenous (IV) fluid resuscitation
- Immobilize cervical spine throughout entire resuscitation
- Intubate prior to transfer
- Transfer patient to trauma service
- Splint displaced tibia-fibula fracture

Recommended Supplies

- **Manikin:** Pediatric (e.g., Laerdal SimJunior or Gaumard Pediatric HAL)
- **Moulage:**
    - Left parietal scalp hematoma and contusion
    - Ecchymosis in the left upper quadrant of the abdomen
    - Left shin deformity
    - Clothing with red stains/blood
- **Resources:** Length-based resuscitation tape (e.g., Broselow)
- **Manikin set up:** Two IV lines in place with drainage bag
- **Equipment:**
    - Pediatric airway equipment of various sizes/airway cart
        - Simple face mask
        - Non-rebreather mask
        - Nasal cannula
        - Oxygen tubing
        - Suction
        - Bag with mask
        - Endotracheal tubes
        - Colorimeter
        - Tape
        - Trauma shears
        - Warm blankets

- IV tubing, lines, pumps, poles, and angiocatheters
- Intraosseous needles and line kit (e.g., EZ-IO)
- Rigid splinting materials gauze, tape, ace wrap
- Cervical collars of various sizes
- Ultrasound machine

- **Medications:** succinylcholine, rocuronium, etomidate, ketamine, midazolam, isotonic fluids, other standard code cart medications

Supporting Files

- eFAST Ultrasound: Positive for intraperitoneal fluid, no pericardial fluid, no pneumothorax
  - Subxiphoid view
  - Right upper quadrant
  - Left flank
  - Bladder
  - Lung, M-mode
  - Lung view
- Single-view post-intubation chest x-ray: ET tube in proper position, pulmonary contusion
- Leg x-ray: Displaced fracture of the tibia and fibula (time permitting)
- Pelvis x-ray
- Point-of-care labs from venous blood sample

Imaging is unnecessary in this case, except perhaps a post-intubation CXR. However, bedside plain radiographs and ultrasound should be allowed. The patient is much too sick to leave the department for a CT scan. The instructors will have to redirect the learner if they order the patient to leave the resuscitation area. Transport to a Level 1 trauma center will be available 10 minutes into the case and transfer should not be delayed for CT scan.

Participants/Roles

- Team leader
- Airway manager
- Survey physician
- Medication preparer
- Medication giver
- Proceduralist
- Family liaison/history taker

- Standardized patient, faculty, or senior resident (actor) to play patient's parent

** Team roles may need to be adjusted in order to suit local practices and norms*

Faculty or other embedded participants can play a nurse, respiratory therapist, or tech. A nurse can play a nurse or tech, if there are not enough learners to perform the above roles. Additionally, learners may have to play multiple roles to simulate an environment with less providers.

Prerequisite Knowledge

- **Faculty**
  - PALS protocols
  - General knowledge of emergency medicine
  - Simulation implementation and debriefing experience

- **Emergency medicine residents**
  - Preferably PGY-2 year or above
  - Completed ATLS
  - Splinting techniques

Case Alternatives

- As written, resuscitation with crystalloid fluid will improve the patient's shock. One can argue that blood is a better choice. According to the most recent edition of Rosen's, "The debate regarding the choice of colloids versus crystalloids for resuscitation is ongoing. No indisputable advantages of colloids have been demonstrated. Therefore, the less expensive and more readily available crystalloids are the mainstay of treatment."

- For a post-scenario assignment, faculty can encourage learners to search the literature regarding fluid resuscitation guidelines in trauma.

Resources

1. Gross EA. (2018) Multiple Trauma in Walls, RM. Rosen's Emergency Medicine: Concepts and Clinical Practice. Elsevier, Inc., pp 287-300.
2. Murray BL. (2018) Pediatric Trauma in Walls, R.M. Rosen's Emergency Medicine: Concepts and Clinical Practice. Elsevier, Inc., pp 2042-2057.
3. Management of Pediatric Trauma. Committee on Pediatric Emergency Medicine, Council on Injury and Violence, and Poison Prevention, Section on Critical Care, Section on Orthopaedics, Section on Surgery, Section on Transport Medicine, Pediatric Trauma Society, and Society of Trauma Nurses Pediatric Committee Pediatrics August 2016, 138 (2) e20161569. https://doi.org/10.1542/peds.2016-1569
4. Holmes JF, Lillis K, Monroe D, et al. Identifying children at very low risk of clinically important blunt abdominal injuries. Ann Emerg Med 2013; 62:107. PMID: 23375510
5. Bixby SD, Callahan MJ, Taylor GA. Imaging in pediatric blunt abdominal trauma. Semin Roentgenol 2008; 43:72. PMID: 18053830
6. Capraro AJ, Mooney D, Waltzman ML. The use of routine laboratory studies as screening tools in pediatric abdominal trauma. Pediatr Emerg Care 2006; 22:480. PMID: 16871106
7. Tosounidis TH, Giannoudis PV. Paediatric trauma resuscitation: an update. Eur J Trauma Emerg Surg.2016; 42: 297–301. PMID: 26696087

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC3. Diagnostic Studies
PC7. Disposition
PC10. Airway Management
PC12. Goal-directed Focused Ultrasound
ICS2. Team Management

Initial Presentation

ITEM	FINDING
Overall Appearance	6-year-old female eyes closed. Ill-appearing. Slow and shallow respirations. There is an obvious deformity to her left lower leg.
HPI	Patient arrives by private vehicle accompanied by a parent. “It happened so fast! She was playing in the front yard. The ball rolled into the street. Before I had a chance to do anything, she ran after the ball into the street and a car hit her. We live close to the hospital, so I drove her straight here.” If the learners ask for specifics: The car was going about 35-40 MPH (30 MPH zone). She possibly got hit on her chest/right side and fell to her left. Initially she cried out loud and then has been moaning since.
Past Medical/Surgical History	• Asthma • Immunizations up-to-date
Medications	Albuterol every 4 hours, as needed
Allergies	Amoxicillin causes a rash
Family History	Father has asthma
Social History	• No pets • No smokers • Attends school • Lives with both parents and younger brother

Primary Survey

ITEM	FINDING
Airway	No airway obstruction
Breathing	No crepitus. No deformity. RR=8. Shallow respirations. No decreased breath sounds. Crackles in the left lung field.
Circulation	Weak pulses in all extremities. 4-second cap refill.
Disability	Glasgow Coma Score (GCS) = 9 • Eyes open to painful stimuli (2) • Verbally, she mumbles incoherently (2) • Motor response is localization of pain. She pushes the examiner away when her abdomen is palpated (5) Non-focal exam otherwise.
Exposure	(See physical exam section)

Stage 1

Begin Simulation (Stage 1 of 4)

Primary Survey:
Start to second IV fluid bolus

CRITICAL ACTIONS

- Team leader assigns tasks and use Broselow tape or another reference tool for weight
- Obtain history from parent
- Perform primary survey
- Perform BMV
- Place patient on continuous cardiac monitor
- Order vascular access at two sites
- Obtain point-of-care glucose
- Place cervical collar
- Give 2 intravenous (IV) fluid boluses (see notes below)
- Perform rapid sequence intubation (RSI) (see notes below)
- Discuss progress and plan of care with the parent (and involves them in decision-making)

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 36.4°C, **HR:** 140, **BP:** 82/56, **RR:** 8, **SpO_2:** 90%
General	Eyes closed. Ill-appearing. Slow and shallow respirations.
HEENT	Left parietal scalp hematoma and contusion. 4 mm pupils. PERRL.
Neck	Normal. Nontender. No step-offs. No crepitus.

Physical Exam (continued)

ITEM	FINDING
Lungs	No crepitus. No deformity. Respiratory Rate = 8. Shallow respirations. Crackles in the left lung field.
Cardiovascular	HR=140. Regular rhythm. Normal heart sounds. Weak pulses. 4-second cap refill.
Abdomen	Hypoactive bowel sounds. Tenderness and ecchymosis in the left upper quadrant. No guarding/rebound. No distention. No mass.
Genitourinary	Normal. Pelvis stable.
Neurological	GCS = 9 • Eyes open to painful stimuli (2) • Verbally, she mumbles incoherently (2) • Motor response is localization of pain. She pushes the examiner away when her abdomen is palpated (5). Non-focal exam otherwise
Skin	Pale, cool, diaphoretic
Back	Normal. Nontender. No step-offs. No crepitus. Axilla unremarkable
Rectal	Normal tone. Vault empty. Heme test negative.
Extremities	Left shin is deformed without tenting of the skin. Neurovascularly intact distally. Other extremities are normal.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Successful ventilation (BMV)	SpO_2 = 96%	This could be at the start of the case or during attempted ET tube.
Intubation attempt without RSI medication (e.g., laryngoscope blade placed in oropharynx)	Patient vomits SpO_2 decreases to 80% HR decrease to 80 BP: 72/56 RR: 8	
Paralytic agent administered for RSI	RR = 0	
No IV fluids given for 5 minutes	HR increase to 150 BP decreases to 60/40 RR: 8 SpO_2: 80%	
RSI without adequate fluid resuscitation	BP decreases to 60/40 HR: 150 RR: 8 SpO_2: 80%	
First IV fluid bolus given	No changes	A single fluid bolus could be: • 400-500 mL of crystalloid, or • 1 unit (~300 mL) of packed red blood cells (pRBC)
Second IV fluid bolus given	Proceed to **Stage 2**.	

Stage 2

Secondary survey:
After 2 IV fluid boluses given through intubation and splinting

CRITICAL ACTIONS

!

- Perform RSI (if not performed during **Stage 1**)
- Arrange transfer to trauma center (hand-off communication to trauma doctor)
- Splint tibia-fibula fracture prior to transfer

Physical Exam

ITEM	FINDING
Vital Signs	**HR:** 115, **BP:** 90/62, **SpO_2:** 96% (with BMV or ETT)
Exam Changes	• Pt intubated with RR at bagged rate, if intubated in **Stage 1** • Capillary refill 3 seconds, if they received IV fluid resuscitation in **Stage 1**

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
One minute without assisted ventilation	SpO_2 decreases to 80% HR decrease to 80 BP: 72/56 RR: 8	This could be during attempted ET intubation.

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Intubation attempt without RSI medication (e.g., laryngoscope blade placed in oropharynx)	Patient vomits SpO_2 decreases to 80% HR decrease to 80 BP: 72/56 RR: 8	
Paralytic agent administered for RSI	RR = 0	
10 minutes elapsed without ET intubation or BMV	Patient RR becomes irregular and drops to 5 and HR goes down to 50, BP is not recordable GCS = 6 (E = 1, V = 1, M = 4) SpO_2: 60%	Would need to initiate pediatric code and CPR
The patient has been intubated and given 2 fluid boluses. Nurse (embedded participant) announces that the receiving hospital is on the line.	Proceed to **Stage 3**	

Stage 3

Increased intracranial pressure:
After initial stabilization through ICP management

CRITICAL ACTIONS

- Elevate the head of the bed
- State the need to hyperventilate the patient to a pCO_2 of 30-35 mmHg and order a blood gas
- Administer either mannitol or hypertonic saline

Physical Exam

ITEM	FINDING
Vital Signs	**HR:** 60, **BP:** 130/82
Exam Changes	Patient develops decorticate posturing

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
All 3 critical actions performed	**HR** 90 **BP** 110/70 Proceed to **Stage 4**.	
If an action is not done by 5 minutes into stage		Facilitator can prompt: "Is there anything else we should do to help?"

Stage 4

Case conclusion:
After management of ICP through handoff to accepting trauma center (at least 10 minutes from start of case)

CRITICAL ACTIONS

- **Reassess patient and prepare for transfer**
- Hand-off communication to trauma doc, if not already done

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	Unchanged
Exam Changes	No changes

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Time consuming diagnostic tests ordered (i.e. CT scan)	Prompt learner to transfer to a trauma center	Sample prompt: "The charge nurse tells you the patient is much too sick to stay here. "

Ideal Scenario Flow

Learners enter the room and identify immediately that the patient is critically ill. They immediately ask for IV access and cardiac/respiratory monitoring. A primary survey is rapidly completed

- **Airway:** Learners recognize impending need for intubation. They initiate BMV and set up equipment and medications for rapid sequence intubation (RSI).
- **Breathing:** Assessed
- **Circulation:** Learners recognize shock and order some form of IV fluid resuscitation (isotonic crystalloid or blood).
- **Disability:** Assessed and cervical collar applied.
- **Exposure:** The patient is undressed and log rolled. Blankets are applied to the patient.

A secondary survey and history are then obtained. Learners complete rapid sequence intubation and, if not done concurrently with the secondary survey, obtain/interpret FAST exam, POCT labs, splint tibia/fibula fracture, obtain chest X-ray to confirm ET tube placement and pelvis/leg X-ray (time permitting). They recognize the need for transfer and arrange for immediate transfer to a Level 1 Trauma Center and provide a thorough handoff to the accepting physician.

Anticipated Management Mistakes

1. **Failure to provide adequate respiratory support:** Learners may not immediately recognize the need for BMV and provide oxygenation initially without assisted ventilation. The nurse may redirect by stating that the oxygen saturation is not improving despite oxygen with nasal cannula or non-rebreather mask and there is poor chest rise.

2. **Difficulty with assessment of vital signs:** Learners may be unfamiliar with equipment and fail to correctly place monitor leads or apply an inappropriate cuff sizing for the pediatric patient. The nurse can cue learners to use the Broselow tape/cart to

select correct equipment (depending on what is available in your simulation center). If an inappropriate cuff is selected, faculty can report that the blood pressure doesn't result and have the nurse suggest the cuff is incorrectly sized.

3. **Inadequate fluid resuscitation:** Learners may stop after one fluid bolus and defer blood transfusion to the trauma center. The nurse may redirect them to trauma protocol and transfer guidelines.

4. **Incomplete secondary survey:** Learners may not remove all clothing and not log roll the patient. The nurse may ask for missing documentation per trauma record sheet cuing them to complete the secondary survey.

5. **Inappropriate imaging:** Learners may order imaging (e.g., CT scan) that requires the patient to leave the Emergency Department. The nurse expresses concern that the patient is unstable to leave the department for CT scan. Also, the patient's father may ask questions that will cast doubt on the decision to leave the department.

6. **Delay in transfer:** Immediately after resuscitation, learners might not initiate transfer to a Level 1 Trauma Center. Many current residents train at trauma centers and therefore, do not habitually recognize the urgent need to transfer. Again, the nurse or patient's father can prompt the learners.

7. **Ignoring family in the room:** Learners may forget that family is in the room if they stay quiet. The learner may get annoyed with them if they are in the way too much and keep asking questions. They will have to balance informing the father what is going on while asking him to not interfere in medical care. The nurse may ask for a social worker to be with the father.

Debriefing Points

Demonstrate the evaluation of a pediatric patient with blunt trauma using a standard systematic approach (application)

- Evaluation of traumatic injuries follows a standardized approach taught in Advanced Trauma Life Support (ATLS)

- Evaluation begins with addressing any life-threats identified in the ABCs, followed by a systematic head to toe exam known as the secondary survey. This includes continued reassessment and a return to ABCs as the clinical condition changes.

Describe signs/symptoms of blunt multisystem trauma (comprehension)

- There are specific injury mechanisms that should lead the practitioner to suspect the presence of intra-abdominal injury, such as a handlebar injury to the upper abdomen and a seat belt sign from a motor vehicle accident.

- It must be remembered that a negative Focused Abdominal Sonography for Trauma (FAST) exam alone does not exclude hemoperitoneum or intra-abdominal injury, and repeated assessment is warranted to ascertain a change in the patient's clinical condition.

- The spleen is the most commonly injured organ in pediatric abdominal trauma. Non-operative management has become standard practice.

Construct and implement initial medical management plan for a child with blunt multisystem trauma (application)

- Adjuncts to the primary survey may include a chest X-ray, a pelvic X-ray, and the FAST exam. FAST is a valuable tool to evaluate abdominal trauma and identify free fluid/blood. Note that the FAST is less helpful diagnostically in children, as hemodynamically stable children with a positive FAST are much more likely to need non-operative management as opposed to adults. Hemodynamically unstable children (hypotensive, need

>40 mL/kg of isotonic fluid) with a positive FAST should undergo diagnostic laparotomy.

Construct and implement initial medical management plan for a child with traumatic brain injury (application)

- Head trauma accounts for 80% or more of the traumatic injuries leading to death in US children older than 1 year. Most pediatric head trauma occurs secondary to motor vehicle accidents, falls, assaults, recreational activities, and child abuse.

- The unique anatomy of children may make them more likely to develop an intracranial lesion due to head trauma. They have a larger head-to-body size ratio, a thinner cranial bone and less myelinated neural tissue. Children with traumatic brain injury more commonly develop a pattern of diffuse axonal injury and secondary cerebral edema compared with adults.

- Severity of head trauma is classified according to GCS as follows:
    - **GCS 14 to 15: Minor head trauma**
    - **GCS 9 to 13: Moderate head trauma**
    - **GCS ≤8: Severe head trauma**

- A structured approach to the assessment of airway, breathing, circulation and disability (ABCD) is utilized with attention to the cervical spine. The goal of stabilization is to avoid secondary injury to the traumatized brain from hypoxia, hypotension, or raised intracranial pressure. Occasionally, early and definitive treatment of a primary intracranial injury may be required (e.g., epidural hematomas).

Demonstrate airway management of a sick child using appropriate adjuncts, BMV, and/or endotracheal intubation (application)

- Airway management is a critical component of pediatric resuscitation, especially in trauma patients. Along with ET intubation, one should also include airway adjuncts of BMV, oral airway, and nasal airway.

- The goal of ET intubation is to ensure optimal gas exchange. The most common indications in a trauma patient are coma, shock, apnea, and airway obstruction.

- The use of video laryngoscopy in trauma patients with limited neck mobility is helpful in optimal visualization of the airway.

- Common airway complications include right mainstem intubation, esophageal intubation, massive aspiration, unilateral or bilateral vocal cord paralysis, subglottic stenosis, failure to adequately preoxygenate, and extubation during transport.

Use fluids and/or blood in emergent resuscitation (application)

- Recognizing shock in the pediatric trauma patient can be more difficult as the signs of shock can be more subtle than in adult patients. A child that appears only as irritable initially may have lost as much as 30% of his or her blood volume. Children may decline rapidly, hence peripheral IV access with 2 age-appropriate IV angiocatheters should be achieved in all multisystem trauma patients. Isotonic fluid boluses of 20 mL/kg over 20 minutes are first line. Rapid infusers are used in older children and adults.

- In the resuscitation of infants, toddlers, and small children <20 kg, an efficient pump may be a 10 mL syringe, operated by a clinician, attached to traditional IV pump tubing, with a one-way valve is in place, and utilizing a pull-push technique.

- Massive transfusion is a strategy to deal with the bleeding critically ill trauma patient by administering large volume of blood products in a short period of time. It is a well-established practice in the adult population. Massive transfusion in pediatrics is based on institutional protocols.

Explain diagnosis and management to caregivers (synthesis)

- In a difficult and stressful environment, compassionate and clear communication with caregivers is critical, as they are strong partners in the treatment of their children. This should not impede lifesaving treatment, but if at all possible, a member of the treatment staff should be assigned to stay with parents and explain various interventions. Failure to provide a communication liaison may result in anxious parents that may obstruct care. The decision to transfer to a higher level of care and need for transport with Advanced Life Support services should be explained.

Develop a plan for transfer to a trauma center for definitive management (synthesis)

- For a multisystem trauma, care at a designated level I trauma center should be considered based on State Trauma policy and guidelines for interfacility transfer with appropriate consent and EMTALA documentation.

- When a regional pediatric referral center is available within the trauma system, the most severely injured children may be transported to a facility with a level I or II pediatric trauma designation.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

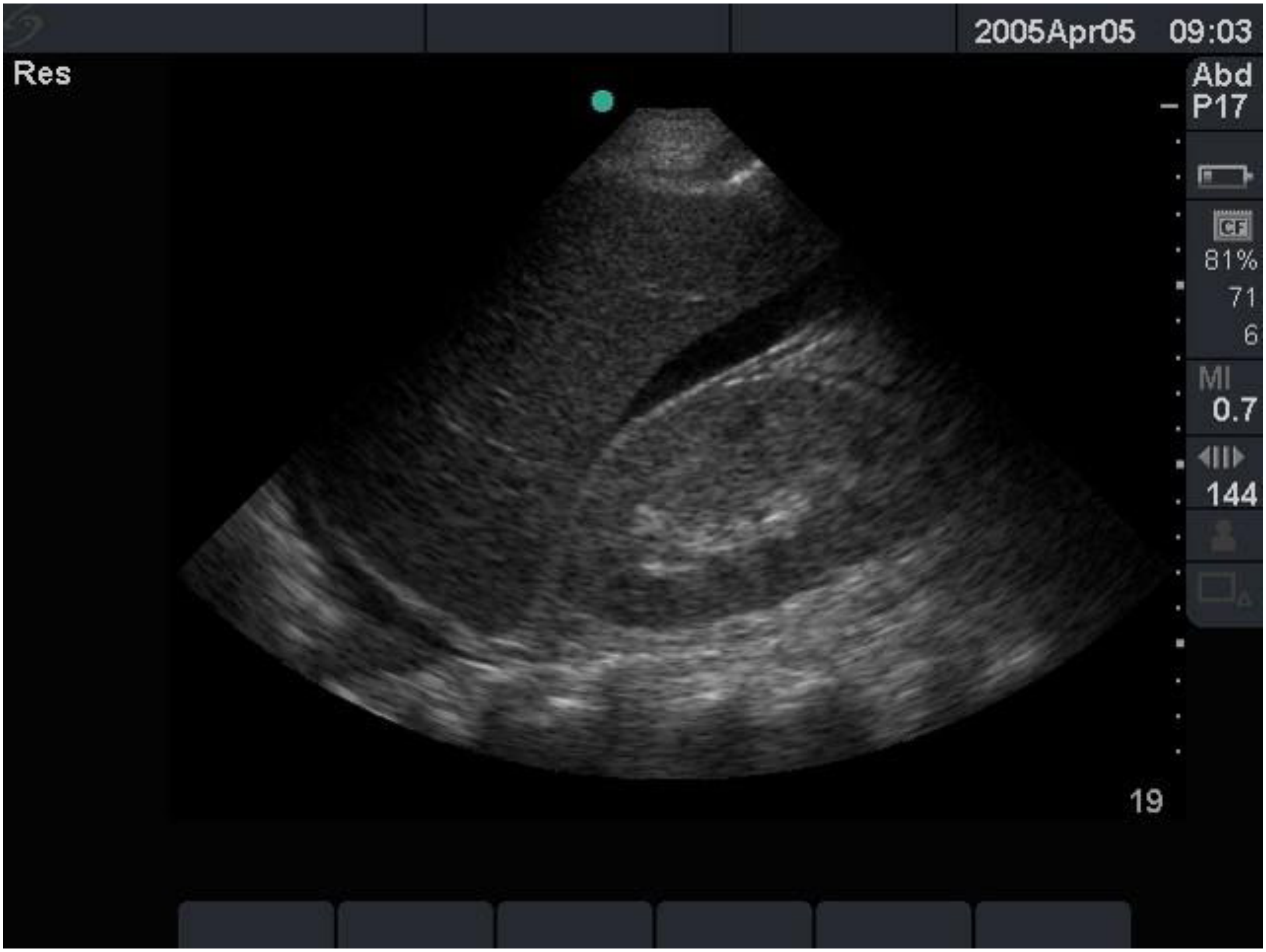
Supporting Files

eFAST Images
1a: Subxiphoid view

Supporting Files

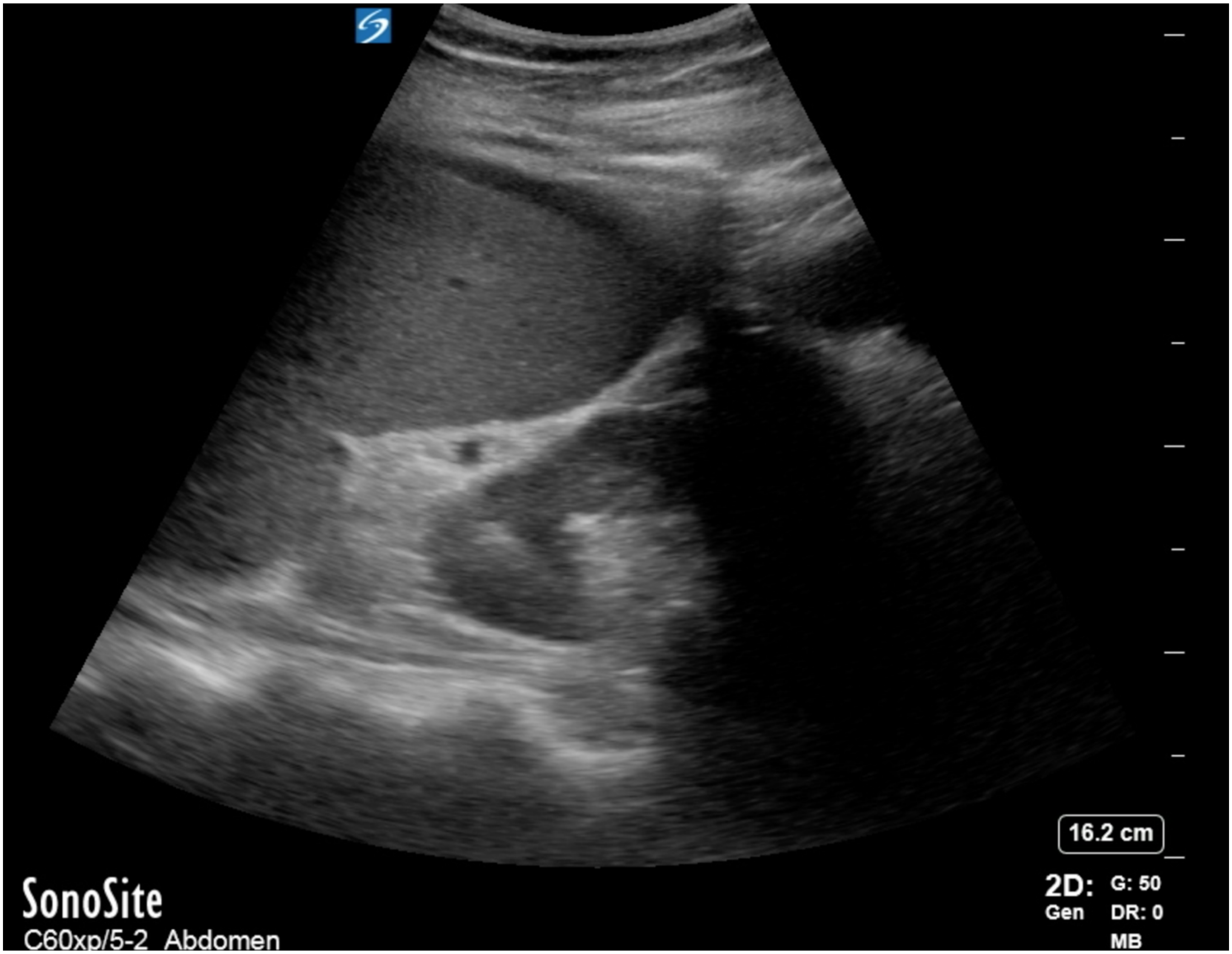
eFAST Images

1b: Right Upper Quadrant view



Supporting Files

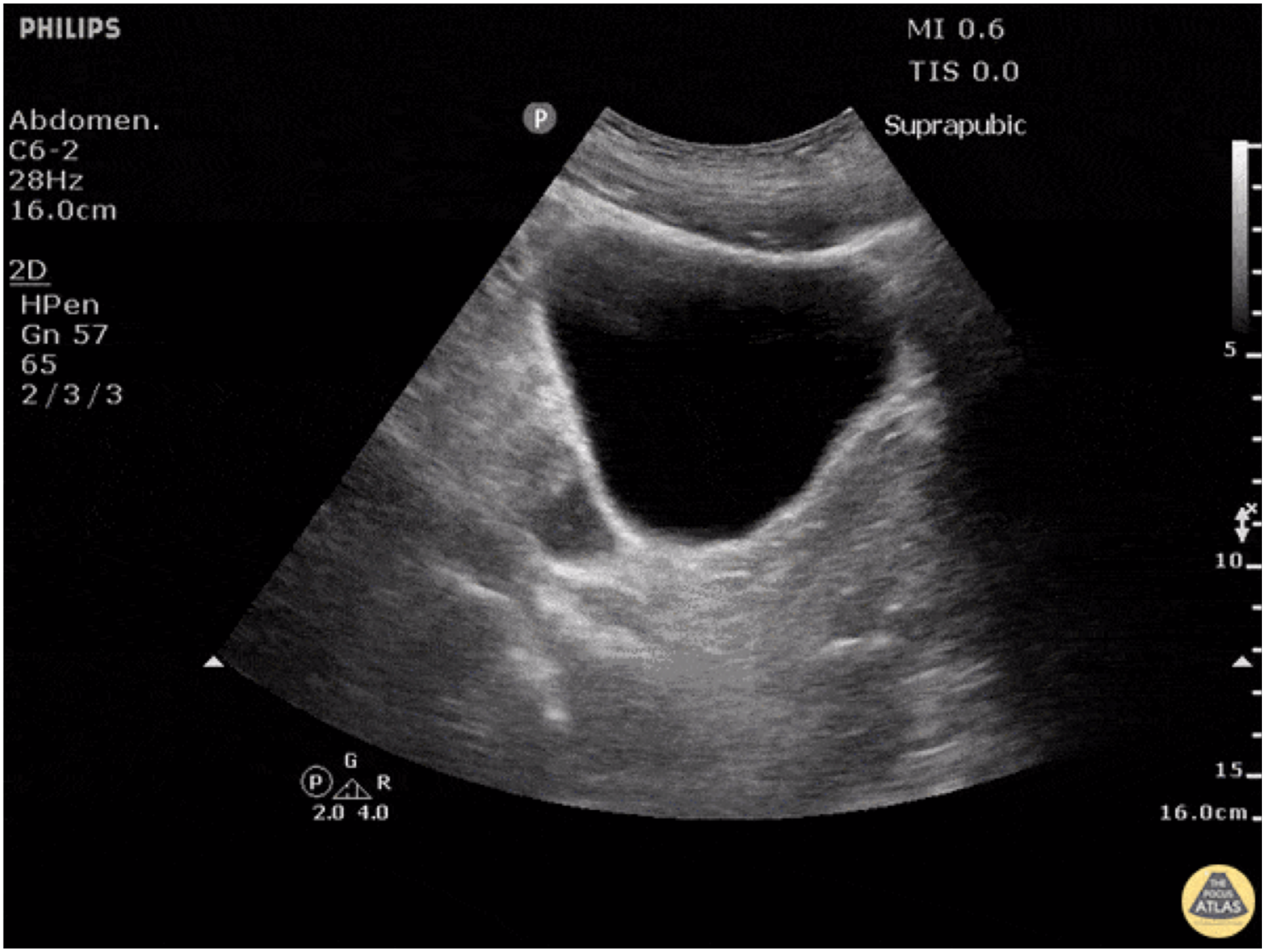
eFAST Images
1c: Left Upper Quadrant view



Supporting Files

eFAST Images

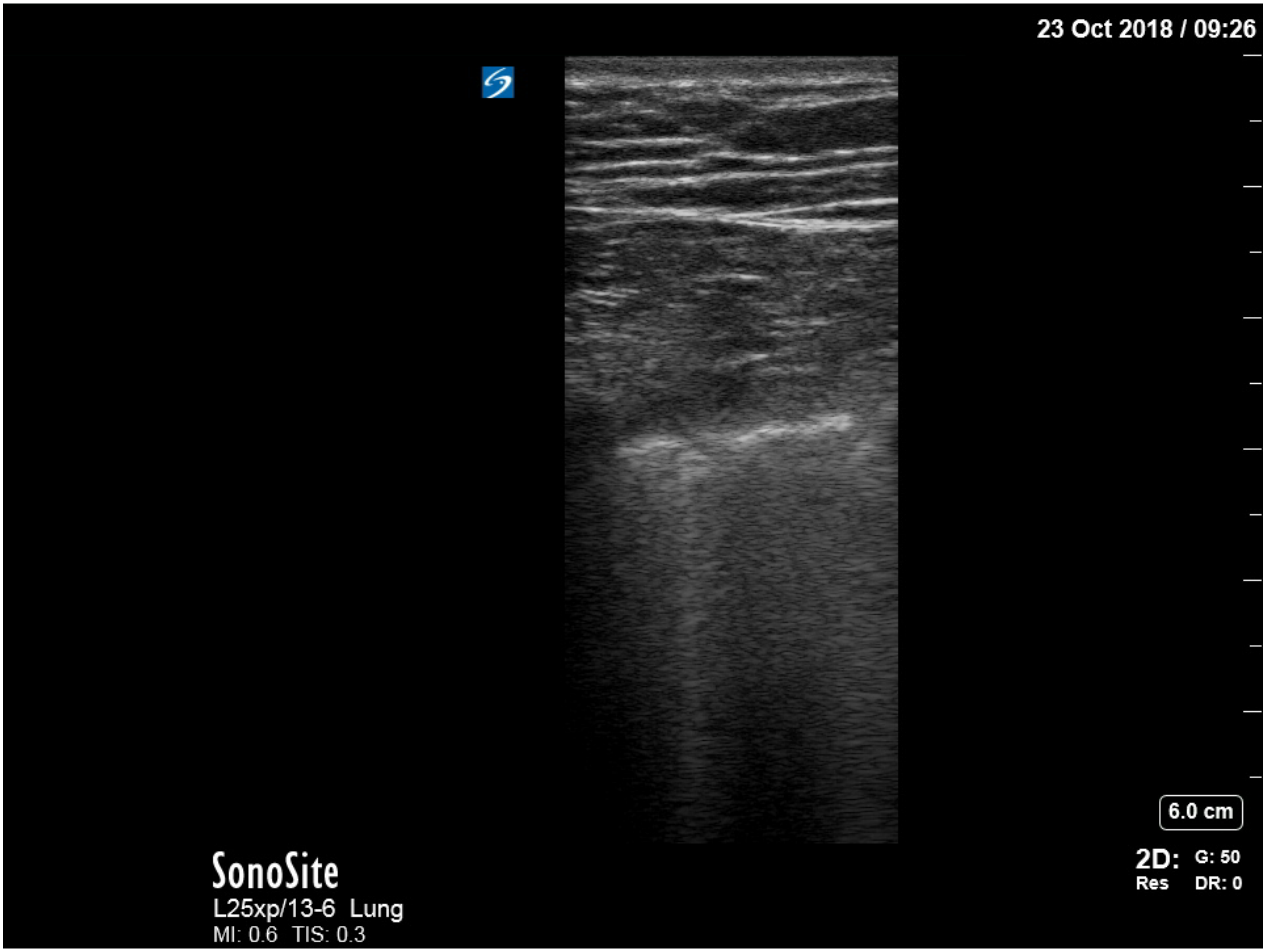
1d: FAST Suprapubic view



Supporting Files

eFAST Images

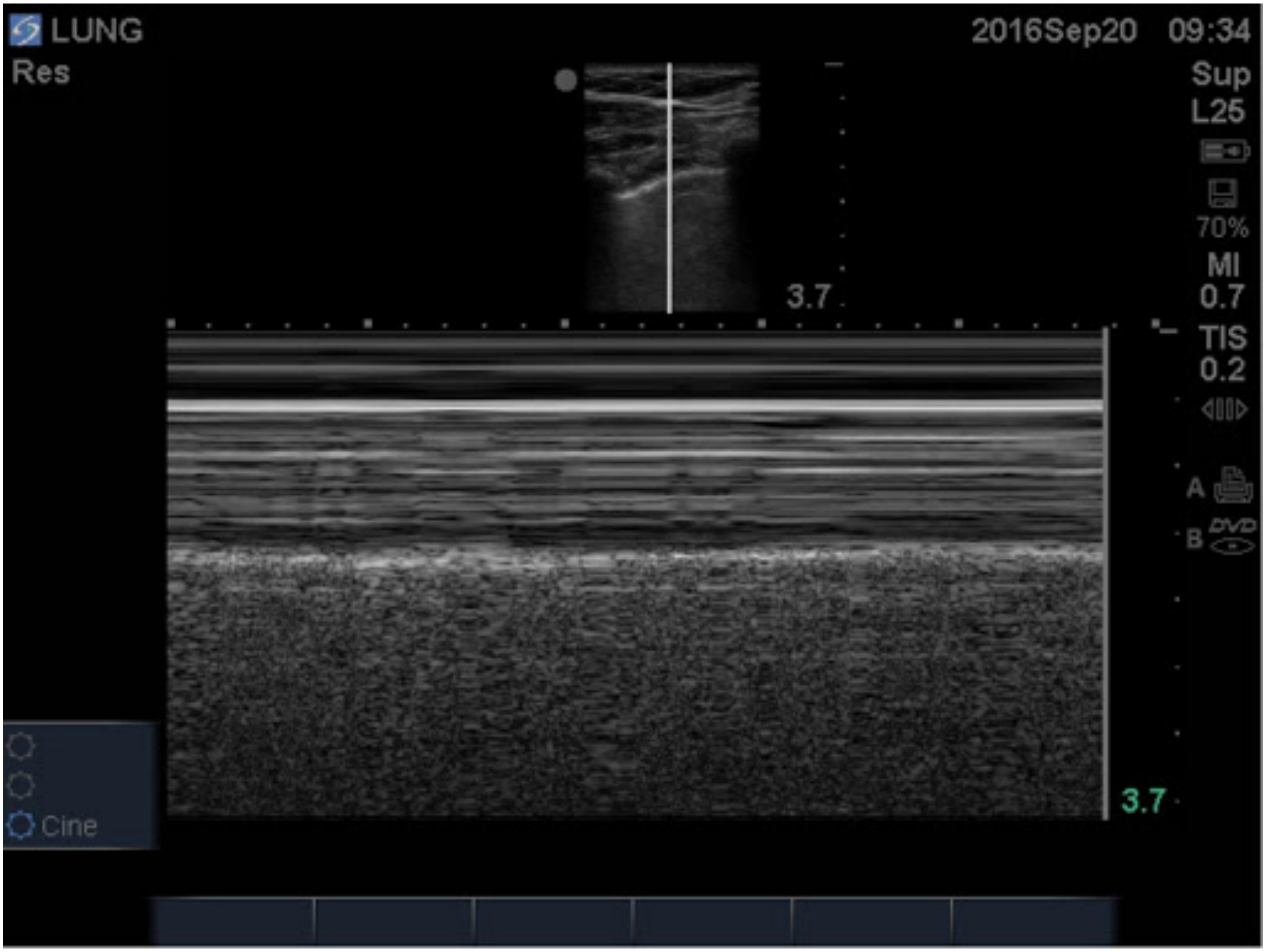
1e: FAST Lung view



Supporting Files

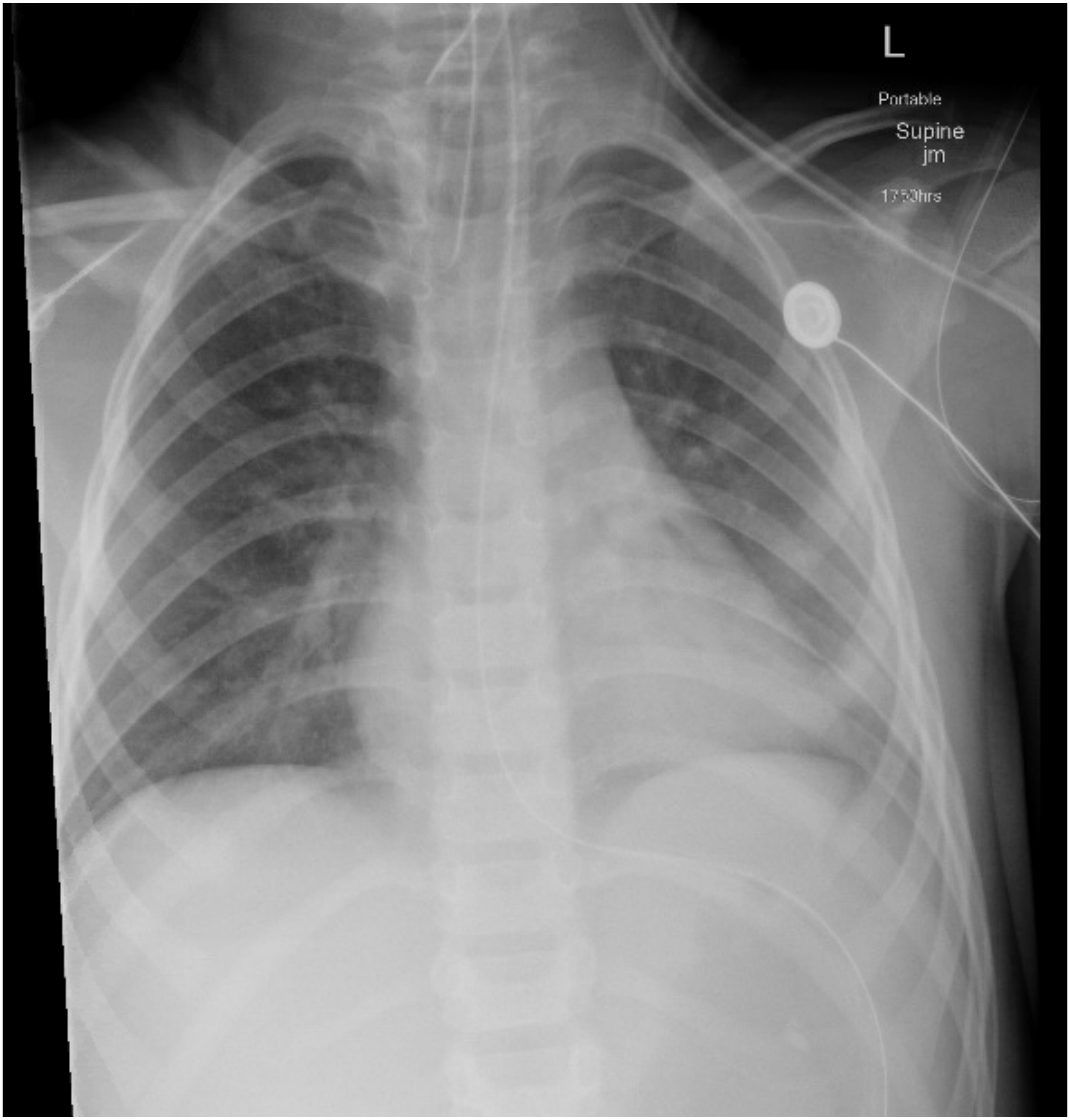
eFAST Images

1f: E-FAST M-mode view



Supporting Files

Chest X-Ray



Supporting Files

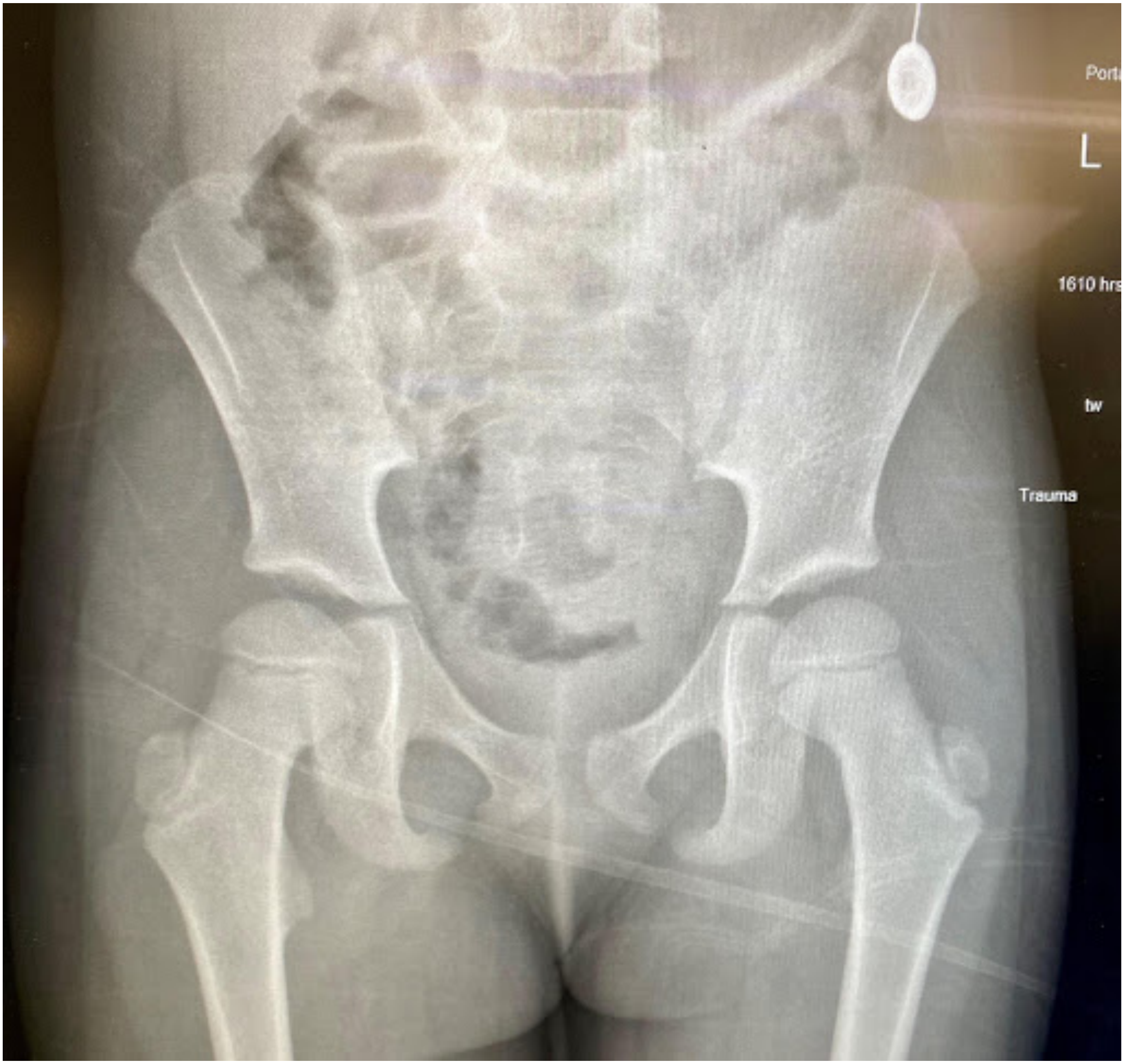
Tibia-Fibula X-ray

Supporting Files

Tibia-Fibula X-ray

Supporting Files

Pelvis X-ray



Supporting Files

Notes

E-FAST Interpretation
Positive for intraperitoneal fluid, no pericardial fluid, no pneumothorax. Images from Dr. Kevin Roth.

Chest X-ray
Pulmonary contusion and endotracheal tube in proper position. Image from Dr. Manu Madhok.

Tibia-Fibula X-ray
Tibia-fibula fracture. Image from Dr. Manu Madhok.

Pelvis X-ray
Normal pelvis x-ray. Image from Dr. Manu Madhok.

Supporting Files

Lab Results

Point of Care

Venous Blood Gas

LABORATORY TEST	VALUE	UNITS
pH	7.316	
pCO_2	46	mmHg
pO_2	40	mmHg
HCO_3	18	mEq/L
O_2 sat	70	%

Supporting Files

Lab Results

Basic Metabolic Panel

LABORATORY TEST	VALUE	UNITS
Sodium	139	mEq/L
Potassium	4.7	mEq/L
Chloride	101	mEq/L
Bicarbonate	18	mEq/L
BUN	17	mg/dL
Creatinine	0.8	mg/dL
Glucose	99	mg/dL

Supporting Files

Lab Results

Complete Blood Count

LABORATORY TEST	VALUE	UNITS
Hemoglobin	2.7	g/dL
Hematocrit	38	%

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant playing the patient's parent

Case Background Information

Your daughter has just been hit by a car. You saw it happen and you immediately picked her up and took her to the nearest Emergency Department (ED). She has numerous injuries that need to be addressed.

This ED is not a Level 1 Trauma Center. Level I Trauma centers will provide the most comprehensive care of your daughter's injuries. The learners will have to stabilize her first (give IV fluids and place a tube in her airway), and then arrange transfer for her to go to the Level 1 Trauma Center.

Who are the Learners?

Emergency medicine residents
This case is specifically aimed at residents who have fair knowledge/experience caring for critically injured children. They should be competent regarding any emergency procedures your daughter needs. Because she has numerous injuries, they may have trouble figuring out what order they should take each action/decision.

Also, this case asks the residents to work in an environment that cannot provide definitive care for your daughter. Residents don't typically train in this environment, so they might not know if/when they should arrange transfer to a Level 1 Trauma Center.

Standardized Patient Information

Your demeanor is concerned but relatively calm. You do not want to obstruct care but want to know what is happening. Do not interrupt them if they are thinking out loud or discussing care with one another but ask questions when possible if they don't explain what they are doing.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you? Or "what happened?"): "It happened so fast! She was playing in the front yard. The ball rolled into the street. Before I had a chance to do anything, she ran after the ball into the street and a car hit her. We live close to the hospital, so I drove her straight here."

- AGE: 6 years old

- PAST MEDICAL HISTORY: Asthma

- SOCIAL HISTORY: No pets. No smokers. Attends school. Lives with both parents and younger brother.

- FAMILY HISTORY: Father has asthma

- PAST SURGICAL HISTORY: None

- MEDICATIONS: Albuterol every 4 hours, as needed

- ALLERGIES: Amoxicillin gives her a rash

- IMMUNIZATIONS: Up-to-date

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:

- "Is she breathing?"
- "Is she in a coma?"
- "Is she bleeding internally?"
- "Why is her leg bent like that?"
- "Is she going to be OK?"

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
If they order a CT scan prior to arranging transfer	"What will the CT scan tell you?" Keep pursuing this line of questioning until the learners inform you that she can have injuries that require management by a specialist (i.e., trauma surgeon, neurosurgeon, or pediatric critical care doctor).
If the learners inform you that she needs to be managed by a specialist	"Will that doctor come here? To this hospital?"
If the learners continue to insist on getting additional tests, like CT scans, before transfer	"Does this mean she's getting better? That she doesn't need to be transferred?"

Simulation Case 8

Myocarditis

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Updated September 4, 2020

Setup

Chief complaint: Lethargy, shortness of breath
Patient age: 10 years old
Weight: 32 kg

Brief Narrative Description of Case

This 10-year-old male presents in cardiogenic shock. History reveals a preceding viral illness. Initial management with supplemental oxygen (O_2) and intravenous fluids (IVF) will only marginally improve the patient. Physical exam findings (crackles on lung exam, palpable liver edge) and diagnostic test results (chest x-ray with cardiomegaly, pulmonary edema; bedside ultrasound with diminished left ventricular function) will reveal that the patient is in cardiogenic shock.

To stabilize the patient, learners will need to perform stabilization and start inotropic medication. (For advanced learners, the patient will go into ventricular tachycardia (VT) after intubation). Ideally, they should obtain an echocardiogram and a cardiology consult. Case concludes when care is transferred to the pediatric intensive care unit (PICU).

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Describe the signs/symptoms of shock in a child **(comprehension)**
2. Demonstrate early evaluation of a critically ill patient **(application)**
3. Construct a differential diagnosis for shock in a pediatric patient **(synthesis)**
4. Interpret the signs/symptoms of myocarditis **(evaluation)**
5. Compare and contrast the signs and symptoms of cardiogenic shock related to other causes of shock **(evaluation)**
6. Construct and implement initial medical management of cardiogenic shock **(application)**
7. Demonstrate focused history taking from a caregiver **(application)**
8. Explain diagnosis and management to caregivers **(synthesis)**

9. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

- Assemble team in the patient room upon recognition of a critically ill child
- Assign/assume team roles
- Perform primary assessment
- Administer supplemental oxygen
- Place patient on continuous cardiac monitor
- Obtain IV access and initiate IVF
- Obtain history from parent
- Perform focused physical exam
- Order appropriate diagnostic tests (lab, ECG, CXR, echo)
- Verbalize the recognition of cardiogenic shock
- Start inotropic agent (e.g., epinephrine, dobutamine, norepinephrine, milrinone)
- Verbalize concern for myocarditis
- Consult pediatric cardiology
- Transfer care of the patient to the pediatric ICU
- Address parental concerns and questions

Recommended Supplies

- **Manikin:** child
- **Moulage:** none
- **Resources:** PALS cards and/or length-based tape (e.g., Broselow Tape)
- **Manikin set up:** No access in place at start of case, drain bag in place
- **Equipment:**
    - IV supplies
    - Cardiac monitor
    - Ultrasound machine
    - Pediatric Airway Equipment:
        - Nonrebreather mask
        - End tidal CO_2 monitor
        - BMV with different size masks
        - Oxygen tubing
    - Non-invasive positive pressure such as BiPAP

- **Medications:**
  - Epinephrine – code dose and drip
  - Dobutamine
  - Norepinephrine
  - Milranone
  - Antibiotics
  - Crystalloid (e.g., normal saline)

Supporting Files

- CXR: Cardiomegaly, pulmonary edema
- ECG: Left axis deviation, with non-specific ST segment changes
- Labs
- Echocardiogram: Poor LV function

Participants/Roles

- Team leader
- Airway manager
- Survey physician
- Medication preparer
- Medication giver
- Family liaison/history taker
- Standardized patient (actor or faculty) to play patient's parent

** Team roles may need to be adjusted in order to suit local practices and norms*

Faculty or other embedded participants can play a nurse, respiratory therapist, or tech, if there are not enough learners to perform the above roles.

Prerequisite Knowledge

- **Faculty**
  - PALS protocols
  - General knowledge of emergency medicine
  - Simulation implementation and debriefing experience

- **Emergency medicine residents**
  - Any stage of training (preferably PGY-2 or higher)
  - Completed PALS certification

- Bedside cardiac ultrasound knowledge

Case Alternatives

Patient could go into cardiac arrest at several points during the case:

- If team attempts intubation, especially if inotropic medication have not been given
- Anytime during the case, the patient may go into a ventricular arrhythmia without pulses requiring 1 round of epinephrine and 1 round of unsynchronized defibrillation at 2 J/kg.

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC3. Diagnostic Studies
PC4. Diagnosis
PC5. Pharmacotherapy
PC7. Disposition
PC 12. Goal-directed Focused Ultrasound (Diagnostic/Procedural)
ICS1. Patient Centered Communication
ICS2. Team Management

Resources
1. Canter CE, Simpson KE. Diagnosis and treatment of myocarditis in children in the current era. Circulation. 2014;129:115-128. PMID: 24396015
2. Tunuguntla H, Jeewa A, Denfield SW. Acute myocarditis and pericarditis in children. Pediatric in Review. 2019;40:14-25. PMID: 30600275
3. Horeczko T. Myocarditis. Pediatric Emergency Playbook. 2019.

Initial Presentation

ITEM	FINDING
Overall Appearance	10-year-old, tachypneic, pale and tired appearing
HPI	The patient arrives by private vehicle accompanied by mother and/or stepfather (married to mother). Gender of this parent is based on the availability of the standardized patient. Notably, the patient has been triaged as a level 3 (moderate acuity). The patient is not on the monitor. The only adult in the room is the parent. "We picked him up from his biological father's place today. He has just been extremely tired and looks like he doesn't feel well." If the learner asks for more specifics: • "He seems to be breathing faster, so I gave him an albuterol treatment (2 puffs) but that doesn't seem to have helped." • "He was sick with a cold about two weeks ago." • "He was at his biological father's this weekend. We picked him up, and our son said his stomach and chest hurt and he didn't feel well. He went to lie down. When we checked on him, he looked pale and unwell, so I brought him here." ROS: • Vomited once • Chest pain that is not positional or pleuritic • Shortness of breath • Abdominal pain (RUQ) • Tired • No rash, fevers, behavior changes, headache, or neck pain

Initial Presentation (continued)

ITEM	FINDING
Past Medical/Surgical History	• Well controlled intermittent asthma • No hospital admissions • No surgical history
Medications	Albuterol every 4 hours, as needed
Allergies	None
Family History	None
Social History	Parents do not live together, and patient spends time at each house • No smoking/vaping • Attends school • No pets

Stage 1

Begin Simulation (Stage 1 of 4)

Cardiogenic Shock (Initial Presentation):
Start through review of ECG and/or CXR

CRITICAL ACTIONS

- Team leader identifies patient is high acuity
- Team leader asks for help and assigns roles
- Obtain history from parent
- Perform primary survey
- Administer supplemental oxygen
- Place patient on continuous cardiac monitor
- Obtain vascular access
- Perform focused physical exam and recognizes right sided crackles (+/-liver edge)
- Order diagnostic tests (ECG, CXR, labs)
- Verbalize recognition of compensated shock from exam and monitors
- Discuss progress and plan of care with the parent (and involves them in decision-making)

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.5°C, **HR:** 130, **BP:** 82/50, **RR:** 40, **SpO_2:** 92% on room air
General	Tired, tachypneic
HEENT	Normal
Neck	Normal

Physical Exam (continued)

ITEM	FINDING
Lungs	No retractions, wheezes, or grunting; tachypneic with crackles bilaterally at the bases
Cardiovascular	Tachycardic, gallop, 1+ pulses, capillary refill 5 seconds
Abdomen	Hepatomegaly present, soft, focal mild tenderness to palpation in the right upper quadrant
Neurological	Responds to voice but one word answers (GCS 15), no abnormalities, PERRL
Skin	Pale, cool, mottled, diaphoretic, delayed capillary refill 5 seconds
Other Relevant System	No edema

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Team attempts IV line		IV successfully placed
No oxygen given in 5 minutes	SpO_2 88%, RR 50	Nurse: "The patient appears hypoxemic!"
Supplemental oxygen given	No change in SpO_2	
No fluid given in 5 minutes	HR 130, BP 75/40	Nurse: "Should we do anything about the blood pressure?"
10-20 mL/kg crystalloid bolus given	No change in HR or BP	If learner recognizes physical exam findings concerning for cardiogenic shock, may do 10 mL/kg fluid

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
>20 mL/kg fluid given	SPO_2 88%, RR 55	Nurse: “He looks like he’s having more trouble breathing”
If albuterol attempted	HR 130, RR 50, no improvement in exam	Nurse: “I don’t think that helped”
Learners order bedside glucose	No change	Result is 90 mg/dL
Learners order bedside blood gas	No change	VBG • pH 7.31 • pCO_2 36 mmHg • pO_2 68 mmHg (80 on oxygen • HCO_3 18.1 mEq/L • Lactate 4.6 mg/dL • Na 138 mEq/L • K 4.8 mEq/L • Bicarb 8 mEq/L
Learners order other labs such as CBC, electrolytes, troponin, ESR, CRP	No change	Labs are pending
Learners order ECG and/or CXR	Allow time to review diagnostic tests, then proceed to **Stage 2**.	

Stage 2

Cardiogenic shock (Decompensated):
Review diagnostic tests through initiation of vasopressors
OR intubation without vasopressors

CRITICAL ACTIONS

- **Verbalize the recognition of cardiogenic shock**
- Perform bedside cardiac ultrasound
- **Start pressor/inotropic agent (e.g., epinephrine, dobutamine, norepinephrine, milrinone)**

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.5°C, **HR:** 135, **BP:** 75/40, **RR:** 50, **SpO_2:** 92%
Exam Changes	• Worsening crackles, now diffuse bilaterally • Tachypnea worse

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
>20 mL/kg total fluid given	SpO_2 88%, RR 55	
Learners do not recognize worsening physical exam	No change	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Learners do not verbalize the recognition of cardiogenic shock	No change	
Learners place ultrasound probe in appropriate location of mannequin's chest to obtain cardiac views	No change	
Vasopressors/inotropes initiated (epinephrine or dobutamine drip)	• Capillary refill improves to 3 seconds • Color improves 1 minute after initiation of drip. • Respiratory rate decreases to 40. • HR decreases to 130. • If vasopressors/inotrope started, progress to **Stage 4**.	The cardiologist (embedded participant) could be consulted to help with pressor choices
CPAP or BiPAP started	SpO_2 92%, RR 30, improved respiratory effort	
Intubation without vasopressors	Proceed to **Stage 3** (ventricular tachycardia).	Alternately, for more advanced learners, **Stage 3** is inevitable.

Stage 3

Ventricular Tachycardia With Pulses:
Initiation of vasopressors (or intubation without vasopressors) through synchronized cardioversion with vasopressors

CRITICAL ACTIONS

- Place defibrillator pads on patient
- Perform synchronized cardioversion

Physical Exam

ITEM	FINDING
Vital Signs	**BP:** 65/30, **HR:** 150
Exam Changes	• Ventricular tachycardia with HR 150 on the monitor • Thready pulse

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Learners do not recognize the rhythm change		Nurse: “Look at the monitor!” or “The patient’s blood pressure is worse.”
Learners cardiovert with less than 2 J/kg	No change	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Prior to shock delivery, the defibrillator is set to over 10 J/kg or NOT set to synchronized		Nurse: "I think we should recheck the defibrillator settings."
Synchronized cardioversion with at least 2 J/kg AND the patient is not on vasopressors	Rhythm changes to sinus rhythm at a rate of 150 bpm. BP 75/40.	
Synchronized cardioversion with at least 2 J/kg AND the patient has been placed on vasopressors	Proceed to **Stage 4**	

Stage 4

Stabilization and Conclusion:
After pressors started (or optionally after cardioversion)

CRITICAL ACTIONS

- **Verbalize concern for myocarditis**
- **Consult pediatric cardiology**
- Transfer care of the patient to the pediatric ICU
- **Address parental concerns and questions**

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**HR:** 130, **BP:** 95/60, **RR:** 45, **SpO_2:** 100%
Exam Changes	• Patient appears more comfortable • Color improved • Capillary refill now 3 seconds

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Learners request cardiology or PICU consult	No change	Facilitator fills the role of consultant. If learners do not state a differential diagnosis, ask: "What do you think is going on?"

Ideal Scenario Flow

The team enters the room and immediately recognizes that the patient appears to be sick with evidence of shock. They place the patient on oxygen and call for additional support. The team completes a physical exam and recognizes crackles and hepatomegaly. An IV is placed, and 10-20 mL/kg fluid bolus is given for shock. The team recognizes a worsening exam after the IV fluid bolus and orders a CXR, ECG, and echocardiogram because of the concern for myocarditis. Non-invasive position pressure may be initiated. They initiate inotropic medication for cardiogenic shock. For advanced learners, the patient may progress to ventricular tachycardia requiring defibrillation. The team then discusses the case with cardiology and/or PICU and transfers the patient to the appropriate level of care. The parents are kept aware of medical decision making throughout the encounter.

Anticipated Management Mistakes

1. **Failure to recognize cardiogenic shock vs septic shock:** This may be expressed several ways. For example, the learners may only treat the patient with IV fluids and antibiotics. The faculty and standardized patient should be prompted to ask the learners "what else could be going on?" "Is there anything else you can do about the blood pressure?" "Can an infection really do all of this?"

2. **Preoccupation with intubating the patient:** Children with cardiogenic shock are at high risk for arrest during RSI due to decreased preload and cardiac output. This should only be performed emergently when loss of life is an imminent risk. Otherwise, the risk, benefits, and back-up plan should be discussed with a pediatric cardiologist first.

Debriefing Points

Describe the signs/symptoms of shock in a child (comprehension)

Children tend to compensate well initially. In compensated shock, homeostatic mechanisms help maintain systolic blood pressure within the normal range for age. To compensate, the heart rate will increase, and peripheral vasoconstriction occurs. Findings on exam may include delayed capillary refill, diminished pulses, and cool extremities. Urine output decreases as perfusion to the kidneys decreases. Once compensatory mechanisms have been exhausted, uncompensated shock occurs. Systolic hypotension and altered mental status from brain hypoperfusion occur. Decreased respiratory drive can occur as cardiovascular collapse ensues

Demonstrate early evaluation of a critically ill patient (application)

Learners should approach a critically ill patient in a standardized fashion. Airway, breathing, and circulation should be assessed immediately. Interventions such as airway repositioning/adjuncts, BMV, and CPR should be started concurrently, if required. After A, B, C have been addressed, the patient should be evaluated for disability and exposed for a thorough head to toe exam. In pediatrics, people often say that D also stands for “don’t forget the dextrose” as a blood glucose level should be checked in any child with altered mental status.

Construct a differential diagnosis for shock in a pediatric patient (synthesis)

The 4 general categories of shock include distributive (warm shock), hypovolemic, obstructive, and cardiogenic (typically cold shock). Sepsis is the most common cause of distributive shock in children. Anaphylactic shock may present with or without a previously known allergy. Neurogenic shock is very rare in children. Hypovolemic shock is the most common cause of pediatric shock worldwide. Obstructive shock may present in the setting of the ductus arteriosus closing in the presence of a ductal dependent lesion (e.g., coarctation, hypoplastic left heart) or from acute obstruction of cardiac outflow (e.g., tension pneumothorax, tamponade, massive pulmonary embolism). Cardiogenic shock may occur from either an arrhythmia that leads to insufficient cardiac output or from a cardiomyopathy (genetic, infectious, infiltrative, ischemic) including myocardial depression related to sepsis.

Interpret the signs/symptoms of myocarditis (evaluation)

The signs and symptoms of myocarditis are usually vague initially and similar to those of viral syndromes. Many children less than 10 years old will experience respiratory (e.g., cough, shortness of breath, tachypnea) and/or GI symptoms (e.g., abdominal pain, nausea, vomiting). Children older than 10 years often complain of symptoms that are more obviously cardiac in origin such as palpitations, chest pain, and syncope. General symptoms such as lethargy and fever may also be reported.

There is no specific laboratory test for myocarditis. AST will be elevated in a majority of cases (85% of patients), due to hepatic congestion. Troponin and BNP are elevated in a majority of cases, but not all, so a negative test does not rule out the disease. Inflammatory markers might be elevated. A chest radiograph is abnormal in approximately 50% of children with myocarditis and may show cardiomegaly and/or pulmonary edema/venous congestion. An ECG is usually abnormal, but changes are generally non-specific. It may reveal diminished voltage, ST segment or T-wave changes, atrial or ventricular enlargement, premature beats, or heart block. An echocardiogram usually shows impaired ventricular function. Definitive diagnosis is often made by endomyocardial biopsy.

Compare and contrast the signs and symptoms of cardiogenic shock relate to other causes of shock (evaluation)

While cardiogenic shock shares many features of other causes of shock (tachycardia, hypotension, altered mental status, lactic acidosis, decreased urine output), some features are more suggestive of a cardiac etiology. These include signs of “pump failure” such as a gallop (typically S3), pulmonary edema, hepatomegaly. An elevated JVP may be seen in older children/teenagers but is often difficult to impossible to appreciate in young children due to the size and shapes of their necks. The patient will likely demonstrate further deterioration with aggressive fluid boluses, highlighting the importance of reassessment of interventions and smaller fluid boluses (10 mL/kg), if cardiogenic shock is suspected.

Construct and implement initial medical management of cardiogenic shock (application)

Initial management should be aimed at increasing cardiac output. In the case of a ductal-dependent lesion, PGE-1 should be started expeditiously. In the setting of decreased myocardial functioning, inotropes may be used to increase cardiac output while vasopressors may help maintain systemic venous return. Epinephrine, dobutamine, and milrinone will all increase output while norepinephrine will promote SVR. Dopamine has been associated with increased mortality in cardiogenic shock compared to norepinephrine (study in adults). Decreasing metabolic demand is also an important initial step. Fever should therefore be treated. Positive pressure ventilation including potential intubation may be required. However, catastrophic myocardial depression may occur during induction and therefore non-emergent intubation should be done in consultation with a pediatric cardiologist.

Demonstrate focused history taking from a caregiver (application)

The history should be focused during the initial evaluation and explore possible etiologies of shock. The symptoms of cardiogenic shock are often vague so review of systems should focus on recent cardiac, pulmonary, and GI symptoms. Inquiry should focus on recent illnesses/infection symptoms, potential exposure to ingestions or toxins, and potential causes of immunocompromise. A vaccination history should be obtained. Medications and allergies should be inquired about, just like for all patients.

Explain diagnosis and management to caregivers (synthesis)

If personnel are available, one member of the team may stay with the family to gather history and explain interventions. Information should be relayed to the family using layperson's terms. The rationale for invasive interventions such as IV placement should be explained preceding or at the time of occurrence, when possible. The results of diagnostic tests and imaging should be relayed to the family in a timely fashion.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

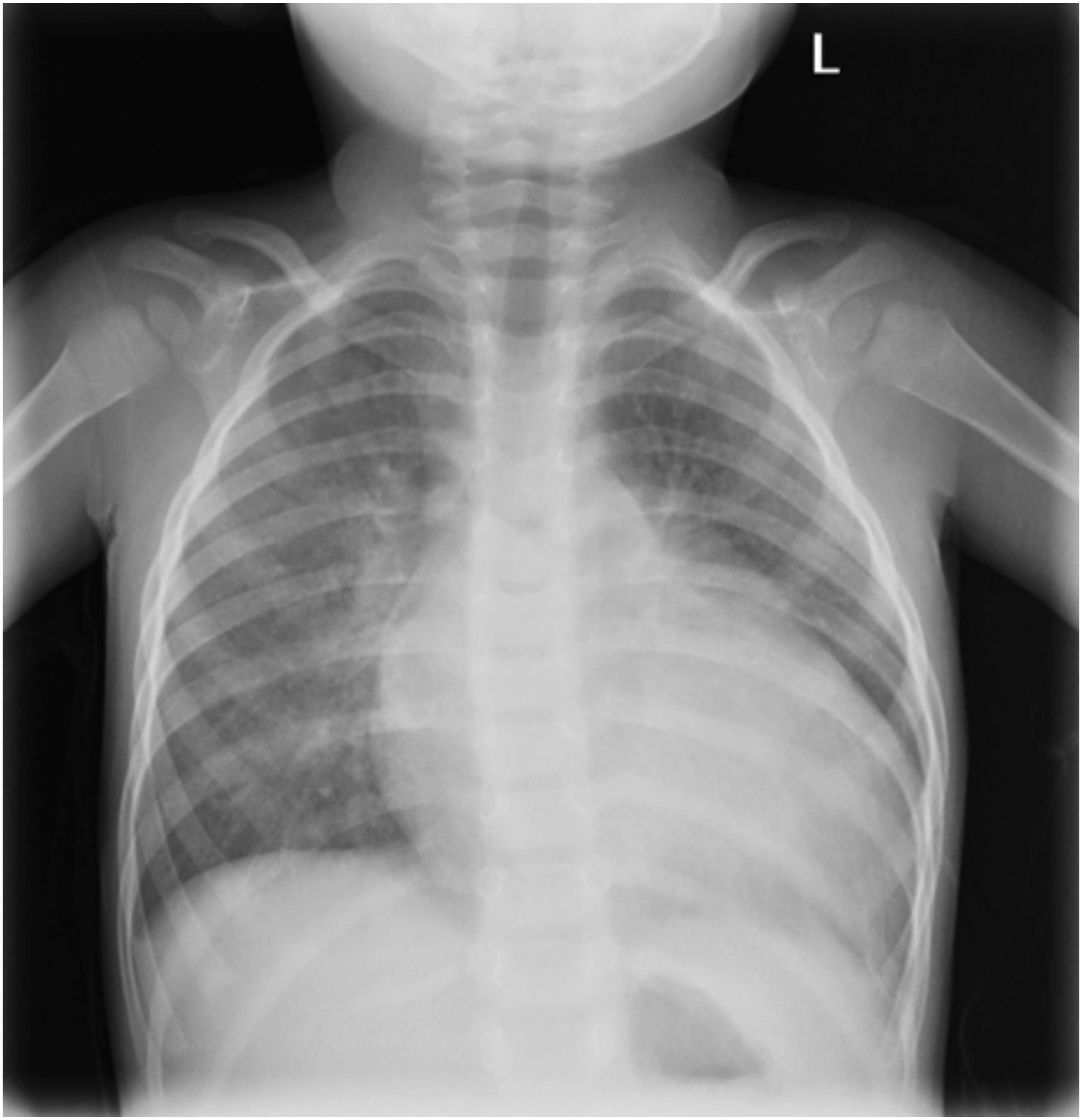
- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

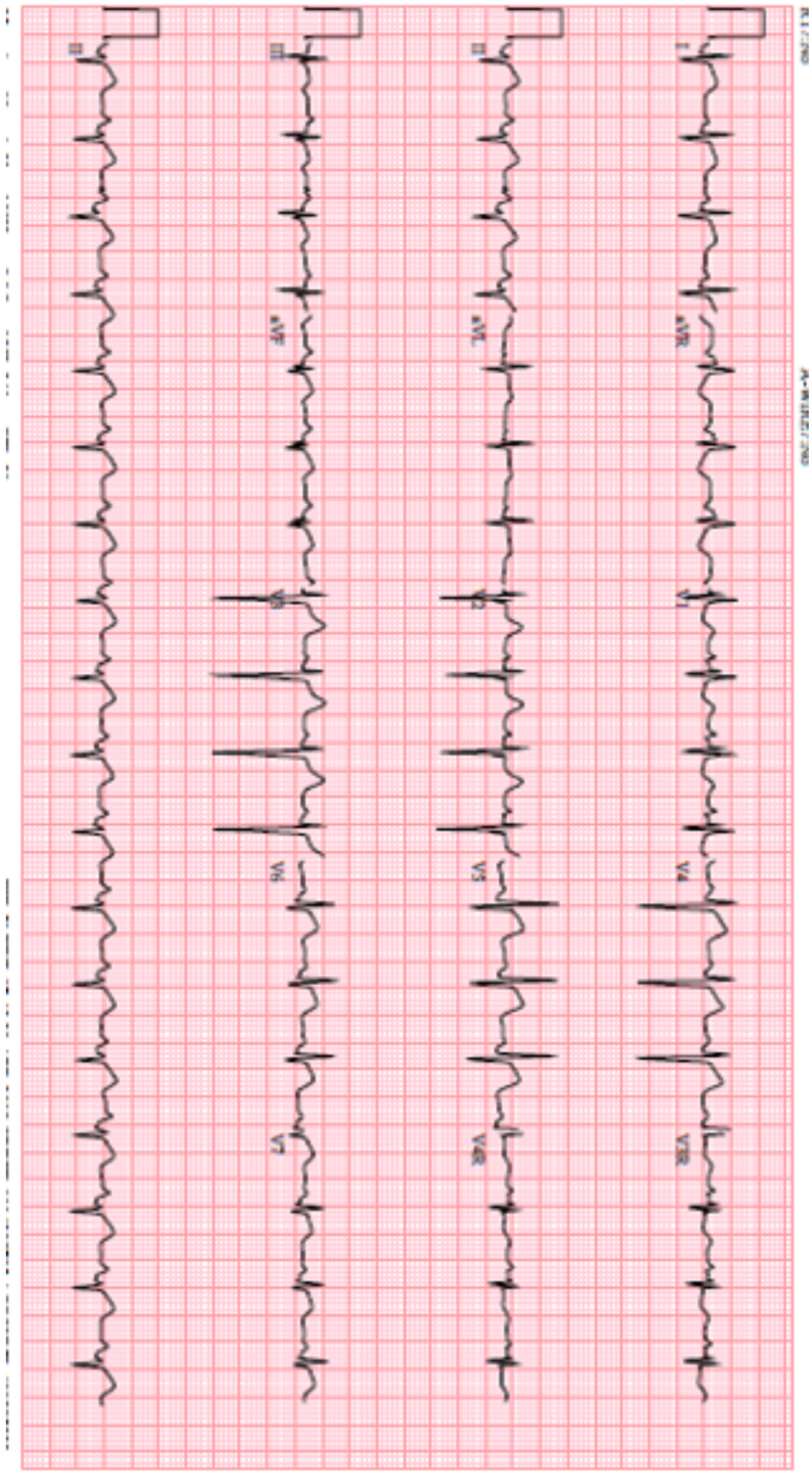
Supporting Files

Chest X-ray



Supporting Files

ECG



Supporting Files

Notes

CXR Interpretation
Chest x-ray with cardiomegaly and pulmonary edema. Image from Dr. Rebekah Burns.

ECG Interpretation
ECG with left axis deviation and non-specific ST segment changes. Image from Dr. Rebekah Burns. (Additional ECGs can be found at Life in the Fast Lane.)

Supporting Files

Lab Results

Venous Blood Gas

LABORATORY TEST	VALUE	UNITS
pH	7.31	
pCO_2	36	mmHg
pO_2	68 (80 on oxygen)	mmHg
HCO_3	18.1	mEq/L

Supporting Files

Lab Results
CBC with Differential

LABORATORY TEST	VALUE	UNITS
WBC	22.1×10^3	$/mm^3$
Hemoglobin	9.5	g/dL
Hematocrit	31.3	%
Platelets	388×10^3	$/mm^3$
MCV	75	fL/red
MCH	22.7	pg
MCHC	30.3	g/dL
RDW	17.5	%
Neut %	61	%
Bands %	7	%
Lymph %	23	%
Mono %	6	%
Eos %	0	%
Baso %	0	%

Supporting Files

Lab Results
Comprehensive Metabolic Panel

LABORATORY TEST	VALUE	UNITS
Sodium	132	mEq/L
Potassium	5.6	mEq/L
Chloride	96	mEq/L
Bicarbonate	17	mEq/L
BUN	33	mg/dL
Creatinine	0.2	mg/dL
Glucose	119	mg/dL
Calcium	9	mg/dL
CK	826	U/L
AST	85	U/L
ALT	65	U/L
Troponin	0.51	mcg/mL
Lactate	4	g/dL
CRP	23.3	mg/dL
ESR	30	mm/hr

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant playing the patient's parent

Case Background Information

Your son has myocarditis, or inflammation of his heart that can make it function poorly. This can come on after a viral infection and can have very vague symptoms. Oftentimes, children are fatigued, breathing fast, have low blood pressures, and appear pale because they are not able to circulate blood effectively due to their heart not pumping well. They can present similarly to how someone in shock due to an infection can look. The treatment for myocarditis is to start vasopressors that help improve cardiac output (the amount of blood pumped from the heart). It is important to avoid giving too much fluid because this can overload the heart. Sometimes this can happen when the diagnosis is not clear and learners are trying to treat shock due to infections. You are bringing your son to the Emergency Department because he has been very tired, short of breath, and pale appearing. He was at his father's house over the weekend so at first you thought he was just tired from too many activities; however, when he wouldn't wake up easily from a nap, and you noticed him breathing hard, you brought him to the ED.

Who are the Learners?

Emergency medicine residents

This case is specifically aimed at second year residents who have had one year of experience in gathering information from patients and families and performing standard medical treatments and procedures. They should be familiar with going through a differential diagnosis of the various things that may be going on and recognizing sick patients. They should also be familiar with keeping families informed of decision making and explaining interventions.

Standardized Patient Information

You brought your son to the emergency department because he is tired, not wanting to wake up and breathing fast. He was fine when you dropped him at his dad's house 2 days ago.

Your demeanor is concerned but more for an illness that may need some antibiotics by mouth, as opposed to anything too serious. You are confused as to why the patient needs so many people and interventions. Do not interrupt them if they are thinking out loud or discussing care with one another but ask questions when possible if they don't explain what they are doing. Voice concern as to whether the patient needs everything they are doing.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you? Or "what happened?"): "He just seems really tired and under the weather."

- AGE: 10 years old

- ADDITIONAL HISTORY: You first state that he was tired around 9 am but thought he had just stayed up late. He took a nap right when you picked him up from his dad's. Around noon you went to check on him because he hadn't woken up. He was cool and clammy and looked like he was breathing hard. At first, you thought he may have a cold virus and tried an albuterol treatment. This didn't seem to help too much, and he wanted to go right back to sleep. You decided to bring him in to be checked out. No other medication was given, and you didn't check a temperature at home. He had a cold a few weeks ago but seemed to be better prior to today.

- PAST MEDICAL HISTORY: Mild asthma

- SOCIAL HISTORY: Lives with you most of the time. Spends every other weekend with dad. Does not smoke.

- FAMILY HISTORY: Unremarkable

- PAST SURGICAL HISTORY: None

- MEDICATIONS: Albuterol every 4 hours, as needed

- ALLERGIES: No known allergies

- IMMUNIZATIONS: Up-to-date

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:

- "He just seems so tired."
- "Usually the albuterol helps but this time it didn't seem to."

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
If they place an IV	"Why does this have to be done? Usually we get antibiotics and go home."
After they place an IV	"What are you going to use that for?"
If they get a chest x-ray and ECG without explaining to you	"What is going on? Why does he need all of this? Do I need to be concerned?"

Simulation Case 9

Neonatal Delivery

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Updated September 17, 2020

Setup

Chief complaint: Neonatal delivery
Patient age: Neonate of unknown gestational age
Weight: 2.5 kg

Brief Narrative Description of Case

You are working a shift in your Emergency Department (ED) when you hear an overhead announcement that a woman who delivered a baby moments ago in the ambulance bay is being wheeled into the resuscitation bay. She is in notable distress, screaming in pain and yells “It happened so fast! Is the baby ok?! Oh, I’m in so much pain!” The nurses turn to you for direction.

The anticipated interventions of the Emergency Medicine (EM) resident are designed to include the ACGME milestones listed by The Emergency Medicine Milestone Project, listed below in bold:

1. **Team management** (ICS2): Call for stat obstetric (OB) and pediatric (Peds) help and newborn warmer bed (OB will arrive promptly leaving the EM resident to care only for the neonate until Peds arrives once the case learning objectives are met); utilization of TeamSTEPPS (see Debrief section) or other techniques for effective teamwork and communication used by your specific institution.

2. **Performance of Focused History and Physical** (PC2): Assess the neonate patient per the Neonatal Resuscitation Program (NRP) protocol (see Supporting File).

3. **Emergency Stabilization** (PC1) and **Medical Knowledge** (MK): Escalate care per NRP protocol to address the following medical and procedural learning objectives:
    - **Airway Management** (PC10): Respiratory distress, bradycardia, and hypoxemia requiring positive pressure ventilation (PPV) and/or continuous positive airway pressure (CPAP)
    - **Pharmacotherapy** (PC5), **General Approach to Procedures** (PC9), and **Other Diagnostic and Therapeutic Procedures** (PC14): Hypoglycemia that requires emergent umbilical

venous catheter (UVC) placement (see Supporting File) and administration of D10 bolus; hypothermia requiring warming bed, blankets, hat
- **Patient-centered communication** (ICS1): Effectively and sensitively communicate with the new mom that her infant is critically ill and will be transferred to the NICU for ongoing evaluation and management

Overall topics in this scenario include: Neonatal resuscitation (NRP) (AR11), diagnosis and management of neonatal hypoglycemia (EN03), effective communication with parents (ICHP01), delivering bad news (ICHP08), recognize a sick child (SS01), basic airway maneuvers, including appropriate positioning based on pediatric anatomy (AR01), bag valve mask ventilation (AR05), and installation of umbilical artery or vein catheter (CP3_05).

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Demonstrate post-delivery resuscitation of a neonate following NRP guidelines **(application)**
2. Demonstrate early evaluation of a critically ill patient **(application)**
3. Demonstrate umbilical line placement **(application)**
4. Demonstrate focused history taking from a caregiver **(application)**
5. Explain diagnosis and management to caregivers **(synthesis)**
6. Demonstrate teamwork and closed loop communication **(application)**
7. Organize transfer to a higher level of care where needed resources are available (analysis)

CRITICAL ACTIONS

General:

- Elicit a team to help with tasks, specifically: team lead, monitors and survey, airway, access, labs/medication administration, runner for help
- Acknowledge a high-risk newborn delivery in the ED and call for stat OB and pediatrics help
- Obtain ED newborn kit (specific to your ED), newborn warmer bed, and follow NRP algorithm

CRITICAL ACTIONS (continued)

- Identify the neonate in respiratory distress with hypoglycemia and hypothermia
- Effectively communicate with neonatology consultants
- Deliver the news to the parent that the neonate requires critical care support and will be taken to the Neonatal Intensive Care Unit for ongoing management

Specific roles:

- Role: **Team lead**
  - Assign team roles (monitors and survey, airway, access, labs/medication administration, runner for help)
  - Elicit helper to bring newborn warmer bed, if not already located in ED
  - Acknowledge and follow NRP algorithm
  - Report initial impression of the neonate according to the first questions of NRP: Term? Tone? Breathing or crying?
  - Instruct airway role to perform maneuvers (i.e., reposition airway, suction, start PPV by 60 seconds of life)
  - Instruct monitors/survey role to apply leads and communicate exam
  - Get more history from the Mom and learn she had limited prenatal care and does not know her due date
  - Given this history, in the setting of a limp neonate, continue NRP and request fingerstick blood sugar level (BSL), acknowledge hypoglycemia (BSL <40 mg/dL), request access with emergent UVC and administration of dextrose bolus (D10W 2 mL/kg)
  - Recognize hypothermia (T <36.5°C) and request warmer, warm blankets, hat
  - Treat hypoglycemia and presumed sepsis with dextrose and antibiotics
  - Effectively give the pediatric consultant (NICU or pediatrics) a recap of patient presentation and discussion of current concerns
  - Sensitively communicate with mom that her neonate is critically ill and will be transferred to the Neonatal Intensive Care Unit (NICU) for ongoing management

CRITICAL ACTIONS (continued)

- Role: **Monitors and survey**
  - Place baby on newborn bed under a radiant warmer
  - Start APGAR timer
  - Record neonate's weight from bed scale (if available) or estimate based on estimated gestational age or use length-based tools available in your institution
  - Place pulse oximeter on neonate's right wrist (pre-ductal)
  - Apply cardiac monitors
  - Place temperature probe
  - Report loudly to group their initial impression of the neonate according to the first questions of NRP: Term? Tone? Breathing or crying?

- Role: **Airway**
  - Acknowledge respiratory distress and impending cardiorespiratory failure
  - Comment on patient's respiratory effort (i.e., apnea, gasping, etc.) and bradycardia
  - Demonstrate appropriate maneuvers according to NRP algorithm, start PPV by 60 seconds of life

- Role: **Access**
  - Place emergency UVC

- Role: **Labs/Medication administration**
  - Obtain heel stick blood sugar level (BSL), and note the patient is hypoglycemic
  - Administer D10W bolus
  - Administer antibiotics (ampicillin, gentamicin)
  - Order labs/imaging when requested, including venous point-of-care (POC) labs, cord gas, blood and urine cultures, CBC, CRP, BMP, chest/abdominal X-ray
  - If requested, naloxone, epinephrine, anti-epileptics, or other medications are "pending or being drawn up"

- Role: **Runner for help**
  - Call stat OB, Peds and/or NICU help
  - Get newborn warmer bed, ED delivery kit, and UVC tray
  - Obtain ample warm blankets, hat, supplies PRN

CRITICAL ACTIONS (continued)

- Call pharmacology and radiology when requested

Recommended Supplies

- **Manikin/Simulated actor**:
  - Neonate manikin that can be ventilated
  - Simulated patient actor to play laboring mother
- **Moulage:** None
- **Resources:** NRP algorithm, Broselow tape or other weight-based equipment -sizing and medication dosing reference
- **Manikin set up:** Cyanotic, bradycardic, and limp infant with minimal respiratory effort delivers in ED
- **Equipment:**
  - Newborn warmer bed with scale and timer (if not available, bring accessory timer and scale next to bed)
  - Warm blankets
  - Newborn hat
  - Diaper
  - Monitors: Pulse oximetry, cardiac, temperature
  - Rectal thermometer
  - Heel stick sampling kit, including alcohol wipe, lancet, portable BSL reader
  - ED delivery kit: sterile gloves, sterile towels and drapes, surgical scissors, hemostats, syringes (10 ml), needles (25 G), gauze sponge (4 x 4), rubber suction bulb, neonatal airways, cord clamps, towels (infant), placenta basin.
  - ED UVC Tray and UVC lines: Sterile drapes and gauze, scalpel (No. 11-blade), 3-0 silk suture on a curved needle, small clamps, forceps, scissors, and needle holder, curved iris forceps without teeth, umbilical tie, infusion solution (usually NS or D10W), 3-way stopcock, tegaderm and tape. UVC sizing: 5.0 Fr for term babies
  - T-piece resuscitator (e.g. Neopuff® group) or flow-inflating bag with neonatal mask
  - Suction: Bulb and wall suction (set at 80-100 mmHg)
  - Oxygen source
- **Medications:**
  - Dextrose 10% (0.1 g/mL). Dose: 2 mL/kg of D10W bolus,

continuous infusion of 60 mL/kg/24hrs
    - Ampicillin dose: 100 mg/kg/dose, gentamicin dose: 4 mg/kg/dose
    - All other meds "being drawn up":
        - Naloxone: If drawn up and given, will have no effect on clinical status
        - Epinephrine: If drawn up and given, HR and BP will increase but no change in oxygen saturation

Supporting Files

- Neonatal Resuscitation Program (NRP) algorithm
- Point-of-care labs
- X-ray after UVC placement

Participants/Roles

- **Participations/learners:**
    - Team leader
    - Airway manager
    - Survey physician
    - Medication preparer
    - Medication giver
    - Family liaison/history taker

- **Other:**
    - Faculty or other embedded participants can play a nurse, respiratory therapist, or tech, if there are not enough learners to perform the above roles
    - Standardized patient (actor or faculty) to play patient's parent

** Team roles may need to be adjusted in order to suit local practices and norms*

Prerequisite Knowledge

- **Faculty**
    - NRP protocols
    - General knowledge of emergency medicine
    - Simulation implementation and debriefing experience

- **Emergency medicine residents**
    - Any stage of training
    - Completed a required obstetric and pediatric rotation in medical school
    - UVC insertion (for procedural list)
    - Neonatal intubation

Case Alternatives

- If the participants do not follow NRP initially, the patient becomes progressively more hypoxemic and bradycardic, such that the neonate decompensates into cardiorespiratory failure requiring resuscitation.

Milestones
PC1. Emergency Stabilization (PC1)
PC2. Performance of Focused History & Physical (PC2)
PC3. Diagnostic Studies (PC3)
PC4. Diagnosis (PC4)
PC5. Pharmacotherapy (PC5)
PC7. Disposition (PC7)
PC9. General Approach to Procedures (PC9)
PC10. Airway Management (PC10)
PC14. Other Diagnostic and Therapeutic Procedures
MK. Medical Knowledge (MK)
ICS1. Patient Centered Communication (ICS1)
ICS2. Team Management (ICS2)

Resources
1. Weiner, Gary M., et al. Textbook of neonatal resuscitation (NRP). 2019.
2. Wing R. Emergent umbilical venous catheter (UVC) placement. Brown Emergency Medicine. 2015.

Initial Presentation

ITEM	FINDING
Overall Appearance	You arrive in time to see mother wheeled in with newborn on stretcher with cord attached. You see clear fluid without meconium. The newborn is not breathing or crying and is limp and blue. **Embedded participant:** The nurse wheels the laboring mother into ED trauma bay. This embedded participant tends to the mother who is fine and will wait until OB comes to ED. The embedded participant nurse cuts the cord, wraps the newborn in a towel and passes the baby to the ED resident participant. The mother does not appear to be febrile and does not have evidence of hemorrhage. The residents do not provide medical care to the mother.
HPI	The simulated patient actor plays laboring mother is wheeled into ED trauma bay and screams in pain, yelling "It happened so fast! Is the baby ok? Oh, I'm in so much pain!" If the learners ask about prenatal care, the actor says she had some prenatal care early in the pregnancy but lost her job and insurance. So, she has not been to the OB since early in her 2nd trimester. She believes the baby is at least a month to her due date but can't remember. Denies taking any medication, substance use, and is unable to offer any more information due to distress of her labor.
Mother's Past Medical/Surgical History	Precipitous delivery, unknown gestational age, but mother thinks ~35 weeks. No prenatal care since 2nd trimester.
Mother's Medications	Unknown
Mother's Allergies	Unknown

Initial Presentation (continued)

ITEM	FINDING
Family History	No known family history of birth defects
Mother's Social History	Single mother, unemployed, uninsured. Denies substance use.

Stage 1

Begin Simulation (Stage 1 of 4)

Initial Assessment of Neonate:
Start of case through start of Positive Pressure Ventilation (PPV)

CRITICAL ACTIONS

The following actions must be completed during this stage to progress to the next stage:

- Call for OB/Peds/NICU help
- Elicit help to gather supplies (see above recommended supplies)
- Elicit a team to help with tasks, specifically: Team lead, monitors and survey, airway, access, labs/medication administration, runner for help
- Acknowledge and start following NRP algorithm
- By 60 seconds of life, start PPV

Physical Exam

ITEM	FINDING
Vital Signs	**T:** cold to touch, **HR:** 70, **BP:** unable to obtain, **RR:** gasping and irregular, **SpO_2:** unknown
General	Blue, floppy neonate, gasping, and not crying
HEENT	Eyes closed
Neck	Floppy
Lungs	Course bilaterally, minimal respiratory effort
Cardiovascular	Bradycardic; full body cyanosis with capillary refill delayed to 4 seconds; no murmurs, rubs, or gallops

Physical Exam (continued)

ITEM	FINDING
Abdomen	Umbilical cord intact, once clamped and cut noted to have 3 vessels (2 arteries, 1 vein). No omphalocele or gastroschisis.
Neurological	Limp
Skin	Wet, mottled, and cool to touch
Musculoskeletal	No obvious skeletal abnormalities

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Team takes newborn from nurse, finds and turns on warmer bed, brings neonate to warmer bed, dries with blankets.	Neonate remains blue, limp, with limited breathing and HR <100 despite simply drying with a towel.	
Start APGAR timer.		Facilitator or participant starts timer.
Participants divide into roles.		If no roles delineated in group, nurse demands to know who is in charge.
Team lead delegates nurse to call stat OB, Peds, NICU consultants.		Help is notified and is "en route."

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Orient to NRP algorithm and verbalize answers to the first questions: • Term? • Tone? • Breathing or crying?		If unable to find the NRP algorithm, the facilitator can decide if they would like to provide the algorithm. Answers to NRP questions given by facilitator when asked: • **Term?** No - late preterm ~35wks • **Tone?** Floppy • **Breathing or crying?** Minimal/none
Patient weighed in warmer bed/scale; Monitors applied to patient (pre-ductal pulse oximetry probe to right hand, cardiac monitors, temperature monitor, rectal temperature).	• Pre-ductal SpO_2: 40% • HR: <100 • Rectal temp: 35°C/95°F • Wt: 2.5 kg • Limited respiratory effort	
Warm, dry, stimulate baby	No change in vital signs or exam	
Start PPV at 40-60 bpm	Within first 15 seconds of PPV: chest is moving symmetrically with course and symmetric breath sounds auscultated bilaterally.	

Stage 2

Neonatal Resuscitation:
Start of PPV through 120 seconds of PPV

CRITICAL ACTIONS

The following actions must be completed during this stage to progress to the next stage:

- Continue down NRP algorithm
- Continue PPV, and perform MR SOPA airway maneuvers
- Note hypothermia, and provide warming maneuvers
- Reassess respiratory effort after HR and SpO_2 improve with PPV
- Recognize the need for some ventilatory support, though no longer needs PPV
- Initiate CPAP and request neonatal CPAP set up

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 35°C, **HR:** 90, **BP:** not yet obtained, **RR:** gasping and irregular when not supported with PPV, **SpO_2:** 55% on RA, 65% on 100% FiO_2
Exam Changes	Neonate still has limited respiratory effort without PPV support; weak cry

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Reassess vital signs at 1 minute of life	Pre-ductal SpO_2: 50% HR: 90 Rectal temp: 35°C/95°F Wt: 2.5 kg Limited respiratory effort	
PPV continued	HR to 130 gradually	
FiO_2 increased to 100%	SpO_2 increases to gradually >95%	
Note hypothermia and request warming measures (blankets, turn up warmer, chemical blanket if available) Repeat rectal temp following interventions	With warming maneuvers, temperature rises to 37°C.	
After an additional 60 seconds of PPV with 100% FiO_2	SpO_2 98%, HR 130	
Stop PPV to reassess work of breathing	Grunting and retractions without PPV	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Provide CPAP for patient manually, ask RT for neonatal CPAP setup if available at site	Work of breathing improves if CPAP started with PEEP of 5, good breath sounds bilaterally, vital signs remain stable at SpO_2 98%, HR 130s Without CPAP, grunting retractions and RR starts to increase. Muscle tone improves, making PPV difficult to coordinate with patient's spontaneous breaths	
After 120 sec of PPV	Proceed to **Stage 3**.	

Stage 3

Recognition and Treatment of Life Threatening Issues:
>2 minutes of life AND 120 sec of PPV through correction of hypoglycemia

CRITICAL ACTIONS

The following actions must be completed during this stage to progress to the next stage:

- Continue CPAP, wean FiO_2
- Place emergency UVC after 2 failed PIV attempts
- Obtain ancillary studies: POC labs, x-ray
- Note the patient is hypoglycemic at 30 mg/dL (<40 mg/dL)
  - Administer D10W bolus at 2 mL/kg through UVC
  - The estimated vs baby warmer scale weight is 2.5 kg, so give 5 mL bolus.
  - Following bolus, give D10W at 60 mL/kg/24hrs = ~6.25 mL/hr
- Consider broad differential for respiratory failure in newborn, including sepsis, respiratory distress syndrome, upper airway anatomic abnormalities (e.g., choanal atresia), intrathoracic lesions (e.g., congenital diaphragmatic hernia, congenital pulmonary airway malformation), congenital heart disease, intrauterine stroke
- Order antibiotics: Ampicillin 100 mg/kg/dose and gentamicin 4 mg/kg/dose
- Call NICU for consultation and discuss the case
- Discusses with team and pharmacy medical doses for neonatal code

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 130, **MAP:** 35-40 mmHg, **RR:** 40-60 (bagged), grunting, **SpO_2:** 98% on 100% FiO_2

Physical Exam (continued)

ITEM	FINDING
Exam Changes	• Heart rate 130 bpm • Oxygen saturation 98% • Improving respiratory effort but still requires some support • Equally coarse bilateral breath sounds • Muscle tone improving

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
CPAP continued, weaning FiO_2 to maintain SpO_2 goals within NRP ranges	• SpO_2 remains >95% if wean FiO_2 from 100% to 50%. • SpO_2 falls to 90-95% if FiO_2 weaned to 30%. • SpO_2 falls below 90% if weaned to RA MAP 35-40	Avoiding HYPERoxia is a important learning point, especially with premature infants. In general, the team should wean FiO_2 once HR stable.
Ask for a heel stick sampling kit, including alcohol wipe, lancet, portable glucometer	BSL 30 mg/dL	
Ask for peripheral IV access		Participant or RN attempts and fails peripheral IV attempts x 2
Ask for an IO kit		Unable to find IO kit
Ask for UVC supplies		UVC kit brought to bedside
Participant places low-lying UVC	Access is successful	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Order x-ray	X-ray returns	Confirm UVC is not in the liver, notable for bilateral patchy opacities and significant gastric distension
Order and give dextrose bolus (D10W @ 2 mL/kg = 5 mL) followed by D10 infusion at 60 mL/kg/24hrs =~6.25 mL/hr based on 2.5 kg weight. Repeat heel stick BSL after D10W bolus administered.	Repeat BSL 100 mg/dL	
Order labs off UVC (cord gas, blood and urine cultures, CBC, CRP, BMP)		Labs “pending”
Order antibiotics: ampicillin 100 mg/kg/dose and gentamicin 4 mg/kg/dose		Antibiotics “en route”
Place OG tube	OG successfully placed	
Team member updates mom on plan.	Proceed to **Stage 4**	Mom verbalizes understanding and thanks team for the care of her newborn.

Stage 4

Case Conclusion:
Correction of hypoglycemia through NICU signout

CRITICAL ACTIONS

The following actions must be completed during this stage to progress to the next stage:

- Discussion of patient with NICU and appropriate disposition stated.

!

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 130, **MAP:** 35-40 mmHg, **RR:** 60 on CPAP, **SpO_2:** >95% on CPAP at 50% FiO_2
Exam Changes	Improved color, tone, and respiratory effort

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Call NICU, local pediatric hospital for transport or for discussion of patient; give full patient summary		NICU accepts the patient. They make recommendations to secure the UVC access, continue D10W at maintenance rate, antibiotics, and maintain normothermia (36.5-37.5°C).

Ideal Scenario Flow

Learners enter the room to find a precipitous newborn delivery. The neonate is cool, cyanotic, not crying, and floppy. They immediately warm the baby with blankets while simultaneously setting up a warmer bed. The heart rate and tone improve following the NRP algorithm and providing effective PPV. The neonate's tone and color improve, the heart rate rises to a goal of >100, and the pulse oximetry improves. Without PPV, the infant's work of breathing still increases, so CPAP should be initiated, with resultant improvement in work of breathing and continued vital signs at NRP goals. They also must recognize and treat hypothermia and hypoglycemia. They place an emergency UVC after 2 failed PIV attempts, while no IO kit can be found. They consider sepsis and order labs and antibiotics. The learners may prepare intubation equipment and accessory airways but never have to use them as the newborn is appropriately supported with non-invasive positive pressure ventilation via CPAP. The scenario concludes when the team makes an appropriate disposition decision for the infant (NICU) and updates the mother on the plan. If the participants do not follow NRP, the patient's condition deteriorates into cardiorespiratory failure.

Anticipated Management Mistakes

1. **Failure to follow NRP:** If the learners fail to follow the NRP protocol, the neonate will collapse into cardiopulmonary failure. The facilitator might guide the learners by providing the NRP algorithm and/or embed a respiratory therapist to provide effective PPV which maintains the heart rate at goal.

2. **Failure to consider hypothermia:** A cold neonate will decompensate quickly. If participants do not recognize that the baby is cold, have the SP playing the mom say: "it's cold in here and my baby looks freezing!"

3. **Failure to consider hypoglycemia:** In neonatal and pediatric resuscitation, the "D" in ABCD also stands for Dextrose, and the "S" in the STABLE neonatal resuscitation course stands for Sugar. If participants do not check the baby's glucose level and treat hypoglycemia, the patient will decompensate. As the

facilitator, consider having the Mom SP say "my baby needs to eat something- I want to nurse my baby! How do you know she isn't hungry?"

4. **Failure to obtain access with UVC:** The participants fail twice while trying to obtain a peripheral IV. Getting parenteral access on this patient is of utmost importance. If they do not recall the option of getting neonatal access through the umbilical vein, consider embedding a nurse participant to grab the UVC tray and placing it next to the patient. If they are unsuccessful placing the UVC, during the debrief consider watching a video on how to place a UVC.

Debriefing Points

Demonstrate post-delivery resuscitation of a neonate following NRP guidelines (application)

Learners should approach a newborn delivery in a standardized fashion, using the NRP algorithm. The emphasis is on the airway and breathing in NRP resuscitation. If the neonate continues to have decreased oxygen saturation, consider problem the following interventions:

"MR SOPA"

- **M** - Adjust **Mask**
- **R** - **Reposition** head to open airway
- **S** - **Suction** mouth then nose
- **O** - **Open** mouth, lift jaw forward
- **P** - Gradually increase **Pressure** until visible chest rise is noted
- **A** - Use artificial **Airway** (ETT or LMA)

Persistent desaturations could also be indicative of a mixing heart lesion or inadequate oxygen transfer in the lungs.

Demonstrate early evaluation of a critically ill patient (application)

Learners should approach a sick neonate in a standardized fashion. Airway, breathing, and circulation should be assessed immediately. Interventions such as airway repositioning/adjuncts and starting PPV or CPAP should happen promptly. After A, B, C have been addressed, the patient should be evaluated for disability and exposed for a thorough head to toe exam and a blood sugar level should be obtained. Labs/imaging should be ordered and antibiotics and fluids administered in a timely fashion.

Demonstrate umbilical line placement (application)

See Wing's Emergent umbilical venous catheter (UVC) placement blog post with Brown Emergency Medicine (2015).

Demonstrate focused history taking from a caregiver (application)

The maternal history should be focused during the initial evaluation on possible prenatal etiologies of neonatal respiratory failure. Assign a participant to get a thorough history from the mother in a sensitive manner.

Explain diagnosis and management to caregivers (synthesis)

If personnel are available, assign one member of the team to stay with the mother to gather history and explain interventions. Update the mother on the baby's status, interventions that have been done, and what next steps are (admission to the NICU). Avoid using medical jargon.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give dextrose with D10W: 3 mL bolus via the UVC"; Med Prep - "D10W 3 mL bolus giving via UVC"; Leader- "That's correct.")

- **SBAR:** A framework for team members to structure information when communicating to one another.
  - S = Situation (What is going on with the patient?)
  - B = Background (What is the clinical background or context?)
  - A = Assessment (What do I think the problem is?)
  - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

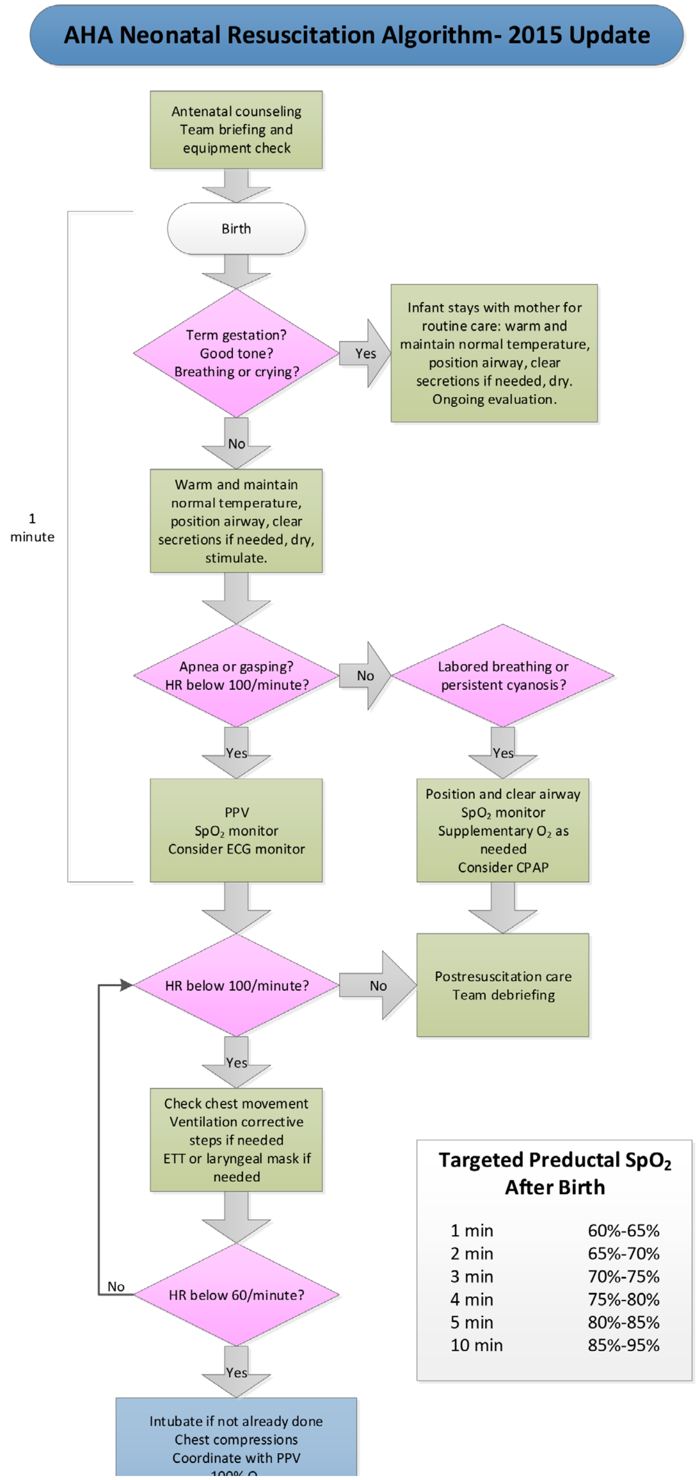
- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Organize transfer to a higher level of care where needed resources are available (analysis)

Give an organized and thorough patient sign-out to the transferring team (NICU/Peds/transport team). Be specific about the presenting scenario, initial evaluation, labs/imaging obtained, and what interventions were done with an update on how the patient responded to said interventions.

Supporting Files

Neonatal Resuscitation Program
[Adapted from the 2016 American Heart Association and American Academy of Pediatrics reference chart]



Targeted Preductal SpO_2 After Birth	
1 min	60%-65%
2 min	65%-70%
3 min	70%-75%
4 min	75%-80%
5 min	80%-85%
10 min	85%-95%

Supporting Files

Point of Care Lab Results

Venous Blood Gas and Other Point of Care Labs (Umbilical Vein Catheter)

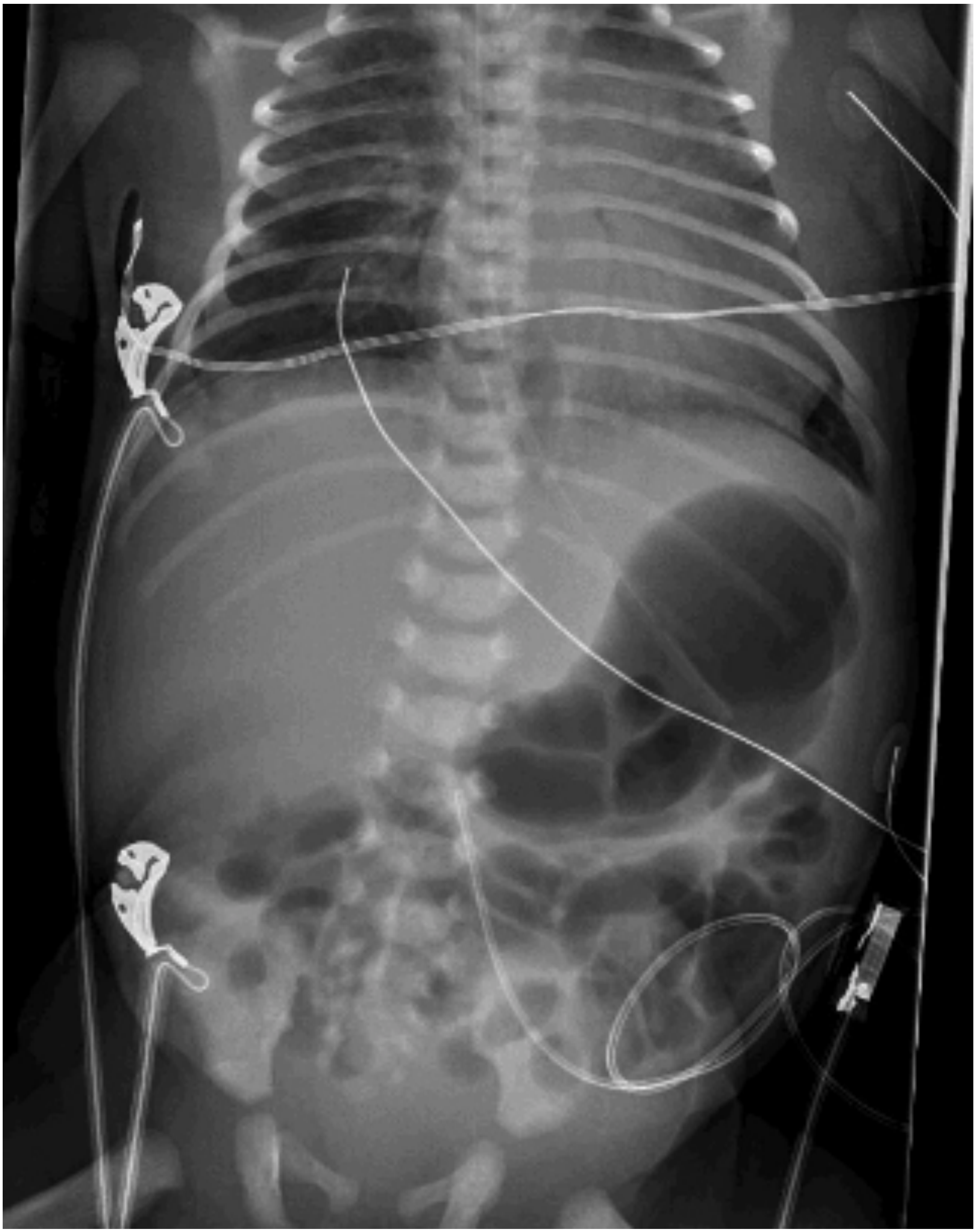
LABORATORY TEST	VALUE	UNITS
pH	7.15	
pCO_2	60	mmHg
pO_2	25	mmHg
HCO_3	20	mEq/L
Base excess	-2	mEq/L
SpO_2	50	%
Na	135	mEq/L
K	3.7	mEq/L
Cl	110	mEq/L
HCO_3	20	mEq/L
Glucose	30	mg/dL
BUN	18	mg/dL
Cr	0.7	mg/dL
Hct	37	%
HgB	12.3	g/dL

Pending Labs

Cord gas, CBC, blood, urine cultures, CRP, BMP

Supporting Files

X-ray



Supporting Files

Notes

X-Ray Interpretation
Some patchy opacities in the lung fields. Support devices seen include ECG leads, temperature probe, orogastric tube, and low-lying UVC. Image from Dr. Leah Carr.

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant playing the patient's mother, who just delivered her baby precipitously in the ambulance bay of your Emergency Department

Case Background Information

The case is a precipitous delivery of a newborn in the ambulance bay of a busy ED. You had limited prenatal care early in the pregnancy, but lost your job and insurance so has not been to the OB since early in the 2nd trimester. You believe the baby is close to her due date but can't remember. Your newborn is immediately taken away to be medically resuscitated.

Who are the Learners?

The targeted learners are Emergency Medicine interns and residents. They have little prior experience delivering and resuscitating babies but do have significant experience in gathering information from patients and family members.

Standardized Patient Information

You are emotional about not being able to hold your baby upon delivery, are insistent on knowing how the baby is, and are frightened by the austere and unfamiliar ED environment. You should make it known that you are very upset and want to be with your baby, but you are calmed if someone talks to you and explains what is happening, as to not distract the residents from the neonatal resuscitation.

Meanwhile, the infant is being attended to by the medical team. The medical team resuscitates the baby by following the Neonatal Resuscitation Program (NRP) algorithm and by doing the following: breathing for and supplementing oxygen to the newborn who is having persistently low blood oxygen levels with PPV and then CPAP, obtaining IV access through the umbilical cord, giving dextrose-containing fluids to correct low blood sugar, warming the baby, and eliciting prompt specialty help from the Neonatal Intensive Care Unit (NICU).

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you? Or "what happened?"): Precipitous newborn delivery with limited prenatal care

- YOUR AGE: 25 years old

- ADDITIONAL HISTORY: Prenatal care limited to first trimester. Baby is estimated to be at or near term.

- PAST MEDICAL HISTORY: None

- SOCIAL HISTORY: Lives alone and denies substance use.

- FAMILY HISTORY: Does not know

- PAST SURGICAL HISTORY: None

- MEDICATIONS: None

- ALLERGIES: No known drug allergies

- IMMUNIZATIONS: Up-to-date

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:
- "How is my baby? I want to hold my baby."
- "Why don't I hear crying?"
- "Can someone tell me what's going on?"

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
If they ask about prenatal care	"I lost my job and insurance so haven't seen a doctor in months. I had some prenatal care early in the pregnancy, but have not been to the OB since early in her 2nd trimester. I think the baby is at least a month within my due date but can't remember."
If participants do not recognize that the baby is cold	"Is my baby cold? The hands and feet are blue!"
If participants do not check the baby's blood sugar level and treat hypoglycemia	"My baby needs to eat something. I want to nurse my baby! How do you know she isn't hungry?"
If participants do not recognize persistent hypoxemia and difficulty breathing	"Is my baby breathing normally?"

Simulation Case 10

Non-Accidental Trauma

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Setup

Chief complaint: Difficult to arouse, poor feeding
Patient age: 4 months old
Weight: 5 kg

Brief Narrative Description of Case

A 4 month-old girl is brought in by EMS accompanied by a parent (father and/or mother), because the infant appeared less alert upon awakening from a nap. The child was with a babysitter while both parents were working. The father was called by the babysitter that the child had not been feeding as her usual today and was difficult to arouse after her nap. On initial assessment, the infant is lethargic with minimal activity, only responsive to painful stimuli. Oxygen, monitor, and IV access are attempted but unsuccessful requiring IO access. The infant subsequently has a tonic-clonic seizure controlled after administration of medications; however, the infant becomes apneic requiring intubation. Expanded differential diagnosis includes trauma, sepsis, ingestion, metabolic disorders, and intracranial pathology. Physical exam findings include frenulum tear and bruising on non-bony prominence, concerning for physical abuse. Post-intubation CXR shows posterior rib fractures and a head CT reveals a subdural hematoma without a skull fracture, suggesting radiographic evidence of non-accidental trauma. Concerns of physical abuse are effectively communicated in a non-accusatory manner with family and mandated reporting requires the case to be reported to child protective services.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Describe signs/symptoms and findings suggestive of non-accidental trauma in an infant **(comprehension)**
2. Demonstrate early evaluation of a critically ill infant **(application)**
3. Demonstrate airway management of a sick child including bag-mask ventilation (BMV) and intubation **(application)**
4. Construct a differential diagnosis for altered mental status/ seizure in an infant **(synthesis)**
5. Formulate an initial diagnostic plan for a critically ill infant with

altered mental status/seizure **(synthesis)**
6. Construct and implement initial management of status epilepticus in an infant with first and second line medications **(application)**
7. Demonstrate the evaluation of a pediatric patient with concern for trauma using a standard systematic approach **(application)**
8. Manage head trauma in an infant **(application)**
9. Demonstrate intraosseous placement **(application)**
10. Demonstrate focused history taking and discussion about concern about non-accidental trauma (NAT) with a caregiver **(application)**
11. Explain diagnosis and management to caregivers **(synthesis)**
12. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

- Assemble team with defined roles and identify sick infant
- Obtain IO access after failed IV attempts
- Acutely manage status epilepticus by management of airway, and administration of appropriate medications
- Airway: Appropriately manage airway with BMV and successful intubation
- Recognize signs and symptoms concerning for non-accidental trauma
- Demonstrate effective team communication
- Demonstrate effective communication with parent, especially delivery of bad news

Recommended Supplies

- **Manikin:** Infant
- **Moulage:** Bruise to abdomen, flank (red-purple color make-up). Torn frenulum (apply red dried blood under upper lip at central incisor teeth, clinical photograph to supplement oral exam).
- **Resources:** PALS cards and/or length-based tape (e.g., Broselow Tape)
- **Manikin set up:** No IV line – ability to place IO
- **Equipment:**
    - Cardiac monitor and leads
    - Pulse oximetry

- Pediatric airway equipment of various sizes/airway cart
  - Nonrebreather mask
  - Bag valve mask
  - Oxygen tubing
  - Suction
  - Intubation equipment (3.5 cuffed ETT, Miller 1 blade, stylet, suction, ET CO_2 monitor)
  - Cervical collar
  - Intraosseous equipment including E-Z IO, needle, stabilizer, and connectors, saline flushes
- **Medications:** Normal saline, lorazepam, fosphenytoin, fosphenytoin, levetiracetam, phenobarbital, ceftriaxone, RSI medications as per hospital protocol, mannitol, 3% normal saline
- Bedside ultrasound

Supporting Files

- Chest XR
- Head CT
- Oral cavity photograph showing torn superior frenulum
- Lab results

Participants/Roles

- Team leader
- Airway manager
- Survey physician
- Medication preparer
- Medication giver
- Family liaison/history taker
- Standardized patient (actor or faculty) to play patient's parent

** Team roles may need to be adjusted in order to suit local practices and norms*

Faculty or other embedded participants can play a nurse, respiratory therapist, or tech, if there are not enough learners to perform the above roles.

Prerequisite Knowledge

- **Faculty**
    - PALS protocols
    - General knowledge of emergency medicine
    - Simulation implementation and debriefing experience

- **Emergency medicine residents**
    - Any stage of training (preferably PGY-2 or greater)
    - Completed PALS certification
    - Intubation, IO placement

Case Alternatives

- The patient may have refractory seizures requiring multiple rounds of anti-seizure medications. Emergent management of increased intracranial pressure could be incorporated into the case.

Resources

1. Paul A, Adamo M. Non-accidental trauma in pediatric patients: a review of epidemiology, pathophysiology, diagnosis and treatment. Transl Pediatr. 2014;3: 195–207. PMID: 26835337
2. Ronning M, Carolan P, Cutler G, Patterson R. Parasagittal vertex clots on head CT in infants with subdural hemorrhage as a predictor for abusive head trauma. Pediatr Radiol. 2018;48:1915-1923. PMID: 30187091
3. Christian CW. Committee on Child Abuse and Neglect. The evaluation of suspected child physical abuse. Pediatrics. 2015;135:e1337–e1354. PMID: 25917988
4. Interfacility Transfer Toolkit for the Pediatric Patient, in M.a.C.H.B. Health Resources and Services Administration, EMSC (EMSC) Program, Editor. 2018. p. 1-42.
5. Bhananker, S., J. McFadyen, and R. Ramaiah, Initial assessment and management of pediatric trauma patients. International Journal of Critical Illness and Injury Science(2012. 2(3): p. 7.
6. Committee On Pediatric Emergency Medicine, C.O.I., et al., Management of Pediatric Trauma. Pediatrics, 2016. 138(2).
7. Dudley NC, Hansen KW, Furnival RA, Donaldson AE, Van Wagenen KL, Scaife ER. The effect of family presence on the efficiency of pediatric trauma resuscitations. Ann Emerg Med. 2009;53(6):777-84.e3. PMID 19013688
8. Nakayama DK, Gardner MJ, Rowe MI. Emergency endotracheal intubation in pediatric trauma. Ann Surg. 1990;211(2):218-223. PMID 2301999
9. Rotondo M, Cribari C, Smith R. Resources for Optimal Care of the Injured Patient. Committee on Trauma. 2014, Chicago, IL: American College of Surgeons. p 1-215.
10. Starnes AB, Oluborode B, Knoles C, Burns B, McGinnis H, Stewart K. Direct Air Versus Ground Transport Predictors for Rural Pediatric Trauma. Air Med J. 2018;37(3):165-169. PMID 29735228
11. Khanna S, Davis D, Peterson B, et al. Use of hypertonic saline in the treatment of severe refractory posttraumatic intracranial hypertension in pediatric traumatic brain injury. Crit Care Med. 2000;28(4):1144-1151. PMID 10809296
12. Fox S. Pediatric trauma pitfalls. Ped EM Morsels 2019.
13. Sobolewski B. Clinical predictors and evaluation of blunt abdominal trauma in children. PEM Cincinnati 2015.
14. Sobolewski B. Why we do what we do: Benzodiazepines as first line therapy for status epilepticus. PEM Cincinnati 2019.
15. American College of Surgeons Trauma Quality Programs. Best practices guidelines for trauma center recognition of child abuse, elder abuse, and intimate partner violence. 2019.

Milestones

PC1. Emergency Stabilization (PC1)
PC2. Performance of Focused History & Physical (PC2)
PC3. Diagnostic Studies (PC3)
PC5. Pharmacotherapy (PC5)
PC9. General Approach to Procedures (PC9)
PC10. Airway Management (PC10)
PC14. Other Diagnostic and Therapeutic Procedures
ICS1. Patient Centered Communication (ICS1)
ICS2. Team Management (ICS2)
ICHP01. Effective communication with Parents
ICHP08. Delivering Bad News
TR12. Pediatric Trauma Resuscitation: Primary, secondary, interventions
TR02. D&M of Major Traumatic Brain Injury
TR07. D&M of Common Traumatic Conditions: Blunt abdominal trauma
CP2_01. Place an Intraosseous Line

Initial Presentation

ITEM	FINDING
Overall Appearance	4-month-old baby girl, lethargic, quiet
HPI	A 4 month-old female is brought in by EMS accompanied by her father because she seems less alert. Both parents were at work today. The father was called by the babysitter because upon waking, the baby was very difficult to arouse and did not want to feed as she usually does. She was well appearing this morning when her parents left for work. When her father arrived home, she would not wake up and EMS was called. If the learners ask for specifics: She was born at 37 weeks, normal vaginal delivery. Initially breast fed but now on formula (Similac Sensitive). She is a spitty baby and the PMD is managing gastroesophageal reflux without any medication. She has received her 2-month and 4-month immunizations. She has been fussy lately and no stool since yesterday. No reported fever, URI, or vomiting.
Past Medical/Surgical History	Born full term, NSVD, no issues with pregnancy or delivery
Medications	None
Allergies	None
Family History	Not significant
Social History	Lives at home with mom and dad Has had the same babysitter for 2 months No other children are in the home

Stage 1

Begin Simulation (Stage 1 of 4)

Altered Mental Status in an Infant:
Start through 3 minutes

CRITICAL ACTIONS

- Team leader assigns tasks
- Obtain history from parent
- Perform primary survey
- Administer supplemental oxygen
- Place patient on continuous cardiac monitor
- IO Access after failed IV
- Labs sent once access obtained (point of care glucose, VBG, CBC, blood culture, CMP, lipase, PT/PTT/INR, UA, urine culture, urine tox)
- Discuss progress and plan of care with the parent (and involve them in decision-making)

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 36.5°C, **HR:** 100, **BP:** 100/60, **RR:** 18, **SpO_2:** 93%
General	Moaning and intermittent crying
HEENT	• Normocephalic, atraumatic scalp without hematomas or step offs appreciated • Anterior fontanelle open and full • Pupils 3 mm and reactive • Frenulum tear to upper lip
Neck	Spine midline, and no step offs appreciated

Physical Exam (continued)

ITEM	FINDING
Lungs	Clear to auscultation bilaterally, equal breath sounds
Cardiovascular	Regular rate and rhythm, no murmurs
Abdomen	Soft, non-distended, small 1-2 cm bruising to L side of abdomen
Neurological	GCS 9: Eye Opening to painful stimuli (2), Withdraws from pain (4), Irritable/inconsolable (3)
Skin	Bruising to L abdomen and back (1-2 cm)

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Place patient on bedside monitors and supplemental oxygen with NRB mask	No change in patient condition	Vital signs appear on the monitor
Attempt IV access and order for fluids, labs (point of care glucose, VBG, CMP, CBC, blood culture, UA and urine culture, Urine Tox)	IV attempt unsuccessful	Point of care labs obtained once access obtained
Antibiotics ordered for presumed sepsis, unresponsive child	No change in case	Allow usual time delay between ordering and administering of antibiotics
If learners attempt central line access after failed IV attempts		Allow attempt to be made; however, a seizure starts mid-attempt, prompting them to attempt an IO line.
3 minutes elapse into case	Patient has a generalized seizure. Proceed to **Stage 2**.	

Stage 2

Respiratory Failure and Intubation:
3 minutes into case through administration of 2 doses of benzodiazepines AND review of labs

CRITICAL ACTIONS

- Demonstrate appropriate BMV using head tilt/chin lift, C and E, or two handed technique
- Perform endotracheal intubation (direct laryngoscopy or video laryngoscope, adequate preparation- suction, stylet) with appropriate RSI medications, if ordered
- Appropriately manage a seizure (benzodiazepine as first line x 2 doses, and fosphenytoin or alternative as second line. Alternatives include: phenytoin, levetiracetam, phenobarbital)
- Request and correctly interpret CXR: Post-intubation CXR identifies posterior rib fractures

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 36.5°C, **HR:** 70, **BP:** 100/70, **RR:** 5, **SpO_2:** 85%
Exam Changes	None

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
IO placed in an appropriate location	Learners have access	
1st dose of benzodiazepine given for seizure	Seizure continues	
Blood glucose level and point of care labs requested		Blood glucose= 80 mg/dL
2nd dose of benzodiazepine given followed by fosphenytoin or levetiracetam	Seizure stops and RR decreases to 5	
Patient receives BMV	• RR increases to bagged rate • SpO_2 increases to 97%	
RSI medications requested		• Consider no need for RSI given patient is apneic and unresponsive • May consider atropine if RSI used given age (<1 year) to prevent reflexive bradycardia during intubation • Caution with use of etomidate given concern for possible sepsis in differential • Consider propofol as sedative given anti-epileptic properties
RSI medication given +/-	Spontaneous respiratory effort stops	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Patient is intubated	• RR increases to rate at which patient is bagged or vent setting (~20 bpm) • O_2 sat increases to 100% • $ETCO_2$ 30 mmHg once intubated	
CXR requested		Images provided to learners: • ETT placement identified • Posterior ribs identified If the learners are not noting rib fractures, the nurse can ask that they look at the ribs or can patch in a call from radiologist confirming tube in good position and rib fractures.
5 minutes after IV/IO access, labs are available	Proceed to **Stage 3** after team reviews labs	Point of care labs result (give what is available at your institution)

Stage 3

Secondary Survey:
Cessation of seizure and review of labs through ordering of head CT

CRITICAL ACTIONS

- **Obtaining a CT head**
- Trauma surgery and neurosurgical consult
- **Precautions taken to protect against increasing intracranial pressure and consider cervical spine immobilization**

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 36.5°C, **HR:** 75, **BP:** 100/70, **RR:** 20, **SpO_2:** 98%
Exam Changes	None

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Head of bed elevation, hyperventilation	HR increases by 10 beats per minute	
Mannitol or hypertonic saline given	HR increases by 20 beats per minute over next 1 minute. BP decreases by 10/10 over 1 minute.	Mannitol 0.5 g/kg IV/IO, or 3% normal saline 3-5 mL/kg IV/IO

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
CT head requested		A plan should be made for who will accompany patient to Radiology
CT abdomen requested		Nurse can inform the team that the child looks too unstable at the moment for an abdominal CT.
Pediatric/trauma surgery consulted		Facilitator to role play in **Stage 4**
Neurosurgery consulted		Facilitator to role play in **Stage 4**

Stage 4

Case Conclusion:
Completion of head CT through discussion with father

CRITICAL ACTIONS

- **Identify child abuse as likely cause of patient's presentation**
- Verbalize need for social work consult, ophthalmology consult, skeletal survey, c-spine immobilization
- **Discuss with parent why child abuse is likely cause and discuss standard care and policy, initiate phone call to CPS**

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37°C, **HR:** 90, **BP:** 90/60, **RR:** 20 (intubated), **SpO_2:** 98%
Exam Changes	None

Ideal Scenario Flow

The learners enter the room and see a lethargic inconsolable infant. They immediately place the patient on bedside monitors, provide supplemental oxygen, and attempt IV access. An IO line is placed after multiple failed attempts at IV access. Baseline labs are sent. The patient has a generalized tonic-clonic seizure, which is first refractory to two doses of lorazepam. The seizure breaks with second line medications, however, the patient becomes apneic. The decision to intubate the patient should be made, and the intubation is successful. The physical exam is significant for lethargy and altered mental status, abdominal bruising, and an upper lip frenulum team. A CXR is then obtained to confirm placement of ET tube which shows multiple posterior rib fractures in different stages of healing. Learners should obtain a CT head due to the patient's presentation, which reveals a subdural hematoma without a skull fracture, which should raise suspicion for child abuse, or non-accidental trauma. Cervical spine and Increased intracranial precautions should be taken (head of bed elevated to 30 degrees, hyperventilation). Labs, if obtained, show an increase in AST/ALT >100 which further raises concern for blunt abdominal injury concerning for child abuse in conjunction of CXR and CT head findings. Bedside ultrasound with a FAST exam is not indicated. However if obtained, you can report no free fluid. In this case, the patient is not stable for CT abdomen/pelvis imaging, if requested. Abdominal CT and skeletal surveys can be deferred for later management. Trauma surgery and neurosurgery are consulted. Communication with family regarding concerns are addressed, and child protective service is notified.

Anticipated Management Mistakes

1. **Problem with bedside monitors:** Learners may be unfamiliar with equipment and fail to correctly place monitor leads, apply an inappropriate cuff sizing for pediatric patient, or fail to ask for an estimated weight. The facilitator can cue learners to use the Broselow tape/bag/cart or other resource to select the correct equipment (depending on what is available in your simulation center). If an inappropriate cuff is selected, you can report that the blood pressure doesn't result and have the nurse suggest the cuff is incorrectly sized.

2. **Difficulty with access:** After brief (no more than two) attempts at peripheral lines, the learners should proceed to IO access. The nurse (embedded participant) or instructor can say "I don't see any available veins, we've already tried twice, is there anything else we could do" to prompt IO placement if needed.

3. **Develop anchor bias towards sepsis:** Learners may focus on central line access, IV antibiotics, fluid bolus/pressors as learners have proceeded down the sepsis pathway. If this continues after the first 3 minutes of the case, a seizure will start. The facilitator will exclaim that the child is shaking.

4. **Failure to recognize the need for intubation:** The patient has no obvious airway obstruction, but has diminished GCS. A seizure causes concern for airway protection. The patient will start desaturating and become apneic, if this is not addressed.

5. **Failure to think of child abuse as a differential diagnosis:** The nurse will ask about bruises and ask aloud how this non-mobile baby got bruises. If learners are not noting rib fractures, the nurse can ask for them to look at the ribs or can report a call from the radiologist confirming that the tube is in good position and the finding of rib fractures.

6. **Failure to recognize frenulum tear and bruises as findings of child abuse:** The nurse will attempt oral suction and ask the learners to look at the dried blood under upper lip in the mouth and ask the parent about it.

7. **Failure to recognize need for Trauma Team consultation:** Learners may decide to pursue advanced imaging or admission to a critical care setting. The nurse will advocate for a trauma physician and neurosurgeon to discuss appropriate imaging and disposition.

8. **Failure to recognize vertex bleed as sign of abusive head injury:** The facilitator can discuss sentinel injuries and cardinal signs of child abuse during debriefing.

9. **Ignoring father in the room:** Learners will likely forget that family is in the room if they stay quiet or get annoyed with them if they are in the way too much. They will have to balance informing the father what is going on while asking him to not be a hindrance to medical care.

Debriefing Points

Describe signs/symptoms and findings suggestive of non-accidental trauma in an infant (comprehension)

- Recognize sentinel injuries of a frenulum tear, bruising on non-bony prominences, healed rib fractures, and intracranial injury as findings suggestive of child abuse in an infant. Remember sentinel injuries with the mnemonic **"TEN-4-FACES-P,"** standing for bruises of the Torso, Ears, and Neck; any bruise in infants less than 4 months of age, bruises of the Frenulum, Angle of the jaw, Cheek, Eyelid, and Subconjunctival hemorrhage; and Patterned bruises. The American Academy of Pediatrics guideline states that any injury to a young pre-ambulatory infant suggests child abuse. Note that this 4 month-old infant is pre-ambulatory.

- Identify parasagittal vertex clots on head CT in infants with subdural hemorrhage as a predictor for abusive head trauma

- Abusive abdominal trauma: Relatively rare (0.5-11% of cases), but is the 2nd leading cause of child abuse associated mortality (head injury is 1st). Mortality rates are as high as 45%. Because it is estimated that abdominal trauma contributes ~50% of abusive fatalities, providers should be vigilant for occult abdominal trauma and consider obtaining screening labs.

Demonstrate early evaluation of a critically ill infant (application)

Recognize an ill-appearing infant given the presentation of lethargy, decreased level of responsiveness, and decreased feeding. These findings are often the only signs of a seriously ill infant given the young age of the patient. Inability to arouse the patient or decreased desire to feed should be seen as red flags.

Demonstrate airway management of a sick child including BMV and intubation (application)

- Airway management is a critical component of pediatric resuscitation, especially in trauma patients

- This is not limited to endotracheal intubation, and should also include your adjuncts of BMV and OPA/NPA

- Two-person BMVpreferred to one-person BMV: One person with two-hand C&E hold to ensure proper seal, and one person to bag the patient

- If two people not available, one hand should maintain C&E hold to ensure proper seal and one hand to bag

- The goal of intubation is to ensure optimal gas exchange

- The most common indications for intubation in a trauma patient are: Coma, shock, apnea, and airway obstruction, GCS <8.

- Common airway complications include: Right mainstem intubation, esophageal intubation, massive aspiration, unilateral or bilateral vocal cord paralysis, subglottic stenosis, failure to adequately preoxygenate, and extubation during transport.

- **Rapid Sequence Intubation:** Adding medications should not prolong the time to intubation in emergency situations. If the infant is lethargic and apneic, like in the current case, one can proceed to intubate without medication.
    - Pre-medications
        - **Atropine** (0.02 mg/kg IV - max 1 mg) may benefit infants under 1 year to blunt the vagal response that can cause significant bradycardia. Strongly consider in patients that have very irritated myocardium (myocarditis, cardiogenic shock etc.)
        - **Fentanyl** (1-3 mcg/kg IV at 3 minutes prior to induction) may blunt the transient increase in ICP that can occur with induction in patients with severe head trauma; however, the evidence is not strong for its use.
        - **Lidocaine** is another medication that has been used in the past to prevent a rise in ICP; however, its use has not been supported in children and is no longer considered the standard of care.
    - Sedatives
        - Ketamine, etomidate, and propofol are good options each with their own side effects.
        - **Ketamine** (1-2 mg/kg) is generally the preferred agent

as it is hemodynamically advantageous. It once had been reported with a theoretical risk of increased ICP, but this is NO longer considered true.
    - **Etomidate** (0.3 mg/kg) is relatively hemodynamically neutral; however, it has a theoretical risk of adrenal suppression and therefore should not be used in septic patients.
    - **Propofol** (1-2 mg/kg) has a rapid onset; however, it has no analgesic properties and can cause profound hypotension. Has antiepileptic properties.
- Paralytics
    - For neuromuscular blockade, both **rocuronium** (1-1.5 mg/kg) and **succinylcholine** (1-2 mg/kg) are good options. Rocuronium is the preferred agent at most institutions.
    - Succinylcholine has a more rapid onset and a shorter duration; however, it can cause hyperkalemia and can trigger malignant hyperthermia in susceptible patients.

Construct a differential diagnosis for altered mental status/status epilepticus in an infant (synthesis)

Provide possible etiologies for seizure in this scenario as a shared mental model: Trauma, toxin, infection, electrolyte abnormality, metabolic etc. or consider AEIOU-TIPS mnemonic for altered mental status (Alcohol/Acidosis, Endocrine/Epilepsy, Infection, Opiates/Overdose, Uremia, Trauma , Insulin, Poisoning, Stroke). Utilize bedside point-of-care labs in evaluation and management of severe status epilepticus. Use lorazepam as a first line treatment agent.

Formulate an initial diagnostic plan for a critically ill infant with altered mental status/seizure (synthesis)

Initial evaluation should target the evaluation for the possible causes listed above. Laboratory evaluation should look for hypoglycemia, acid/base status derangements, abnormal electrolytes, kidney and liver dysfunction, and signs of infection. Point of care labs followed by more detailed evaluation is warranted. Blood and urine can often be obtained emergently during the initial resuscitation period. While a lumbar puncture to evaluate for meningitis/encephalitis may be needed, this should be deferred until the patient is stable which may be after administration of empiric antibiotics. A targeted toxicology evaluation and ECG may be required. Neuroimaging such as CT should be performed when needed after the child has been stabilized, and the airway is protected or secured.

Construct and implement initial management of status epilepticus in an infant with first and second line medications (application)

Benzodiazepines are recommended as the first-line medication for pediatric seizures; two doses are recommended before proceeding to second-line medications like fosphenytoin or levetiracetam. Consider phenobarbital for refractory seizures or in infants ≤2 months old.

Demonstrate the evaluation of a pediatric patient with concern for trauma using a standard systematic approach (application)

- Evaluation of traumatic injuries follows a standardized approach taught in Advanced Trauma Life Support (ATLS)
- Evaluation begins with addressing any life-threats identified in the ABCs. This is followed by a head to toe exam known as the secondary survey. This includes continued reassessment and a return to ABCs as the clinical condition changes
- The E-FAST ultrasound exam typically occurs during or after the secondary survey. E-FAST is a valuable tool – but more so in adults as children may have physiologic free fluid and injuries that will not require surgery as compared to adults with similar findings. It may be just as appropriate to screen those children with labs (AST/ALT, pancreatic enzymes, urinalysis, CBC) and CXR before considering CT.

Manage head trauma in an infant (application)

- Prevent hypotension, hypoxemia, hypercarbia, and hypovolemia. They will worsen secondary brain injury.
- Watch for raised Intracranial pressure. Mannitol 0.5 g/kg IV/IO or 3% saline 3-5 mL/kg IV/IO are commonly used for elevated ICP.
- Maintain the head of bed at 30 degrees to aid in venous drainage.
- Ensure the head is midline to ensure one side's venous flow is not being constricted.

Demonstrate intraosseous placement (application)

IV access is often difficult to obtain in small children, especially given that this patient is likely dehydrated from decreased feeding. It is important to recognize that IO access is necessary and important to give fluids and medications.

Demonstrate focused history taking and discussion about concern about non-accidental trauma with a caregiver (application)

- Components of history taking: Past medical history, surgical history, family history, medications, allergies, social history, vaccination history

- SAMPLE mnemonic (S – signs and symptoms; A – allergies; M – medications; P – pertinent past medical history; L – last oral intake; E – events leading up to presentation) is helpful to quickly obtain necessary information. For this scenario, obtaining a quick history of falls/possible trauma, new caregivers, etc. is critical.

Explain diagnosis and management to caregivers (synthesis)

A shared mental model of concern for child abuse: Demonstrate effective communication with a parent, both with obtaining an appropriate history and delivering bad news. Ask for understanding and offer clarification. Show images to explain if appropriate.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

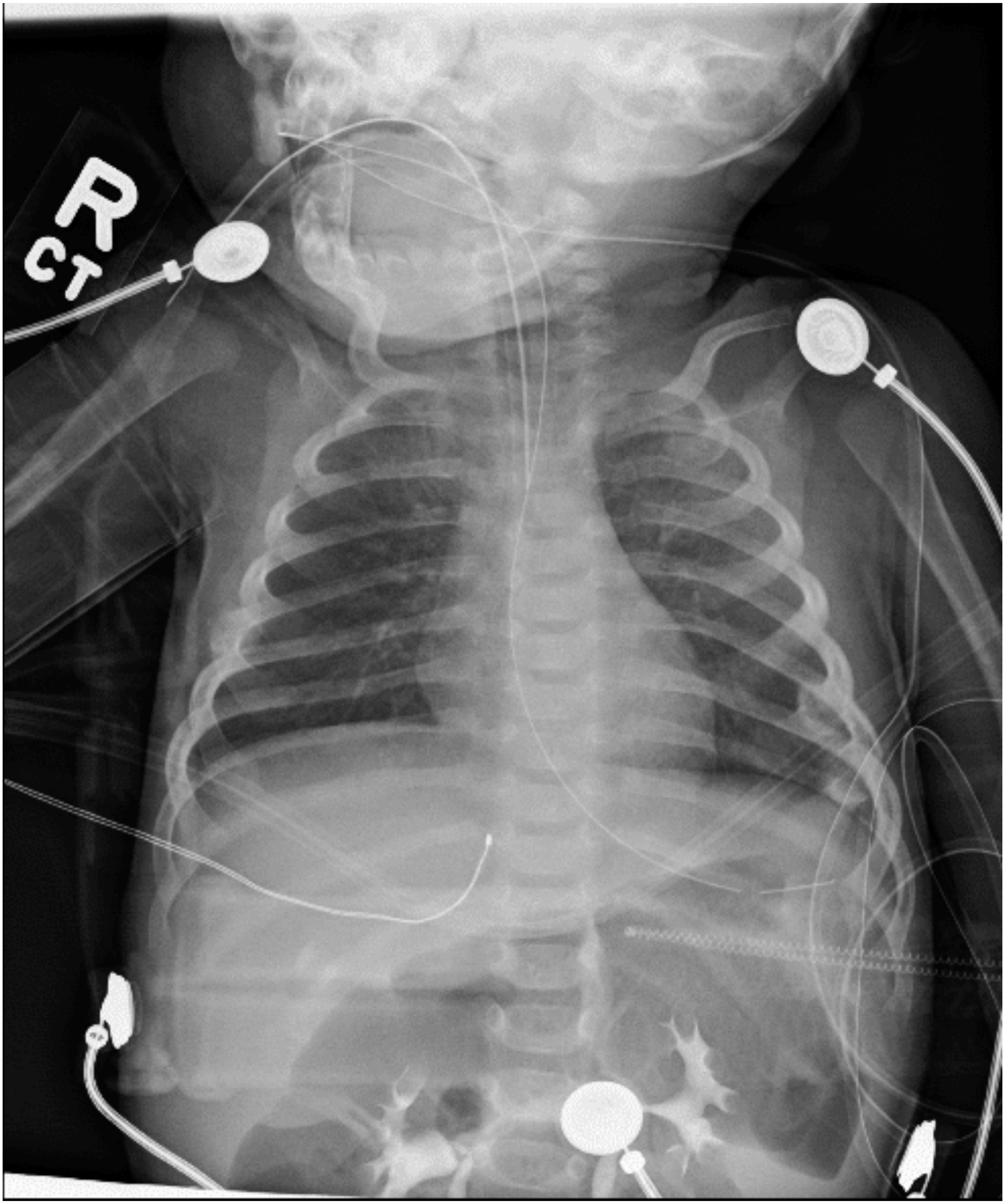
- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Supporting Files

Chest X-ray



Supporting Files

Head CT

Supporting Files

Examination of mouth

Supporting Files

Notes

CXR Interpretation
Post-intubation chest x-ray with posterior rib fractures. Image from Dr. Rebekah Burns.

Head CT Interpretation
Head CT with a subdural hematoma. Image from Dr. Manu Madhok.

Examination of the Mouth - findings
Upper lip frenulum tear. Used with permission from owner Dr. James Metz.

Supporting Files

Laboratory Results

Venous Blood Gas and Other Point of Care Labs

LABORATORY TEST	VALUE	UNITS
pH	7.25	
pCO_2	55	mmHg
pO_2	85	mmHg
HCO_3	16	mEq/L
Base excess	-8	mEq/L
Saturation O_2	85	%
Glucose	87	mg/dL
Ionized Calcium	5	mg/dL
Hematocrit	40	%
Hemoglobin	10	g/dL

Supporting Files

Lab Results
CBC with Differential

LABORATORY TEST	VALUE	UNITS
WBC	11.1×10^3	/mm³
Hemoglobin	10.8	g/dL
Hematocrit	31.5	%
Platelets	415×10^3	/mm³
MCV	88	fL/red
MCH	30.3	pg
MCHC	34.3	g/dL
RDW	12.3	%

Supporting Files

Lab Results
Comprehensive Metabolic Panel

LABORATORY TEST	VALUE	UNITS
Sodium	135	mEq/L
Potassium	4.2	mEq/L
Chloride	98	mEq/L
Bicarbonate	18	mEq/L
BUN	15	mg/dL
Creatinine	0.5	mg/dL
Glucose	87	mg/dL
Protein	7.2	g/dL
Albumin	4.5	g/dL
Total Bilirubin	0.2	mg/dL
AST	210	U/L
ALT	130	U/L
Alkaline Phosphsatase	200	U/L

Supporting Files

Lab Results

Urine Studies

LABORATORY TEST	VALUE	UNITS
Urinalysis	Clear	
Urine Toxicology Screen	Negative	

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant playing the patient's parent

Case Background Information

A 4-month-old girl arrives atto the Emergency Department by ambulance, accompanied by her father/mother, because she seems less alert. Both parents were at work today. The father/mother was called by the babysitter because upon waking, the baby was difficult to arouse and did not want to feed as she usually does. She was fine when the parents left for work in the morning. When her father/mother arrived home the infant would not wake up. He/she was concerned and called EMS. The other parent is on his/her way home from work now and will be meeting at the hospital.

The infant has a seizure with visible shaking during the case. The father/mother will be appropriately concerned and the team will need to explain what is happening to the child. Also, the patient will then require an airway tube to be placed to help the infant breathe. The father/mother will be extremely worried while all this activity is happening around the patient. Finally, bruises, rib fractures, and an internal bleeding in the brain are identified. The father/mother will be approached with concern of child abuse, and the team will discuss the concern with them as well as the process of involving Child Protective Services.

Who are the Learners?

Emergency medicine residents of different training levels

This case is aimed at residents who have a fair understanding for the care of injured children. They should be competent in any emergency procedures pertaining to stabilization of this patient.

Standardized Patient Information

You have arrived via ambulance with your infant because you are concerned she is not acting right. When you arrived home from work, your babysitter told you she was not acting herself and you noticed that she was difficult to arouse. The infant seems to be breathing on her own but is not waking up or crying with stimulation.

You are very concerned about your baby and appropriately worried this situation is very serious. You cannot understand why she is acting this way.

You do not interrupt the case with questions but you answer whatever questions are asked of you. Other than the information provided above, you do not offer additional information and say "I don't know, she was fine when I left this morning". You are cooperative but visibly upset. You are concerned but are not overly emotional.

You will be watching while critical actions occur, including the infant will have a seizure with visible shaking, and asking "what is happening". The team will need to place a tube into the baby's airway to assist with breathing. You will be visibly concerned, not obstructive to the case, and will not ask too many questions to allow the team to proceed.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you? Or "what happened?"): "I don't know, she was fine this morning. Now she's not acting herself."

- AGE: 4 months old

- ADDITIONAL HISTORY: Not moving around even when I try to wake her. Been fussy lately for a week and no bowel movement since yesterday. No reported fever, URI, or vomiting.

- PAST MEDICAL HISTORY: None

- SOCIAL HISTORY: Lives at home with mom and dad. Has had the same babysitter for 2 months. No other caregivers / family members / friends / siblings regularly around the baby.

- FAMILY HISTORY: Unremarkable

- PAST SURGICAL HISTORY: None
- MEDICATIONS: None
- ALLERGIES: No known allergies
- IMMUNIZATIONS: Up-to-date with 2 month vaccinations
- FEEDINGS: Initially breast fed but now on formula (Similac Sensitive). She is a spitty baby and PMD is managing gastroesophageal reflux without any medications. Normal feeding prior to today. This morning took a 4 oz bottle of formula. Babysitter told parents that the infant had difficulty taking her afternoon feeding.
- WET DIAPERS: Normal
- BIRTH HISTORY: She was born at 37 weeks, normal vaginal delivery, no issues with pregnancy or delivery

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Learners may ask you questions, such as the following. Your answers are provided.

- Any history of trauma or falls? Answer: No
- Any recent illnesses or fever? Answer: No
- What are these marks on her belly/back? Answer: I don't know, not noted before.
- What is the blood in the mouth from? Answer: I don't know, not noted before.
- Could the infant have gotten into any medications? Answer: No
- Any issues with development or growth? Answer: No
- Can you call the babysitter and ask additional questions? Answer: She is not available.
- Any other questions may answer "I don't know."

Things you could say without being asked:

- "Is she going to be ok?"
- "Why is she acting like this?"
- "Is she breathing?"

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
When seizure activity starts	"What is happening?"
When the team prepares for intubation or other procedures	"What are you doing?" (Ask with concern but not overly emotional or interruptive.)
When the team addresses the concern for child abuse with you and the need to call Child Protective Services	"What do you mean? How could this be happening?" (Be cooperative and not combative. Remain appropriately concerned.)

Simulation Case 11

PEA / Ventricular Fibrillation

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Setup

Chief complaint: Cardiac arrest
Patient age: 4 years old
Weight: 14 kg

Brief Narrative Description of Case

A 4-year-old male is brought in by EMS with CPR in progress after he was found face down in a swimming pool. The patient will present with pulseless electrical activity (PEA) and no IV access. Learners will need to establish IV/IO access, provide bag-mask ventilation (BMV), recognize PEA, follow PALS algorithm for PEA, and consider reversible causes. After 2 rounds of epinephrine, the patient will go into ventricular fibrillation (VF). Learners will need to recognize VF and follow PALS algorithm accordingly. After the third shock, the patient will go into normal sinus rhythm (NSR). The learner should recognize return of spontaneous circulation (ROSC), stabilize the patient, discuss with family, and discuss disposition of the patient.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Demonstrate early evaluation of a critically ill patient **(application)**
2. Recognize PEA and ventricular fibrillation (knowledge)
3. Apply the appropriate PALS algorithms for PEA and ventricular fibrillation **(application)**
4. Demonstrate airway management of a sick child including synchronized bag mask ventilation and intubation **(application)**
5. Demonstrate intraosseous placement **(application)**
6. Construct and implement initial medical management after ROSC **(application)**
7. Demonstrate focused history taking from a caregiver **(application)**
8. Explain diagnosis and management to caregivers **(synthesis)**
9. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

- Assign/assume team roles
- Obtain history from parent
- Perform primary assessment
- Airway management of an unconscious child (BMV, ETT)
- Provide high-quality CPR including rate and depth, rotating compressor, and minimizing interruptions
- IO placement
- Apply defibrillator pads to patient
- Perform defibrillation
- Use a length-based tape to estimate weight and medication doses
- Direct a team to immediately being CPR, deliver BMV, and establish a safety net (IV-O_2-monitor) for a pulseless child
- Call for and confirm that correct equipment (e.g., defibrillator, airway devices) is at the bedside
- Explain medical condition to parent

Recommended Supplies

- **Manikin:** Child, able to have IO placed
- **Moulage:** None
- **Resources:** PALS cards and/or weight-based tape (e.g., Broselow Tape)
- **Manikin set up:** IV line x 2 in place with drainage bags (IVs unavailable at start of case, learners must place IO)
- **Equipment:**
    - IV supplies
    - Intraosseous equipment including E-Z IO, needle, stabilizer, and connectors, saline flushes
    - Defibrillator and pads with snaps for simulator
    - Pediatric Airway Equipment:
        - Nonrebreather
        - End tidal CO_2 monitor
        - Bag-valve mask with different size masks
        - Oxygen tubing
        - Suction
        - ET tubes
        - Stylet

        - Laryngoscope with blades
        - LMA (optional)
- **Medications:** Epinephrine, atropine, normal saline 1L bag, normal saline flushes, lidocaine, amiodarone, D10 or D25, norepinephrine

Supporting Files

- Lab results
- POC labs/blood gas
- Glucose
- Chemistry
- Chest x-ray after intubation

Participants/Roles

- Participants/learners:
    - Team leader
    - Airway manager
    - Survey physician
    - Medication preparer
    - Medication giver
    - Defibrillator
    - Chest compressor (2)
    - Family liaison/history taker

- Other:
    - Faculty or other embedded participants can play a nurse, respiratory therapist, or tech, if there are not enough learners to perform the above roles
    - Standardized patient (actor or faculty) to play patient's parent

** Team roles may need to be adjusted in order to suit local practices and norms*

Prerequisite Knowledge

- **Faculty**
    - PALS protocols
    - General knowledge of emergency medicine
    - Simulation implementation and debriefing experience

- **Emergency medicine residents**
    - Any stage of training
    - Completed PALS certification

Case Alternatives

- Initial intubation attempt may be declared a failure (even if tube is actually passed through cords) simulating a difficult airway requiring use of LMA.
- IO placement fails after first use or unsuccessful placement in proximal tibia so must consider other sites for IO placement.
- The patient may be hypoglycemic during PEA stage and will not respond to epinephrine until glucose is administered.
- The patient may be hypothermic (temp <33°C). The patient will not change from PEA to VF until the learner states 2 ways to rewarm the patient, through passive versus active techniques (warm fluids, warm blankets, Bair hugger, and bladder irrigation).
- The patient may develop unstable ventricular tachycardia with a pulse after defibrillation requiring synchronized cardioversion with at least 0.5 J/kg prior to return of normal sinus rhythm.

Milestones
PC1. Emergency Stabilization (PC1)
PC2. Performance of Focused History & Physical (PC2)
PC3. Diagnostic Studies (PC3)
PC5. Pharmacotherapy (PC5)
PC7. Disposition (PC7)
PC9. General Approach to Procedures (PC9)
PC10. Airway Management (PC10)
PC14. Other Diagnostic and Therapeutic Procedures
ICS2. Team Management (ICS2)

Resources
1. Donoghue A, Hsieh T, Nishiaski A, Myers S. Tracheal Intubation during Pediatric Cardiopulmonary Resuscitation: A Videography-Based Assessment in an Emergency Department Resuscitation Room. Resuscitation. 2016;99:38-43. PMDI: 26703462
2. Duff JP, Topjian A, Berg MD, et al. 2018 American Heart Association Focused Update on Pediatric Advanced Life Support: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2018;138:e731–e739. PMID: 30571264
3. AHA PALS Provider Manual, 2016

Initial Presentation

ITEM	FINDING
Overall Appearance	4-year-old child unresponsive, pale, receiving bag mask ventilation and CPR
HPI	Patient arrives by EMS with no accompanying parent initially **Learner should listen to EMS report:** "The patient was found down in the family swimming pool. Not known how long the patient was in the pool. Pulled from the pool by mom who called 911 immediately and started CPR. The patient is apneic, blue, and pulseless when EMS arrived. EMS was unable to obtain IV access, and no medications were given. CPR and assisted ventilation were administered by EMS en route to the hospital."
Past Medical/Surgical History	Born full term with no complications. History of PE Tubes at age 2 for recurrent otitis media.
Medications	None
Allergies	No known drug allergies
Family History	Unremarkable
Social History	Lives at home with parents and 2 month old sister No pets No smoking Goes to preschool

Stage 1

Begin Simulation (Stage 1 of 4)

Initial Evaluation:
Start through identification of PEA

CRITICAL ACTIONS

- Team leader makes it clear he/she is the leader and assigns roles/tasks
- Gets history from EMS providers; no parent available initially
- Check for a pulse, recognize pulselessness, and continue CPR/BMV with effective chest compressions of correct depth and rate
- Place patient on continuous cardiac monitor
- Apply defibrillator pads (may not do this until patient is in VF)
- Obtains vascular access IV/IO
- Establishes appropriate weight of patient using length base tape
- Verbalizes recognition of PEA (no pulse, bradycardic rhythm on monitor)

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 34°C rectal, **HR:** 35, **BP:** unable to obtain, **RR:** 20 with BMV, **SpO_2:** not reading
General	Unresponsive, pale, no spontaneous movement
HEENT	Head with no signs of trauma; pupils 3 mm bilaterally, wet hair
Neck	Normal
Lungs	Coarse breath sounds heard bilaterally with BMV
Cardiovascular	No cardiac activity

Physical Exam (continued)

ITEM	FINDING
Abdomen	Distended
Neurological	Unresponsive, no spontaneous movement, pupils 3 mm bilaterally, unresponsive
Skin	Cool, no rashes
Other Relevant System	No bruising or other signs of trauma

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
On arrival: Feel for a pulse	Recognizes pulseless; continues CPR	If they do not feel for a pulse and only look at the monitor, the nurse prompts, "Does the patient have a pulse?"
Continue high quality CPR and assisted ventilation	Pulses can be palpated with compressions.	Rate of 15:2 if more than one provider
Ask for patient to be placed on a monitor	Vitals revealed on monitor	Nurse can prompt if leader does not ask for patient to be placed on monitor
If there is an inadequate seal with BMV	Poor chest rise	With adjuncts or repositioning good chest rise and air movement with BMV
May decide to intubate	If attempts intubation, intubation is successful	
Attempt to establish peripheral IV access	Nurse will say IV access unsuccessful	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Place IO in appropriate location	Nurse will say IO access successful	
Parent arrives after IV/IO access obtained		The parent is upset trying to find out how her/his child is doing. If someone is assigned to explain to the parent that the patient is critical and what the team is doing, the parent will calm down.
Verbalize recognition of PEA	Proceed to **Stage 2**.	If PEA is unrecognized, the nurse can ask, “What rhythm are we treating?”

Stage 2

PEA Algorithm:
Recognition of PEA through second dose of epinephrine

CRITICAL ACTIONS

- Follow PALS algorithm for the treatment of PEA
- Administers epinephrine (0.01 mg/kg followed by flush; CPR continued for 2 minutes before recheck of pulse and rhythm). Gives second dose 3-5 minutes after the first dose
- Discuss a few reversible causes and treatment for them (hypothermia, hypoglycemia, acidosis, hyperkalemia)
- Verbalizes rhythm change to VF
- Parent given option to remain in room with patient with parent being updated by liaison/social work/etc.

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 34°C rectal, **HR:** 110-120 with compressions, **BP**: unobtainable, **RR:** 0 (if intubated, at bagged rate; if not, at compression:BMV ratio of 15:2), **SpO_2:** 95% with intubation or BMV
Exam Changes	No change

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Epinephrine (first dose) given	Patient remains pulseless and in PEA with a HR 30-40 with rhythm check	
Pulse check 2 minutes after epinephrine given	No change in rhythm	
Consider at least 1 reversible cause	Will have a change of rhythm from PEA to VF if at least 1 reversible cause is considered. Otherwise, the patient will continue in PEA until at least one is considered.	Nurse can prompt by asking if they should get any labs (glucose, bedside gas, electrolytes).
(Option) Dextrose stick=35 mg/dL: Give D10 or D25	After the second dose of epinephrine, will have change of rhythm to VF; Go to **Stage 3**.	Dose glucose per Broselow or 5 mL/kg of D10, or 2 mL/kg of D25
(Option) Hypothermia T <33.5°C: Will state 2 ways to rewarm patient (warm fluids, warm lights, bladder lavage). If check for hypothermia and >33.5 no actions needed	After the second dose of epinephrine, will have change of rhythm to VF; Go to **Stage 3**.	
(Option) Acidosis pH= 7.0: Give $NaHCO_3$ at 1 mEq/kg	After the second dose of epinephrine, will have change of rhythm to VF; Go to **Stage 3**.	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
(Option) Hyperkalemia with K=6.7: Treat with a dose of calcium and then state other potential treatments for hyperkalemia, such as glucose and insulin	After the second dose of epinephrine, will have change of rhythm to VF; Go to **Stage 3**.	
Epinephrine (second dose), given after 3-5 minutes with continued compressions	Rhythm changes to VF. Go to **Stage 3**.	

Stage 3

Ventricular Fibrillation Algorithm:
Start of ventricular fibrillation through two rounds of defibrillation

CRITICAL ACTIONS

- Continue to support airway with BMV and continue CPR at 15:2 compression-ventilation ratio (unless patient was intubated)
- Defibrillator pads should be placed, if not already done previously
- Intubation should not be attempted at this point as it should be recognized that immediate defibrillation should be attempted
- Follow PALS algorithms for VF and defibrillation at 2-10 J/kg
- Resume CPR immediately after shock delivered
- Recognize return of NSR

Physical Exam

ITEM	FINDING
Vital Signs	**HR:** 100-120 with CPR, **BP:** unobtainable, **RR:** at bagged rate, **SpO_2:** 93% with BMV
Exam Changes	No changes

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Pulse check 2 minutes after second dose of epinephrine	Rhythm on monitor changes to VF, and the patient remains pulseless without compressions.	If learners do not recognize rhythm change, nurse can say, "It looks like the rhythm has changed on the monitor."
Recognize VF and place defibrillator pads, if not already on	No change in case	
Defibrillation at 2-4 J/kg followed by immediate chest compressions	Rhythm check 2 minutes after shock; still in VF	
Defibrillation at 4-6 J/kg followed by immediate chest compressions	Rhythm check 2 minutes after shock; still in VF	
Epinephrine 0.01 mg/kg after second shock and every 3-5 minutes	No changes in rhythm	Asking for amiodarone or lidocaine is acceptable
Defibrillation at 6-10 J/kg (no more than 10 J/kg)	CPR is resumed immediately after shock; rhythm check 2 minutes after shock; patient now in NSR with 1+ pulses. Go to **Stage 4**.	
If learner attempts to intubate before defibrillation	Unsuccessful intubation	Nurse says: "I thought we should not delay defibrillation to intubate a patient in VF"
Cessation of CPR immediately after defibrillation without 2 minutes of high quality CPR		ROSC is not achieved

Stage 4

Case Conclusion:
ROSC and NSR identified through signout to admitting team or facility

CRITICAL ACTIONS

- Recognize return of spontaneous circulation and stabilize the patient (treat hypotension, keep normothermic, treat hypoglycemia)
- Titrate oxygen to keep oxygen saturation 94-99%
- Ask for blood gas, electrolytes, and calcium, if not already done
- Update family
- Plan disposition as admission versus transfer

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 35.5°C rectal, **HR:** 125, **BP:** 70/56, **RR:** 20, **SpO_2:** 95%
Exam Changes	• Patient color improving • Cardiovascular: Tachycardia, regular rhythm • Lungs: Rhonchi bilaterally • Capillary refill now 3-4 sec

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Titrate oxygen to maintain oxygen saturations 94-99%		
Give patient 20 mL/kg of NS for low BP	BP increases to 80/65 after fluids given	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Give warm fluids and use warm blankets, lights, or Bair hugger	Temperature increases to 36.5-37°C	
Intubate patient with cuffed ET tube after ROSC, if not already done so	Patient successfully intubated	
Ask for CXR after intubation	CXR will have pulmonary edema and ET tube will be slightly high	
Admit to PICU or transfer to higher level of care		
Update parents that patient is critical and that he needs to be admitted/transferred to PICU.	If do not talk with parents, parents can ask questions, “Will my baby wake up? Will he be normal?”	Nurse can prompt the leader to explain to parents the plan and prognosis for their child.

Ideal Scenario Flow

The learners enter the room to find a patient that is unconscious, pulseless, with EMS actively bagging the patient and doing CPR. The learners recognize that the patient is in PEA and continue chest compressions. IV/IO access is attempted. The IV attempts fail, but the IO is successful. Learners may or may not attempt intubation at this point. PALS algorithm is used for treatment of PEA, and after 2 rounds of epinephrine and high quality CPR, the patient goes into VF. At this moment, learners recognize that CPR needs to be continued and prepare to defibrillate the patient. The patient is defibrillated 1 or 2 times at 2-4 J/kg, then 4-6 J/kg, and then 6-10 J/kg before ROSC is achieved. The patient has mild hypothermia and hypotension after ROSC is achieved. The hypothermia severity is mild, and warm fluids/ warm blankets can be used. Hypotension should be treated with fluids, and pressors should be considered, if fluids are inadequate. The learners ensure that the family understands the patient's medical course and answers questions. The learners admit or transfer the patient to a Pediatric ICU.

Anticipated Management Mistakes

1. **Failure to check for a pulse** on initial presentation and see the heart rate on the monitor as 30-40, thereby thinking the patient has symptomatic bradycardia instead of PEA. In this scenario, if this happens, the nurse will prompt the leader by asking if there is a pulse.

2. **Intubation of the patient when VF is recognized.** If this occurs, the nurse or RT will state that they thought it was best to defibrillate as quickly as possible when a patient has VF or pulseless ventricular tachycardia. The facilitators, during debriefing, can discuss the risk/benefit of intubation during arrhythmic events and can point out there were signs of adequate bagging with good chest rise, equal breath sounds, and good oxygen saturation levels.

3. **Not resuming immediate CPR after defibrillation:** In this case if this happens, it will most likely not achieve ROSC. Real time guidance can be offered by the facilitator.

4. **Difficulty using defibrillator:** Many hospitals are switching to new defibrillators, and we found that many of the learners are not comfortable using the new equipment. If this is found, a tutorial may be necessary to teach the use of defibrillators.

Debriefing Points

Demonstrate early evaluation of a critically ill patient (application)

Learners should approach a critically ill patient in a standardized fashion. Always check for responsiveness. If unresponsive, check for a pulse. If no pulse, start CPR and proceed to airway, breathing, and circulation. Interventions such as airway repositioning/adjuncts/intubation should be considered if poor air movement or difficulty with BMV. After A, B, and C have been addressed, the patient should be evaluated for disability and exposed for a thorough head to toe exam. In pediatrics, people often say that D also stands for "don't forget the dextrose" as a blood glucose level should be checked in any child with altered mental status. In this case, the learner is stopped at C and must treat the circulation problems before they can go on to D and E, but still should consider dextrose as a reversible cause. Once ROSC is achieved disability and exposure should be completed to look for any other injuries that may have occurred.

Recognize PEA and ventricular fibrillation (knowledge)

It is important to not only look at the monitor but to also feel for a pulse. If the monitor is only checked the learner might think the patient has symptomatic bradycardia and if they only feel for a pulse then they might assume asystole. For VF the learner must be familiar with what VF looks like and understand there is no pulse with VF as the heart only quivers.

Apply the appropriate PALS algorithms for PEA and ventricular fibrillation (application)

During debriefing it is good to walk through verbally the algorithms for both of these rhythms. This is a good time to review what good CPR is:

- Child: Rate of 100-120 with chest compression of 1/3 of AP diameter or about 2 inches (5 cm)
- Infant: About 1.5 inches (4 cm) in an infant

Allow complete recoil and rotate compressors frequently. Minimize interruptions to <10 sec.

- **PEA**
  1. Continue CPR and BMV (discussed in next objective)
  2. Obtain IV/IO access
  3. Consider advanced airway
  4. Epinephrine 0.01 mg/kg per dose (0.1 mg/mL concentration) given every 3-5 minutes IV/IO, followed by NS flush. May give epinephrine 0.1 mg/kg (1 mg/mL concentration) down the ET tube if no access is obtained.
  5. CPR continued throughout and stopped for <10 secs to check for a pulse and resumed immediately if pulse not felt
  6. Pulse check / rhythm check 2 minutes after epinephrine given
  7. Repeat epinephrine if still in PEA
  8. Consider and treat reversible causes: Hypovolemia, hypoxia, hydrogen ion (acidosis), hypoglycemia, hypo or hyperkalemia, hypothermia, tension pneumothorax, tamponade, toxins, pulmonary or coronary thrombosis (PALS 2016)

- **Ventricular fibrillation**
  1. Place defibrillator pads if not already on the patient
  2. Continue CPR and BMV
  3. Do intubate patient before giving shock. Best to try and get out of VF as soon as possible.
  4. Shock patient with 2-4 J/kg followed be immediate compressions
  5. Continue CPR for 2 minutes before rhythm check.
  6. If still in VF, shock again at 4-6 J/kg followed by immediate compressions.
  7. Give epinephrine 0.01 mg/kg every 3-5 minutes.
  8. If after second shock and still no change in rhythm, consider an advanced airway
  9. Continue increasing J/kg with subsequent defibrillations, but no more than 10 J/kg
  10. May consider amiodarone 5 mg/kg or lidocaine 1mg/kg after epinephrine given.
  11. Also consider reversible causes if not done above.

Demonstrate airway management of a sick child including synchronized bag mask ventilation and intubation (application)

Learners should recognize that adequate bag-valve mask ventilation is critical in the care of a patient. Good air entry should be evaluated and if poor chest rise then the patient should be repositioned, air way opened, oral/nasal airways considered. If continues with poor air entry with BMV, advanced airways should be considered. Being prepared for a difficult airway in any critical patient is important. Have a plan, such as calling for back-up (anesthesia, more experienced physician, respiratory therapist) and having rescue equipment at bedside (video laryngoscopy, LMA, and cricothyrotomy kit).

When performing BMV, the compression to ventilation ratio should be 15:2 when there are 2 or more providers (30:2 when only 1 provider). Once the patient is intubated, it is not necessary to do the 15:2 ratio but the patient should not be bagged too fast. A rate of 1 breath every 8-10 seconds and each breath should be given over 1 sec. Continue to watch for visible chest rise. If BMV is too rapid and too much air is insufflated, the abdominal distention can occur and make BMV more difficult.

The learners should be able to choose appropriate size equipment for this child and should recognize that this child should have a cuffed ET tube placed. Once an advanced airway is in place, the learner should use capnography or capnometry to confirm and monitor ET tube placement. When a patient is in VF, defibrillation should be prioritized over intubation.

Demonstrate intraosseous placement (application)

Intraosseous lines should be placed in critically ill children when IV access cannot be obtained quickly (no more than 2 attempts at peripheral IV or no access within the first 60 seconds of a resuscitation).

The learner should be able to voice or show during the case the different sites that intraosseous lines can be placed. For children less than 6 years of age, placement in the proximal/distal tibia and distal femur are preferred over the humerus.

- Proximal tibia
- Distal tibia
- Distal femur
- Proximal humerus

Use the EZ IO drill and drill the needle until it is secure in the bone.

Be careful not go through the posterior aspect of the bone, especially in young infants. Make sure that your hand, which is holding the limb is NOT directly behind where you are drilling.

Needle selection is weight-based. The pink EZ-IO is most commonly used in pediatrics because it's good for 3-39 kg. The blue needle is adult size (or ≥ 40 kg).

What can be infused?

- Anything that you would put through an IV can go through an IO. In some ways it's better because you do not have to worry about extravasation of potentially harmful medications (CaCl or epinephrine drips) like you do with a peripheral IV. However, you must always keep a solution infusing, or the IO will become clogged.

What labs can be sent from an IO?

- You can do most labs, except for the CBC which will inaccurate because it will be from the marrow and not circulation.

If the patient is awake or alert, what can you do for the pain?

- The infusion of IV fluids and other products or medications through the IO can be painful. If you inject 2-5 mL of 2% preservative and epinephrine-free lidocaine into the bone through the IO, this will reduce the pain from the infusions (2-5 mL infants/children, 5-10 mL for adults).

Resources demonstrating IO placement:

- EZ-IO IO Access [PDF]
- Video [YouTube]

Discussion points for common errors:

- Did the team recognize the need and get the IO in a timely fashion? Many people will wait too long before they place an IO. It really should happen within the first minute if there is no access.

- Did they pick the right location? If so, this is a good opportunity to discuss alternative sites for IO placement and what are the contraindications for IO placement:
    - Fracture in the selected bone
    - Overlying infection in the soft tissue

    - Previous orthopedic surgery (pins, etc.) in that bone

- Where was the holder's second hand? Was it safe or could they have injured themselves if they went through the bone?

- Did they use aseptic technique? They should clean the overlying tissue with betadine or similar agent prior to drilling the bone.

- How did they secure the IO? Inside the IO kit, there are "locks" or securing sites that can be fitted over the IO and hold them in place. Did they use it? If not, important to discuss because they can come out or be knocked out in an emergency.

- **Tip:** If you are using the "old" or handheld IO's, you can take a needle driver from a suture kit, clamp it to the exposed part of the needle and then tape that to the child's leg using cloth or wide strips of tape.

Construct and implement initial medical management after ROSC (application)

When the patient returns to NSR, the learner should recognize ROSC. Once ROSC has occurred the learner should do the following:

1. Optimize ventilation and oxygenation. Titrate FiO_2 to maintain oxygen saturation 94-99%.
2. If no advanced airway was placed prior,consider placing now.
3. Assess for shock. Treat contributing factors and give 20 mL/kg of isotonic crystalloid (may consider 10 mL/kg if suspect poor cardiac function). Consider the need for pressor support if shock is refractory to fluid resuscitation.
4. Assess blood gas, serum electrolytes, glucose, calcium, if not already done so previously
5. Monitor for and treat hypoglycemia.
6. Keep the patient normothermic, avoiding hyperthermia.
7. Treat any agitation and seizures.

Demonstrate focused history taking from a caregiver (application)

The initial history will come from EMS. The learner should take the few seconds to listen to what the EMS personnel have to report. When the mother arrives, a person should be assigned to get a history from her. It should be focused on what occurred when the patient drowned, such as any possible trauma, how long the patient might have been submersed, any other medical conditions that might make resuscitation more difficult, or medical problems that may have led him to drown. Medications and allergies should be inquired about, just like for all patients.

Explain diagnosis and management to caregivers (synthesis)

If personnel are available, one member of the team may stay with the family to gather history and explain interventions. Family members should be given the option of staying in the room and watching the resuscitation or stepping out of the room. Information should be relayed to the family using layperson's terms. The rationale for invasive interventions such as IV placement/IO placement, CPR, BMV, defibrillation, and intubation should be explained preceding or at the time of occurrence, when possible.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The

sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Supporting Files

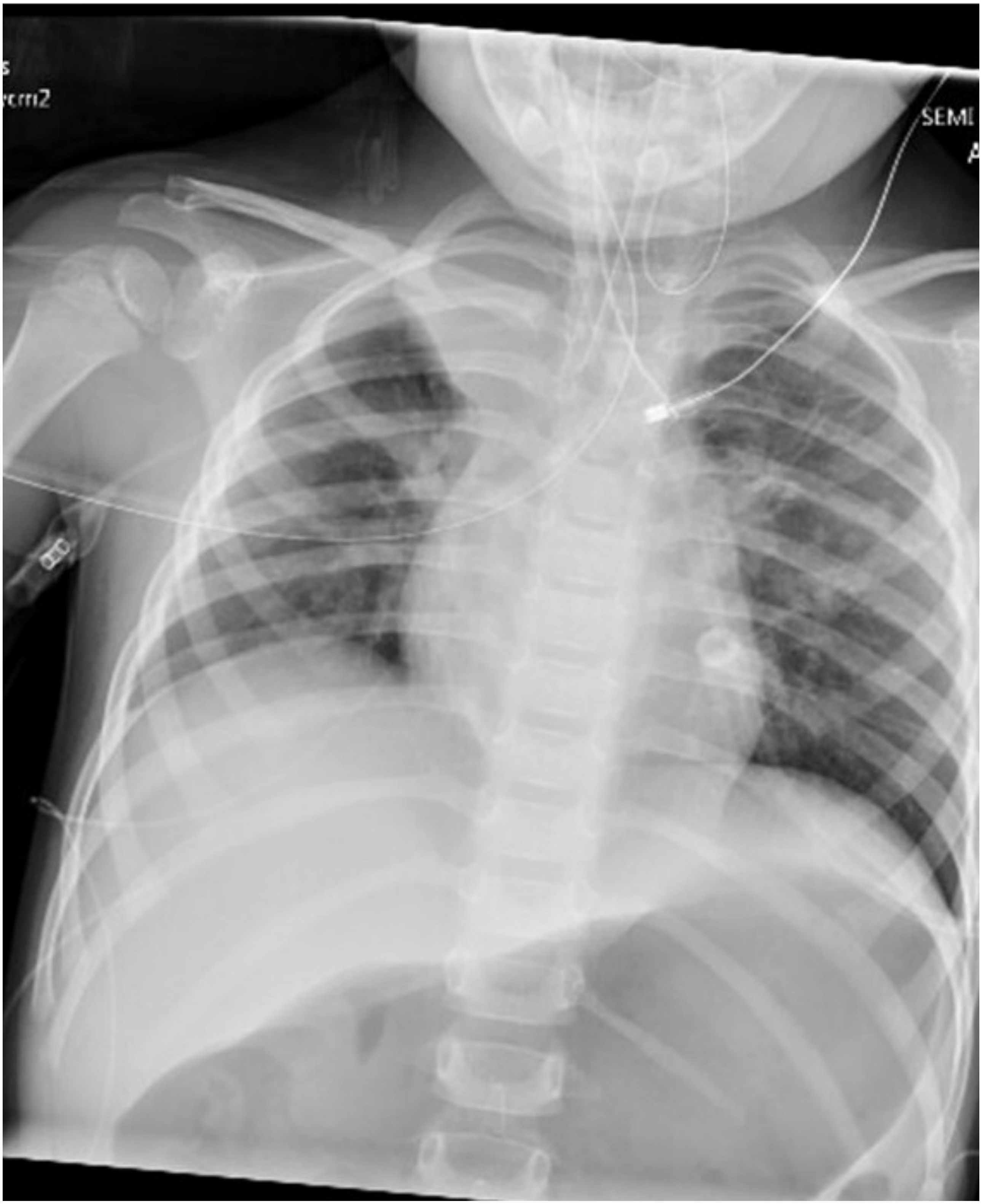
Laboratory Results

Venous Blood Gas and Other Point of Care Labs on 100% FiO_2

LABORATORY TEST	VALUE	UNITS
pH	7.02	
pCO_2	110	mmHg
pO_2	30	mmHg
HCO_3	15	mEq/L
Base excess	-10	mEq/L
Na	130	mEq/L
K	3.2	mEq/L
Cl	100	mEq/L
Glucose	185	mg/dL

Supporting Files

Chest X-ray



Supporting Files

Notes

Chest x-ray interpretation
Post intubation film showing right upper lobe atelectasis and pulmonary edema bilaterally. Image from Dr. Rebekah Burns.

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant playing the patient's parent or guardian

Case Background Information

A 4-year-old boy was found down in a pool by his mom. It is unknown how long he's been unconscious. Mom gets him out of the pool, calls 911, and initiates chest compressions. On arrival, EMS finds the patient to be in asystole. They continue chest compression and administer BMV, but are unable to obtain IV access. On arrival to the ED, the patient is being bagged and receiving chest compressions.

Who are the Learners?

Emergency Medicine interns

- May have experience in obtaining a history from family
- Some may have PALS certification others may not be familiar with medical treatments and procedures

Emergency Medicine junior residents (PGY-1/PGY-2)

- Should have experience in obtaining access on patient and able to place an IO line

Emergency Medicine senior residents (PGY-3/PGY-4, or PGY-2 in a 3-year training program)

- Should have experience in running the code, following PALS algorithm, being team leader, and airway management

Standardized Patient Information

You find your 4-year old son unconscious in the pool, face down, and scream to tell people to call 911. You initiate CPR. EMS arrives and takes your son. You show up at the ED a few minutes after your son has arrived.

You are worried about your son dying. You look anxious as you arrive into the ED. You start asking a lot of questions: How is my son? What are they doing? Is he going to be okay?

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you? Or "what happened?"): Drowning, cardiac arrest
- AGE: 4 years old
- ADDITIONAL HISTORY: Your son was at a pool party. You were talking to another mom, when you noticed your son was not around. Someone screamed from afar and said that a child was in the pool. You run towards the pool and find your son face down in the pool, unconscious.
- PAST MEDICAL HISTORY: Had frequent ear infections first 2 years of life
- SOCIAL HISTORY: Lives with mom, dad, 2-month-old sister. Loves dogs. Goes to preschool.
- FAMILY HISTORY: Unremarkable
- PAST SURGICAL HISTORY: PETs placed at 2 years of age
- MEDICATIONS: None
- ALLERGIES: No known allergies
- IMMUNIZATIONS: Up-to-date
- BIRTH HISTORY: Healthy baby, born full term via vaginal delivery. No ICU stay.

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:

- "What is going on? Is my son alive? Is he breathing? What am I going to do?"

Simulation Case 12

Penetrating Trauma

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Updated August 19, 2020

Setup

Chief complaint: Gun shot wound to right abdomen
Patient age: 4 years old
Weight: 18 kg

Brief Narrative Description of Case

This scenario takes place at a Level 1 trauma center. The patient is 4 years old and was an accidental casualty in a drive-by shooting. He has a gunshot wound to his right torso causing hemodynamic instability. On primary survey, learners will ideally recognize that the patient is having respiratory distress and perform needle decompression and place a chest tube. The patient will also need emergent airway management with adjuncts, bag valve mask, and/or intubation. The patient has an intra-abdominal hemorrhage, requiring aggressive fluid resuscitation and blood transfusion (initiation of institutional massive transfusion protocol). The learner should communicate to the parent(s) the interventions that were performed and provide a final disposition to the operating room for definitive management.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Demonstrate the evaluation of a pediatric patient with penetrating trauma using a standard systematic approach **(application)**
2. Construct and implement initial medical management plan for a child with a penetrating trauma **(application)**
3. Perform fluid resuscitation for shock including institutional protocol for blood transfusion **(application)**
4. Demonstrate airway management of a sick child using appropriate adjuncts, bag valve mask, and/or endotracheal intubation **(application)**
5. Demonstrate needle decompression, pediatric chest tube placement, and tube size selection **(application)**
6. Demonstrate focused history taking from a caregiver **(application)**
7. Explain diagnosis and management to caregivers **(synthesis)**
8. Demonstrate teamwork and closed loop communication

(application)

9. Develop a plan for transfer to a trauma center for definitive management **(synthesis)**

CRITICAL ACTIONS

- Team lead assigns roles
- Obtain focused history from emergency medical services (EMS) and additional SAMPLE history from parents
- Place patient on monitor and obtain initial vital signs
- Obtain vascular access (intravenous or intraosseous)
- Perform primary survey and identify tension pneumothorax
- Manage pediatric airway
- Employ proper use of airway adjuncts (may include effective bag-mask ventilation (BMV), nasopharyngeal airway, oropharyngeal airway, laryngeal mask airway, jaw thrust, shoulder roll)
- Obtain a definitive airway (endotracheal intubation or surgical airway)
- Perform proper needle decompression and chest tube placement with appropriate size selection
- Perform E-FAST exam and identify intra-abdominal hemorrhage
- Perform adequate intravenous fluid resuscitation for hypovolemic shock
- Initiate massive transfusion protocol
- Complete secondary survey
- Call pediatric trauma service for disposition to operating room, and notify Pediatric Intensive Care Unit or other appropriate higher level of care
- Communicate effectively and compassionately with parents of a sick child
- Disposition patient to the operating room

Recommended Supplies

- **Manikin:** Trauma child
- **Moulage:** Gun shot wound (GSW) to the right abdomen/thorax (entrance wound at right subcostal margin, exit wound on right mid back), blood stained clothes

- **Resources:** Pediatric Advanced Life Support (PALS) cards and/or length-based tape (e.g., Broselow Tape)
- **Manikin set up:**
  - Ability to needle decompress the right chest and place a chest tube. Can be set up separate from manikin on skills trainer, depending on available simulation equipment available. If only adult trauma manikin, consider increasing the age of the child (e.g., 10 years old, 30 kg)
  - Extremities available for peripheral IV placement attempts and intraosseous (IO) device access
- **Equipment:**
  - PALS cart to include airway equipment
    - Nasopharyngeal airways (NPA)
    - Laryngeal mask airways (LMA)
    - Oropharyngeal airways (OPA)
    - Cuffed endotracheal tubes
    - Laryngoscope blades and handles
  - Bag mask ventilation (BMV) with appropriate sized masks
  - Ventilator
  - Needles for pneumothorax decompression (14g and 16g peripheral IVs)
  - Chest tube set ups
    - Tube thoracostomy 18/20/22 Fr
    - Percutaneous chest tube kits
    - Pleuravac
  - IV supplies and tubing
  - IO supplies
  - Video laryngoscope (optional)
- **Medications:** Rapid sequence intubation (etomidate, ketamine, succinylcholine, rocuronium), sedation/analgesia (fentanyl, morphine, versed), blood products (uncrossed trauma cooler), tranexamic acid, cefazolin, Tdap immunization, cardiac arrest medications (code cart – epinephrine, atropine, calcium chloride, amiodarone, lidocaine, dextrose 50%), IV fluids

Supporting Files

- Ultrasound: FAST images which shows fluid in the abdomen and absent lung sliding on the right
- Chest radiograph (CXR) showing appropriate chest tube placement

- Lab results with blood gas showing mild metabolic acidosis, low/normal hemoglobin/hematocrit, and mild transaminitis. Urinalysis with hematuria.

Participants/Roles

- **Learners**
  - Team leader
  - Airway manager / respiratory therapist
  - Medication preparer
  - Medication giver
  - Recorder (optional)
  - Pharmacist (optional)
  - ED technician (optional)

- **Embedded participant**
  - Parent(s) of the patient – provides history of event and SAMPLE history. Asks about pain medicine for the patient, if not given. If the patient goes to the operating room without informing you, ask what's going on and what's going to happen.
  - Nurse – provides exam findings, if asked, for parts of the exam difficult to simulate. Can decide if initial peripheral intravenous lines are successful or if want to push learner to intraosseous access.
  - Consultants - Surgical fellow/attending – can be phantom and provide phone consult if needed.

Prerequisite Knowledge

- **Faculty**
  - PALS protocols
  - General knowledge of emergency medicine
  - Simulation implementation and debriefing experience

- **Emergency medicine residents**
  - Any stage of training (preferably PGY- 2 or higher for team lead; recommended after Pediatric intensive care unit rotation)
  - Completed PALS certification
  - Trauma assessment and management training, such as Advanced Trauma Life Support (ATLS)

- Familiarity with pediatric airway management
- Criteria for institutional trauma team activation (EM1)
- Knowledge of institutional massive transfusion protocol (EM1)
- Skills training on needle decompression and chest tube placement
- Training on E-FAST performance

Recommended to review prior to session

- Intubation and chest tube placement for pediatric patients

Case Alternatives

- The patient could go into pulseless electrical activity (PEA) if chest decompression is not done within 2 minutes of presentation.

- The patient remains hemodynamically unstable until the chest tube is placed and a massive transfusion protocol (MTP) initiated.

- Incorporate transfer concerns and consideration of limited resources, if setting changed to a non-trauma center or non-pediatric hospital.

- Can increase case difficulty by making patient have a difficult airway due to blood or general poor visibility.

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC3. Diagnostic Studies
PC4. Diagnosis
PC5. Pharmacotherapy
PC7. Disposition
PC8. Task-Switching
PC9. General Approach to Procedures
PC10. Airway Management
PC11. Anesthesia and Acute Pain Management
PC12. Other Diagnostic/Therapeutic Procedures (FAST)
PC15. Medical Knowledge
PC22. Patient Centered Communication
PC23. Team Management

Resources
1. McFadyen JG, Ramaiah R, Bhananker SM, et al. Initial Assessment and management of Pediatric Trauma Patients. Int J Crit Illn Inj Sci; 2:121-127. PMID [23181205]
2. Dudley NC, Hansen KW, Furnival RA, et al. The Effect of Family Presence on the Efficiency of Pediatric Trauma Resuscitations., Ann Emerg Med; 53:777-84. PMID [19013688]
3. Sobolewski B. [Do we need to perform a digital rectal exam in injured children?] PEM Cincinnati blog. Published May 2016. Accessed June 2020.
4. Fox SM. [Pediatric Trauma Pitfalls]. PEM Morsels. Published June 2019. Accessed June 2020.
5. Nickson C. [Trauma! Penetrating Abdominal Injury]. Life in the Fast Lane. Published Feb 2019. Accessed June 2020.
6. Interfacility Transfer Toolkit for the Pediatric Patient, M.a.C.H.B. Health Resources and Services Administration, EMSC (EMSC) Program, Editor. 2018. p. 1-42.
7. Bhananker S, McFadyen J, Ramaiah R. Initial assessment and management of pediatric trauma patients. International Journal of Critical Illness and Injury Science. 2012;2: 121-127.
8. Committee On Pediatric Emergency Medicine, C.O.I., et al., Management of Pediatric Trauma. Pediatrics, 2016. 138(2).
9. Cotton BA, Nance ML. Penetrating trauma in children. Semin Pediatr Surg, 2004. 13(2): 87-97.
10. Dudley NC, Hansen KW, Furnival RA, Donaldson AE, Van Wagenen KL, Scaife ER. The effect of family presence on the efficiency of pediatric trauma resuscitations. Ann Emerg Med. 2009; 53(6):777-84.e3.
11. Hansen M, Meckler G, O'Brien K, et al. Pediatric Airway Management and Prehospital Patient Safety: Results of a National Delphi Survey by the Children's Safety Initiative-Emergency Medical Services for Children. Pediatr Emerg Care. 2016;32(9):603-607.
12. Nakayama DK, Gardner MJ, Rowe MI. Emergency endotracheal intubation in pediatric trauma. Ann Surg. 1990;211(2):218-223.
13. Rotondo M, Cribari C, Smith R. Resources for Optimal Care of the Injured Patient. Committee on Trauma. 2014, Chicago, IL: American College of Surgeons. 1-215.
14. Shroyer MC, Griffin RL, Mortellaro VE, Russell RT. Massive transfusion in pediatric trauma: analysis of the National Trauma Databank. The Journal of Surgical Research. 2017 Feb;208:166-172.
15. Starnes AB, Oluborode B, Knoles C, Burns B, McGinnis H, Stewart K. Direct Air Versus Ground Transport Predictors for Rural Pediatric Trauma. Air Med J. 2018;37(3):165-169.

Initial Presentation

ITEM	FINDING
Overall Appearance	4-year-old male with eyes closed, whimpering, and with rapid shallow respirations. Blood stained clothes greater on the right side.
HPI	**Instructor:** "You receive a call from EMS that a patient is being brought in after a shooting at a nearby shopping mall. EMS was not able to establish vascular access, and they are now at your front doors. The parent accompanies the patient." **Parent:** "We were in line to get Auntie Annie's pretzel when someone just opened fire. I think it was gang related. I tried to pull him out of harm's way, but I was not fast enough. As soon as I saw he was hit, I called 911. Is he going to die?" **If the learner asks for it:** No additional information given. The learner must interview parent and EMS for below information.
Past Medical/Surgical History	No past medical history. Parents have limited access to health care and have not completed the immunization schedule.
Medications	None
Allergies	Apples and pears; no known drug allergies
Family History	No history of bleeding disorders
Social History	• Lives at home with mother, father, and older brother • Smoking outside house only • No access to firearms at home • Pet dog

Stage 1

Begin Simulation (Stage 1 of 3)

Primary Survey (A-B):
Start through needle compression and intubation

CRITICAL ACTIONS

- Team lead assigns roles
- Place patient on monitor and obtain full set of vital signs
- Obtain vascular access and order labs
- Perform primary survey
- Identify tension pneumothorax
- Needle decompression
- Manage pediatric airway (can be done in next step)
- Employ proper use of airway adjuncts (may include effective BMV, NPA, OPA, LMA, jaw thrust, shoulder roll)
- Obtain a definitive airway (endotracheal intubation or surgical airway)
- Initiate volume resuscitation (blood or saline)

Primary Survey

ITEM	FINDING
Vital Signs	**T:** 37.1°C, **HR:** 160, **BP:** 68/48, **RR:** 36, **SpO_2:** 85%
Airway	No airway obstruction, no pooling of secretions, no stridor. If asked, the trachea is deviated to the left.
Breathing	Agonal and shallow breathing at rate of 36. Absent breath sounds on the right. Asymmetric chest rise.
Circulation	Palpable pulses in all extremities, 4-second capillary refill, and cool extremities.

Primary Survey (continued)

ITEM	FINDING
Disability	Dextrose – Point of care glucose 105 mg/dL Glasgow Coma Scale (GCS) = 8 Eyes open to painful stimuli (2) Verbally, he mumbles incoherently (2) Motor response is withdrawal to pain without crossing midline (4) Alternative rating system: AVPU – The patient is responsive to only painful stimuli
Exposure	No additional wounds identified. No area of massive hemorrhage posteriorly.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Needle decompression not performed with primary survey or attempt to confirm with chest radiograph (CXR)	Patient will arrest into pulseless electrical activity (PEA)	PEA arrest (electrical rate 53 without a pulse, blood pressure or pulse oximetry reading). Return of spontaneous circulation (ROSC) when needle decompression performed.
Access can be IV or IO. Labs can be obtained from either source. The examiner can choose to push to IO, if desired.		If the facilitator desires IO placement, the nurse can state, “The IV blew” or “I’m unable to place the IV.”

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Needle decompression/ chest tube placement attempted	Parent angrily asks: "Why are you stabbing my child with a needle? Aren't you supposed to do no harm!?"	Parent continues to ask questions until the learner addresses him and tactfully asks him to watch but not interfere with medical care. Can call social work/ chaplain for support.
Appropriate needle decompression performed	Whoosh of air, breathing improves, blood pressure improves to 72/50 mmHg, heart rate unchanged, saturations increase to 92%.	Oxygen saturation improves; however, BP will not fully correct until the patient receives blood products (in the next stage).
Rapid sequence intubation (RSI) without initiation of fluid resuscitation, or if no volume resuscitation given in first 5 minutes	BP decreases to 60/40 mmHg.	If the case progresses without the learner addressing the hypotension, can give cue with a question from the nurse, such as "The patient's pressure is still really low."
Intubation attempt without RSI medications (laryngoscope blade placed in oropharynx before medications are called for)	The patient vomits. The SpO_2 decreases to 80%. The heart rate decreases to 80.	**Alternative:** PEA arrest and after 1 round of CPR, the patient has ROSC. During PEA, the heart rate is sinus at 53 bpm without a pulse, blood pressure, or readable pulse oximeter reading. The airway can either be secured during or after after the code.
Intubation with RSI medications	The RR changes to the bagged rate. The SpO_2 is 95%. Proceed to **Stage 2**.	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Sedation orders not placed after intubation	Parent and nurse state that the patient seems uncomfortable after the intubation.	Satisfied with bolus or drip sedation
Learners ask for advanced imaging such as a CT scan	Nurse states “I don’t feel comfortable taking him to the CT scanner with that blood pressure.”	The patient should go to the operating room without advanced imaging.

Stage 2

Completion of Primary Survey:
Needle decompression and intubation through completion of primary survey (A through E), massive transfusion protocol, and chest tube placement

CRITICAL ACTIONS

- **Obtain focused history from EMS, additional SAMPLE history from parents**
- **Manage pediatric airway (if not done in Stage 1)**
    - **Employ proper use of airway adjuncts (may include effective BMV, NPA, OPA, LMA, jaw thrust, shoulder roll)**
    - **Obtain a definitive airway (endotracheal intubation or surgical airway)**
- **Complete secondary survey**
- **Perform proper chest tube placement with appropriate size selection (if not done in Stage 1)**
- **Reassess volume resuscitation and initiate massive transfusion protocol (MTP) per institutional protocol and consider TXA**
- Call pediatric trauma service for disposition to OR, and notify PICU (Institution appropriate trauma team activation)
- Perform FAST exam and identify intra-abdominal hemorrhage

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.3°C, **HR:** 140, **BP:** 72/54, **RR:** 16-20, **SpO_2:** 98%
General	Ill-appearing with blood-stained clothes. Eyes closed.
HEENT	4 mm pupils are equal and reactive. No head or neck trauma. No hemotympanum. Face stable. Oropharynx clear, no blood. No scalp hematomas.

Physical Exam (continued)

ITEM	FINDING
Neck	No posterior midline tenderness; no stepoffs, deformities, or crepitus
Lungs	Fast but shallow respirations. Absent breath sounds on the right. Single bullet hole to the right torso. E-FAST with no lung sliding on the right.
Cardiovascular	Regular rhythm, tachycardic. No murmurs. Palpable pulses with delayed (>4 sec) cap refill. Cool extremities.
Abdomen	No hepatomegaly. E-FAST with fluid in the right upper quadrant (Morrison's pouch). No bruising. No distention. Abdominal wound present with oozing.
Neurological	GCS 8 (eyes open to painful stimuli, moans incoherently, withdraws to pain). Moves all extremities. Normal tone.
Skin	Cool, clammy, diaphoretic
Back	Normal rectal tone and gluteal squeeze. Non-tender spine with no stepoffs, deformities, or crepitus
Extremities	Soft compartments. No deformity
Exam changes	• After the patient is intubated, the respiratory rate is at a ventilation rate of 16-20 breaths per minute with clear breath sounds on left and coarse breath sounds on right. Symmetric chest rise. • Coarse breath sounds now present on the right (after chest tube placement).

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Initiation of blood products	BP improves to 80/60 mmHg	Should follow institutional protocol to activate massive transfusion protocol.
Resident calls for incorrect size of chest tube	Nurse asks, “Doctor, are you sure about that tube size?”	Chest tube size chart on Broselow tape.
Chest tube placed	Air leak present in the chamber **Go to Stage 3**.	Nurse will report 50 mL of frank blood and air from chest tube, if asked.
Chest radiograph not ordered	X-ray tech comes in and asks, “Hey did you want an x-ray on this kid?” or trauma surgeon can request a CXR to confirm tube positioning.	Chest tube and endotracheal tube (ETT) in appropriate position. No retained ballistic fragments. Pneumothorax decompressed.
Massive transfusion not initiated (by minute 10 of simulation time) or positive FAST images misinterpreted/not obtained	The patient continues to get more tachycardic (180 beats per minute) and hypotensive (60/40 mmHg).	PEA arrest if not recognized. After x2 doses of epinephrine and blood transfusion will get ROSC.
Needs airway secured for anticipated clinical course		Nurse can ask, “He doesn’t seem to be protecting his airway, should we intubate him before moving to the OR?”

Stage 3

Reassessment and Disposition:
Chest tube placed, airway secured, blood products through discussion with surgeon

CRITICAL ACTIONS

- Consult (Pediatric) Trauma surgery (confederate) and give recommendations for urgent ex-laparotomy
- **Activate appropriate level trauma (if not already done)**
- **Communicate effectively and compassionately with parents of a sick child**
- **Discuss care with parents**

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.3°C, **HR:** 140, **BP:** 80/60, **RR:** 18, **SpO_2:** 98%
Exam Changes	• Intubated, sedated with chest tube • Capillary refill now <3 seconds, warm/well perfused extremities

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Embedded participant (surgeon or nurse) is called before a tetanus shot is updated	The surgeon asks "Did he get all his vaccinations... including the one for tetanus?" or the nurse prompts to ask about tetanus status.	Case proceeds to the OR either way. This is a point for feedback and the learner should consider.
Learner does not address parent about disposition to OR	Parent asks, "What is going on? Where are you taking my son? Is he going to live?"	Case proceeds after parent updated on plan and disposition

Ideal Scenario Flow

The learners enter the room to find a trauma patient altered and in respiratory distress. They immediately start their primary survey while delegating team members to place the patient on a bedside monitor, order for IV access and supplemental O_2, and obtain a brief history.

- Learners immediately recognize that the patient is hypoxic and hypotensive with fast and shallow breathing, and that there are no breath sounds on the right. Immediate needle decompression leads to temporary resolution of a tension pneumothorax.

- If IV access is difficult to obtain, the learners should proceed to IO access. Labs are obtained, prioritizing type and crossmatch.

- Supplemental oxygen is provided, and an IV fluid bolus is ordered. The patient remains altered with GCS 8 and is intubated for airway protection.

- The E-FAST exam is positive for intraperitoneal blood and lack of lung sliding (if performed prior to chest tube/decompression).

- The patient's respiratory distress has improved; however, hypotension is refractory to IV fluids until massive transfusion protocol is initiated and going.

- The team lead decides on operative management, informs the parent of the care plan, and consults the pediatric trauma surgery service for emergent exploratory laparotomy.

Anticipated Management Mistakes

1. **Difficulty with bedside monitors:** Learners may be unfamiliar with equipment and fail to correctly place monitor leads, apply an inappropriate cuff sizing for a pediatric patient, or fail to hook the manikin up to the defibrillator if the patient goes into PEA. The facilitator can cue learners to use a Broselow tape/bag/cart or other resource to select the correct equipment (depending on what is available in your simulation center). If an inappropriate cuff is selected, you can report that the blood pressure doesn't result and have the nurse suggest the cuff is incorrectly sized.

2. **Failure to immediately recognize the need for needle decompression:** If this is not done within the first 3 minutes from the start of the case, the patient will go into circulatory collapse and PEA. The PALS algorithm is started.

3. **Failure to recognize the need for intubation:** The patient has no obvious airway obstruction, but his diminished GCS is a concern for airway protection. The patient may start coughing/gagging on secretions if this is not addressed by the end of **Stage 2**.

4. **Ignoring family in the room:** Learners will likely forget that the family is in the room if they stay quiet or get annoyed with them if they are in the way too much. They will have to balance informing the parent what is going on while asking him to not be a hindrance to medical care.

5. **Failure to resuscitate with blood products:** Should initiate and follow massive transfusion protocol for your local institution. If no protocol is available, recommend administration of tranexamic acid and balanced transfusion (including packed red blood cells, platelets, and fresh frozen plasma). The instructor can prompt learners by calling from the blood bank and asking about the anticipated amount of products needed or ask if they want the protocol initiated.

6. **Difficulty with access:** After brief (no more than two) attempts at peripheral IV lines, learners should proceed to IO access. The nurse or instructor can say "I don't see any available veins, and we've already tried twice. Is there anything else we could do?" to prompt IO placement if needed.

7. **Recognition of need for operative management:** Residents should not pursue advanced imaging or admission to a critical care setting. They should advocate for their patient if the surgeon is resistant to going to the operating room.

Debriefing Points

Demonstrate the evaluation of a pediatric patient with penetrating trauma using a standard systematic approach (application)

- Evaluation of traumatic injuries follows a standardized approach taught in Advanced Trauma Life Support (ATLS)
- Evaluation begins with addressing any life-threats identified in the ABCs. This is followed by a head to toe exam known as the secondary survey. This includes continued reassessment and a return to ABCs as the clinical condition changes.
- The E-FAST exam typically occurs during or after the secondary survey.

Construct and implement initial medical management plan for a child with a penetrating trauma (application)

- Penetrating trauma accounts for 10-20% of pediatric trauma admissions. Of these injuries, gunshot wounds are the most common mechanism. [Cotton B, Nance M. Penetrating Trauma in Children. Seminars in Ped Surg. 2004 May;13(2): 87-97. PMID 15362278]
- Firearm injuries have the highest fatality rate for all mechanisms and all age groups. Firearm injuries double at age 12 and increase until age 22. Prior to age 12, firearms account for 2% of trauma and 15% of traumatic mortality. [National Trauma Data Bank 2016 Annual Report. Accessed June 2020.]
- Penetrating trauma often requires surgical intervention. The assessment and evaluation of a child with penetrating trauma should focus on stabilization and getting surgical services available.
- Immediate stabilization can include airway management, needle decompression/chest tube placement, volume resuscitation, tourniquet application, fracture immobilization, or other similar procedures.
- This approach is similar for adult patients, but varies primarily in medication dosing and equipment sizing.

Perform fluid resuscitation for shock including institutional protocol for blood transfusion (application)

- Massive transfusion protocols vary between institutions, but typically should be implemented when there is an ongoing or anticipated large volume transfusion need.
- Tranexamic acid (TXA) should be administered within 3 hours of injury.

Demonstrate airway management of a sick child using appropriate adjuncts, BMV, and/or endotracheal intubation (application)

- Airway management is a critical component of pediatric resuscitation, especially in trauma patients. This is not limited to endotracheal (ETT), and should also include your adjuncts of BMV and OPA/NPA. The goal of ETT is to ensure optimal gas exchange.
- Most common indications for ETT in a trauma patient: Coma, shock, apnea, airway obstruction
- Common airway complications: Right mainstem intubation, esophageal intubation, massive aspiration, unilateral or bilateral vocal cord paralysis, subglottic stenosis, failure to adequately preoxygenate, and extubation during transport

Demonstrate needle decompression, pediatric chest tube placement, and tube size selection (application)

- Background on pneumothorax and hemothorax:
    - Accumulation of air and blood (respectively) in the space between the visceral and parietal pleura of the hemithorax can impair oxygenation, ventilation and hemodynamics.
    - In traumatic hemothorax, >15 mL/kg blood at time of insertion or >3-4 mL/kg/hr is an indication for surgical intervention. This is similar to adults (>1500 mL at insertion or ongoing >150 mL/hr).
    - Etiologies may include traumatic, spontaneous or iatrogenic.
    - Signs, symptoms, and exam findings vary, but can include being asymptomatic, dyspnea, chest pain, asymmetric chest rise, tracheal deviation, hypoxia, and hypotension.
- Diagnosis and management:
    - A pneumothorax can quickly be confirmed with ultrasound

or chest x-ray.In the appropriate clinical setting, needle decompression should be performed immediately.

- Needle decompression can be performed in the midclavicular line, 2nd intercostal space or the anterior mid-axillary line in the 5th intercostal space.
  - Lin, M. "Trick of the Trade: Don't miss the pneumothorax in needle thoracostomy". Academic Life in Emergency Medicine. Published Oct 2012. Accessed June 2020.
- Needle decompression is a stabilizing procedure and should be followed by placement of a chest tube or surgical intervention.
- Chest tube placement: Similar to adults, a chest tube should be placed in the 5th intercostal space at the midaxillary line. [Busti AJ, Hinson J. "Chest Tube Thoracostomy". Evidence-Based Medicine Consult. Published Sept 2015. Accessed June 2020.]

- Chest tube size
  - Use Broselow tape
  - Calculate size using formula
    - 4 x ETT = maximum chest tube size (e.g., used for hemothorax)

Demonstrate focused history taking from a caregiver (application)

- Components of history taking: Past medical history, surgical history, family history, medications, allergies, social history, vaccination history
  - SAMPLE mnemonic (S – signs and symptoms; A – allergies; M – medications; P – pertinent past medical history; L – last oral intake; E – events leading up to presentation) is helpful to quickly obtain necessary information.
- For this scenario, obtaining a quick history of pertinent medical problems, allergies, and events is critical.

Explain diagnosis and management to caregivers (synthesis)

Use a teach-back approach.

Develop a plan for transfer to a trauma center for definitive management (synthesis)

- The American College of Surgeons (ACS) accredits pediatric and adult trauma centers. Your local EMS system likely has protocols to transfer directly to a trauma capable facility. However, non-pediatric trauma centers will be needed to stabilize and transfer pediatric patients.
- It is important to consider your facility's pediatric readiness to provide initial stabilization and transfer to a variety of both medical and trauma pediatric patients requiring a higher level of care.
- Consider ground versus air transport depending on the patient's condition, medical needs during transport, risk for decompensation, and distance to travel. Consider utilizing available critical care or pediatric specific transport teams

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

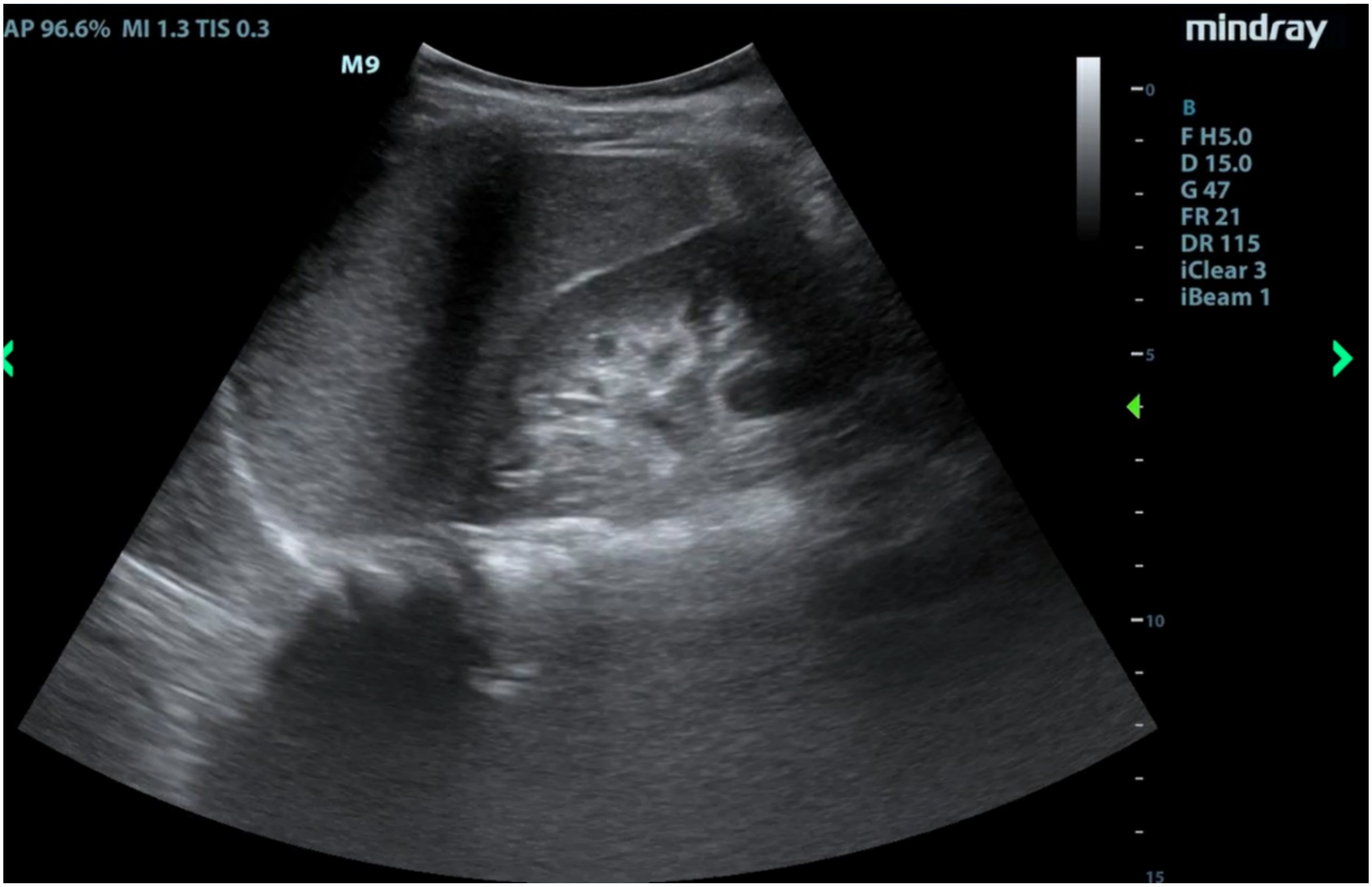
- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Supporting Files

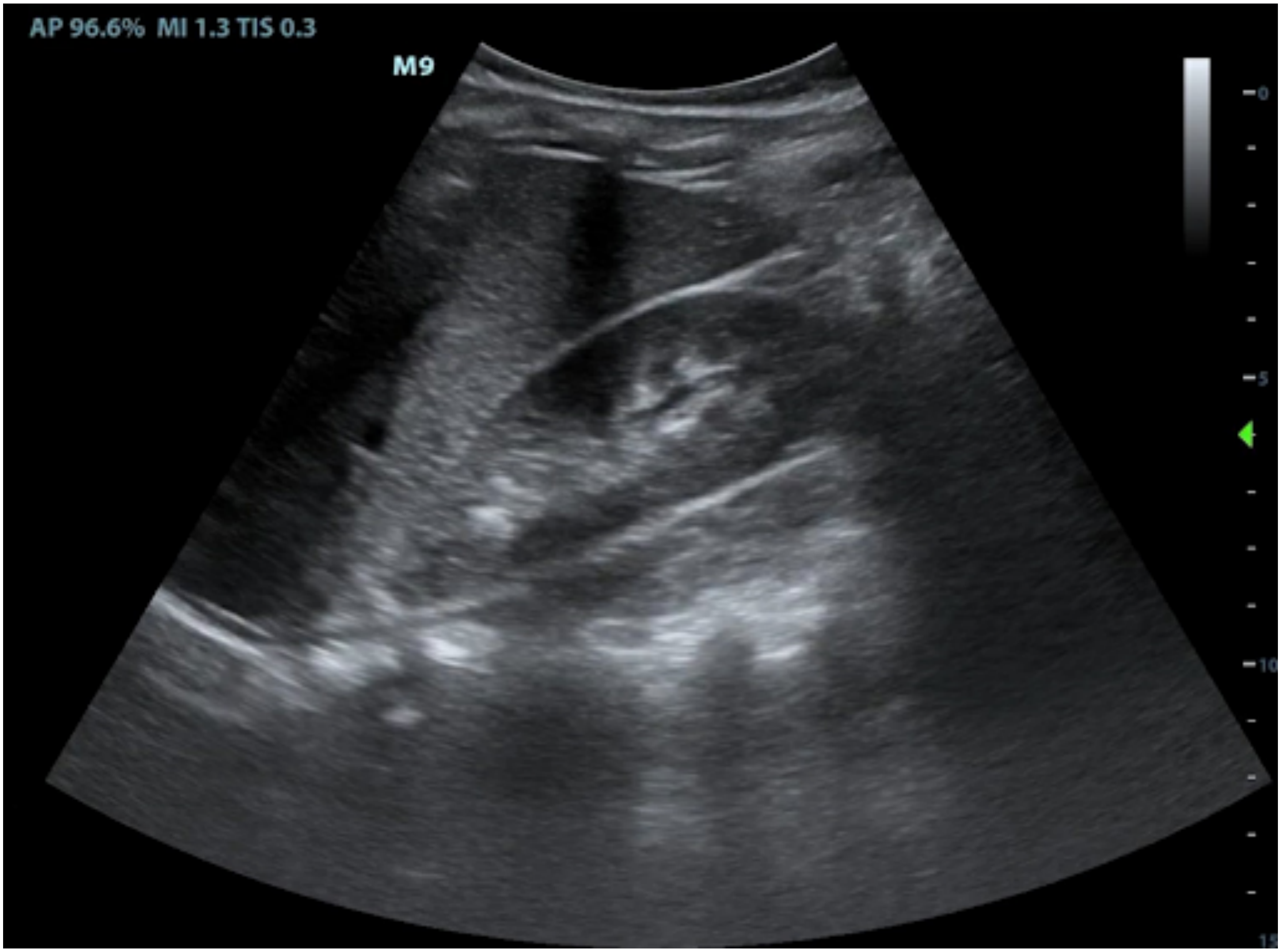
E-FAST Ultrasound Images
RUQ View



Supporting Files

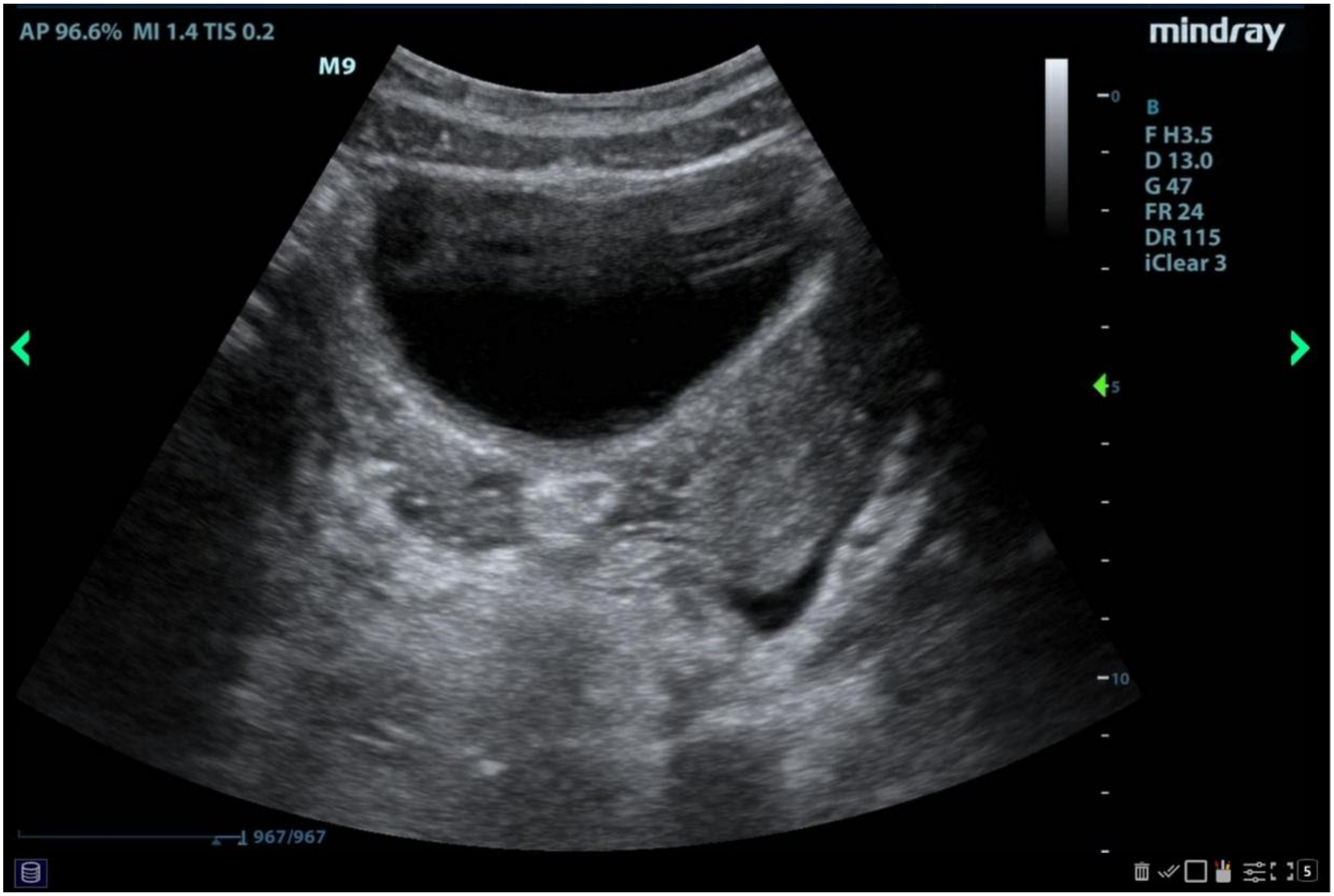
E-FAST Ultrasound Images

LUQ View



Supporting Files

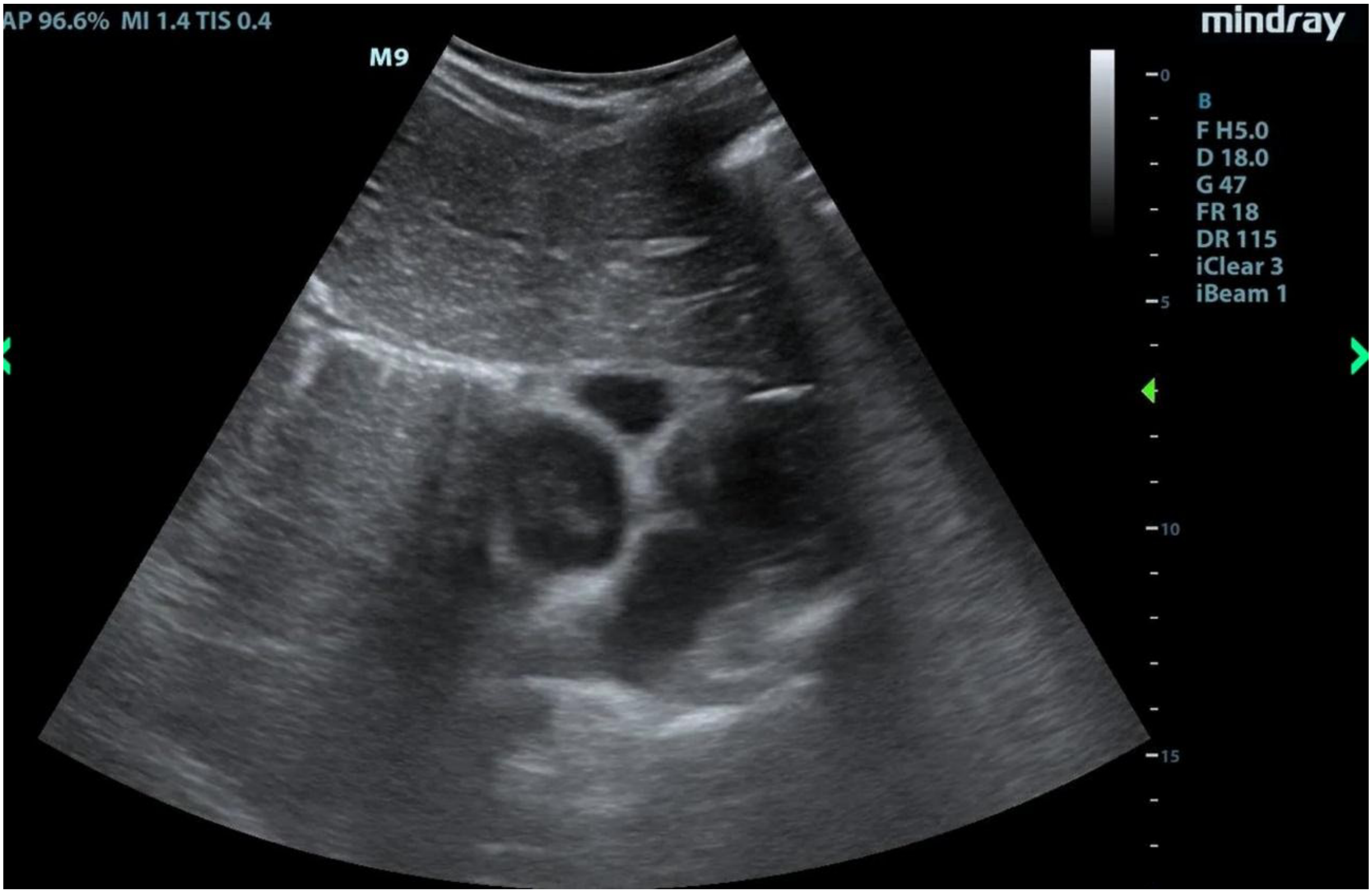
E-FAST Ultrasound Images
Pelvic View



Supporting Files

E-FAST Ultrasound Images

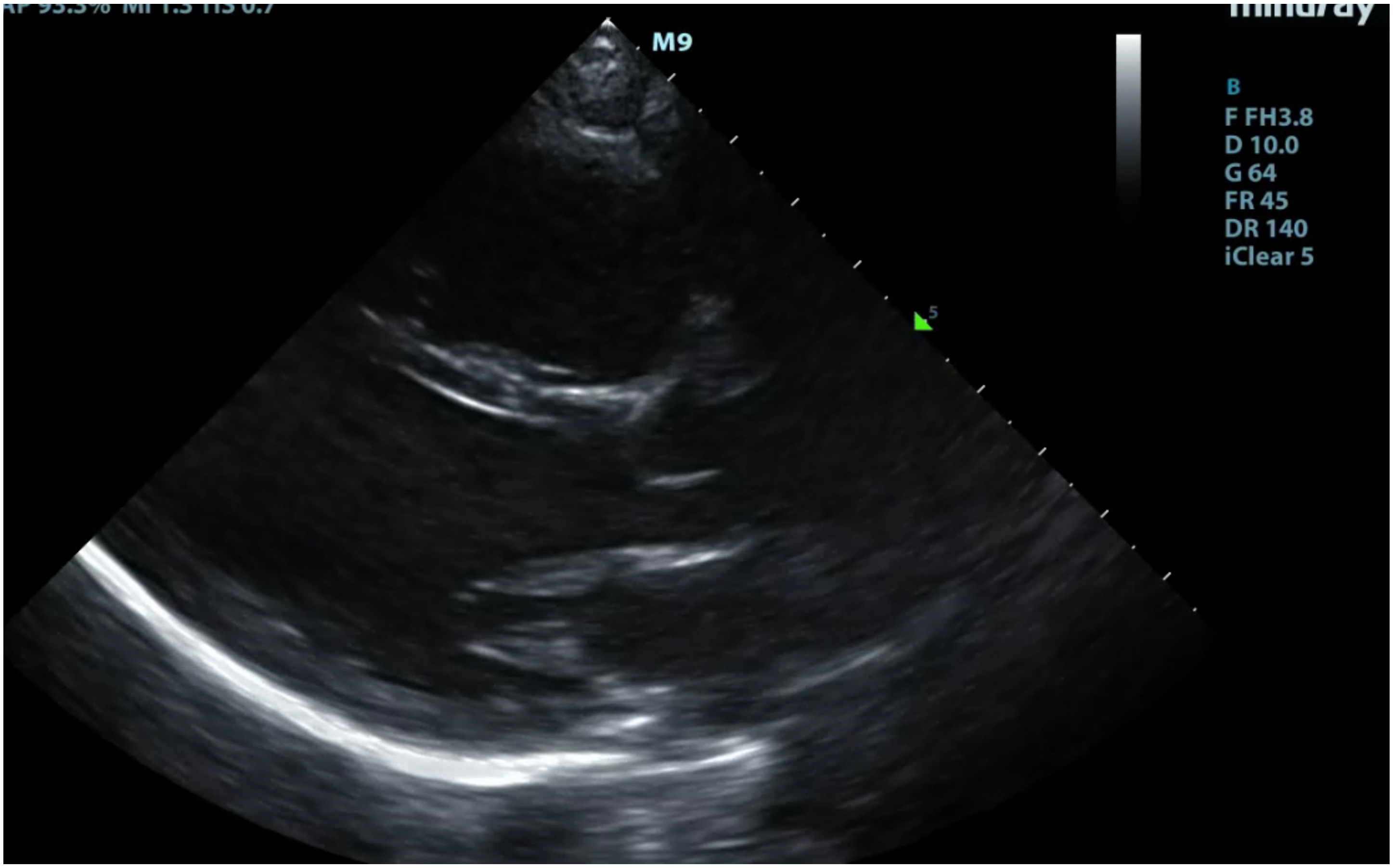
Subxiphoid View of the Heart



Supporting Files

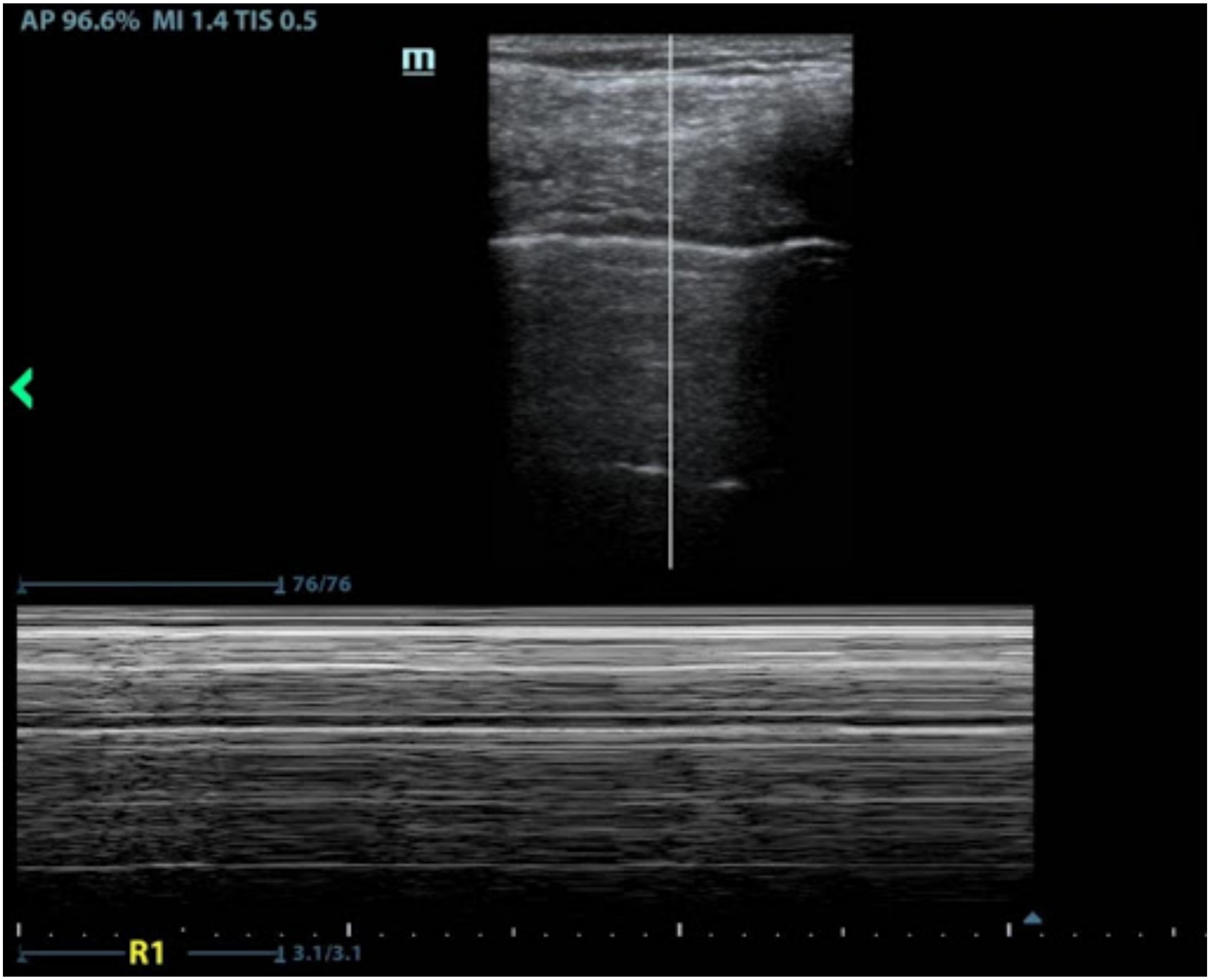
E-FAST Ultrasound Images

Parasternal Long View of the Heart



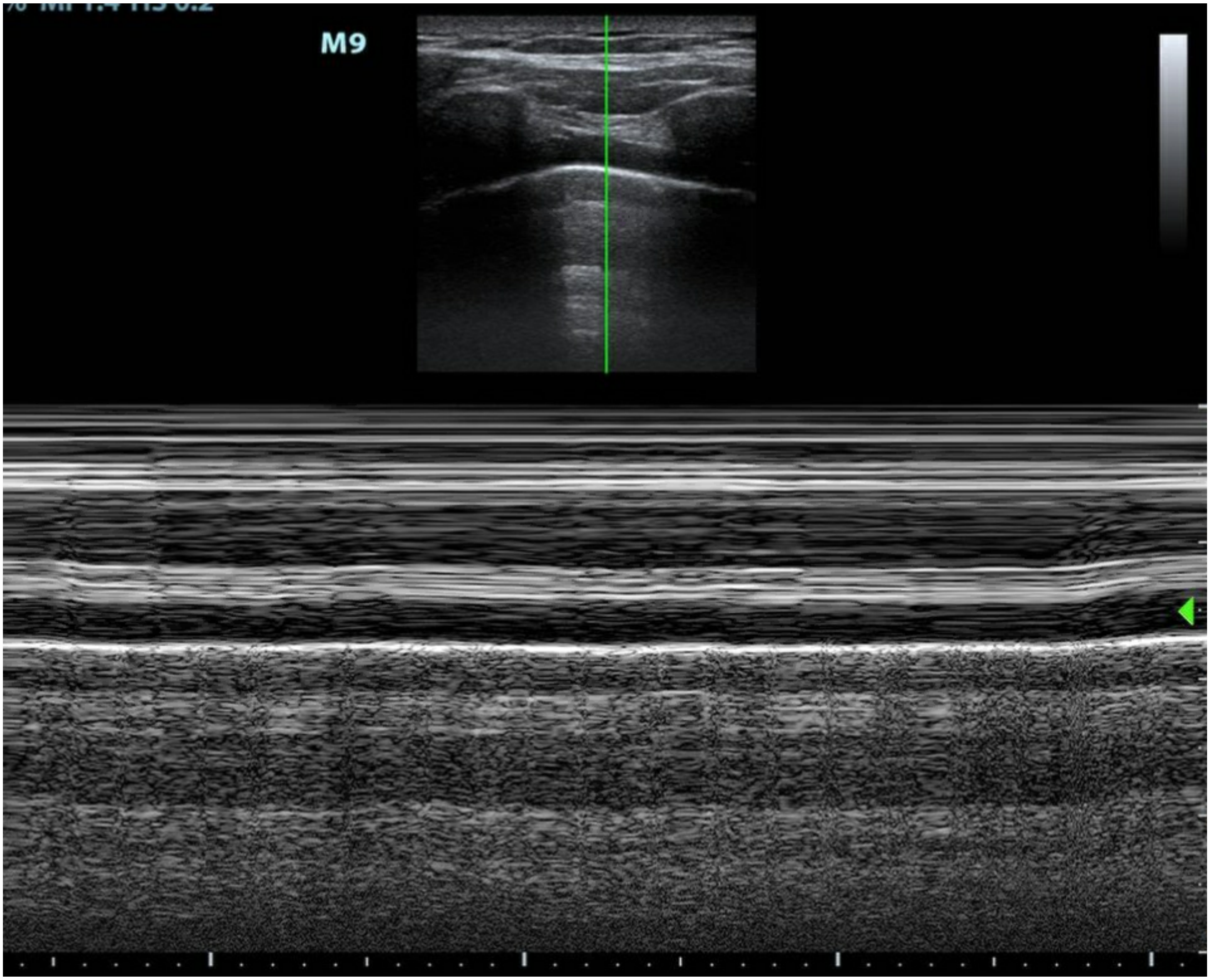
Supporting Files

E-FAST Ultrasound Images
Right Lung View in M-Mode



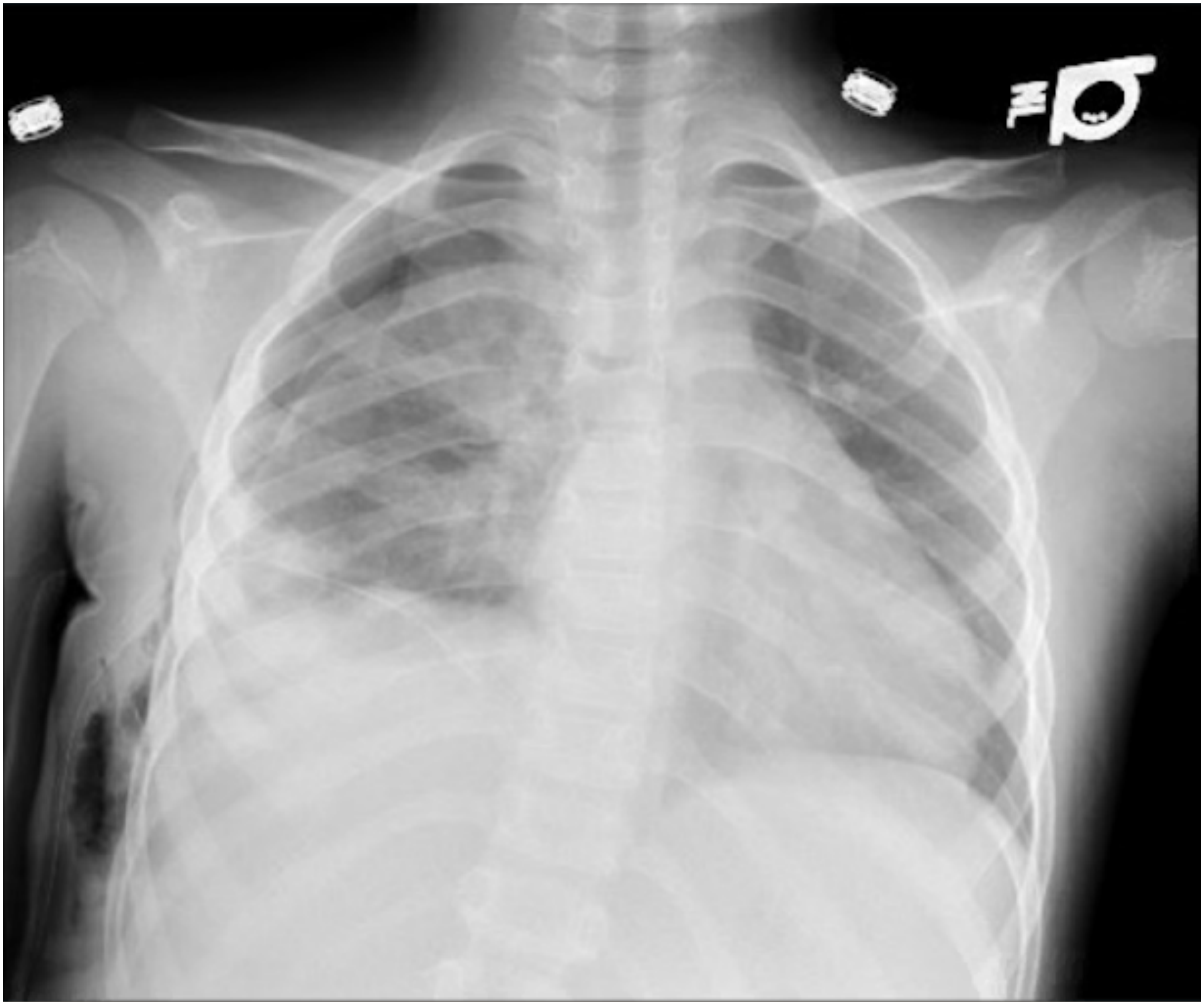
Supporting Files

E-FAST Ultrasound Images
Left Lung View in M-Mode



Supporting Files

Chest X-ray



Supporting Files

Notes

E-FAST Interpretation
Images from Dr. Daphne Morrison Ponce

- RUQ View: No free fluid
- LUQ View: No free fluid
- Pelvis View: Free fluid in pelvis
- Subxiphoid View: No pericardial effusion
- Parasternal Long View: No pericardial effusion
- Right Lung View: Suggestive of a pneumothorax given “bar code” appearance in M-mode
- Lung Lung View: No pneumothorax given “seashore” appearance in M-mode

Chest X-ray Interpretation
CXR with chest tube in posterior apex with lung re-expansion. Image from Dr. Daphne Morrison Ponce.

Supporting Files

Laboratory Results

Venous Blood Gas and Other Point of Care Labs

LABORATORY TEST	VALUE	UNITS
pH	7.27	
pCO_2	49	mmHg
pO_2	24	mmHg
HCO_3	23	mEq/L
Sodium	136	mEq/L
Potassium	4.2	mEq/L
Chloride	104	mEq/L
Ionized calcium	1.16	mmol/L
Glucose	99	mg/dL
Lactate	2.6	mmol/L
Hemoglobin	23	mEq/L

Supporting Files

Lab Results
CBC with Differential

LABORATORY TEST	VALUE	UNITS
WBC	36.6×10^3	/mm³
Hemoglobin	12.7	g/dL
Hematocrit	38.5	%
Platelets	304×10^3	/mm³
RBC	4.17	M/mcL
MCV	92.3	fL/red
MCH	30.5	pg
MCHC	33.0	g/dL
RDW	12.1	%
MPV	10.8	fL
Immature granulocytes %	1.2	%
Neut %	84.3	%
Lymph %	5.6	%
Mono %	8.4	%
Eos %	0.2	%
Baso %	0.3	%

Supporting Files

Lab Results

Comprehensive Metabolic Panel

LABORATORY TEST	VALUE	UNITS
Sodium	136	mEq/L
Potassium	4.5	mEq/L
Chloride	105	mEq/L
Bicarbonate	21	mEq/L
BUN	15	mg/dL
Creatinine	0.65	mg/dL
Glucose	87	mg/dL
Calcium	9.1	mg/dL
Anion Gap	12	mEq/L
Protein	6.8	g/dL
Albumin	4.7	g/dL
AST	140	U/L
ALT	84	U/L
Alkaline phosphatase	66	U/L
Total bilirubin	1.3	mg/dL
Lipase	48	U/L

Supporting Files

Lab Results

Coagulation Factors and Type & Screen

LABORATORY TEST	VALUE	UNITS
Blood Type	O positive	
Antibody Screen	Neg	

LABORATORY TEST	VALUE	UNITS
PTT	18.0 (low)	sec
PT	11.0	sec
INR	1.1	

Supporting Files

Lab Results
Urinalysis

LABORATORY TEST	VALUE	UNITS
Color	Light yellow	
Appearance	Normal	
Specific Gravity	1.010	
pH	6.0	
Leukocyte esterase	Neg	
Nitrite	Neg	
Protein	30 (normal)	mg/dL
Glucose	Neg	
Ketone	Neg	
Urobilinogen	Normal	
Blood	250	U/mcL
Squamous epithelial cells	Few	cells
RBCs	247	/hpf
WBCs	6	/hpf

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant playing the patient's parent

Case Background Information

The patient is your 4-year-old son. You were at the local shopping mall when there was an active shooter. He was injured on his right side. He is bleeding from the injury. He is moaning and having difficulty breathing. He needs emergent blood transfusion and a chest tube to remove air from around his lung. You are very worried about him and feeling guilty for being at the location of the shooting.

Who are the Learners?

Emergency medicine residents

They should inform you briefly of what they are doing and speak with you more in-depth prior to moving your son to a different location in the hospital.

Standardized Patient Information

Your 4-year old son was shot on the right side when there was an active shooter at the shopping mall. You are very worried about him because he's not talking and interacting normally. Additionally, you're feeling guilty for being in the location where there was an active shooter. You feel responsible for not protecting him. The medical team should acknowledge your concerns and provide basic information upon arrival (e.g., "he's very sick, we're going to take care of him", "we need to put a breathing tube in place, we will talk more in a moment"). In the beginning of the case, there will be many critical medical actions.

If the team plans to transfer your son to the operating room, ICU, another hospital location, or other area outside the Emergency Department without updating you on his condition and plan of care, you should become more insistent with your questions.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you? Or "what happened?"): "Somebody shot my son."

- AGE: 4 years old

- ADDITIONAL HISTORY: "We were in line to get Auntie Annie's pretzel when someone just opened fire. I think it was gang related. I tried to pull him out of harm's way, but I was not fast enough. As soon as I saw he was hit I called 911. Is he going to die?" "He's getting sleepier and not talking to me."

- PAST MEDICAL HISTORY: Healthy, partially vaccinated due to difficulty with access to care

- SOCIAL HISTORY: Lives at home with mother, father, and older brother. Smoking outside the house only. No access to firearms at home. Pet dog.

- FAMILY HISTORY: No history of bleeding disorders.

- PAST SURGICAL HISTORY: None

- MEDICATIONS: None

- ALLERGIES: Apples and pears. No known drug allergies.

- IMMUNIZATIONS: Vaccinated initially. 1-year shots were given late because we couldn't get appointment with his PCP. Thinks he caught up on all vaccines except the 4-year-old shots.

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Continue to express concern about your son without being obstructive.

Things you could say without being asked:

- "Is he going to be okay? Is he in pain? I should have moved him out of the way."

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
After your child is intubated and/or has a chest tube place	"Is he in pain? Why is he breathing like that?"
When your child is given a blood transfusion	"Is that safe? Why does he need blood?"
If your child is being moved to OR/ICU	"Where are you taking my son?"

Simulation Case 13

Pneumonia and Septic Shock

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Updated August 18, 2020

Setup

Chief complaint: Respiratory distress
Patient age: 10 years old
Weight: 20 kg

Brief Narrative Description of Case

This scenario occurs in a community Emergency Department (ED) that is not a pediatric referral center. This patient with a complex medical history including tracheostomy and cerebral palsy has pneumonia and is brought to the ED due to respiratory distress and hypoxia. The patient acutely worsens due to a trach plug. The trach needs to be replaced in order for the clinical condition to improve. The child's parents should also be kept updated on the patient's care. This episode is very upsetting to the child's parents as they were getting ready to have the trach removed.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Describe signs/symptoms of septic shock in a pediatric patient **(knowledge)**
2. Demonstrate early evaluation of a critically ill, medically complex pediatric patient **(application)**
3. Identify the signs/symptoms of impending respiratory failure in a medically complex pediatric patient **(application)**
4. Construct and implement initial medical management of septic shock in a medically complex pediatric patient **(application)**
5. Demonstrate airway management of a sick child using appropriate adjuncts and bag mask ventilation (BMV) **(application)**
6. Develop a plan to troubleshoot a tracheostomy device **(evaluation)**
7. Demonstrate tracheostomy tube replacement **(application)**
8. Demonstrate focused history taking from a caregiver **(application)**
9. Explain diagnosis and management to caregivers **(synthesis)**
10. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

- Assign/assume team roles
- Obtain history from parent
- Perform primary assessment
- Place patient on continuous cardiac monitor
- Establish vascular access
- Perform focused physical exam
- Recognize severe respiratory distress in a child with a complex medical history
- Prevent hypoxia with supplemental oxygen
- Treat respiratory failure with BMV
- Troubleshoot tracheostomy
- Keep family updated on patient's care

Recommended Supplies

- **Manikin:** Child-sized (5-8 year old) simulation manikin
- **Moulage:** None
- **Resources:** PALS cards and/or color-coded length-based resuscitation tape
- **Manikin set up:** IV lines x1 in place with drainage bag, neck piece with tracheostomy tube in place
- **Equipment:**
  - Pediatric airway cart:
    - Simple face-mask
    - Non-rebreather oxygen mask
    - Nasal cannula
    - Oxygen tubing
    - Suction equipment
    - Bag mask ventilation
    - Intubation equipment (cuffed ETT, Miller 1 blade, stylet, ET CO_2 monitoring)
  - Tracheostomy tube and ties (4.0 trach)
    - Block the end of the trach to mimic a large plug. Super glue works well for this.
  - IV fluid bag, lines, pumps, poles, and angiocatheters
- **Medications:**
  - Code medications: Epinephrine, calcium gluconate, dopamine, D25W

  - Intubation medications: Succinylcholine, rocuronium, etomidate, ketamine, midazolam
  - Antibiotics: Ampicillin, ceftriaxone, azithromycin, vancomycin

Supporting Files

- Chest x-ray (AP and lateral): Multifocal pneumonia
- Point of care lab tests

Participants/Roles

- Team leader
- Airway manager
- Survey physician
- Medication giver
- Family liaison
- Standardized patient (actor) to play patient's parent

Faculty or nurse can play a nurse or tech, if there are not enough learners to perform the above roles.

Prerequisite Knowledge

- **Faculty**
  - PALS protocols
  - General knowledge of emergency medicine
  - Simulation implementation and debriefing experience
  -
- **Emergency medicine residents**
  - Any stage of training (preferably PGY-2 or greater for team lead)
  - Completed PALS certification
  - Bag mask ventilation
  - Rapid sequence induction (RSI)

Case Alternatives

- A pneumothorax may develop if there is aggressive bagging during resuscitation of the child.

- For more advanced learners, the hypotension and peripheral perfusion might not resolve until one or more vasoactive medications are administered (e.g., epinephrine, dopamine).

- The child can develop anaphylaxis to an antibiotic requiring appropriate therapy with IM epinephrine and a second-line antibiotic medication.

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC3. Diagnostic Studies
PC7. Disposition
PC10. Airway Management
ICS1. Patient Centered Communication
ICS2. Team Management

Resources

1. Ambroggio L, Mangeot C, Murtagh Kuroski E, et al. AAP Guideline Adoption for Community-Acquired Pneumonia in the Outpatient Setting. Pediatrics. 2018;142:e20180331. PMID 30254038
2. Nickson C. Pediatric pneumonia in the ED. Life in the Fast Lane. 2019.
3. Gopal P. Troubleshooting the crashing patient with a tracheostomy. Academic Life in Emergency Medicine. 2018.
4. Nickson C. Respiratory distress in tracheostomy patient. Life in the Fast Lane. 2019.
5. Davis AL, Carcillo JA, Aneja RK, et al. American College of Critical Care Medicine Clinical Practice Parameters for Hemodynamic Support of Pediatric and Neonatal Septic Shock. Crit Care Med. 2017;45(6):1061-1093. PMID 28509730
6. Greenwood JC, Winters ME (2019). Tracheostomy Care. In Roberts and Hedges' Clinical Procedures in Emergency Medicine and Acute Care (7th ed., pp. 142-159.e2). Elsevier.
7. Hess DR, Altobelli NP. Tracheostomy tubes. Respir Care. 2014;59(6):956-973. PMID 24891201
8. Horeczko T, Enriquez B, McGrath NE, Gausche-Hill M, Lewis RJ. The Pediatric Assessment Triangle: accuracy of its application by nurses in the triage of children. J Emerg Nurs. 2013; 39(2):182-189. PMID 22831826
9. Textbook of Neonatal Resuscitation (NRP), 7th Ed. (2016).
10. White AC, Kher S, O'Connor HH. When to change a tracheostomy tube. Respir Care. 2010; 55(8):1069-1075. PMID 20667154

Initial Presentation

ITEM	FINDING
Overall Appearance	A 10-year-old boy lying in bed, eyes closed, tracheostomy tube in place, in respiratory distress with tachypnea and retractions.
HPI	Child was brought by his parents. "He's been sick for about a week. After 4 days, the cough wasn't getting better and his fever got worse so we took him to his regular doctor. She started him on some antibiotics. Last night he was coughing a lot and the night nurse suctioned the trach several times and ended up replacing the tube. Since I started taking care of him, we haven't been able to get his sats above 85% so I wanted him checked."
Past Medical/Surgical History	Ex 24-week preemie, chronic lung disease, intellectual disability, cerebral palsy, pneumonia x3, last admitted 1 year ago, seizures. Tracheostomy (weaned off home oxygen 6 months ago) with no ventilator support. G-tube. Immunizations up-to-date. Prior to this episode he had been doing well and they were discussing having the tracheostomy removed.
Medications	Baclofen, oxcarbazepine, azithromycin for the past 4 days
Allergies	No known drug allergies
Family History	Father has asthma
Social History	No pets No smokers Lives with both parents and younger brother

Stage 1

Begin Simulation (Stage 1 of 3)

Initial Presentation:
Start of evaluation through trach replacement

CRITICAL ACTIONS

- Team leader assigns tasks
- Obtain relevant history from parent
- Perform primary survey and identify serious conditions
- Provide supplemental oxygen and basic airway maneuvers
- Perform BMV through tracheostomy
- Suction tracheostomy tube
- Replace tracheostomy tube
- Place patient on continuous cardiac monitor
- Establish vascular access
- Obtain point-of-care rapid glucose level
- Discuss progress and plan of care with the parent (and involve them in shared decision-making)

Primary Survey

ITEM	FINDING
Vital Signs	**T:** 39.2°C, **HR:** 140, **BP:** 95/45, **RR:** 35, **SpO_2:** 82% on room air
General	Boy lying in bed, eyes closed in respiratory distress with tachypnea and retractions
HEENT	Microcephalic, 4 mm pupils are equally round and reactive
Neck	Tracheostomy in place. Nontender. No step-offs. No crepitus.

Primary Survey (continued)

ITEM	FINDING
Lungs	No crepitus. RR=35. Shallow, rapid respirations. Crackles bilaterally, no wheezing.
Cardiovascular	HR=140. Regular rhythm. Normal heart sounds. Weak pulses. 4-second capillary refill.
Abdomen	Normal bowel sounds. Soft, nontender. G-tube in place clean, dry, intact. No guarding/rebound. No distention. No mass.
Neurological	GCS = 7 (eyes open to painful stimuli (2), nonverbal at baseline (1), motor response is withdrawal from pain in that he tried to retract his hand when the IV was placed (4)) Hypertonic in extremities.
Skin	Cool, pale, diaphoretic
Back	Non-tender. No step-offs. No crepitus.
Extremities	Minimal muscle mass; no swelling or deformities

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
One minute without assisted ventilation	• SpO_2 decreases to 75% • HR decreases to 80	
Non-rebreather placed w/o BMV	• SpO2 rises to 89% • RR increases to 45	The child is much more tachypneic with worsened subcostal retractions.
BMV performed via trach	• Bagging is difficult without chest rise • SpO_2 decrease to 78%	This is because trach is plugged.

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Trach is suctioned	• No change in symptoms • SpO_2 decreases to 78% • RR increases to 45	Unable to pass suction catheter. Plugging the end of the tracheostomy tube with super glue can represent a plugged trach effectively.
Trach is replaced	• RR decreases to 25 • Work of breathing improved but still with subcostal retractions • Proceed to **Stage 2**.	The old trach has a thick mucus plug over the tip. The airway obstruction has been addressed but the patient is still in shock with significant pneumonia.
Bedside labs obtained		Point of care labs (other labs pending) **VBG** pH 7.21 pCO_2 75 mmHg pO_2 45 mmHg HCO_3 12 mEq/L Na 130 mEq/L K 4.5 mEq/L iCa 1.1 mmol/L (4.4 mg/dL) Hct 35% Glucose 99 mg/dL

Stage 2

Management of Septic Shock:
Trach change completed through fluid resuscitation and antibiotics

CRITICAL ACTIONS

- Recognize and provide prompt management for shock and pneumonia with IV fluids and antibiotics
- Discuss progress and develop plan of care with the parent (and involve them in decision-making)

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 39.2°C, **HR:** 150, **BP:** 85/40, **RR:** 25 **SpO_2:** 96% on non-rebreather mask placed over the trach or humidified trach collar at minimum 40% FiO_2
Exam changes	Capillary refill 5 seconds

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Parent(s) not updated about trach change	Parent(s) become upset, demanding an update "What's going on? What are you doing?"	The parents should not escalate to the point where security could be called.

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Fluid resuscitation	After first 400 mL (20 mL/kg): BP 95/50, HR 130 After second 400 mL: BP 100/62, HR 115	
Antibiotics given	No change in exam	
If the two critical actions above are completed	Proceed to **Stage 3**.	

Stage 3

Case Conclusion:
Completion of fluid resuscitation/antibiotics through agreement for transfer to pediatric ICU

CRITICAL ACTIONS

- Plan for transfer to pediatric ICU (sign out patient to accepting facility/service)
- Ensure family is updated on plan of care and explain why tracheostomy tube was not functioning

NOTE: The patient should have received appropriate airway management and antibiotics by this final stage.

Physical Exam

ITEM	FINDING
Vital Signs	**HR:** 123, **BP:** 105/60, **RR:** 20 **SpO_2:** 96% on non-rebreather mask placed over the trach or humidified trach collar at minimum 40% FiO_2
Exam Changes	• Improved work of breathing with no retractions • Capillary refill 2 seconds

Ideal Scenario Flow

The learners enter the room to find a medically complex child in respiratory distress. They immediately place the child on bedside monitors and recognize that the patient is hypoxic and hypotensive with altered mental status. Supplemental oxygen is provided over the trach and IV access is established to start a fluid bolus. After completing a physical examination and obtaining an appropriate history, the providers note that the child's respiratory status has not improved with supplemental oxygen (or BMV through the tracheostomy tube) and the trach should be investigated. The trach cannot be suctioned due to an obstructive plug and it must be changed. Once the trach is changed the patient's respiratory status improves. At this point it should be recognized that the patient is still in septic shock. Appropriate management requires additional IV fluid boluses and antibiotics. The family should be updated throughout the course of this scenario. Once the patient has been stabilized, arrangements must be made for transfer to a facility with a pediatric intensive care unit. The chest x-ray (if ordered) reveals a multi-lobar pneumonia.

Anticipated Management Mistakes

1. **Not keeping the family updated:** One of the goals of this case is to have learners balance direct patient care with keeping the family of the patient aware of the plan. We find it helpful to have the parent(s) become increasingly vocal, though not reaching the level of disruption where having the parent removed from the room becomes reasonable.

2. **Trach is repeatedly suctioned/lack of recognition of trach plug:** Sometimes learners get stuck on suctioning the trach as the solution and will repeatedly insert the suction catheter despite the end of the trach being blocked. You can cue them by saying that they are not getting anything out when they suction.

3. **Attempting to intubate from above:** Some groups of learners decide to intubate from above rather than change the trach. If attempts are made to intubate, the parents are instructed to object and point out that the patient's ENT specialist said he would be a difficult airway. If the learners persist and attempt

to intubate without removing the trach, continue to keep the patient in respiratory distress (they will likely notice the trach tube obstructing their attempts to pass the ETT). If the trach is removed and the tube is placed past the stoma then progress the case like the trach was successfully changed.

4. **Failure to recognize septic shock:** At times, once the respiratory distress was addressed with a trach change, some learners feel like the case is over and do not recognize the persistently poor vital signs signifying underlying septic shock. If this is the case it may be helpful to continue to increase the heart rate and decrease the blood pressure until shock is recognized and treated.

5. **Lack of disposition plan:** If the learners stabilize the patient but do not have a disposition plan (e.g., transfer to a facility with a pediatric ICU), the parents have been prompted to ask where they are going next.

Debriefing Points

Describe signs/symptoms of septic shock in a pediatric patient (application)

Septic shock: Shock is a condition where the body's ability to provide oxygen to the tissues is not adequate to the needs of the tissues. Septic shock is a complex pathophysiological state of distributive shock when shock is due to the inflammatory response to a systemic infection.

Shock can be recognized as:

- **Compensated:** Initially the body will compensate for the inadequate oxygen delivery by increasing heart rate and peripheral vasoconstriction. Children often have greater physiologic reserve than adults and can stay in compensated shock for longer.
  - Symptoms include increased capillary refill time, tachycardia, a new flow murmur, diaphoresis, and fatigue.
- **Uncompensated:** At this point the body is no longer able to compensate through increased heart rate and decreased peripheral perfusion. At this point the blood pressure begins to drop. In children this is usually a sign of impending cardiovascular decompensation.
  - Symptoms include decreased blood pressure, altered mental status, and cardiac arrest.

Demonstrate early evaluation of a critically ill, medically complex pediatric patient (application)

In general, the evaluation of a medically complex child does not greatly differ from that of a previously healthy child as both populations require quick assessment of ABC's with emphasis on overall clinical status.

Pediatric assessment triangle:

- **Appearance** (Mental status): Note abnormal tone, level of arousal, and changes in speech/cry
- **Work of Breathing:** Note presence of abnormal breath sounds, retractions, nasal flaring, grunting, apnea etc.
- **Circulation to Skin:** Note presence of pallor, delayed capillary refill, mottling, cyanosis etc.

Primary survey:

- **Airway:** Does the patient have a patent airway?
- **Breathing:** Auscultate for bilateral breath sounds
- **Circulation**: Assess for presence/absence of pulses and degree of peripheral perfusion
- **Disability:** Report Glasgow Coma Scale, examine pupils
- **Exposure**: Allow for adequate visualization of the patient

However, the evaluation of the medically complex, technology-dependent child may require special vigilance compared to the previously healthy such as:

- **Baseline status:** What might be considered abnormal for a previously healthy child may be a baseline attribute of a more medically complex child (e.g., in this case, the patient is nonverbal and therefore the Glasgow Coma Score does not appropriately quantify the change in this patient's mental status). Caregivers are the best resource for this information. Trust them!
- **Medical equipment:** To provide effective care for a medically complex child, providers should be familiar with the equipment they present with. This can range from common equipment such as a gastrostomy tube to more complex machinery, such as vagal nerve stimulators and baclofen pumps.

Identify the signs/symptoms of impending respiratory failure in a medically complex pediatric patient (application)

Respiratory failure is a condition where the body's respiratory system is not able to meet the rest of the body's demands for oxygenation and/or ventilation (elimination of carbon dioxide). Signs of respiratory distress in a medically complex patient are often similar to those of otherwise healthy children (e.g. tachypnea, nasal flaring, retractions, grunting), but depending on the patient's medical history, signs of respiratory distress may be different. For example, a patient with hypotonia might not be able to sit up and tripod or even generate the muscular effort that produces retractions despite being significantly hypoxic.

Construct and implement initial medical management of septic shock in a medically complex pediatric patient (application)

The American College of Critical Care Medicine released updated guidelines for the management of pediatric septic shock in 2014

(Davis, et al., Crit Care Med. 2017). The guidelines are worth reviewing in detail but below is a modified summary:

- Early recognition of sepsis is essential to improve outcomes
- **When sepsis is recognized (minute zero):**
    - Place the child on supplemental O_2 (non-rebreather mask or high flow nasal cannula)
    - Establish IV/IO access x2 as quickly as possible. If traditional IV access is difficult (>2 attempts or trying for >90 seconds), consider an ultrasound-guided IV or IO access, whichever is quickly possible. IO access is appropriate even in awake patients in septic shock.
- **Within 5 minutes:**
    - Administer 20 mL/kg isotonic saline, up to 60 mL/kg.
    - After each bolus, reassess vital signs and capillary refill.
    - Goals include an improvement in heart rate, capillary refill time <2 seconds, and normalization of blood pressure.
    - Keep in mind that a medically complex child may not have the same baseline vital signs expected for age. Previous records and caregivers can be helpful to establish each patient's baseline vital signs.
    - Reassess for crackles/rales and/or hepatomegaly. Stop fluids if any of these signs develop.
    - Correct hypoglycemia and hypocalcemia if present (point of care labs are helpful to get these results back more rapidly).
- **Within the first 30 minutes:**
    - 60 mL/kg of isotonic fluid should have been given by this time, if clinically indicated and no contraindications are present.
- **Within the first 60 minutes:**
    - Administer broad spectrum antibiotics:
        - Ceftriaxone 50-75 mg/kg to a max of 2,000 mg.
            - Do not use in patients <4 weeks of age. In this population ampicillin + gentamicin or ampicillin + cefotaxime are appropriate. Dosing may change with the infant's gestational and post-natal age.
            - Some centers prefer cefepime over ceftriaxone in medically complex patients with septic shock.
        - Vancomycin 15-20 mg/kg
    - Obtain blood cultures
        - Blood cultures should ideally be obtained prior to

administration of antibiotics; however, obtaining sterile access for a culture should not delay IV fluids administration.

- **If hemodynamic goals are not met after 60 mL/kg of isotonic saline, initiate vasopressors**
    - It is ok to initiate vasopressors peripherally but convert to centrally when possible. (Note: Intraosseous access is considered central access.)
    - Cold shock (more common in children): Epinephrine 0.05-0.3 mcg/kg/min
    - Warm shock: Norepinephrine 0.05 mcg/kg/min and up, titrating to response
- Often medically complex children are at risk for adrenal insufficiency (chronic steroid use, panhypopituitarism, etc.). Consider a hydrocortisone stress dose if initiating vasopressors. The initial dose is 50 mg/m².
    - Rough estimate: infants 25 mg, children 50-100 mg

Demonstrate airway management of a sick child using appropriate adjuncts and BMV (application)

In general, children have higher oxygen demand for body weight than adults. This means children may require a higher frequency of bagging, but a common mistake in acute situations is to hyperventilate due to too rapid a rate of bagging the patient. End-tidal carbon dioxide ($EtCO_2$) monitoring attached to the bag can help identify the appropriate rate of bagging.

The size of the bag used for ventilation should be appropriate for the size of the child.

- Infants and small children can use a 450 mL bag
- Older children may benefit from a 1,000 mL bag

A useful mnemonic for pediatric airway management with bag mask ventilation comes from the Textbook of Neonatal Resuscitation (Weiner & Zaichkin, 2016): MR SOPA

- **M: Mask adjustment.** Attempt to obtain a full seal around the mouth and nose. This may require changing the size of the mask to better suit the patient. One size does not fit all!

- **R: Reposition airway.** Given the more prominent occiput in children relative to adults, a shoulder roll can be more effective than a neck roll. Try to place the patient in a "sniffing" position with the chin and nose tilted up. This can be accomplished with a head tilt-jaw thrust maneuver.

- **S: Suction.** Respiratory infection is a common cause for pediatric respiratory distress and providing suction can remove secretions that are obstructing the airway.

- **O: Open mouth.** Similarly, the nose may be obstructed despite suctioning and opening the mouth can be an effective way of improving gas exchange. In an obtunded patient with no gag reflex, this may be accomplished with an oropharyngeal airway.

- **P: Pressure increase.** Particularly in medically complex children, lung compliance may be decreased due to chronic lung disease or frequent pulmonary infections. Higher peak inspiratory pressures may be needed to adequately ventilate and oxygenate. However, caution should be taken to avoid barotrauma and a pneumothorax.

- **A: Alternate airway.** If the above steps are not effective in addressing the child's respiratory distress then progression to more advanced airways are indicated. Besides endotracheal intubation, consider a properly sized laryngeal mask airway.

Propose a plan to troubleshoot a tracheostomy device (evaluation)

If the patient is in respiratory distress, consider that the patient may not have a stable airway. This may be due to obstruction, dislodgement, or the creation of a false passage.

- **Obstruction** may be due to mucus/secretions, blood or granulation tissue. Sometimes these obstructions may create a one-way valve allowing for inspiration but not expiration. Suctioning may not be sufficient to clear the obstruction.

- **Dislodgement** (accidental decannulation) may occur during patient movement, trach manipulation, or connecting/disconnecting the trach from a ventilator.

- A **false passage** may be created during a difficult trach change that places the internal end of the tube into the soft tissues and not into the trachea. If this is recognized a stable airway must be established immediately.

In general, if a tracheostomy is more than 7 days old and the patient is in respiratory distress and there is concern that the tracheostomy tube is the source, the tracheostomy tube should be exchanged. If the tracheostomy tube exchange is unsuccessful or does not lead to improvement in the patient's respiratory distress, consider alternate etiologies of respiratory distress such as pneumonia and pneumothorax.

- If the tracheostomy tube is still believed to be the problem, then you can attempt to provide bag-mask ventilation orally; making sure to occlude the tracheostomy stoma.

- If this is not adequate then consider intubating either through the stoma or orally.
    - If intubating orally, be sure to pass the cuff past the tracheostomy stoma.
    - If intubating through the stoma then use the same size cuffed endotracheal tube as the patient's tracheostomy tube.

Demonstrate tracheostomy tube replacement (application)

If a tracheostomy is less than 7 days old, there is a high risk for complications and tracheostomy tube exchange in the Emergency Department should only rarely be considered appropriate.

The steps for a tracheostomy tube exchange:
- Before beginning, gather appropriately sized airway supplies including 2-3 tracheostomy tubes with the patient's current tube size and 1-2 smaller tubes in case of difficulty.
- Check equipment for lack of defects and ensure the cuff inflates properly.
- Preoxygenate the patient for at least one minute with 100% FiO_2.
- Deflate the old tube's cuff and remove the tube.
- Place the new tube (with solid obturator in place) into the stoma.
- Once in place, remove the obturator, insert the hollow inner cannula, and inflate the cuff.

- Check placement with end tidal CO_2 monitoring.

Demonstrate focused history taking from a caregiver (application)

In acute settings, a useful mnemonic for taking a focused but appropriate history is AMPLE

- **Allergies**
- **Medications.** This may be a long list in a medically complex child. Sometimes caregivers have a list or an app on their phones that list medications. It may be necessary to delegate a member of the medical team to obtain a full medication list from a caregiver. Often caregivers record medication doses in milliliters rather than milligrams. Most medications have standard concentrations from which doses can be calculated.
- **Past medical history.** Asking about immunizations and birth history can often be very helpful. In a medically complex patient be sure to ask about prior surgeries and device placement as well as common comorbidities such as seizures, chronic lung disease, and metabolic disorders.
- **Last food/drink intake.** Medically complex children may be fed orally, through a gastrostomy tube, or a gastro-jejunostomy tube. Be sure to ask open-ended questions about any intake rather than asking about meals.
- **Events leading to presentation.** Ask about changes from the patient's baseline over the past few days with pointed questions attempting to identify critical neurologic, cardiac, and respiratory pathologies.

Explain diagnosis and management to caregivers (synthesis)

While the caregivers of a medically complex child may seem very knowledgeable and savvy (and may use advanced medical terminology), it is important in an acute setting to continue to use simple, patient-centered language. Caregivers are often very anxious and they may require repetition to fully understand what you are trying to convey, particularly if it is bad news. If time allows, using a teach-back method allows you to make sure that the caregiver understands what you are trying to communicate and allows for misunderstandings to be addressed.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

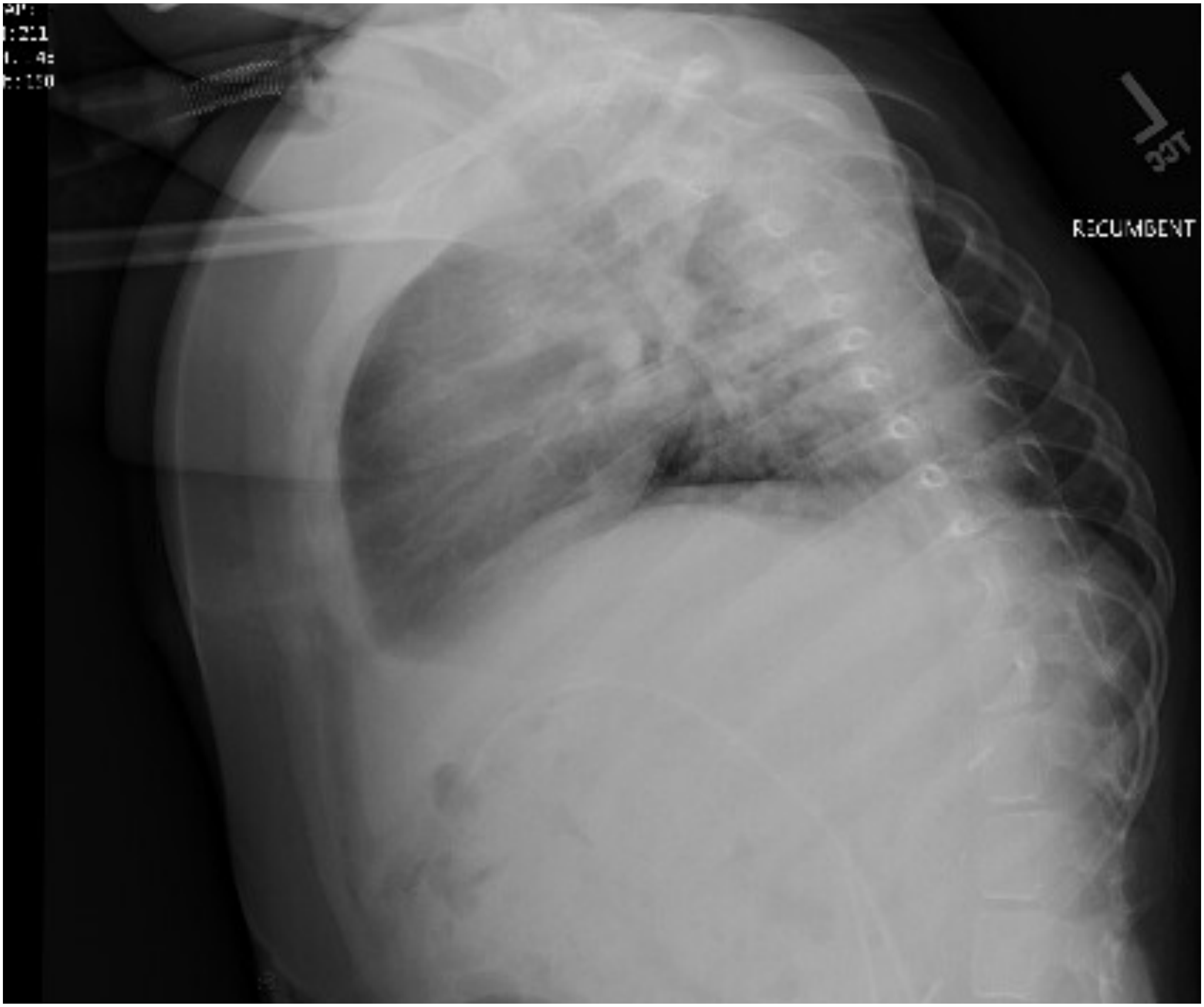
- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Supporting Files

Chest X-ray – AP View

Supporting Files

Chest X-ray – Lateral View



Supporting Files

Notes

Chest X-ray Interpretation

The CXR shows a multifocal pneumonia. Images courtesy of the Division of Diagnostic Imaging and Radiology, Children's National Hospital, Washington, DC

Supporting Files

Laboratory Results

Venous Blood Gas and Other Point of Care Labs

LABORATORY TEST	VALUE	UNITS
pH	7.21	
pCO_2	75	mmHg
pO_2	45	mmHg
HCO_3	12	mEq/L
Sodium	130	mEq/L
Potassium	4.5	mEq/L
Hematocrit	35	%
Ionized Calcium	1.1	mmol/L

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant playing the patient's parent

Case Background Information

Your son has multiple medical problems due to being born prematurely, including a breathing tube in his neck (tracheostomy). Your son has been sick for about a week and is getting worse now with worse trouble breathing. So, you came to the hospital for him to be evaluated. He hasn't been this sick in a year but when he looked like he does today it meant he had to be hospitalized.

Who are the Learners?

Emergency medicine interns: They are in their first year of specialty training and may have experience in gathering information from patients and families but are less familiar with medical treatments and procedures.

Emergency medicine residents: They are in their second to fourth year of specialty training and are growing more comfortable with gathering information, developing a plan and then performing medical treatments and procedures.

Standardized Patient Information

- **Narrative:** He's been sick for about a week. After four days the cough wasn't getting better and his fevers got worse so we took him to his regular doctor. She started him on some antibiotics. Last night he was coughing a lot and the night nurse suctioned the trach several times and ended up replacing the tube. Since I started taking care of him we haven't been able to get his sats above 85% so I wanted him checked

- **Motivation:** You are worried that your son may have to be hospitalized again. This usually means a long hospital stay, sometimes in the intensive care unit and this is frightening.

- **Demeanor:** Initially you are concerned that his breathing is very fast and that his oxygen number "saturation" is much lower than normal. Over time (especially if you do not feel that you have been kept informed about what is going on), it is ok to become more anxious. He has not been this sick for a long time and his physicians were talking about taking out his trach so this illness is clearly a setback.

- **Communication Guidelines:** While it is ok to ask questions, please DO NOT interrupt the learners when they are thinking out loud as one of their objectives is to verbalize their thoughts. Another goal of the session is to have the learners learn how to talk to families so please do not become so upset/obstructive that the learners feel justified having you removed from the room.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you? Or "what happened?"): "His breathing has gotten worse over the past few hours, and I can't get his oxygen saturation above 85%."

- AGE: 10 years old

- ADDITIONAL HISTORY: "He's been sick for about a week. After 4 days, the cough wasn't getting better and his fever got worse so we took him to his regular doctor. She started him on some antibiotics. Last night he was coughing a lot, and the night nurse suctioned the trach several times and ended up replacing the tube. Since I started taking care of him, we haven't been able to get his saturation above 85% so I wanted him checked."

- PAST MEDICAL HISTORY: Born premature at 24 weeks, chronic lung disease, intellectual disability, cerebral palsy, seizure disorder, admitted to the hospital for pneumonia x3 in his life, last admitted 1 year ago. The trach was weaned off of home oxygen 6 months ago, and he is not on a ventilator. He has a G-tube for feeding at night.P rior to this episode he had been doing well and his physicians were discussing having the tracheostomy removed.

- SOCIAL HISTORY: Lives at home with both parents and a younger brother (brother has a mild cold that started a week ago).

- FAMILY HISTORY: Father with asthma

- PAST SURGICAL HISTORY: Tracheostomy placement when he was a baby, G-tube placement around the same time

- MEDICATIONS: Baclofen, oxcarbazepine, azithromycin for the past 4 days (started by primary care doctor). The full medication list is with the other parent who is arriving by car "soon".

- ALLERGIES: No known drug allergies

- IMMUNIZATIONS: Up-to-date

- FEEDINGS: 2 cans of Pediasure overnight by the G-tube. These feedings have been going normally while he's been sick.

- BIRTH HISTORY: Born at 24 weeks premature. Prolonged NICU stay. The main complications of his prematurity are cerebral palsy and chronic lung disease.

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:

- "The doctors said he was getting better. Why is he so sick today?"

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
After the tracheostomy (breathing tube in the neck) is suctioned	"We tried that at home and it didn't make any difference"
If they mention the word "intubate" or talk about putting a "breathing tube in his mouth"	"Why are you doing that? He got the tube in his neck so he wouldn't need a tube in his mouth anymore. His ENT doctor said that it would be really hard to get another tube down his mouth anyway."
If you are not updated with a plan before the tracheostomy tube is removed	"What are you doing? It's not time to change the tube and why would it do that if he's already having trouble breathing?" It's ok to gently press the issue until you feel you have been updated with a plan.
After the tracheostomy tube has been replaced	"He's breathing better but he still doesn't look right."
If you are not told what the next steps are	"Are we spending the night here?"

Simulation Case 14

Status Asthmaticus

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Setup

Chief complaint: Respiratory breathing
Patient age: 6 years old
Weight: 25 kg

Brief Narrative Description of Case

Participants receive a call-in from EMS for a 6-year-old male who reported severe, worsening respiratory distress at home. He is known to have a diagnosis of severe persistent asthma and had been discharged from the hospital 2 weeks prior with an asthma exacerbation.

Learners will designate roles for the resuscitation and prepare medications and equipment for the anticipated scenario. When the patient arrives, severe respiratory distress should be immediately recognized. The patient should be placed on bedside monitors and given supplemental oxygen.

Bronchodilators are immediately initiated with albuterol, ipratropium, and IV steroids administered with no improvement in clinical condition. This should prompt escalation in medical management. Even if given IV magnesium, SQ terbutaline or epinephrine, continuous albuterol, and positive pressure ventilation, he continues to deteriorate. At approximately 10-13 minutes into the scenario, the patient suddenly becomes hypotensive, tachypneic, and hypercarbic, with alteration in mental status (manikin should moan, or report of only moaning to painful stimuli).

A team member begins bag-mask ventilation (BMV). The physical exam reveals asymmetric chest rise and decreased breath sounds on the left (right if this is what is reflected in the task trainer). Learners quickly recognize a pneumothorax and perform an emergency needle decompression while one member talks to the family. The patient improves with improvement in O_2 saturation and overall hemodynamics.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Identify signs/symptoms of impending respiratory failure in a pediatric patient **(application)**
2. Construct a differential diagnosis for respiratory distress in a pediatric patient **(synthesis)**
3. Construct and implement initial medical management of status asthmaticus **(application)**
4. Interpret changes in vital signs and exam suggesting clinical deterioration secondary to a pneumothorax **(evaluation)**
5. Demonstrate a needle decompression of a pneumothorax **(application)**
6. Demonstrate focused history taking from a caregiver **(application)**
7. Explain diagnosis and management to caregivers **(synthesis)**
8. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

Team-based actions:

- Identify team leader and member roles prior to patient presentation (pre-brief/ huddle)
- Prepare the room prior to patient arrival – nebs, medications, intubation equipment
- Deliver first-line medications immediately
- Deliver appropriate second-line medications after recognizing failure to improve on first-line medications
- Recognize tension pneumothorax and perform needle decompression

Individual actions:

- Assigns roles
- Correctly identifies and calls for first- and second-line medications
- Summarizes in a standard fashion every 2-5 minutes for team members
- Hands off to PICU in a standard fashion at the end of the case
- Prepares airway adjuncts including bag-valve mask, LMA, and/or oral airways

CRITICAL ACTIONS (continued)

- Appropriately consents parent or guardian for needle decompression, explaining risk, benefits, and alternatives
- Gathers appropriate equipment
- Performs procedure quickly, safely, and correctly
- Appropriately doses medications in a weight-based manner
- Appropriate 2-person medication check
- Delivers medication in a closed-loop manner
- Documents time and actions during simulation

Recommended Supplies

- **Manikin:** Child, ideally with the ability to perform needle decompression. Alternatively, may use a task trainer in conjunction with manikin, if manikin does not have capability.
- **Moulage:** None
- **Resources:** Pediatric reference card such as PALS card and/or length-based tape (e.g., Broselow Tape)
- **Manikin set up:** IV in place already with drainage system. Clothed or in hospital gown.
- **Equipment:**
    - Monitors in room
    - Large-bore angiocatheter in room and available along with 20- and 60- mL syringes
    - Optional chest tube kit
    - Supplemental oxygen via simple face mask, nasal cannula, nonrebreather
    - Positive pressure ventilation equipment
    - Intubation equipment in room and available
- **Medications with dosing options** (may vary by institution):
    - Albuterol
        - MDI: 90 mcg/puff 4-8 puffs every 20 minutes for 3 doses
        - Nebulization: 0.15 mg/kg/dose (minimum dose: 2.5 mg/dose) every 20 minutes for 3 doses then 0.15 to 0.3 mg/kg/dose not to exceed 10 mg/dose every 1 to 4 hours
        - Continuous nebulization: 10-30 mg/hour
    - Ipratropium
        - Nebulization: 0.25 to 0.5 mg (250 to 500 mcg) every 20 minutes for 3 doses, then as needed 0.25 mg (250 mcg)

every 1 to 8 hours or 1.5 mg over 1 hour
- Nebulization solution with albuterol (ipratropium bromide 0.5 mg/albuterol 2.5 mg): 1.5 to 3 mL every 20 minutes for 3 doses, then as needed for up to 3 hours

- Steroids
  - Prednisone/prednisolone (PO): Loading dose 2 mg/kg/dose, then 1 to 2 mg/kg/day in 1-2 divided doses; maximum daily dose: 60 mg/day
  - Methylprednisolone (IV): Loading dose: 2 mg/kg/dose, then 0.5 to 1 mg/kg/dose every 6 hours
  - Dexamethasone (PO, IM, IV): 0.6 mg/kg once daily as a single dose or once daily for 2 days; maximum dose: 16 mg/dose
- Magnesium sulfate
  - 25 to 75 mg/kg/dose IV as a single dose; maximum dose: 2,000 mg/dose
- Terbutaline
  - PO: 2.5 mg three times daily; maximum daily dose: 7.5 mg/24 hours
  - SubQ: 0.01 mg/kg/dose every 20 minutes for 3 doses; may repeat every 2 to 6 hours as needed
  - Oral inhalation: 1 inhalation (0.5 mg) as needed; if not effective after 5 minutes may repeat dose
- Epinephrine (1:1000 at 0.01 mg/kg IM)
  - Wt 7.5 to <15 kg: Dose 0.1 mg
  - Wt 15 to <30 kg: Dose 0.15 mg
  - Wt ≥30 kg: Dose 0.3 mg
  - Dose may be repeated based on severity and response to initial dose
- Aminophylline IV
  - Loading dose: 5.7 mg/kg/dose
  - Maintenance dose/continuous IV infusion: Children 1 to <9 years: 1.01 mg/kg/hour
- Normal saline or Lactated Ringer's bolus
  - 20 mL/kg bolus as needed

Supporting Files

- Chest radiograph 1 - Hyperinflation
- Chest radiographs 2A and 2B - Left and right-sided pneumothoraces
- Ultrasound image - Pneumothorax

- ECG
- Laboratory results

Participants/Roles

- Team leader
- Member: Airway/ breathing
- Member: Procedures
- Member: Bedside RN (or embedded participant)
- Member: Medication/ code cart (or embedded participant)
- Member (optional): History taker
- Member (optional): Ordering MD
- Member (optional): Documenter/Timekeeper
- Standardized patient (actor or faculty) to play patient's parent

If there are not enough learners to perform the above roles, faculty members or other embedded participant can play a nurse, respiratory therapist, or tech.

** Team roles may need to be adjusted in order to suit local practices and norms*

Prerequisite Knowledge

- **Faculty**
    - PALS protocols
    - General knowledge of emergency medicine
    - Simulation implementation and debriefing experience

- **Emergency medicine residents**
    - Local policies/procedures/protocols for status asthmaticus
    - Familiarity with the procedures of needle decompression, deep sedation, and consenting for procedures

Case Alternatives

- Deviation from any first or second-line asthma treatment should prompt clinical deterioration (increased work of breathing, worsening tachypnea, and/or desaturations). The embedded participant may ask if this could be all from his asthma.

- First-line treatments include bronchodilator therapy and/or steroids. Second-line treatments include magnesium, terbutaline, epinephrine, and/or noninvasive positive pressure as described.
- If learners intubate the patient, increasingly high pressures are required as the patient becomes hypotensive and more hypercarbic. The patient improves with either paralysis or spontaneous modes such as pressure support ventilation in addition to needle decompression of the pneumothorax.

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC3. Diagnostic Studies
PC5. Pharmacotherapy
PC6. Observation and Reassessment
PC7. Disposition
PC9. General Approach to Procedures
PC10. Airway Management
PROF1. Professional Values
ICS1. Patient Centered Communication
ICS2. Team Management

Resources
1. Nievas IF, Anand KJ. Severe acute asthma exacerbation in children: a stepwise approach for escalating therapy in a pediatric intensive care unit. J Pediatr Pharmacol Ther. 2013;18(2):88-104. PMID: 23798903
2. Camargo CA Jr, Rachelefsky G, Schatz M. Managing asthma exacerbations in the emergency department: summary of the National Asthma Education and Prevention Program Expert Panel Report 3 guidelines for the management of asthma exacerbations. J Emerg Med. 2009;37(2 Suppl):S6-S17. PMID: 19683665

Initial Presentation

ITEM	FINDING
Overall Appearance	6-year-old boy who is quiet, in respiratory distress, and has an IV access already established in left arm. (If using manikin with voice, can say 'it hurts to breathe', otherwise, the embedded participant is to report what the manikin is saying.) • Breathing: Tachypneic, diffuse retractions, decreased air entry • Circulation: Pale, good pulses
HPI	**Brief EMS report:** 6-year-old male who reported severe, worsening respiratory distress at home. He is known to have a diagnosis of severe persistent asthma and had been discharged from the hospital 2 weeks prior with an asthma exacerbation. EMS arrived at the home and found the child to be awake and alert; however, he was in respiratory distress with tachypnea and hypoxia to 89%. One nebulized albuterol dose was administered and a peripheral IV was placed in the ambulance en route to the Emergency Department. **If learners ask for specifics:** The patient developed cold symptoms including cough, congestion, and low-grade fever (100.4-101°F) over the past 3 days. The mother has been giving his usual once daily medications (inhaled steroid and montelukast), as well as his rescue albuterol inhaler (which is reserved for worsening symptoms) every 4-6 hours. He seemed to respond well to this regimen over the first 2 days of illness. However, this morning the child woke up with a severe coughing fit. He vomited once after this coughing episode and the mother administered his albuterol inhaler. He did not recover as well as the mother wanted him after the treatment. He seemed to be working hard to breathe and couldn't finish sentences without taking a deep breath. This prompted mom to call 9-1-1 for assistance.

Initial Presentation (continued)

ITEM	FINDING
HPI	Of note, the patient has been a bit more tired than usual over the last 3 days, but he has been eating, drinking, voiding, and stooling as per usual. Additionally, the patient has a history of asthma for which he takes an inhaled steroid twice daily and oral Montelukast once daily. He uses an albuterol inhaler "when he needs it" which varies between 1-4 times per day depending on if he is ill with a cold. He wakes up almost every night due to a coughing fit and can only go back to sleep after taking his albuterol inhaler. Oftentimes, he must sit out of gym class because he cannot keep up with the other children without becoming short of breath. He was discharged from the hospital 2 weeks ago due to an asthma flare. This was his fourth hospitalization for his asthma and during this stay, he needed to take steroids by mouth and albuterol more frequently than he normally would. He didn't need to be in the PICU during this hospital stay; however, the one preceding (last year) he was in the PICU and intubated. Prior to this, he was admitted twice on the general pediatrics floor. Other than his usual daily medications, he has needed steroids by mouth 3-5 times a year for the last 3 years. His asthma is typically triggered by colds, dust, and when he is around dad smoking.
Past Medical/Surgical History	Multiple lifetime admissions, one PICU admission, one prior intubation
Medications	Albuterol PRN Inhaled corticosteroid BID Montelukast once daily
Allergies	Dust-mite, mold, ragweed; No known drug allergies
Family History	Multiple family members with asthma

Initial Presentation (continued)

ITEM	FINDING
Social History	Lives at home with parents, grandmother, older sister, one cat, and one dog (+) smoker (dad) if asked

Stage 1

Begin Simulation (Stage 1 of 4)

Initial Assessment (0-5 min): Initial evaluation through administration of albuterol, ipratropium, and steroids (or just albuterol and 5 minutes)

CRITICAL ACTIONS

Team-based actions, upon hearing a potentially sick patient is arriving to the ED:

- Identify team leader and member roles prior to patient presentation (pre-brief/huddle)
- Prepare the room prior to patient arrival – nebulizer, medications, intubation equipment
- Deliver albuterol/ipratropium and steroids immediately

Individual actions:

- Bedside MD: Assesses patient, performs primary and secondary survey
- Bedside 'RN' or MD member(s):
    - Orders and administers albuterol, ipratropium, steroids, oxygen
    - Places on monitor
    - Appropriately doses medications in a weight-based manner
    - Delivers medication in a closed-loop manner

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.5°C, **HR:** 140, **BP:** 100/60, **RR:** 24, **SpO_2:** 89% on room air, **Wt:** 25 kg
General	Quiet appearing, in respiratory distress, answers questions
HEENT	No facial swelling, uvula midline and non-edematous

Physical Exam (continued)

ITEM	FINDING
Neck	Supple
Lungs	Suprasternal, intercostal, and subcostal retractions; poor air entry bilaterally; faint wheezing; speaking single words
Cardiovascular	Tachycardic, normal S1/S2
Abdomen	Soft, non-tender, non-distended, no organomegaly
Neurological	No deficits
Skin	Pale but warm, capillary refill <2 seconds
Back	Non-tender. No step-offs. No crepitus.
Other Relevant System	If asked, MAY provide a local, institutional pediatric asthma scoring tool in the severe range

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
0-2 minutes: Patient arrives, placed on monitor, hooks up IV to fluids, and supplemental oxygen via nasal cannula administered	No change *If no O_2 administered, the patient desaturates and becomes more tachypneic (RR 30, SpO_2 85%).	
0-5 minutes: First-line medications given (albuterol/ipratropium, steroids)	No change *If medications are not called for by 3 minutes, the patient desaturates and becomes more tachypneic (drop by 10% in sat and increase by 20% RR for each action not performed).	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
After albuterol, ipratropium, and steroids administered	Proceed to **Stage 2**.	Incorporate a "time advance" of about 30 minutes for administration of medications that may take longer to get fully delivered (i.e., once albuterol is administered, it is OK to assume it runs for the entire duration).

Stage 2

Initiation of Second-Line Medications: Administration of albuterol, ipratropium, and steroids through 10 minutes into case (approximately minutes 5-10)

CRITICAL ACTIONS

- Call for additional resources
- Give at least 2 second-line medications
- Initiate noninvasive ventilation

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.5°C, **HR:** 150, **BP:** 90/50, **RR:** 30, **SpO_2:** 90% on oxygen
Exam Changes	Mild worsening of RR. No significant exam change.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
At minute 5-9: Patient gives second-line medication: • Magnesium • Terbutaline, epinephrine • Aminophylline • Ketamine • Heliox • Non-invasive positive pressure ventilation (NIPPV) There may be institutional variation.	If at least 2 medications are given, oxygen saturations rise to 93% for 1 min, then fall to 85%. **Updated vital signs:** • T: 37.5°C • HR: 165 • BP: 70/40 • RR: 40 • SpO_2: 85% on O_2	Learners must give at least 2 second-line medications between 5-10 minutes. **By 7 minutes**, if no second-line medications are given, change vital signs to: • HR to 160 • RR to 35 • SpO_2 to 85% **By 9 minutes**, if 0 or 1 second-line medication is given, change vital signs to: • HR to 170 • RR to 50 • SpO_2 to 80%
At minute 9: Sudden worsening	Develops sudden worsening of respiratory distress. Appears anxious, saturation drop to 85%, RR increases to 40. Proceed to **Stage 3**.	
Standard institutional communication tools utilized		If not performed, the embedded participant or facilitator may ask for a summary.
10 minutes into the case	Proceed to **Stage 3**.	

Stage 3

Pneumothorax:
10 minutes through needle decompression
(approximately minutes 10-15)

CRITICAL ACTIONS

- Call for additional resources (if not already completed)
- Recognize pneumothorax
- Perform needle decompression (team member)
- Give news to parent (team member)
- Maintain global perspective (team leader)

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.5°C, **HR:** 165, **BP:** 70/40, **RR:** 50, **SpO_2:** 85% on oxygen
Exam Changes	• Now anxious, pale, +/- diaphoresis • Cool extremities, capillary refill 3-4 seconds • Decreased and distant right breath sounds

Instructor Notes: Changes and Case Branch Points
In this stage, the patient fails to improve with first-line medications.

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
At 10-12 minutes: Sudden change in respiratory status	Vitals as above	Embedded participant asks, "He's looking worse, what's happening?"
Team recognizes tension pneumothorax	• RR increases to 50 over 60 seconds. • Patient appears diaphoretic with poor perfusion.	If no recognition of tension pneumothorax by minute 15, the patient loses consciousness and becomes apneic despite any additional interventions.
Gives IV fluid bolus	Transient improvement in HR to 160 and BP to 75/40 over 1 minute, then back to **stage 3** vitals over 30 seconds.	
Calls for CXR/ultrasound		CXR/ultrasound should not delay needle decompression.
Obtains needle for tension pneumothorax decompression		
Optional: • Calls for help and discusses with family member briefly • Sedation discussed, but should not delay case • Intubation discussed, but should not delay case		

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Needle decompression performed	Improvement in vital signs to: • BP: 90/50 • HR: 150 • RR: 30 • SpO_2: 90% on O_2	If >3 minutes elapse before the team mobilizes for needle decompression, the patient becomes apneic , oxygen saturations decline from 85% to 70%, HR increases from 165 to 180, and BP drops to 65/30. Consider using a task trainer for needle decompression and/or chest tube placement.
Pneumothorax is not recognized by minute 12	Standardized parent involvement	Parent asks, “Do you think he might have a pneumothorax?”

Stage 4

Case Conclusion:
Resolution after needle decompression

CRITICAL ACTIONS

- Sign-out to PICU team
- Discussion of further treatment and/or contingency planning (e.g., intubation, ketamine, chest tube)

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.8°C, **HR:** 150, **BP:** 90/40, **RR:** 24, **SpO_2:** 95% on support
Exam Changes	• Pallor improves • Consciousness improves, GCS 15 • Capillary refill <2 seconds • Breath sounds bilaterally (fair and equal with biphasic diffuse wheezing)

Ideal Scenario Flow

Learners are given information from EMS regarding the patient en route for respiratory distress. They then assign roles preemptively and begin to prepare the resuscitation room in the ED. This may include setting up bedside monitors, gathering medications, IV access supplies, supplemental oxygen and airway equipment. Upon arrival, the team leader asks another team member to perform a primary survey of the patient. The team immediately recognizes the child's respiratory distress, places him on a cardiac monitor and pulse oximetry, examines the peripheral IV placed by EMS, and deems it to be intact. They identify the patient to be tachycardic, hypoxic, tachypneic, and wheezing on physical exam. This prompts the team to administer first-line medications (supplemental oxygen, albuterol, steroids, and ipratropium). While initial interventions are taking place, one team member is assigned to gather more history from either an embedded participant or EMS. This information is communicated to the team using standardized institutional communication tools.

Despite first-line therapy, there is no clinical improvement in the patient's condition. This prompts the team to escalate care and provide second-line therapy including magnesium, terbutaline, aminophylline, epinephrine, and/or non-invasive positive pressure ventilation. These interventions also provide no relief, and the patient suddenly develops hypotension, tachypnea, hypercarbia, and altered mental status. The team begins bag valve mask ventilation. On re-examination, right-sided decreased breath sounds with asymmetry in the patient's chest rise are noted. With this information, learners are suspicious of a pneumothorax and might order a STAT chest X-ray which confirms this clinical suspicion, although needle decompression without imaging is warranted. An emergent bedside needle decompression is performed, which results in the patient's clinical improvement. A team member is designated to speak with the family member during these events to update and obtain consent. Once stabilized, a team member calls the PICU to give sign out.

Anticipated Management Mistakes

1. **Failure to recognize non-improvement in a critically ill asthmatic patient:** The absence of improvement is sometimes more difficult to detect than other scenario branch points. In this case, a

lifesaving statement from an embedded participant may help keep the scenario on track.

2. **Failure to diagnose tension pneumothorax:** Some learners may note shock but be unable to effectively diagnose tension pneumothorax. In this case, an embedded participant may be helpful by reporting jugular venous distention, tracheal deviation, and/or the absence of breath sounds on the side of pneumothorax.

3. **Failure to discuss procedure with parent:** Oftentimes, participants are focused on the task at hand, and do not maintain situational awareness of the parent. In this case, the parent should ask what is going on, and lead the team member to discuss the emergent procedure with the family.

4. **Failure to share mental model:** Often, novice learners forget to recap for the team. An embedded participant serving as a team member may be helpful in prompting for a recap.

Debriefing Points

Identify signs/symptoms of impending respiratory failure in a pediatric patient (application)

- Respiratory failure: Condition in which the body's respiratory system is unable to oxygenate, eliminate carbon dioxide, or a combination of both.

- The clinical presentation varies depending on the degree of hypoxemia and hypercapnia; however, children commonly demonstrate signs/symptoms of increased work of breathing (tachypnea, nasal flaring, grunting, head bobbing, retractions, etc).

- Assessing a child with respiratory failure should first involve determining the need for emergent intervention. Learners can achieve this by assessing the vital signs, work of breathing, ability for the child to protect his or her airway, level of consciousness, etc.

Construct a differential diagnosis for respiratory distress in a pediatric patient (synthesis)

After or during the stabilization of the patient's airway, a comprehensive history and physical is necessary to evaluate for possible etiologies of the patient's respiratory failure. Factors such as prematurity, chronic medical diagnoses, anatomical abnormalities, associated symptoms, or events leading up to presentation can fine tune the differential diagnoses.

Construct and implement initial medical management of status asthmaticus (application)

Background
- Status asthmaticus: Acute severe bronchospasm unresponsive to initial therapy with bronchodilators
- Prevalence:
    - Overall prevalence is 10% in pediatric population
    - Increased risk of mortality related to:
        - Teenage years

- Current or recent long-term steroid use
- Previous hypoxic syncope or seizure from asthma
- Recent (within 1 month) ED visit or hospitalization
- More than 2 admissions or 3 ED visits in past year
- Genetic, ethnic, and socioeconomic factors

- Risk factors for near fatal asthma:
  - History of sudden, severe exacerbations
  - Previous intubation for asthma or ICU admission
  - 2 admissions in previous 12 months
  - 3 ED visits in previous 12 months
  - Current or recent use of systemic steroids
  - Use of >2 canisters of bronchodilator per month
  - Difficulty recognizing symptoms
  - Psychiatric disorders
  - Urban residence, socioeconomic status
  - Illicit drug use
  - Significant comorbid conditions
  - Certain genetic polymorphisms (Carroll, Sala, Zucker, & Schramm, 2012; Carroll, Stoltz, Schramm, & Zucker, 2009)

Treatment

- Targets alleviating both hypoxia and airway obstruction

- Oxygen: Target O_2 to relieve hypoxia
  - Mechanism usually related to V/Q mismatch

- Inhaled beta agonists
  - Well established initial treatment, often used in combination with ipratropium - preferred as initial therapy (Griffiths & Ducharme, 2013)
  - Albuterol = selective to beta 2, older medications are often non-selective
  - MDI vs. nebulized beta agonists (Kerem et al., 1993)

- Systemic beta agonists
  - SQ epinephrine or SQ/IV terbutaline: Consider in patients unresponsive to nebulized therapy, in uncooperative patients, and in refractory intubated patients
  - Adverse effects/ monitoring: 10% have troponin leak, may have tachyarrhythmias
  - Evidence showing benefit is limited but may decrease incidence of progressive respiratory failure and

subsequent need for invasive mechanical ventilation. (Doymaz, Schneider, & Sagy, 2014)

- Steroids
  - The use of steroids within one hour of ED presentation for children in status asthmaticus reduces the need for hospitalization and possibly duration of illness (Rowe, Spooner, Ducharme, Bretzlaff, & Bota, 2001)
  - No difference between prednisone 2 mg/kg/day x5 days and dexamethasone 0.6 mg/kg/day x1-2 days (Keeney et al., 2014)

- Anticholinergics
  - Bronchodilation results from the blockage of acetylcholine receptors at the neuromuscular junction of bronchial smooth muscle
  - Thought to have less of a bronchodilator effect and slower onset of action than beta-agonists
  - Effective in conjunction with beta-agonists

- Magnesium sulfate (IV)
  - May reduce the need for hospitalization for children presenting to the ED with moderate to severe asthma exacerbations (Blitz et al., 2005; Cheuk, Chau, & Lee, 2005; Griffiths, Kew, & Normansell, 2016; Silverman et al., 2002; Singh, Gaur, & Kumar, 2008)
  - Variably used, however, likely provides benefit when used as an adjunct to bronchodilator therapy and steroids
  - Mechanism:
    - Decreases Ca++ mediated smooth muscle contraction
    - Stabilizes mast cells, possibly decreases histamine release
  - Side effects: Flushing, nausea, fatigue, somnolence, areflexia, respiratory depression, arrhythmias, hypotension
  - Pearl: Keep Mg levels 3.5-4 mg/dL. (Glover, Machado, & Totapally, 2002)

- Non-invasive ventilation (CPAP/BiPAP)
  - Improves alveolar ventilation and allows for muscle relaxation
  - Mechanism of action:
    - Pressure thought to reduce premature airway closure

        - point (decreases intrinsic and expiratory pressure/ auto-peep) inspiratory work load
        - Though to improve the delivery of aerosolized albuterol to poorly ventilated
        - May reduce the premature airway closure point, reducing intrinsic end expiratory pressure and subsequently the inspiratory workload (Venus, Cohen, & Smith, 1988)
    - Contraindications: Poor patient cooperation, inability to supply high FiO_2, hypercapnia, excess respiratory secretions, need for immediate intubation
        - Risk of barotrauma: “Breath stacking” from positive pressure ventilation in the context of severe airway obstruction and air trapping—may cause pneumothoraces. (Basnet et al., 2012; Carroll & Schramm, 2006; Carroll & Zucker, 2008)

- Aminophylline
    - Mechanism of action:
        - Phosphodiesterase inhibitor increasing cAMP binding--> bronchodilator and pulmonary vasodilator (Yung 1998 (Jat & Chawla, 2012; Mitra, Bassler, Watts, Lasserson, & Ducharme, 2005; Ream et al., 2001; Singhi, Grover, Bansal, & Chopra, 2014; Tee et al., 2007; Wheeler et al., 2005; Yung & South, 1998)
        - Sustained improvement in oxygenation, hastened recovery, less tachypnea when compared with terbutaline
    - Adverse effects: Vomiting, seizures, small therapeutic window
    - Must monitor levels

- Ketamine:
    - Mechanism of action:
        - Bronchodilator; releases endogenous catecholamines
        - Releases smooth muscle by activating NMDA receptors in the lung
    - Adverse effects: Laryngospasm, increased secretions, acute delirium/hallucinations
    - Must monitor levels
    - In the ED, may improve severity index, (Denmark, Crane, & Brown, 2006; Jat & Chawla, 2012; Petrillo, Fortenberry, Linzer, & Simon, 2001), although a Cochrane review

concluded that there was not enough evidence to draw strong conclusions (Jat & Chawla, 2012).

- Heliox:
  - Mechanism of action:
    - May improve delivery of albuterol to small airways by reducing airway resistance
  - Adverse effects: None
  - Evidence: Kim et al. showed that children treated with continuous albuterol delivered by heliox showed greater clinical improvement than those treated with oxygen alone delivered albuterol. Differences were evidenced by pulmonary index (measured at 30-minute intervals) at 125 minutes post-randomization (Kim et al., 2005).

Interpret changes in vital signs and exam suggesting clinical deterioration secondary to a pneumothorax (evaluation)

- Pneumothorax: Accumulation of air in the space between the visceral and parietal pleura in the chest cavity resulting in impair oxygenation and/or ventilation
  - Etiologies may include traumatic, spontaneous, or iatrogenic

- Signs, symptoms, and exam findings of a pneumothorax can vary from patients being asymptomatic to shortness of breath, chest pain, asymmetric chest rise, hypoxia, hypotension, bradypnea, altered mental status, and other signs of clinical decompensation.

- Learners should have a high clinical suspicion for pneumothoraces in patients demonstrating acute changes as above.

Demonstrate a needle decompression of a pneumothorax (application)

- Symptomatic patients with stable vital signs may be eligible for needle aspiration (or insertion of a small-bore catheter), as opposed to those with unstable vital signs who may require a larger catheter.

- Concurrent treatments may also include supplemental oxygen, serial chest radiographs, and pain control.

Demonstrate focused history taking from a caregiver (application)

- Components of history taking: Past medical history, surgical history, family history, medications, allergies, social history, vaccination history

- For this scenario, obtaining an asthma history with the following components is of utmost importance:
    - Frequency of albuterol use
    - Last albuterol use
    - Controller medications
    - Hospitalizations/ ED visits related to asthma
    - Frequency of oral steroid courses
    - Prior PICU stays or intubations

Explain diagnosis and management to caregivers (synthesis)

Use a teach-back approach.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation

Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

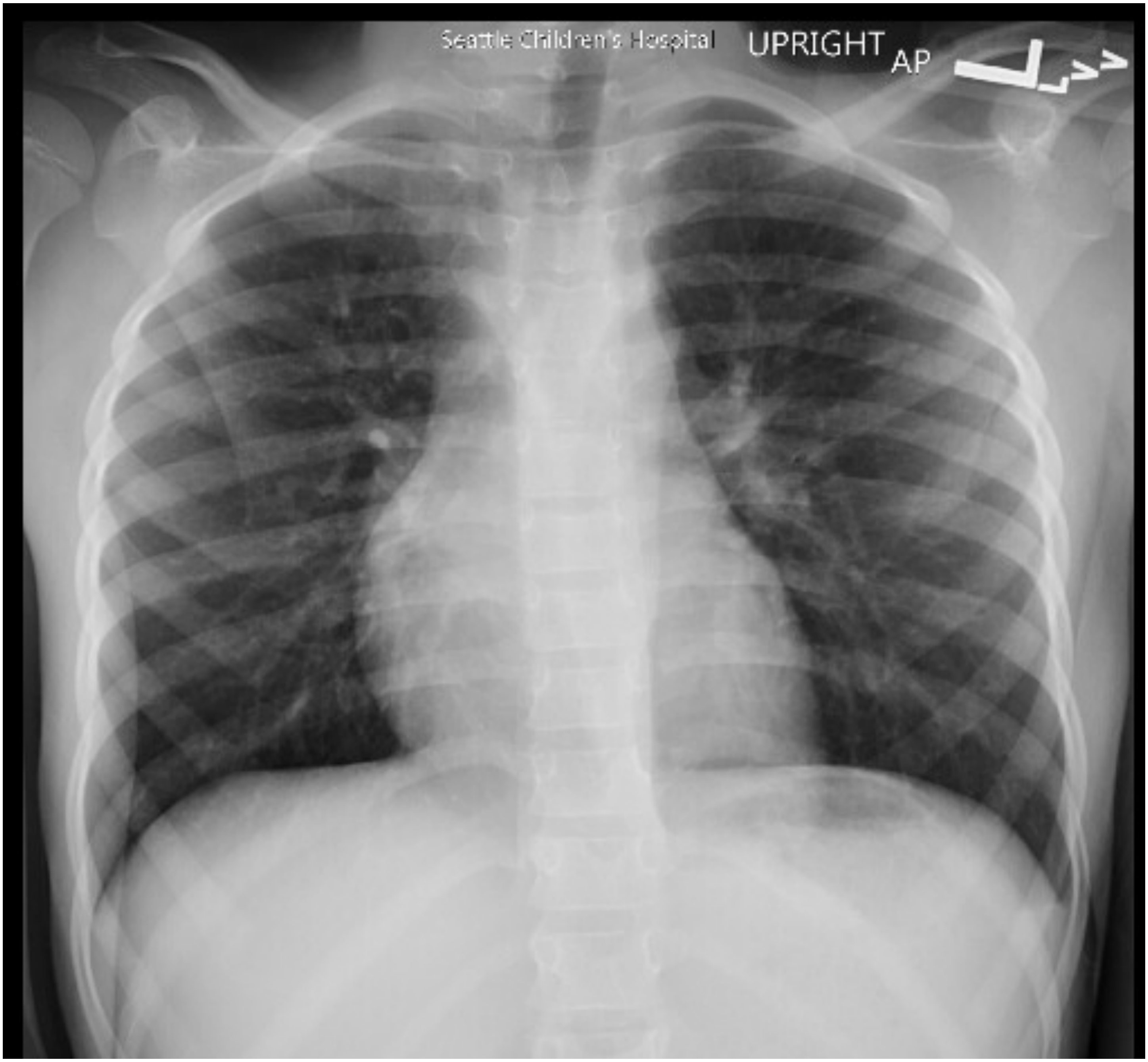
- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

AGENT	DOSE	EFFECTS/COMMENTS	ADVERSE EFFECTS (SHORT TERM)
Oxygen	21-100%	Titrated to keep SpO_2 >90%	
Methylprednisolone	0.5-1 mg/kg/dose IV q 6 hrs	*Anti-inflammatory*	Hyperglycemia, hypertension, dyspepsia/ peptic ulcer, increased appetite
Prednisone/Prednisolone	2 mg/kg/day PO x5 days	*Anti-inflammatory* Max dose 60 mg/dose	Hyperglycemia, hypertension, dyspepsia/ peptic ulcer, increased appetite
Dexamethasone	0.6 mg/kg PO x1-2 days	*Anti-inflammatory* Max dose 16 mg	Hyperglycemia, hypertension, dyspepsia/ peptic ulcer, increased appetite
Albuterol	**Intermittent:** 2.5-5.0 mg in 4 mL saline **Continuous:** 10-30 mg/hr	*Short acting bronchodilator*	Tachycardia, tremor, hypokalemia, headache, dizziness
Ipratropium	**Under 6 yrs old:** 0.75 mg **6 yrs and older:** 1.5 mg	*Anticholinergic* Given over first hour of ED management	Tachycardia, blurred vision, headache, dizziness, dry mouth
Magnesium	25-75 mg/kg IV	*Smooth muscle relaxant* Max dose 2 grams Infuse over 20 min	Flushing, hypotension, nausea (related to rapidity of infusion)
Epinephrine	0.01 mg/kg of 1:1000 SQ/ IM	*Alpha and beta agonist*	Tachycardia, nausea, tremor
Aminophylline	**Load:** 6-7 mg/kg IV **Infusion:** 0.6-1.2 mg/kg/ hr IV	*Phosphodiesterase inhibitor* Titrate to serum level of 10-20 mg /dL Infuse over 20 min	Tachycardia, tremor, seizures, nausea, vomiting, agitation, arrhythmias, hypotension, seizures
Terbutaline	**Load:** 10 mcg/kg IV **Infusion:** 0.5-10 IV mcg/kg/ min **Subcutaneous:** 0.1 mcg/kg/ dose SQ q20 min x 3 doses	*Beta-2 agonist* Infuse over 20 min	Tachycardia, tremor, hypokalemia, hypotension, hyperglycemia
Ketamine	**Load:** 1-2 mg/kg IV **Infusion:** 0.5-2 mg/kg/hr IV	*Bronchodilator*	Laryngospasm, bronchorrhea, increased intraocular, hypertension, hypotension, myocardial depression

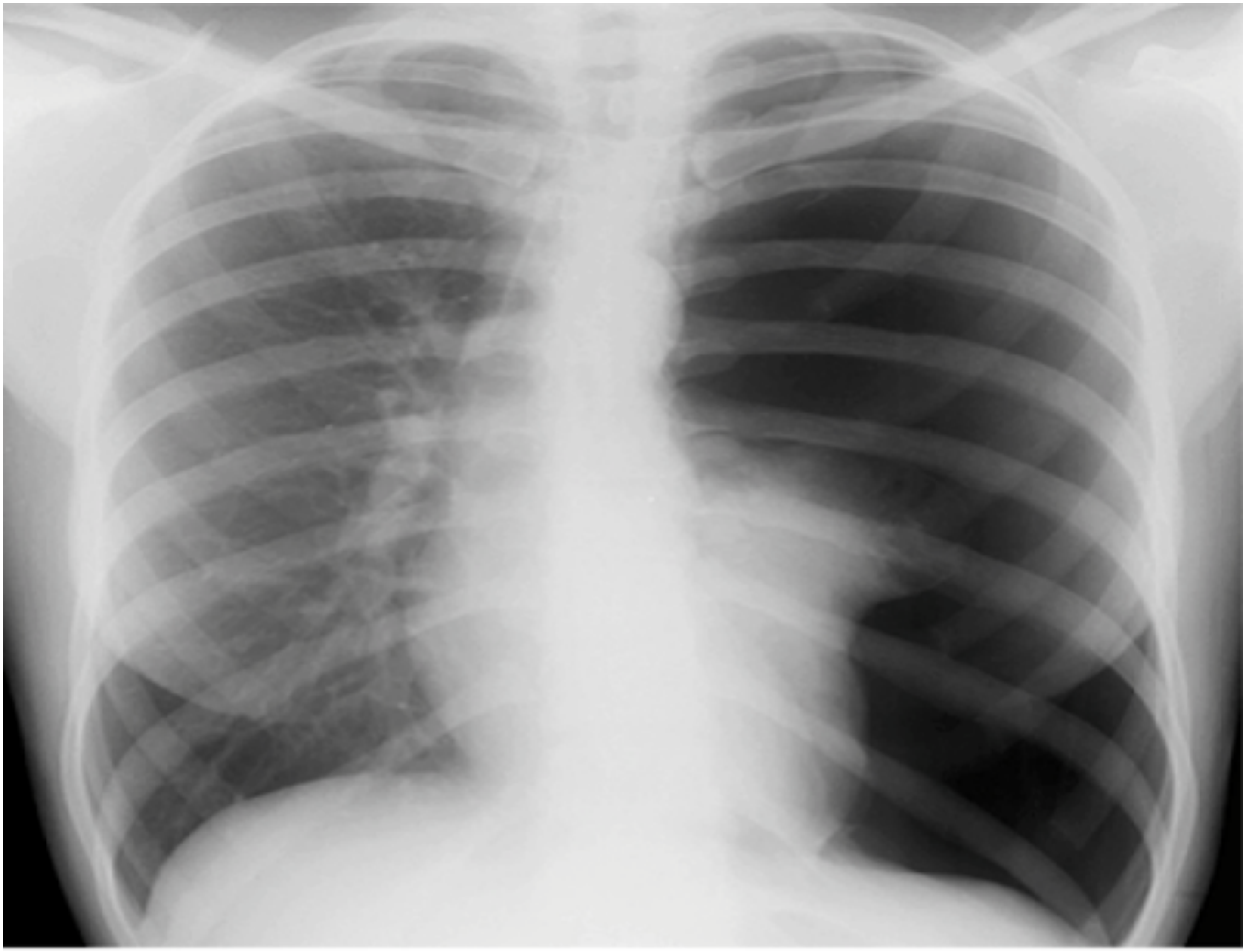
Supporting Files

Chest X-ray #1 – AP View



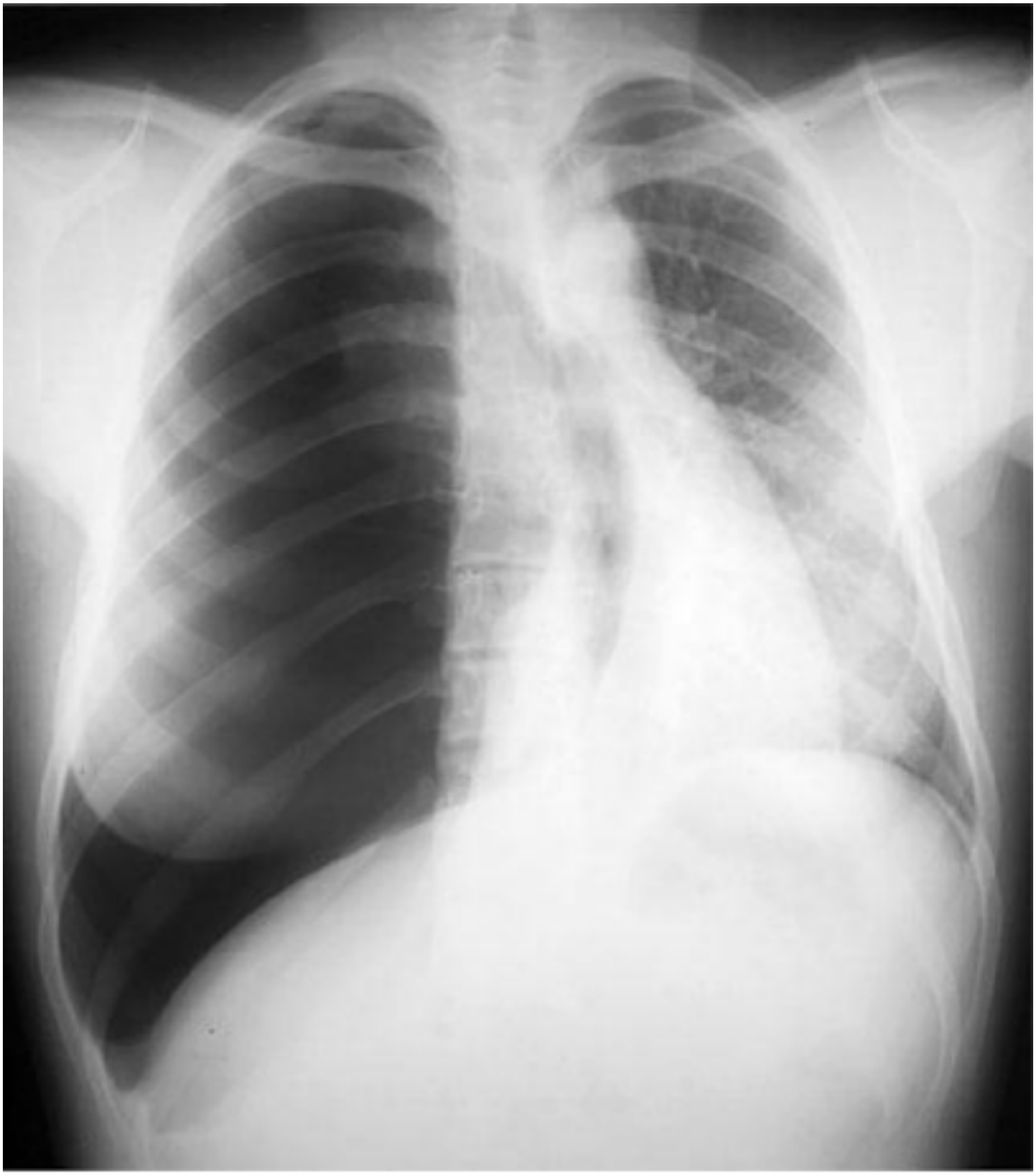
Supporting Files

Chest X-ray #2 - AP View



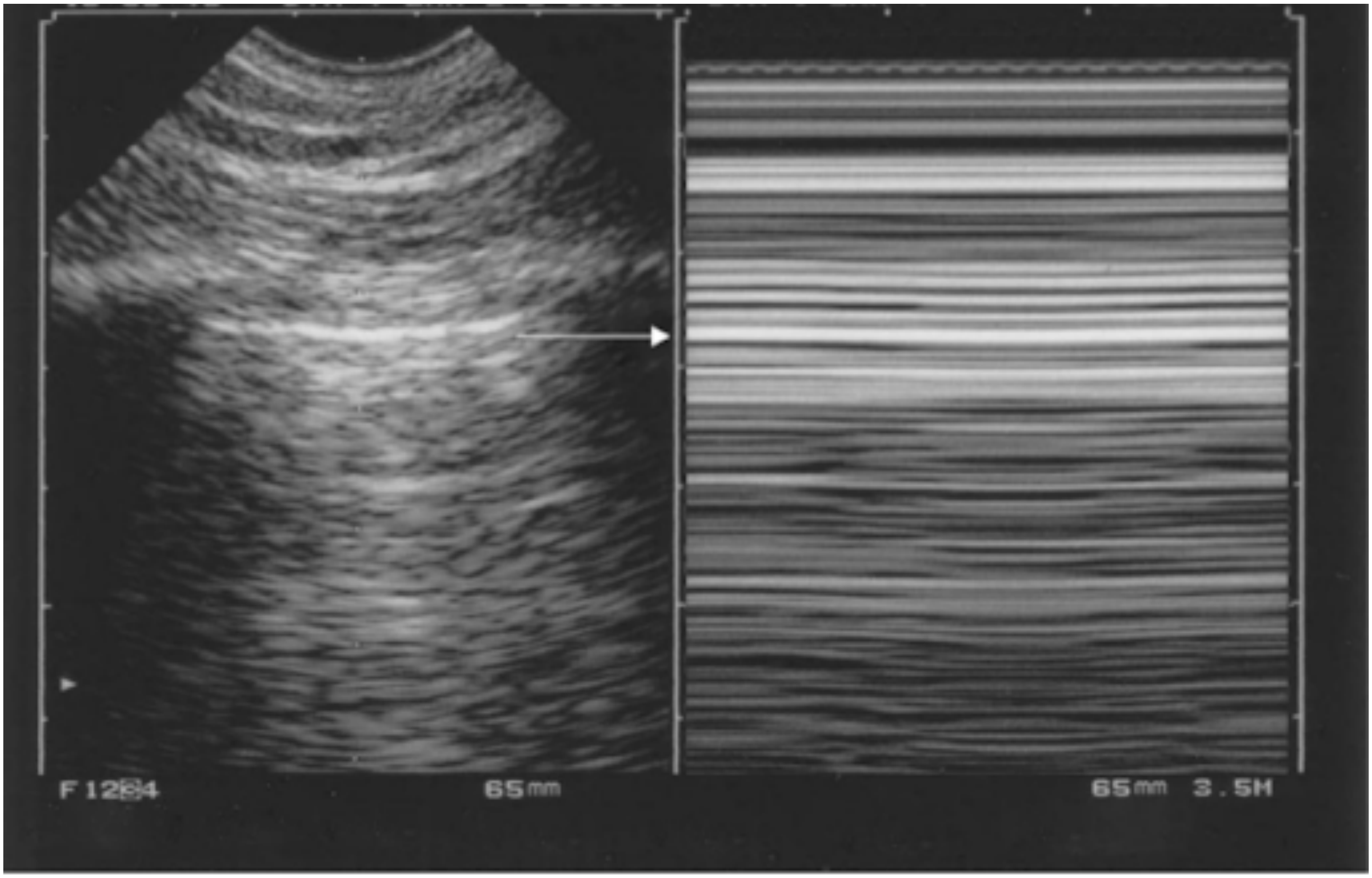
Supporting Files

Chest X-ray #3 – AP View



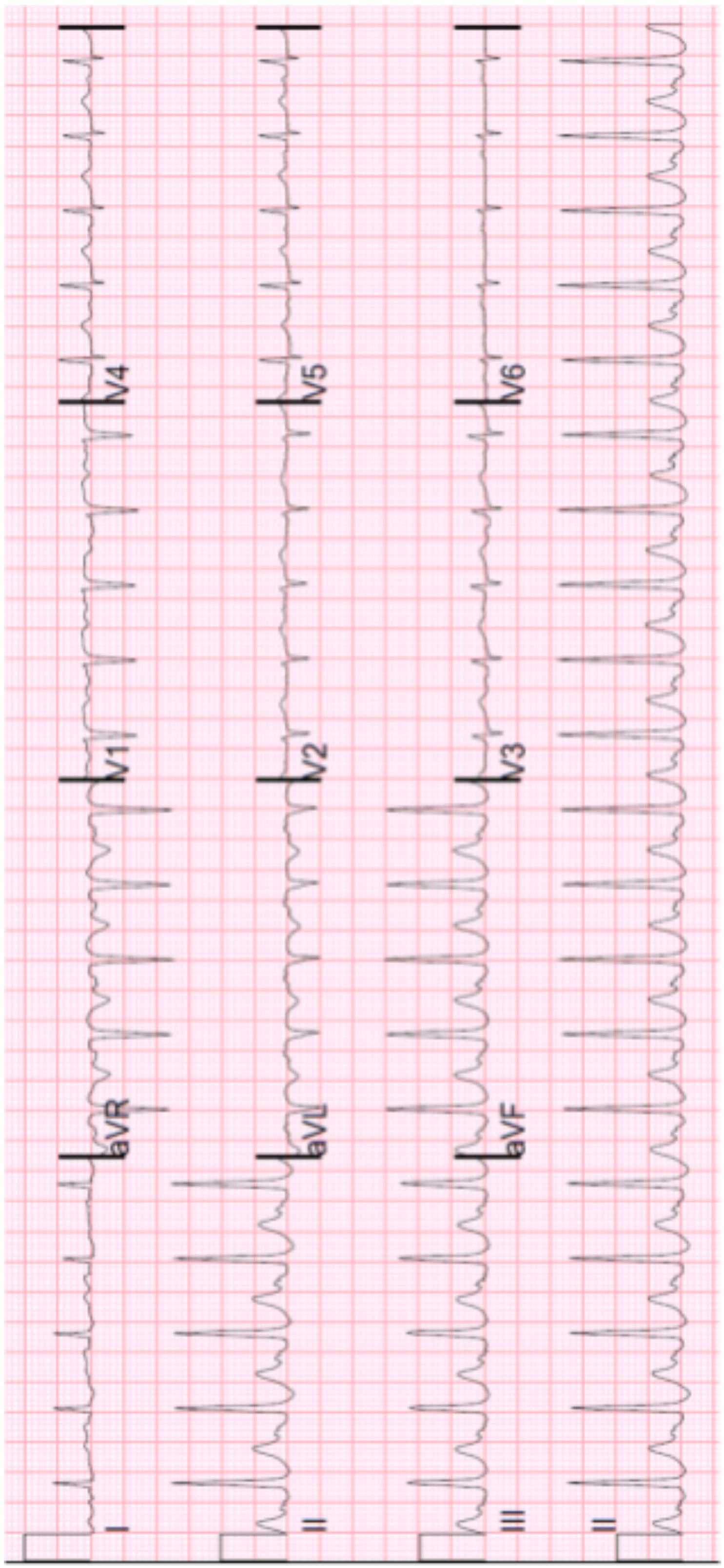
Supporting Files

Lung Ultrasound



Supporting Files

Electrocardiogram



Supporting Files

Notes

Chest X-ray #1 Interpretation
The CXR shows mild hyperinflation of the lungs, otherwise normal. Image from Dr. Rebekah Burns.

Chest X-ray #2 and #3 Interpretation
The CXR shows a left- and right-sided tension pneumothoax. Depending on the available task trainer, the patient may develop either sided pneumothorax.

Lung Ultrasound Interpretation
Pneumothorax

ECG Interpretation
ECG with sinus tachycardia and very low voltage in the precordial leads

Supporting Files

Laboratory Results

Venous Blood Gas (Stage 1 or 2)

LABORATORY TEST	VALUE	UNITS
pH	7.44	
pCO_2	25	mmHg
pO_2	80	mmHg
HCO_3	18	mEq/L

Supporting Files

Laboratory Results

Venous Blood Gas (Stage 3)

LABORATORY TEST	VALUE	UNITS
pH	7.25	
pCO_2	60	mmHg
pO_2	70	mmHg
HCO_3	17	mEq/L

Supporting Files

Laboratory Results
Complete Blood Count

LABORATORY TEST	VALUE	UNITS
WBC	1.0×10^3	$/mm^3$
Hemoglobin	14.0	g/dL
Hematocrit	40.0	%
Platelets	399×10^3	$/mm^3$

Supporting Files

Lab Results

Basic Metabolic Panel and Lactate

LABORATORY TEST	VALUE	UNITS
Sodium	138	mEq/L
Potassium	4.1	mEq/L
Chloride	101	mEq/L
Bicarbonate	18	mEq/L
BUN	12	mg/dL
Creatinine	0.5	mg/dL
Calcium	99	mg/dL
Lactate	4.5	mg/dL

Bibliography

1. Basnet, S., Mander, G., Andoh, J., Klaska, H., Verhulst, S., & Koirala, J. (2012). Safety, efficacy, and tolerability of early initiation of noninvasive positive pressure ventilation in pediatric patients admitted with status asthmaticus: a pilot study. Pediatr Crit Care Med, 13(4), 393-398. doi:10.1097/PCC.0b013e318238b07a. PMID: 22067982.
2. Blitz, M., Blitz, S., Hughes, R., Diner, B., Beasley, R., Knopp, J., & Rowe, B. H. (2005). Aerosolized magnesium sulfate for acute asthma: a systematic review. Chest, 128(1), 337-344. doi:10.1378/chest.128.1.337. PMID: 16002955.
3. Camargo, C. A., Jr., Rachelefsky, G., & Schatz, M. (2009). Managing asthma exacerbations in the emergency department: summary of the National Asthma Education and Prevention Program Expert Panel Report 3 guidelines for the management of asthma exacerbations. J Emerg Med, 37(2 Suppl), S6-S17. doi:10.1016/j.jemermed.2009.06.105. PMID: 19683665.
4. Carroll, C. L., Sala, K. A., Zucker, A. R., & Schramm, C. M. (2012). Beta-adrenergic receptor polymorphisms associated with length of ICU stay in pediatric status asthmaticus. Pediatr Pulmonol, 47(3), 233-239. doi:10.1002/ppul.21544. PMID: 21905268.
5. Carroll, C. L., & Schramm, C. M. (2006). Noninvasive positive pressure ventilation for the treatment of status asthmaticus in children. Ann Allergy Asthma Immunol, 96(3), 454-459. doi:10.1016/S1081-1206(10)60913-1. PMID: 16597080
6. Carroll, C. L., Stoltz, P., Schramm, C. M., & Zucker, A. R. (2009). Beta2-adrenergic receptor polymorphisms affect response to treatment in children with severe asthma exacerbations. Chest, 135(5), 1186-1192. doi:10.1378/chest.08-2041. PMID: 19029431.
7. Carroll, C. L., & Zucker, A. R. (2008). Barotrauma not related to type of positive pressure ventilation during severe asthma exacerbations in children. J Asthma, 45(5), 421-424. doi:10.1080/02770900802085451. PMID: 18569237.
8. Cheuk, D. K., Chau, T. C., & Lee, S. L. (2005). A meta-analysis on intravenous magnesium sulphate for treating acute asthma. Arch Dis Child, 90(1), 74-77. doi:10.1136/adc.2004.050005. PMID: 15613519.
9. Clancy CM, Tornberg DN. TeamSTEPPS: assuring optimal teamwork in clinical settings. Am J Med Qual. 2007;22(3):214-217. doi:10.1177/1062860607300616. PMID: 17485563.
10. Denmark, T. K., Crane, H. A., & Brown, L. (2006). Ketamine to avoid mechanical ventilation in severe pediatric asthma. J Emerg Med, 30(2), 163-166. doi:10.1016/j.jemermed.2005.09.003. PMID: 16567251.
11. Doymaz S, Schneider J, Sagy M. Early administration of terbutaline in severe pediatric asthma may reduce incidence of acute respiratory failure. Ann Allergy Asthma Immunol. 2014;112(3):207-210. doi:10.1016/j.anai.2014.01.003. PMID: 24468309.
12. Glover ML, Machado C, Totapally BR. Magnesium sulfate administered via continuous intravenous infusion in pediatric patients with refractory wheezing. J Crit Care. 2002;17(4):255-258. doi:10.1053/jcrc.2002.36759. PMID: 12501154.
13. Griffiths, B., & Ducharme, F. M. (2013). Combined inhaled anticholinergics and short-acting beta2-agonists for initial treatment of acute asthma in children. Paediatr Respir Rev, 14(4), 234-235. doi:10.1016/j.prrv.2013.08.002. PMID: 24070913.
14. Griffiths, B., Kew, K. M., & Normansell, R. (2016). Intravenous magnesium sulfate for treating children with acute asthma in the emergency department. Paediatr Respir Rev, 20, 45-47. doi:10.1016/j.prrv.2016.07.001. PMID: 27522304.
15. Gupta, V. K., & Cheifetz, I. M. (2005). Heliox administration in the pediatric intensive care unit: an evidence-based review. Pediatr Crit Care Med, 6(2), 204-211. doi:10.1097/01.PCC.0000154946.62733.94. PMID: 15730610.
16. Jat, K. R., & Chawla, D. (2012). Ketamine for management of acute exacerbations of asthma in children. Cochrane Database of Systematic Reviews. doi:10.1002/14651858.CD009293.pub2. PMID: 23152273.
17. Keeney GE, Gray MP, Morrison AK, et al. Dexamethasone for acute asthma exacerbations in children: a meta-analysis. Pediatrics. 2014;133(3):493-499. doi:10.1542/peds.2013-2273

18. Kerem, E., Levison, H., Schuh, S., O'Brodovich, H., Reisman, J., Bentur, L., & Canny, G. J. (1993). Efficacy of albuterol administered by nebulizer versus spacer device in children with acute asthma. J Pediatr, 123(2), 313-317. doi:10.1016/s0022-3476(05)81710-x. PMID: 8345434.
19. Kim, I. K., Phrampus, E., Venkataraman, S., Pitetti, R., Saville, A., Corcoran, T., . . . Thompson, A. (2005). Helium/oxygen-driven albuterol nebulization in the treatment of children with moderate to severe asthma exacerbations: a randomized, controlled trial. Pediatrics, 116(5), 1127-1133. doi:10.1542/peds.2004-2136. PMID: 16263999.
20. Mitra A, Bassler D, Goodman K, Lasserson TJ, Ducharme FM. Intravenous aminophylline for acute severe asthma in children over two years receiving inhaled bronchodilators. Cochrane Database Syst Rev. 2005;2005(2):CD001276. Published 2005 Apr 18. doi:10.1002/14651858.CD001276.pub2. PMID: 15846615.
21. Nievas, I. F., & Anand, K. J. (2013). Severe acute asthma exacerbation in children: a stepwise approach for escalating therapy in a pediatric intensive care unit. J Pediatr Pharmacol Ther, 18(2), 88-104. doi:10.5863/1551-6776-18.2.88. PMID: 23798903.
22. Petrillo, T. M., Fortenberry, J. D., Linzer, J. F., & Simon, H. K. (2001). Emergency department use of ketamine in pediatric status asthmaticus. Journal of Asthma, 38(8), 657-664. doi:Doi 10.1081/Jas-100107543. PMID: 11758894.
23. Ream RS, Loftis LL, Albers GM, Becker BA, Lynch RE, Mink RB. Efficacy of IV theophylline in children with severe status asthmaticus. Chest. 2001;119(5):1480-1488. doi:10.1378/chest.119.5.1480. PMID: 11348957.
24. Rowe, B. H., Spooner, C., Ducharme, F. M., Bretzlaff, J. A., & Bota, G. W. (2001). Early emergency department treatment of acute asthma with systemic corticosteroids. Cochrane Database Syst Rev(1), CD002178. doi:10.1002/14651858.CD002178. PMID: 11279756.
25. Silverman, R. A., Osborn, H., Runge, J., Gallagher, E. J., Chiang, W., Feldman, J., . . . Acute Asthma/Magnesium Study, G. (2002). IV magnesium sulfate in the treatment of acute severe asthma: a multicenter randomized controlled trial. Chest, 122(2), 489-497. doi:10.1378/chest.122.2.489. PMID: 12171821.
26. Singh AK, Gaur S, Kumar R. A randomized controlled trial of intravenous magnesium sulphate as an adjunct to standard therapy in acute severe asthma. Iran J Allergy Asthma Immunol. 2008;7(4):221-229. PMID: 19052352.
27. Singhi S, Grover S, Bansal A, Chopra K. Randomised comparison of intravenous magnesium sulphate, terbutaline and aminophylline for children with acute severe asthma. Acta Paediatr. 2014;103(12):1301-1306. doi:10.1111/apa.12780. PMID: 25164315.
28. Tee AK, Koh MS, Gibson PG, Lasserson TJ, Wilson AJ, Irving LB. Long-acting beta2-agonists versus theophylline for maintenance treatment of asthma. Cochrane Database Syst Rev. 2007;(3):CD001281. Published 2007 Jul 18. doi:10.1002/14651858.CD001281.pub2. PMID: 17636663.
29. Venus B, Cohen LE, Smith RA. Hemodynamics and intrathoracic pressure transmission during controlled mechanical ventilation and positive end-expiratory pressure in normal and low compliant lungs. Crit Care Med. 1988;16(7):686-690. doi:10.1097/00003246-198807000-00008. PMID: 3286121.
30. Wheeler, D. S., Jacobs, B. R., Kenreigh, C. A., Bean, J. A., Hutson, T. K., & Brilli, R. J. (2005). Theophylline versus terbutaline in treating critically ill children with status asthmaticus: a prospective, randomized, controlled trial. Pediatr Crit Care Med, 6(2), 142-147. doi:10.1097/01.PCC.0000154943.24151.58. PMID: 15730599.
31. Yung, M., & South, M. (1998). Randomised controlled trial of aminophylline for severe acute asthma. Arch Dis Child, 79(5), 405-410. doi:10.1136/adc.79.5.405. PMID: 29302790.

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant playing the patient's parent

Case Background Information

Your son has a history of asthma and was recently discharged from the hospital due to a "bad asthma flare." You typically give him an inhaled steroid medicine and oral medicine daily; however, despite these therapies, he developed difficulty breathing over the last day. This is how his usual asthma flares start.

Who are the Learners?

Emergency medicine residents (various stages of training at first, second, third, and possibly fourth years)

First year residents can gather a history and perform physical examinations on patients. However, their medical knowledge and familiarity with pediatric medical treatments and procedures likely is limited. These skills become more refined and developed with each year of training. For the purposes of this simulation, assume learners are in their first or second year of residency training.

Standardized Patient Information

Your 6-year-old with a known diagnosis of asthma developed cold symptoms including cough, congestion, and low-grade fever (100.4-101°F) over the past 3 days. You have been giving his usual once daily medications (inhaled steroid and montelukast), as well as his rescue albuterol inhaler (which is reserved for worsening symptoms) every 4-6 hours. He seemed to respond well to this regimen over the first 2 days of illness. However, this morning your child woke up with a severe coughing fit. He vomited once after this coughing episode and you administered his albuterol inhaler. He did not recover as well as you wanted him after the treatment. He seemed to be working hard to breathe and couldn't finish sentences without taking a deep breath. This worried you and you called 9-1-1 for assistance.
Of note, your son has been a bit more tired than usual over the last 3 days, but he has been eating, drinking, voiding, and stooling as per usual. Upon arrival to the ED, you are concerned about your son's

appearance and increased work of breathing. Allow the team to assess your child and verbalize their thoughts to one another.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you? Or "what happened?"): "He is having a hard time breathing."

- AGE: 6 years old

- ADDITIONAL HISTORY: He has a history of asthma for which he takes an inhaled steroid twice daily and oral montelukast once daily. He uses an albuterol inhaler "when he needs it" which varies between 1-4 times per day depending on if he is ill with a cold. He wakes up almost every night due to a coughing fit and can only go back to sleep after taking his albuterol inhaler. Oftentimes, he must sit out of gym class because he cannot keep up with the other children without becoming short of breath. He was discharged from the hospital 2 weeks ago due to an asthma flare. This was his fourth hospitalization for his asthma and during this stay, he needed to take steroids by mouth and albuterol more frequently than he normally would. He didn't need to be in the PICU during this hospital stay, however, the one preceding (last year) he was in the PICU and intubated. Prior to this, he was admitted twice on the general pediatrics floor. Other than his usual daily medications, he has needed steroids by mouth 3-5 times a year for the last 3 years. His asthma is typically triggered by colds, dust, and when he is around dad smoking.

- PAST MEDICAL HISTORY:
    - Asthma
    - Obstructive sleep apnea
    - Seasonal allergies

- SOCIAL HISTORY: Lives at home with mother, father, grandmother, older sister, one cat, and one dog. Father smokes outside the home.

- FAMILY HISTORY: Mother and older sister with asthma. Father with no known medical diagnoses. Paternal grandfather with lung cancer. Maternal grandmother with high blood pressure and type 2 diabetes.

- PAST SURGICAL HISTORY: Tonsillectomy and adenoidectomy at 4 years old due to sleep apnea

- MEDICATIONS:
  - Inhaled corticosteroid twice daily
  - Montelukast once daily
  - Albuterol inhaler as needed

- ALLERGIES: No known drug allergies.

- IMMUNIZATIONS: Up-to-date although no flu shot this season

- FEEDINGS: Regular diet, no restrictions

- BIRTH HISTORY: Full term male born normal vaginal delivery. Normal pregnancy without complications. Unremarkable newborn course.

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:
- "He was doing fine the past 3 days when I gave him his inhaler, but this is much worse."
- "Someone tell me what is going on!"
- "Why is he not getting better?"

Things you might say triggered by events in the scenario: (continued)

EVENT	YOUR POTENTIAL RESPONSE
If the team does not proceed on to first-line asthma medications (albuterol and steroids)	"Do you think this could all be related to his asthma?" or "This is what happens when he has a bad asthma attack! Do something!"
If the team fails to proceed to second-line asthma medications	"Are there any other medications that will help his breathing?" or "He needs more breathing medications!"
When your child becomes unresponsive and if the team fails to recognize this change	"He just passed out! What else is going on?"
If the team fails to recognize a pneumothorax	"Why is his chest moving like that?"

Simulation Case 15

Status Epilepticus

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Updated August 25, 2020

Setup

Chief complaint: Seizure
Patient age: 3 years old
Weight: 15 kg

Brief Narrative Description of Case

This case involves a 3-year-old female with no significant past medical history, was full term at birth, and who has received all immunizations presents to the Emergency Department after having a witnessed seizure at home. She presents with altered mental status and is actively seizing. The patient is given escalating doses of benzodiazepines resulting in airway compromise requiring intubation. There is clinical concern for status epilepticus, and the team will discuss this with the patient's family and the Neurology consultants. Multiple rounds of benzodiazepines and antiepileptic drugs (AEDs) are required to stop seizure. Or alternatively hypoglycemia and EtOH intoxication will be noted and corrected resulting in seizure cessation.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Describe signs/symptoms of status epilepticus **(comprehension)**
2. Demonstrate early evaluation of a critically ill patient **(application)**
3. Construct a differential diagnosis for status epilepticus in a pediatric patient **(synthesis)**
4. Formulate a diagnostic plan for a critically ill child with seizure **(application)**
5. Construct and implement initial medical management of status epilepticus in a child **(application)**
6. Differentiate benzodiazepines including routes of administration **(analysis)**
7. Identify airway compromise in setting of multiple doses of benzodiazepines **(knowledge)**
8. Demonstrate airway management of a sick child with airway compromise secondary to altered mental status using appropriate adjuncts, BMV, and/or endotracheal intubation **(application)**

9. Demonstrate focused history taking from a caregiver **(application)**
10. Explain diagnosis and management to caregivers **(synthesis)**
11. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

- Perform primary and secondary surveys
- Place patient on monitor, establish access
- Assess airway, place patient on side, suction, and position airway consider adjuncts
- Send initial laboratory tests (fingerstick glucose, CBC, CMP, Mg, Phos, tox screen, anticonvulsant levels if indicated) and perhaps add CBG or VBG
- Obtain a brief history and physical exam (include concern for trauma, ingestion, prior seizure history)
- Identify airway compromise and perform RSI
- Consult Neurology
- Discuss patient status with the family
- Determine disposition for the patient

Recommended Supplies

- **Manikin:** Toddler sized
- **Moulage:** None
- **Manikin set up:** IV with drain bag, massage pad to simulation seizure activity, if needed
- **Equipment:** Intubation supplies, IV supplies, IO, bag valve mask
- **Medications:**
  - Benzodiazepines (depending on local practices): Diazepam, midazolam (buccal, IM, or intranasal), lorazepam
  - Antiepileptic drugs (depending on local practices): Levetiracetam, phenytoin, fosphenytoin, valproic acid, phenobarbital

Supporting Files

- Laboratory results (Complete metabolic panel, CBC, Mg, Phos, tox screen, fingerstick glucose, EtOH level)

- Chest x-ray
- CT head

Participants/Roles

- Team leader
- Airway manager
- Survey physician
- Nurse(s) for medication preparation and administration
- Team member physician
- Team member proceduralist
- Standardized patient (actor or faculty) to play patient's parent

If there are not enough learners to perform the above roles, faculty members or other embedded participants can play a nurse, respiratory therapist, or tech.

** Team roles may need to be adjusted in order to suit local practices and norms*

Prerequisite Knowledge

- **Faculty**
  - PALS protocols
  - General knowledge of emergency medicine
  - Simulation implementation and debriefing experience

- **Emergency medicine residents**
  - Any stage of training (preferably PGY-2 or greater)
  - Completed PALS certification

Case Alternatives

- If greater than 2 rounds of benzodiazepines are given or an incorrect elevated dose of benzodiazepine given, the patient may become apneic.

- If there is a failure to recognize and manage respiratory distress or arrest, the patient could have PEA arrest requiring 2 rounds of CPR and epinephrine before ROSC.

- Learners may be told that IV access is not established during placement attempts in the first 5 minutes necessitating alternative routes for benzodiazepines (buccal, intranasal, rectal).

- For advanced learners, the patient may have refractory status requiring second and third line anti-epileptic drugs administered before cessation of seizure.

- A family member can be difficult or intoxicated requiring additional allocation of resources to family or more high-level communication skills by participants.

- A consulting service may not be available to discuss next steps due to availability or setting of scenario.

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC4. Diagnosis
PC5. Pharmacotherapy
PC7. Disposition
PC10. Airway Management
ICS1. Patient Centered Communication
ICS2. Team Management

Resources

1. Friedman JN. Emergency management of the pediatric patient with generalized convulsive status epilepticus. February 28, 2018. Canadian Pediatric Society.
2. Adams JG. 2013. Emergency Medicine: Clinical Essentials. 2nd edition. Elsevier Saunders Philadelphia. Section IX: Chapter 99.
3. Seattle Children's seizure clinical standard work pathway [PDF], 2019.

Initial Presentation

ITEM	FINDING
Overall Appearance	3-year-old female unresponsive, some secretions from mouth. Shallow respirations, pink color to skin, actively seizing.
HPI	**Volunteered information (by EMS):** We have a 3-year-old female with a witnessed seizure at home. The estimated start of seizure was 11 minutes ago. No medications were given, since we are a basic unit. The family is on the way. The patient has no past medical history, other than 1 episode of an afebrile seizure in the past. She is not on any medications. She has received all immunizations and had an uncomplicated birth delivery. The patient is shaking in all extremities symmetrically. The parent arrives 2 minutes after the EMS leave. **If learners ask for specifics:** No fever. The patient was acting normally earlier in the day. The parents had family from out of town visiting. No trauma. The child was noticed to be first drowsy and clumsy, and subsequently was shaking and drooling. The shaking started 10 minutes ago. The EMS providers were unable to place IV, and no medications given prior to ED arrival. Additional Information should be provided only if learners specifically ask about alcohol or risk of ingestion. A family member from out of town was drinking an alcoholic drink in a water bottle that was left on the counter that the child drank inadvertently.
Past Medical/Surgical History	Afebrile seizure in past
Medications	None

Initial Presentation (continued)

ITEM	FINDING
Allergies	No known drug allergies
Family History	Grandmother with alcohol use disorder
Social History	Lives at home, only child, mother stays at home with child. No daycare. Currently was having a family party

Stage 1

Begin Simulation (Stage 1 of 4)

Initial Assessment and Stabilization:
Start through third dose of benzodiazepine OR administration of additional AED after benzodiazepine

CRITICAL ACTIONS

- Assign team roles
- Obtain history from parent (include concern for trauma, ingestion, prior seizure history)
- Perform primary assessment of airway, breathing, circulation and disability
- Place patient on side and suction
- Position airway and consider adjuncts
- Place patient on continuous cardiac monitor
- Establish access
- Brief history and physical exam
- Send initial laboratory tests (fingerstick glucose, CBC, CMP, Mg, Phos, tox screen)
- Administer glucose for hypoglycemia
- Administer 2 rounds of benzodiazepines for seizure

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 98.1°F, **HR:** 115, **BP:** 92/64, **RR:** 24, **SpO_2:** 94%
General	Unresponsive to verbal stimuli, actively seizing

Physical Exam (continued)

ITEM	FINDING
HEENT	Normocephalic, atraumatic. Secretions at airway, gag reflex intact with use of suction, pupils round and reactive bilaterally
Neck	Normal
Lungs	Shallow breaths, no wheeze, no rales
Cardiovascular	Regular rate and rhythm, no murmurs, pulses palpable, capillary refill normal
Abdomen	Soft
Neurological	Unresponsive to verbal stimuli, incomprehensible sounds
Skin	Pink, no bruising, no rashes

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Patient turned on side and suction/airway maneuvers performed	Pulse ox improves to 96%	Patient bites down on suction catheter.
IV attempted but not successful until second attempt	Patient condition does not change	If still no IV access in 5 minutes, team should provide intranasal, oral, or rectal benzodiazepine.

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Participants request a fingerstick blood glucose.	Glucose level is 25 mg/dL. Seizing stops if dextrose given.	Glucose level will normalize if patient is given IV dextrose bolus. 50-100 rule for glucose: • 2-4 mL/kg of D50 • 5-10 mL/kg of D10 • 10-20 mL/kg of D5
Participant asks for repeat glucose after administration of dextrose	Glucose level is 95 mg/dL. No active seizure.	
At 5 minutes into case or when IV is placed	Active seizure activity resumes. (if new glucose check is done, glucose is now 92 mg/dL)	
Second dose of benzodiazepine is administered	Seizure continues	
Third dose of benzodiazepine or another AED is administered	SpO_2 decreases to 82%, and the patient becomes apneic. The seizure continues.	Proceed to **stage 2**.
Participants request a head CT		Participants are told that the scanner will be available in 15 minutes or that the patient is too unstable for transport.

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Labs such as VBG, CMP, CBC, Tox Screen ordered	VBG/Point of care labs are available: • Glucose 95 mg/dL if dextrose was given • pH 7.15 • pCO_2 35 mmHg • Lactate 5.1 mmol/L • Potassium 3.8 mEq/L	Participants told they have been sent to the lab and will result in 20 minutes if asked.
Bedside FAST ultrasound performed		Participants are told it is normal

Stage 2

Airway Compromise:
After 5 minutes in case OR 2nd dose of benzodiazepine + AED
(or 3rd dose of benzodiazepine) through intubation

CRITICAL ACTIONS

- Selection of RSI medications
- Bag mask ventilation
- Rapid sequence intubation

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 98.1°F, **HR:** 120, **BP:** 84/64, **RR:** 8, **SpO_2:** 82%
Exam Changes	Perioral cyanosis; apneic; pupils equal, round, and normal to large in size

Instructor Notes: Changes and Case Branch Points
In this stage, the patient fails to improve with first-line medications.

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
1 minute into stage or after third dose of benzodiazepine with no active bagging	SpO_2 decreases to 75%, and the patient becomes apneic.	Activate cyanosis on manikin

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Administer levetiracetam or phenytoin as first-line AED	No change. Heart rate increases to 115.	EEG tech or results indicate persistent seizure (if available) or leader/team member should mention that a seizure can still be ongoing and will need ICU transfer and neurology ASAP
RSI performed	SpO_2 increases to 98%. Proceed to **Stage 3**.	Cyanosis resolves
Intubation attempted without paralysis	The patient gags and vomits. SpO_2 decreases further to 60%.	If the patient subsequently is intubated, the SpO_2 will not rise beyond 92% despite ETT placement. Respiratory will note increased secretions through the ETT.
Neurology Consult arrives or is available by phone or telehealth video after intubation.	Patient's HR 115	If learners require support with AED selection, a facilitator may act as the neurology consult to assist with medication selection.

Stage 3

Refractory Seizure:
After intubation through administration of second AED

CRITICAL ACTIONS

- Identify appropriate antiepileptic medications and indications for second-line medications
- Discuss patient status with the family
- Consult neurology

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 98.1°F, **HR:** 99, **BP:** 88/64, **RR:** 20, **SpO_2:** 100%
Exam Changes	EEG monitor (if available) with seizure activity • Depending on the paralytics used (rocuronium vs. succinylcholine), active shaking may be visualized.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Participants request head CT	No change	Nurse states, "I don't think the patient is stable enough for transport."
Administer a second AED (phenytoin, valproate, levetiracetam)	Seizure cessation. Proceed to **Stage 4**.	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Recheck glucose	Glucose 98 mg/dL	EEG indicates seizure activity has stopped.
Family member arrives with new information and admits that the patient may have mistakenly drank vodka from a water bottle.	No change	Prompt team to order additional toxicology lab work if not already ordered.
Reassess 5 minutes after medication given and administer additional AED	Seizure cessation	

Stage 4

Case Conclusion:
After administration of 2 AEDs through discussion with family

CRITICAL ACTIONS

- Determine disposition of patient
- Discuss patient status with the family

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 98.1°F, **HR:** 99, **BP:** 88/64, **RR:** 20, **SpO_2:** 100%
Exam Changes	The patient is intubated and breathing at the bagged rate; pupils round and reactive, but now pinpoint due to intubation medications.

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Participants request head CT	No change	Images provided

Ideal Scenario Flow

The learners enter the room to find a 3-year-old patient being transferred to a stretcher by EMS actively seizing. The seizure activity involves all 4 extremities and movements appear symmetric. The team immediately places the patient on bedside monitors and recognizes that the patient is actively seizing, concerning for status epilepticus. Supplemental oxygen is provided as well as proper positioning and suction of the airway. Fingerstick glucose and IV access is obtained. The patient is noted to be hypoglycemic and given an IV dextrose bolus, resulting in seizure cessation. After completing a physical examination and obtaining an appropriate history including a prior history of an afebrile seizure as well as possible alcohol ingestion. The provider notes that the patient is seizing again, but a rechecked glucose is normal. The initial dose of IV benzodiazepine is given without cessation of the seizure, requiring the team to give a second dose of benzodiazepine. The team recognizes a lower SpO_2 with subsequent benzodiazepine doses and prepares to perform RSI on the patient. After successful intubation, the team consults with Neurology specialists to initiate EEG monitoring (if available) given that the patient is paralyzed and to discuss sequential AED medications. Further history is obtained and there is a concern for alcohol intoxication, resulting in a hypoglycemic-induced seizure. The patient is started on a dextrose infusion and admitted to PICU for further monitoring and care.

Anticipated Management Mistakes

1. **Lack of complete history and exam:** In an acute presentation of a seizure, the history can be overlooked resulting in missing the potential for alcohol intoxication as a cause. Similarly, the examination is also extremely important to rule out traumatic etiology. Embedded participants and prompting can be used to avoid this error. If asked, there are no signs of external trauma, no bruising, no hematoma, normal TMs, and no battle sign.

2. **Failure to recognize the need for airway management:** Some learners may not immediately recognize that the patient requires airway management, leading to a delay in diagnosis and potential apneic arrest. Facilitators can discuss the fact that many patients will become apneic with benzodiazepines. Although some can

be bagged throughout, if it is prolonged, a risk of aspiration, or intractable seizures, the patient will need intubation.

3. **Lack of seizure treatment if no IV access:** Learners may not be aware of alternate ways to provide benzodiazepine medications to patients who are actively seizing.

Debriefing Points

Describe signs/symptoms of status epilepticus (comprehension)

- Status epilepticus in pediatric patients can present in a variety of ways, such as myoclonic, tonic, tonic-clonic, absence, and complex partial.
- Generalized tonic-clonic seizures are the most common form of status epilepticus.
- The minimum time criterion used to be 30 minutes but is now 5 minutes. This can include continued seizure activity or recurrent seizures without return to baseline.

Demonstrate early evaluation of a child in status epilepticus (application)

- Learners should identify that the child is in status epilepticus, defined as >5 minutes of active seizure. A usual assumption is that when a child arrives seizing from home, they have been seizing for over 5 minutes.
- Approach a seizing child in a standardized fashion. Airway, breathing, and circulation should be assessed immediately followed by disability (neurological assessment and dextrose level).
- The initial medical management of status epilepticus in a child should always include ABCD then should be systematic. If the glucose level is low, it should be remedied. Otherwise the step-wise approach should be benzodiazepine, benzodiazepine, levatiracetam OR phenytoin OR phenobarbital bolus (based on age of patient), and then other agents can also be used but not without further consultation with a pediatric neurologist (e.g., can include propofol infusion, midazolam infusion…)
- It is important to note that medical teams must be ready for airway management in a seizing child especially after administration of multiple doses of benzodiazepines.

Construct a differential diagnosis for status epilepticus in a pediatric patient and formulate a diagnostic plan for a critically ill child with a seizure (synthesis)

- The differential should include new onset epilepsy, atypical

febrile seizure, intracranial mass, intracranial bleed, intoxication, and infection (meningitis, encephalitis).
- Lab testing includes glucose, basic metabolic panel, complete blood count, calcium, magnesium, and antiepileptic medication levels (if applicable).
- Neuroimaging, lumbar puncture, additional lab work (inborn errors of metabolism screening, liver function tests, coagulation studies, toxicology screen), and continuous EEG monitoring should be considered especially if seizures lasting beyond 15 minutes.
- EEG should also be considered as patients often can have subclinical seizures following status epilepticus or if the patient is paralyzed/sedated for intubation.

Construct and implement initial medical management of status epilepticus in a child (application)

- Escalating doses of benzodiazepines early is critical in managing status epilepticus
- Delay in administering benzodiazepines may result in prolonged and self-sustaining seizures that become pharmaco-resistant
- Benzodiazepines: First-line medication
    - **Lorazepam:** 0.1 mg/kg IV, can repeat at 5 minutes (max dose 4 mg)
    - **Diazepam:** 0.15 mg/kg IV
        - Rectal administration:
            - Age 2-5 years: 0.5 mg/kg
            - Age 6-11 years: 0.3 mg/kg
            - Age >11 years: 0.2 mg/kg
    - **Midazolam**
        - Intramuscular : 0.05-0.1 mg/kg (max 10 mg)
        - Intranasal: 0.2-0.4 mg/kg
        - Buccal: 0.5 mg/kg
- **Phenytoin/Fosphenytoin:** Stabilizes sodium channels to limit repetitive firing
    - Phenytoin 20 mg/kg IV followed by additional 5 mg/kg if needed
    - Fosphenytoin dosed in phenytoin equivalents and can be given IM if necessary
- **Phenobarbital:** Long acting barbiturate
    - 20 mg/kg IV followed by additional 5 mg/kg if needed
- **Valproic acid:** Broad spectrum anticonvulsant 20-40 mg/kg IV

- **Levetiracetam:** Broad spectrum anticonvulsant 20-60 mg/kg IV
- **Topiramate:** Broad spectrum anticonvulsant 5-10 mg/kg IV
- Refractory status epilepticus: Consider **ketamine and propofol** as additional medications

Differentiate benzodiazepines including routes of administration (analysis)

IV administration of benzodiazepines is ideal. However, if no access is available, consider alternative routes early to avoid delay in medication administration. Consider diazepam or midazolam.

Identify airway compromise in setting of multiple doses of benzodiazepines (knowledge)

Hypoxia is a common etiology for pediatric cardiac arrest. Hypoxia can be a late sign of impending decompensation.

Demonstrate airway management of a sick child with airway compromise secondary to altered mental status using appropriate adjuncts, BMV, and/or endotracheal intubation (application)

- **RSI medications**
    - Consider lidocaine 1 mg/kg IV (max dose 100 mg) as a premedication to decrease ICP in actively seizing patient or fentanyl
    - Induction: Benzodiazepine preferable in status epilepticus
    - Paralytic: Rocuronium 1 mg/kg IV

- **Airway pearls for pediatric patients**
    - Know your equipment
    - In general, pediatric patients have a larger head and tongue and have a more anterior airway. Consider placing a roll under shoulders
    - Cuffed vs uncuffed ET tube: Above age 1 year, a cuffed tube is acceptable.
        - Age/4 + 4 = tube size for uncuffed tube
        - Age/4 + 3.5 = tube size for cuffed tube

Demonstrate focused history taking from a caregiver (application)

- Components of history taking: Past medical history, surgical

history, family history, medications, allergies, social history, vaccination history
- Specifically for patients presenting with a seizure, recent illnesses, fever, and prior seizure history are all very important questions.

Explain diagnosis and management to caregivers (synthesis)

Use a teach-back approach.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- “Airway status?”; Surveying provider- “Airway clear”; Leader- “Breath sounds?”; Surveying provider- “Breath sounds decreased on right”)

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The

sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

Supporting Files

Laboratory Results
Fingerstick Glucose

LABORATORY TEST	VALUE	UNITS
Glucose	25	mg/dL

Supporting Files

Laboratory Results

Fingerstick Glucose, Repeated After Dextrose

LABORATORY TEST	VALUE	UNITS
Glucose	95	mg/dL

Supporting Files

Laboratory Results

Venous Blood Gas

LABORATORY TEST	VALUE	UNITS
pH	7.14	
pCO_2	35	mmHg
Lactate	2.1	mmol/L
Potassium	3.8	mEq/L
Glucose	35	mg/dL

Supporting Files

Laboratory Results

Complete Blood Count

LABORATORY TEST	VALUE	UNITS
WBC	8.0×10^3	$/mm^3$
Hemoglobin	13.9	g/dL
Hematocrit	38.0	%
Platelets	280×10^3	$/mm^3$

Supporting Files

Laboratory Results

Basic Metabolic Panel and Lactate

LABORATORY TEST	VALUE	UNITS
Sodium	141	mEq/L
Potassium	3.8	mEq/L
Chloride	103	mEq/L
Bicarbonate	22	mEq/L
BUN	18	mg/dL
Creatinine	0.3	mg/dL
Glucose	34	mg/dL

Supporting Files

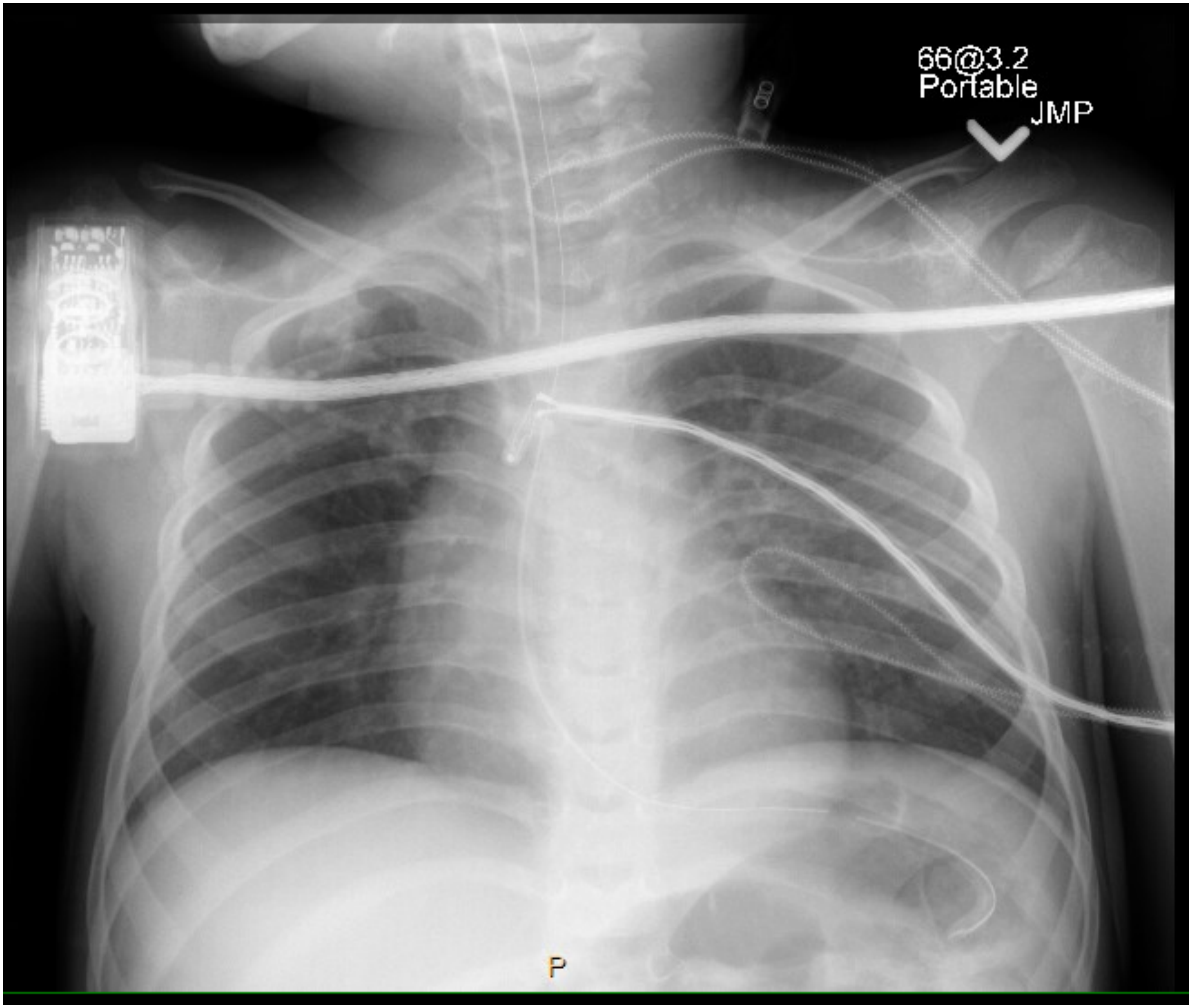
Laboratory Results

Other Labs

LABORATORY TEST	VALUE	UNITS
Ethanol alcohol level	29	mg/dL
Acetaminophen level	Undetectable	mcg/mL
Salicylate level	Undetectable	mg/dL

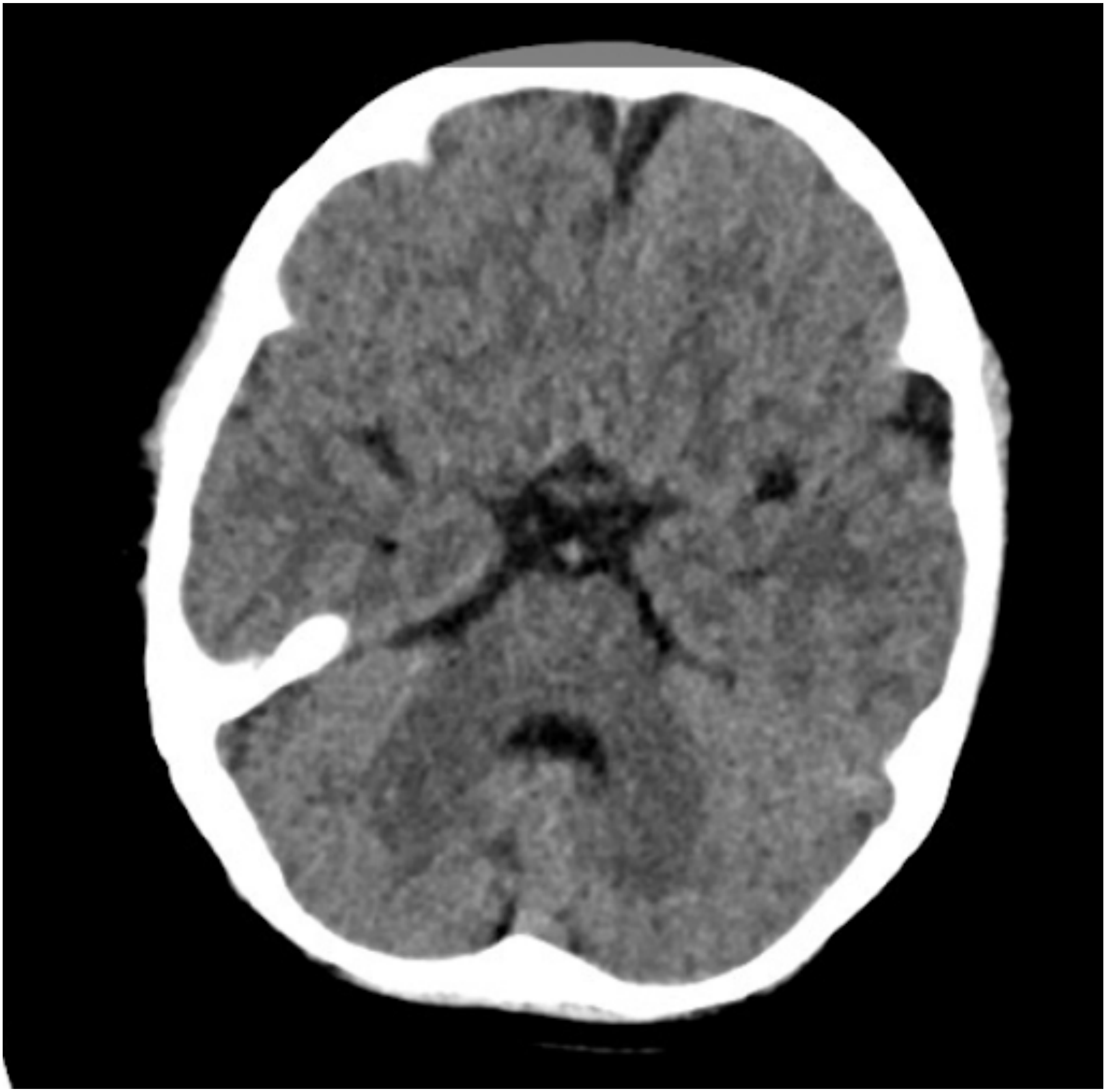
Supporting Files

Chest X-ray



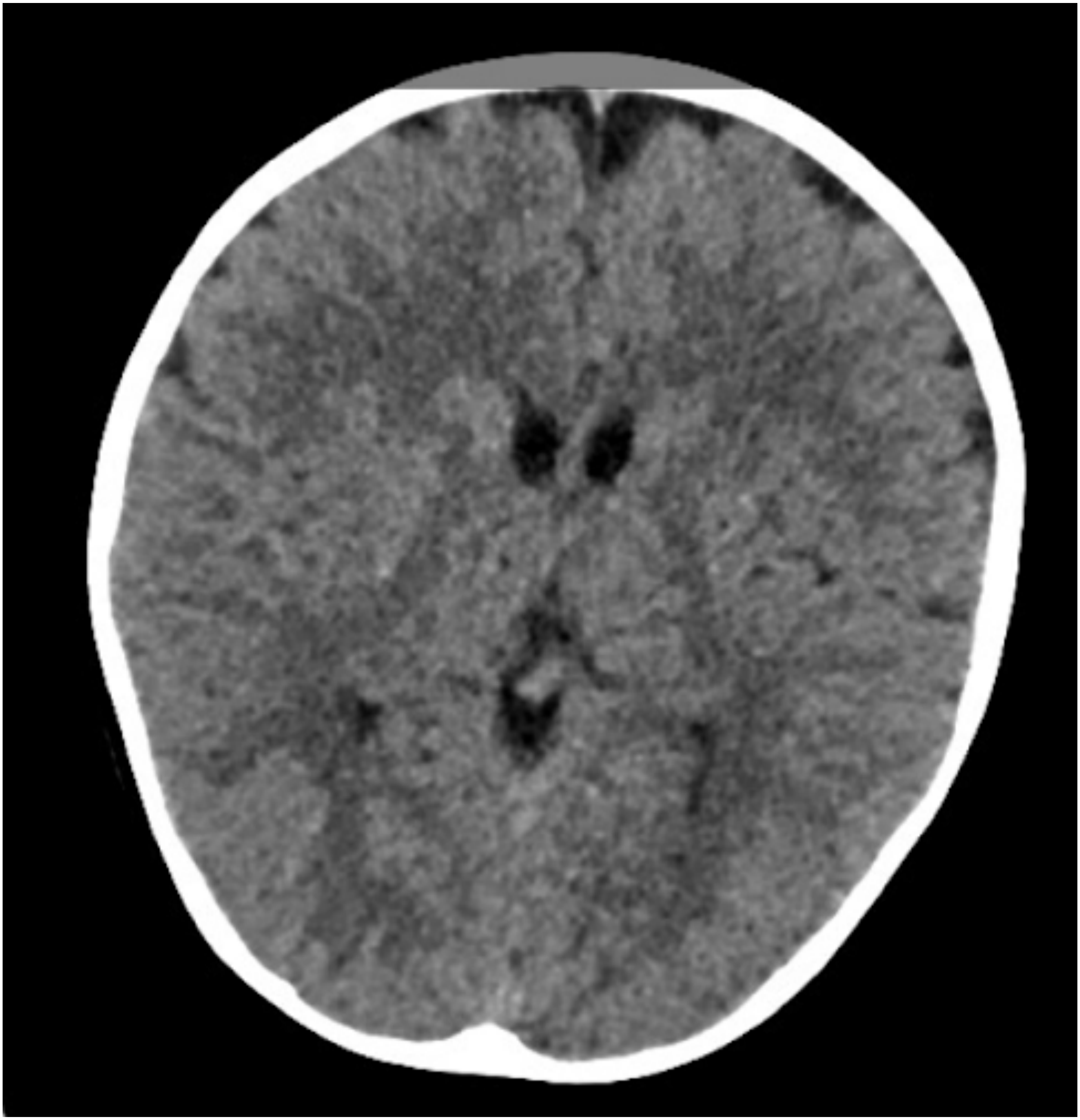
Supporting Files

Head CT 1



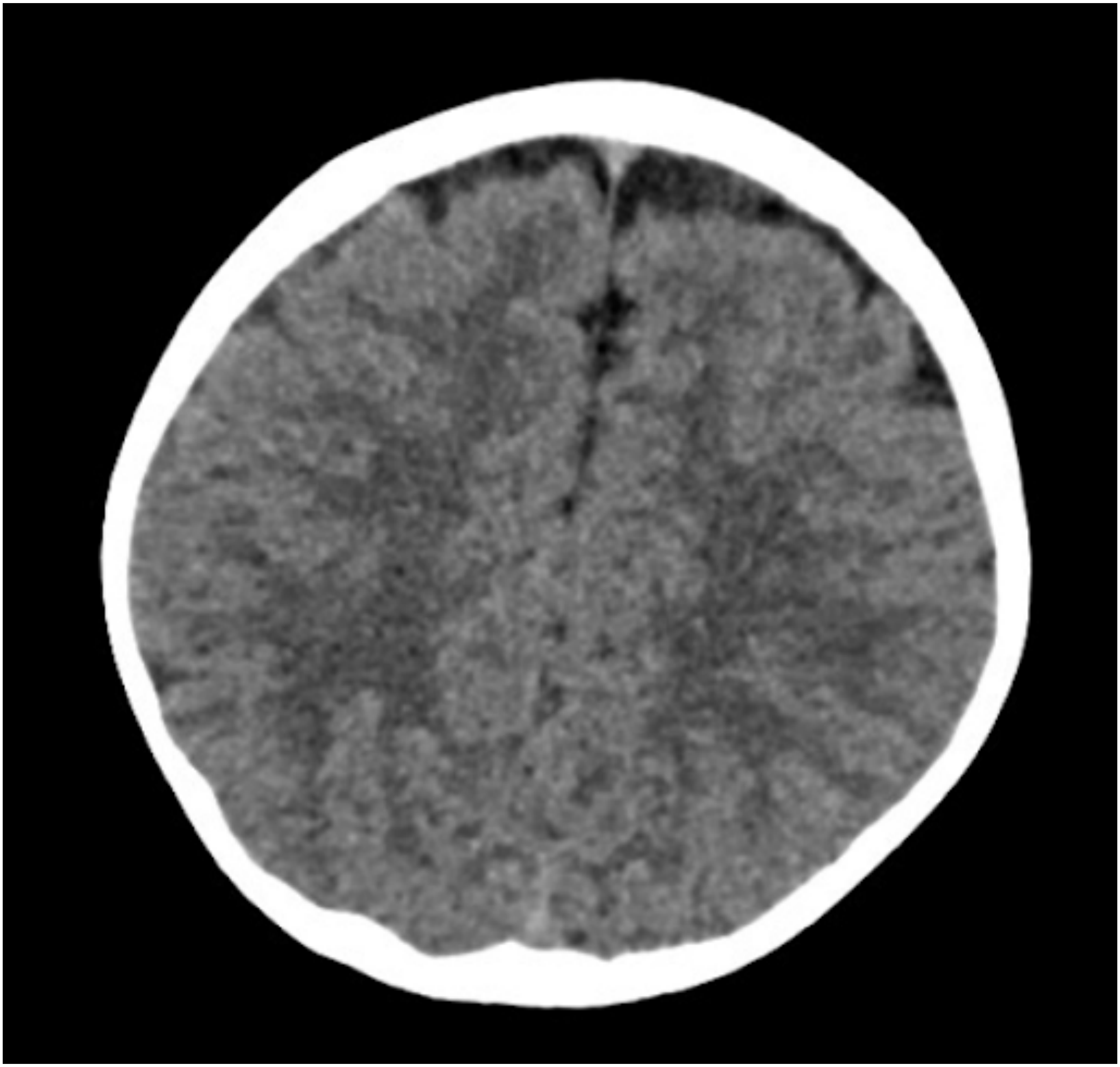
Supporting Files

Head CT 2



Supporting Files

Head CT 3



Supporting Files

Notes

Chest X-ray Interpretation
The post-intubation CXR. Image from Dr. Rebekah Burns.

Head CT Interpretation
Normal. Images from Dr. Rebekah Burns.

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participants playing the patient's parent

Case Background Information

Your daughter was recently diagnosed with a first episode afebrile seizure. The neurologist had said that they will wait for a second seizure before starting on medications. Today she was well with no viral symptoms, no fever, and slept well last night. You noted drowsiness midday, which is not her typical. You have guests over all day today for a family reunion and everything seemed ok. She was running around with a non-labelled water bottle which you assumed was water, but it actually was vodka. She started seizing at home and you were told to keep her in a safe place where she could not hurt herself and roll her to her side which you did. She was seizing with all 4 limbs exhibiting stiff, jerking movement. Her eyes rolled back and there were some secretions in the mouth. You did not notice her bite her tongue, nor any fecal or urinary incontinence. The seizure lasted longer than 5 minutes, so you called 911 and an ambulance brought her to the hospital (arrival to your home until the hospital was 6 minutes). So seizure has been ongoing for 11 minutes.

Who are the Learners?

Emergency medicine residents (various stages of training at first, second, third, and possibly fourth years)

First year residents can gather a history and perform physical examinations on patients. However, their medical knowledge and familiarity with pediatric medical treatments and procedures likely is limited. These skills become more refined and developed with each year of training. For the purposes of this simulation, assume learners are in their first or second year of residency training.

Standardized Patient Information

See Case Background Information.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you? Or "what happened?"): "She was fine and then she lost consciousness and started to seize!"
- AGE: 3 years old
- ADDITIONAL HISTORY: Previously well child. Had her first episode of a seizure about a month ago with no fever.
- PAST MEDICAL HISTORY: Asthma, obstructive sleep apnea, seasonal allergies
- SOCIAL HISTORY: Lives at home with mother, father, and older brother. Has family visiting for a few days and everyone was enjoying their time. Grandmother has a drinking problem which is well known and so you keep almost no alcohol at home because you want to make sure she is safe around your children. However, she sometimes will do anything to get her drink.
- FAMILY HISTORY: No family history of epilepsy
- PAST SURGICAL HISTORY: None
- MEDICATIONS: None
- ALLERGIES: No known drug allergies.
- IMMUNIZATIONS: Up-to-date
- FEEDINGS: Regular diet, no restrictions
- BIRTH HISTORY: Full term girl born by spontaneous vaginal delivery. Normal pregnancy without complications. Unremarkable newborn course.

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:

- "Oh my gosh, is she going to be ok, I can't believe this is happening. What's wrong with her? Is she going to be ok?"
- "She seemed fine. She hasn't been sick at all, no fevers, or anything."
- "Why isn't she stopping to seize?"
- "She slept well last night but seemed drowsy this afternoon, more than usual."

Participants will have to calm the SP parent while also designating a team member to answer additional questions.

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
When participants inquire more about the drowsiness	"I don't know. She just seemed less coordinated. You know, we do have family in from out of town and I saw her drinking out of my mom's water bottle. I assumed it was water but do you think it could be something else? She has a drinking problem, oh my gosh, I can't believe this is happening." "I don't have any medications at home, we are all fine- there is no way she could have taken something… oh wait- my mom!" "My mom has a drinking problem… my daughter was drinking from her water bottle… could she have had alcohol in there! Oh my!!!"

Simulation Case 16

Supraventricular Tachycardia

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Setup

Chief complaint: Poor feeding
Patient age: 6 month old
Weight: 7 kg

Brief Narrative Description of Case

A 6-month-old girl is brought in by parents for poor feeding. She is in compensated supraventricular tachycardia (SVT) on initial exam. Learners will initiate initial assessment by obtaining history and performing physical. SVT will be identified on cardiac monitoring and/or ECG. SVT will be unresponsive to vagal maneuvers and adenosine. 10 minutes into the case, the patient will decompensate and require bag mask ventilation (BMV) and electrical cardioversion, which will succeed in converting the patient into sinus rhythm. Learners will then identify a disposition plan for the patient.

Primary Learning Objectives

At the end of this simulation, participants should be able to:

1. Demonstrate early evaluation of a critically ill patient **(application)**
2. Describe signs/symptoms of SVT in an infant **(comprehension)**
3. Differentiate compensated from decompensated shock in an infant **(analysis)**
4. Demonstrate physiologic (vagal), pharmacologic, and electrical cardioversion for SVT **(application)**
5. Demonstrate BMV in an infant **(application)**
6. Demonstrate focused history taking from a caregiver **(application)**
7. Explain diagnosis and management to caregivers **(synthesis)**
8. Demonstrate teamwork and closed loop communication **(application)**

CRITICAL ACTIONS

- Assign/assume team roles
- Obtain history from parent

CRITICAL ACTIONS (continued)

- Perform primary assessment
- Administer supplemental oxygen
- Place patient on continuous cardiac monitor
- Obtain vascular access
- Perform focused physical exam
- Verbalize recognition of SVT from ECG and/or monitor
- Perform vagal maneuver (ice pack to face, rectal stimulation via thermometer insertion, knees to chest)
- Administer adenosine in appropriate dose(s) (0.1-0.2mg/kg IV) with rapid flush
- Apply defibrillator pads to patient
- Support oxygenation and ventilation by bag-mask ventilation (BVM)
- Perform synchronized electrical cardioversion
- Explain diagnosis to parent and how it relates to the patient presentation

Recommended Supplies

- **Manikin:** Infant (e.g., Laerdal SimBaby or Gaumard Newborn PEDI)
- **Moulage:** None
- **Resources:** Pediatric Advanced Life Support (PALS) cards and/or weight-based tape (e.g., Broselow Tape)
- **Manikin set up:** Intravenous (IV) line x 1 in place with drainage bag
- **Equipment:**
    - Defibrillator with snaps for simulator or pediatric defibrillator pads
    - Pediatric airway equipment of various sizes/airway cart
        - Simple facemask
        - Non-rebreather mask
        - Nasal cannula
        - Oxygen tubing
        - Bag valve mask (self-inflating bag with infant mask)
        - Suction
        - Optional: Intubation supplies (laryngoscope, end tidal CO_2, endotracheal (ET) tube, laryngeal mask airway

(LMA) or Intersurgical i-gel®, stylet, tape)
    - 3-way stop cock
    - Syringes
    - Ice pack
- **Medications:** Adenosine, midazolam or lorazepam, fentanyl or morphine, epinephrine, normal saline bag, normal saline flush, optional intubation medications (rocuronium, succinylcholine, atropine, ketamine, propofol, etomidate)

Supporting Files

- Initial ECG (supraventricular tachycardia)
- Post-cardioversion ECG (sinus rhythm)
- Chest x-ray post conversion (normal)
- Chest x-ray after intubation (optional Stage 3)
- Point-of-care labs

Participants/Roles

- Participants/learners:
    - Team leader
    - Airway manager
    - Survey physician
    - Medication preparer
    - Medication giver
    - Family liaison/history taker

- Other:
    - Faculty or other embedded participants can play a nurse, respiratory therapist, or tech, if there are not enough learners to perform the above roles
    - Standardized patient (actor or faculty) to play patient's parent

** Team roles may need to be adjusted in order to suit local practices and norms*

Prerequisite Knowledge

- **Faculty**
    - PALS protocols

- General knowledge of emergency medicine
- Simulation implementation and debriefing experience

- **Emergency medicine residents**
  - Any stage of training (preferably PGY-1 or PGY-2)
  - Completed PALS certification

Case Alternatives

- Have learners apply defibrillator pads, charge, and deliver shock even if these roles are usually performed by a different team member.
- If residents attempt intubation during the case, the patient loses pulses and the team must administer CPR for 2 minutes and one dose of IV epinephrine before rhythm returns to unstable SVT.
- If an unsynchronized shock is delivered while the patient is in SVT, the rhythm converts to ventricular fibrillation (VF). Chest compressions must be started and the patient converts to sinus tachycardia after defibrillation with 2 J/kg.

Milestones
PC1. Emergency Stabilization
PC2. Performance of Focused History & Physical Exam
PC3. Diagnostic Studies
PC5. Pharmacotherapy
PC9. General Approach to Procedures
PC10. Airway Management
PC14. Vascular Access
ICS1. Patient Centered Communication
ICS2. Team Management

Resources
1. de Caen AR, Berg MD, Chameides L, et al. Part 12: Pediatric Advanced Life Support: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2015;132(18 Suppl 2):S526-42. PMID: 26473000
2. Chang PM, Silka MJ, Moromisato DY, Bar-Cohen Y. Amiodarone versus procainamide for the acute treatment of recurrent supraventricular tachycardia in pediatric patients. Circ Arrhythm Electrophysiol. 2010;3:134-40. PMID: 20194798

Initial Presentation

ITEM	FINDING
Overall Appearance	6-month-old female alert, but crying and fussy
HPI	Patient arrives by private vehicle accompanied by a parent. “She does not want to take her formula for the past 8 hours” **If the learners ask for specifics:** She seems hungry, but then stops drinking her formula after she has had about one ounce. Before today, she took about 4-6 ounces every 3 hours. The patient is bottle-fed and has been on Enfamil formula since birth. ROS: Fatigue, fussiness, and sweating with attempted feeding. No fevers, cough, emesis, diarrhea or rashes.
Past Medical/Surgical History	• Born at 37-weeks gestation. Unremarkable gestation and delivery. • Prior history of admission for bronchiolitis at 2 months of age.
Medications	None
Allergies	No known drug allergies
Family History	Unremarkable
Social History	No pets. No smokers. Attends daycare.

Stage 1

Begin Simulation (Stage 1 of 4)

Compensated SVT:
Start through second dose of adenosine OR 10 minutes into case

CRITICAL ACTIONS

- **Team leader assigns tasks**
- **Obtain history from parent**
- **Perform primary survey**
- **Administer supplemental oxygen**
- **Place patient on continuous cardiac monitor**
- **Obtain vascular access**
- **Perform focused physical exam**
- **Verbalize recognition of SVT from ECG and/or monitor**
- **Verbalize stable vs unstable SVT appropriately**
- Perform vagal maneuver (ice pack to face, rectal stimulation by thermometer insertion, knees to chest)
- Administer normal saline bolus at 5-10 mL/kg
- **Discuss progress and plan of care with the parent (and involve them in decision-making)**
- **Administer adenosine (0.1-0.2 mg/kg IV, rapid push with immediate flush for first dose; 0.2 mg/kg for subsequent doses)**
- **Apply defibrillator pads to patient (should be in place prior to performing vagal maneuvers or administering adenosine)**

** Unbolded items may be excluded depending on local practices and norms.*

Physical Exam

ITEM	FINDING
Vital Signs	**T:** 37.5°C, **HR:** 280, **BP:** 100/70, **RR:** 50, **SpO_2:** 96%, **Wt:** 7 kg
General	Alert, crying, tachypneic
HEENT	Normal
Neck	Normal
Lungs	Clear to auscultation bilaterally
Cardiovascular	Tachycardic, no abnormal heart sounds, strong pulses, capillary refill 4 seconds
Abdomen	Normal, liver edge palpated just below costal margin
Neurological	Fussy but alert; moves all extremities
Skin	Diaphoretic, mottled
Other Relevant System	No edema

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Team attempts IV line		Faculty/nurse verbalizes that the attempt is successful.
Supplemental oxygen provided	SpO_2 = 100%	
Treatment initiated without discussing with the parent		Parent asks, "Why does this have to be done?" Parent will be satisfied with a direct/accurate explanation.

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Vagal maneuver attempted such as ice pack administered to patient's face (without obscuring the mouth or nose), performing rectal stimulation via thermometer insertion, or placing knees to chest	No change in cardiac rhythm	Patient tolerates procedure
Adenosine administered (each dose)	No change in cardiac rhythm or (optional) very transient change in heart rate that returns to 280. Brief flat line after administration with resumption of SVT.	Prior to administration, faculty/nurse will ask for clarification on how the medication should be given
Gradually over the first 10 minutes of the case OR after second dose of adenosine (0.2 mg/kg)	Proceed to **Stage 2**.	

Stage 2

Decompensated SVT:
10 minutes from the start of the case (or after second dose of adenosine) through cardioversion at 1 J/kg

CRITICAL ACTIONS

- Verbalize decompensated state
- Support airway by BMV
- Perform synchronized electrical cardioversion

Physical Exam

ITEM	FINDING
Vital Signs	**HR:** 280, **BP:** 60/38, **RR:** 4, **SpO_2:** 80%
Exam Changes	• The patient becomes unresponsive. Notably, she stops crying. • Central pulses 1+ • Shallow, infrequent respirations • Capillary refill 5 seconds

Instructor Notes: Changes and Case Branch Points
In this stage, the patient fails to improve with first-line medications.

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Learners do not recognize decompensated state or change in mental status		Nurse or parent says, "What happened? She's not responding?"

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Learners do not recognize poor inspiratory effort		Nurse says, “Her respirations are really shallow and it seems her respiratory rate has decreased.”
BMV started with appropriate seal and rate	SpO_2 = 96% but patient over-breathing bagging	
Learners attempt to intubate rather than cardiovert	If they proceed with intubation, the patient rapidly develops bradycardia to 50. This then progresses to PEA, requiring CPR and 1 dose of IV epinephrine (0.01mg/kg) before ROSC.	Nurse states, “I am worried the patient will further decompensate if we don’t cardiovert her as quickly as possible.”
10-20 mL/kg isotonic bolus given	Capillary refill improves to 4 seconds. Crackles develop at the lung bases. No changes in SpO_2.	
30-40 mL/kg isotonic fluid given	Capillary refill improves to 4 seconds. Crackles develop at the lung bases. SpO_2 decreases to 92% with supplemental oxygen.	
50-60 mL/kg of isotonic fluid given	SpO_2 decreases to 85%, diffuse crackles, liver palpated at 2 cm below costal margin.	
Synchronized cardioversion at 0.5 J/kg	No change in cardiac rhythm	

Instructor Notes (continued)

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
Synchronized cardioversion at 1 J/kg	Conversion to sinus rhythm. Proceed to **Stage 4**. If learners are PGY-3 or PGY-4, the rhythm is sinus rhythm for a few seconds and then converts back to SVT (no matter how many cardioversion attempts are done). If there are more than 3 cardioversion attempts at (1 J/kg), the rhythm changes to VF and the patient loses pulses.	If learners are PGY-3 or PGY-4 go to optional **Stage 3**. Learners must start chest compressions at a ratio of 15:2 and defibrillate with 2 J/kg before return to sinus tachycardia for a few seconds and then back to SVT.
Pain medication and/or sedative provided before cardioversion	No change in case	
Delivery of unsynchronized shock	Rhythm changes to VF, and the patient loses pulses.	Learners must start chest compressions at a ratio of 15:2 and defibrillate with 2 J/kg before return to sinus tachycardia, then go to **Stage 4**. If learners are PGY-3 or PGY-4, the rhythm reverts to SVT. Go to optional **Stage 3**.

Stage 3 – Optional

Refractory SVT:
After cardioversion at 1 J/kg through administration of amiodarone or procainamide

CRITICAL ACTIONS

- Verbalize cardioversion is not working (refractory SVT)
- Support airway by BMV or intubation at this stage
- Management of SVT with anti-arrhythmic medications

Physical Exam

ITEM	FINDING
Vital Signs (with BMV in Stage 2)	**HR:** 280, **BP:** 60/40, **RR:** 4, **SpO_2:** 80%
Vital Signs (without BMV in Stage 2)	**HR:** 280, **BP:** 72/40, **RR:** 30 (or bagged rate), **SpO_2:** 97%
Exam Changes	Same as **Stage 2**: • The patient is unresponsive. • Central pulses 1+ • Shallow, infrequent respirations • Capillary refill 5 seconds

Instructor Notes: Changes and Case Branch Points

INTERVENTION / TIME POINT	CHANGE IN CASE	ADDITIONAL INFORMATION
BMV started with appropriate seal and rate	SpO_2 = 96%	
Learners intubate patient with RSI	SpO_2 = 99%	If intubation is successful
Learners intubate patient without RSI		Pt gags, and the nurse states, "The child just had a large emesis."
Synchronized cardioversion at 0.5 J/kg - 2 J/kg	Few seconds of sinus rhythm (HR 160's), then goes back to SVT	
Learners do not recognize cardioversion is not working		Nurse says, "It doesn't seem like the shocks are working."
Amiodarone or procainamide administered	Converts to sinus rhythm. Proceed to **Stage 4**.	

Stage 4

Case Conclusion:
After cardioversion with 1 J/kg OR administration of amiodarone or procainamide

CRITICAL ACTIONS

- **Obtain post-conversion ECG and POC/baseline labs (if not already done)**
- **Verbalize recognition of sinus rhythm**
- **Explain diagnosis to parent and how it relates to the patient presentation**
- **Consult pediatric cardiology**
- Notify admission team/arrange for transfer

** Unbolded items may be excluded depending on local practices and norms*

Physical Exam

ITEM	FINDING
Vital Signs	**HR:** 160, **BP:** 80/52, **RR:** 40, **SpO_2:** 100%
Exam Changes	• Crying and responsive • Pulses 2+ • Capillary refill 3 seconds

Ideal Scenario Flow

Learners enter the room to find that the infant is alert but crying and fussy. They immediately place the patient on bedside monitors and recognize that the patient has a narrow complex tachycardia with evidence of diminished distal perfusion. Stable SVT is identified. Supplemental oxygen is provided, and an IV is placed. Vagal maneuvers may be attempted while access is being obtained and adenosine is being prepared. The patient is rapidly given at least 2 doses of adenosine without resolution of the arrhythmia. The patient's circulation, oxygenation, and ventilation then deteriorate as she develops unstable SVT. The patient requires BMV with good response to appropriate bagging. Synchronized cardioversion is then attempted with return of sinus rhythm after administration of at least 1J/kg. After cardioversion, the patient becomes responsive and no longer requires BMV.

Anticipated Management Mistakes

1. **Intubation of patient during decompensated SVT:** We found that learners sometimes proceeded to intubate the patient rather than provide BMV while cardioverting the patient. In this scenario, this leads to PEA, requiring CPR and epinephrine. We found it helpful to discuss the risk/benefit of intubation when effective oxygenation and ventilation can be provided by BMV during an arrhythmic event. Facilitators may also point out signs of adequate bagging such as chest rise, equal breath sounds, and improvement in SpO_2.

2. **Excessive fluid resuscitation:** Some of our learners may provide aggressive fluid resuscitation in an attempt to normalize heart rate and blood pressure. Given the underlying cardiac dysfunction in the setting of SVT that has likely been present for several hours, this can lead to volume overload and signs of heart failure. Facilitators can point out decreasing SPO_2 and worsening crackles and hepatomegaly to clue in learners.

3. **Delivery of unsynchronized shock:** The patient does not ever lose a pulse in this scenario, and therefore should be managed using the PALS "pediatric tachycardia with a pulse and poor perfusion algorithm." If an unsynchronized shock is delivered to

the patient, she will develop ventricular fibrillation requiring CPR and defibrillation. The indications of synchronized cardioversion should then be reviewed during the debriefing. Alternatively, a facilitator can also reorient learners to the appropriate algorithm and provide real time guidance before an unsynchronized shock is delivered to the patient.

Debriefing Points

Demonstrate early evaluation of a critically ill patient (application)

Learners should approach a critically ill patient in a standardized fashion. Airway, breathing, and circulation should be assessed immediately. Interventions such as airway repositioning/adjuncts, BMV, and CPR should be started concurrently, if required. After A, B, C have been addressed, the patient should be evaluated for disability and exposed for a thorough head-to-toe exam. In pediatrics, people often say that D also stands for "don't forget the dextrose" as a blood glucose level should be checked in any child with altered mental status.

Describe signs/symptoms of SVT in an infant (comprehension)

Unlike adults and older children, infants are unable to report a sensation of their heart racing. Instead, caregivers and providers must rely on other non-specific signs and symptoms. Infants' hearts may tolerate the rapid rate for many hours so presenting symptoms might be reported over a longer period than in older patients. Common complaints from parents are generally non-specific and include increased fussiness, pallor, poor feeding, sleepiness, quick breathing, or increased spit ups/new vomiting. On exam, infants will be tachycardic with heart rates greater than 220. They may have signs of decreased peripheral perfusion such as delayed capillary refill. Signs of congestive heart failure will likely only be present if the episode has lasted more than 24 hours. An ECG is used to identify SVT. Most cases of SVT will present with a narrow QRS and absent or abnormal p-waves.

Differentiate compensated from decompensated shock in an infant (analysis)

Children tend to compensate well initially. In compensated shock, homeostatic mechanisms help maintain systolic blood pressure within the normal range for age. To compensate, the heart rate will increase and peripheral vasoconstriction occurs. Findings on exam may include delayed capillary refill, diminished pulses, and cool extremities. Once compensatory mechanisms have been exhausted, decompensated shock (now referred to as hypotensive shock in

PALS) occurs. Systolic hypotension and altered mental status from brain hypoperfusion occur. Decreased respiratory drive can occur as cardiovascular collapse ensues.

Demonstrate physiologic (vagal), pharmacologic, and electrical cardioversion for SVT (application)

Vagal maneuvers can be attempted while other supplies and medications are gathered. The patient should be on a continuous ECG monitor while attempts to break SVT are made. Defibrillator pads should also be in place. In infants, a bag of ice and water may be placed over the face (without obstructing the nose and mouth) for 15-30 seconds in an attempt to elicit the "diving reflex." Rectal stimulation via thermometer insertion is another method. Carotid massage should not be performed in infants. Orbital pressure should be avoided in all patients, as this may result in retinal injury.

If the rhythm is not rapidly converted by vagal maneuvers, **pharmacologic management** should be emergently instituted. For stable SVT, adenosine 0.1 mg/kg (max 6 mg) should be administered by rapid IV injection. If SVT continues, 0.2 mg/kg (max 12 mg) should be used for subsequent doses.

For refractory SVT in the setting of decompensated (hypotensive) shock, **synchronized cardioversion** at 0.5-1 J/kg should be performed. If not effective, increase to 2 J/kg. The patient may receive sedatives such as fentanyl, versed, ketamine, or etomidate before, but cardioversion should not be delayed if the patient is unstable.

If cardioversion attempts are not working, then the learners need to consider adding an antiarrhythmic medication (amiodarone 5 mg/kg or procainamide 15 mg/kg). In older children, verapamil 0.1-0.3 mg/kg may be considered for use in refractory SVT. However, it should not be used in infants as it may cause myocardial depression, hypotension, and cardiac arrest. Beta-blockers such as esmolol may be considered for refractory SVT that is well tolerated. If the patient is stable, a cardiology consultation is strongly recommended prior to giving antiarrhythmics other than adenosine.

Demonstrate BMV in an infant (application)

When? If the patient is not adequately ventilating on his/her own, it is very important for us to do this for him/her. The most common scenarios will be when the patient exhibits the follow conditions:

- Inadequate respiratory effort
- Hypoventilation
- Apnea

These can all be caused by a variety of issues but it is imperative that the learners recognize this early and intervene given that respiratory arrest is the MOST common reason for an arrest in pediatrics.

How?

1. **Positioning:** Make sure that the patient is in the appropriate anatomical position and that the airway is patent. This can be hard in children under 4 years old, because their heads are large in proportion to their bodies and will cause them to flex and obstruct their airways. To make sure they are in a neutral position, slide a roll or towel under the shoulders. The goal is to elevate them by 2 inches.

2. **Tilt the head back and lift the chin:** This will pull the tongue and airway up and forward to open the airway. It is very important to remember that the pediatric airway is much less developed and floppier, and thus can "fall back" and cause obstruction in patients. This maneuver is often enough but remember that oral airways and nasal trumpets can be used in some patients.

3. **Size matters:** There are 3 different mask sizes and if your mask is too big or too small, you will not have a good seal. So if the mask doesn't look correct, try another one. For self-inflating bags, there are multiple sizes as well. These are designed to limit total volumes based on patient size and thus, reduce associated barotrauma from BMV. The goal is for tidal volumes between 5-8 mL/kg.

4. **Seal is crucial:** If you are short staffed, then one person can hold the mask in place and bag at the same time. This is done using the "EC" technique. With your left hand, hold the mask with your thumb and index finger creating a "C" to hold the mask to the face. Then position your 3rd, 4th and 5th digits along the jaw to

make an "E" and lift the jaw up to the mask. "Push down" with the C part and "pull up" with the E part, making a tight seal between mask and face. Then bag with the R hand and keep the seal with the L hand. This can be difficult to do and will require practice to master this technique. Ideally, if you have adequate staffing, you should use a two-person technique. In this case, a second person holds the mask in place using "EC" technique on both sides of the mask. This allows one to maximize the seal between the mask and the face and allows optimal positioning of the airway to achieve adequate ventilation. The other person can then focus on bagging and observing the child's chest for adequate chest rise.

5. **How fast?** For pediatric patients, you should provide a breath about every 3-5 seconds or a rate of 12-20/minute (for neonates, the rate is one breath every 3 seconds or 40-60 breaths/min). Remember that you MUST let the patient exhale or they will not be adequately ventilating and they will build up CO_2. If they are intubated, the rate is one breath every 6 seconds (10 breaths/min).

6. **Which bag?** You can use either a self-inflating bag or an anesthesia bag, depending on availability or practice patterns at your institution. The self-inflating is technically easier because it does NOT require that you be connected to an oxygen source. Ideally, one should always be connected to oxygen and that way you can treat any hypoxia if present, but the anesthesia bag WILL NOT work without an active gas source to inflate it. Self-inflating bags also come with a pressure setting so that you can increase or decrease your maximum inspiratory pressure and thus, prevent barotrauma of the lungs. Note that self-inflating bags cannot be used to provide CPAP, while the anesthesia bags can do this.

Common pitfalls and debriefing points:

- Was the patient in the appropriate position to maximize his/her airway? Most commonly, the learners will forget that a child's head is larger than an adult's and will not compensate for this.

- Was the mask sized appropriately for the patient's size/age? Again, this is a very common error and using the wrong size means poor seal and poor BMV technique.

- Was the size of bag used appropriate for the patient?

- Did they use single or two-person technique for BMV? If so, did the person holding the mask use the appropriate "EC" grip with good seal? Did they maximize the airway by use head-tilt and jaw-thrust appropriately?

- Was the bag used connected to an oxygen source?

- What rate did they use? Was it appropriate for the age of the patient?

- Did they use the right pressure setting if they were using a self-inflating bag?

Resources

- Bag Mask Ventilation Video (AAP) - login required
- Bag Valve Mask Ventilation in Pediatrics (University of Florida) YouTube Video

Demonstrate focused history taking from a caregiver (application)

- Components of history taking: Past medical history, surgical history, family history, medications, allergies, social history, vaccination history

- Specifically for patients presenting with a seizure, recent illnesses, fever, and prior seizure history are all very important questions.

Explain diagnosis and management to caregivers (synthesis)

If personnel are available, one member of the team may stay with the family to gather history and explain interventions. Information should be relayed to the family using layperson's terms. The rationale for interventions such as ice to the face, IV placement, cardioversion, and BMV should be explained preceding or at the time of occurrence, when possible.

Demonstrate teamwork and closed loop communication (application)

Teams may use different frameworks to improve team dynamics and communication. Below are a few definitions that may be helpful to discuss, adapted from the AHRQ TeamSTEPPS Pocket Guide.

- **Brief:** Short session prior to start of encounter to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies

- **Huddle:** Ad hoc team discussion to re-establish Situation Awareness; designed to reinforce plans already in place and assess the need to adjust the plan

- **Callout:** A strategy used to communicate critical information during an emergent event. Helps the team prepare for vital next steps in patient care. (Example: Leader- "Airway status?"; Surveying provider- "Airway clear"; Leader- "Breath sounds?"; Surveying provider- "Breath sounds decreased on right")

- **Check-back:** A closed-loop communication strategy that requires a verification of information ensuring that information conveyed by the sender is understood by the receiver as intended. The sender initiates the message; the receiver accepts it and restates the message. In return, the sender verifies that the re-statement of the original message is correct or amends if not. (Example: Leader- "Give diphenhydramine 25 mg IV push"; Med Prep- "Diphenhydramine 25 mg IV push"; Leader- "That's correct")

- **SBAR:** A framework for team members to structure information when communicating to one another.
    - S = Situation (What is going on with the patient?)
    - B = Background (What is the clinical background or context?)
    - A = Assessment (What do I think the problem is?)
    - R = Recommendation (What would I do to correct it?)

- **Situation monitoring:** The process of continually scanning and assessing a situation to gain and maintain an understanding of what is going on around you.

- **Situation awareness:** The state of "knowing what's going on around you."

- **Shared mental model:** Result of each team member maintaining situation awareness and ensures that all team members are "on the same page." An organizing knowledge structure of relevant facts and relationships about a task or situation that are commonly held by team members.

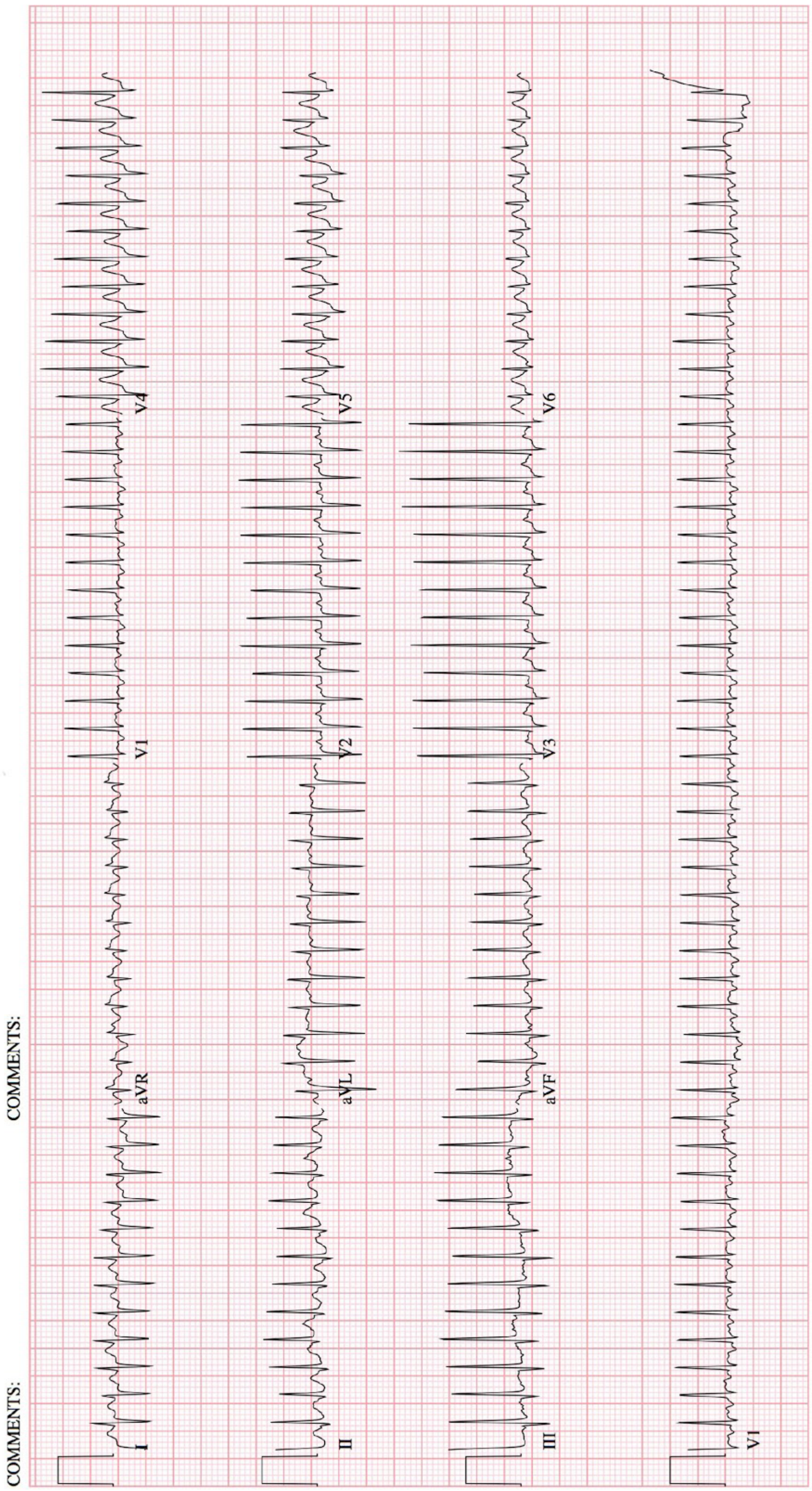
- **STEP:** A tool for monitoring situations during complex situations. A systematic method to review **S**tatus of patient, **T**eam members' performance and status, **E**nvironment, and **P**rogress towards goal.

- **Cross-monitoring:** A harm error reduction strategy that involves 1. Monitoring actions of other team members 2. Providing a safety net within the team. 3. Ensuring that mistakes or oversights are caught quickly and easily. 4. "Watching each other's back."

- **CUS:** Signal phrases that denote "I am **C**oncerned," "I am **U**ncomfortable," and "This is a **S**afety Issue." When spoken, all team members should understand clearly not only the issue but also the magnitude of the issue.

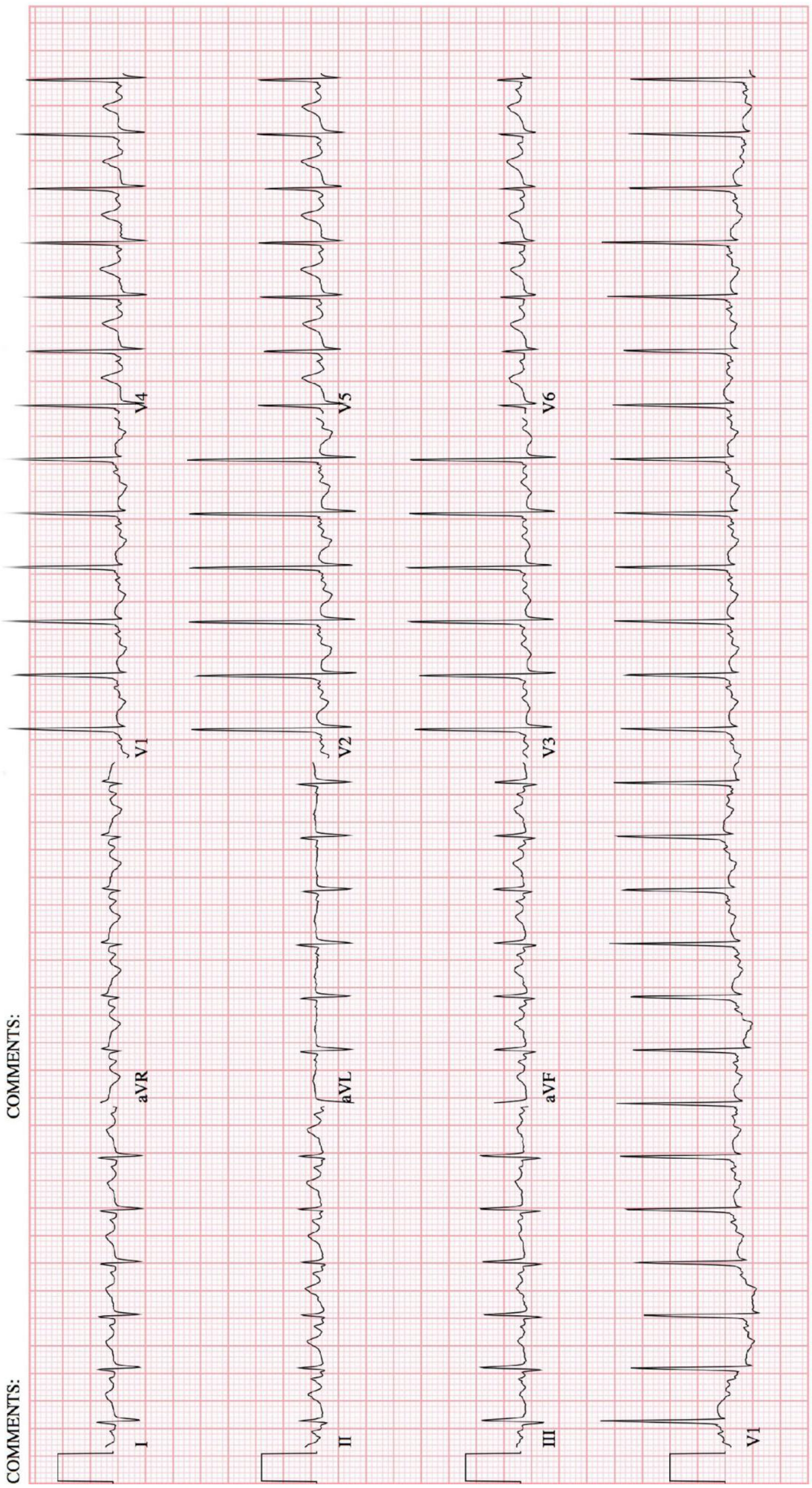
Supporting Files

Initial ECG



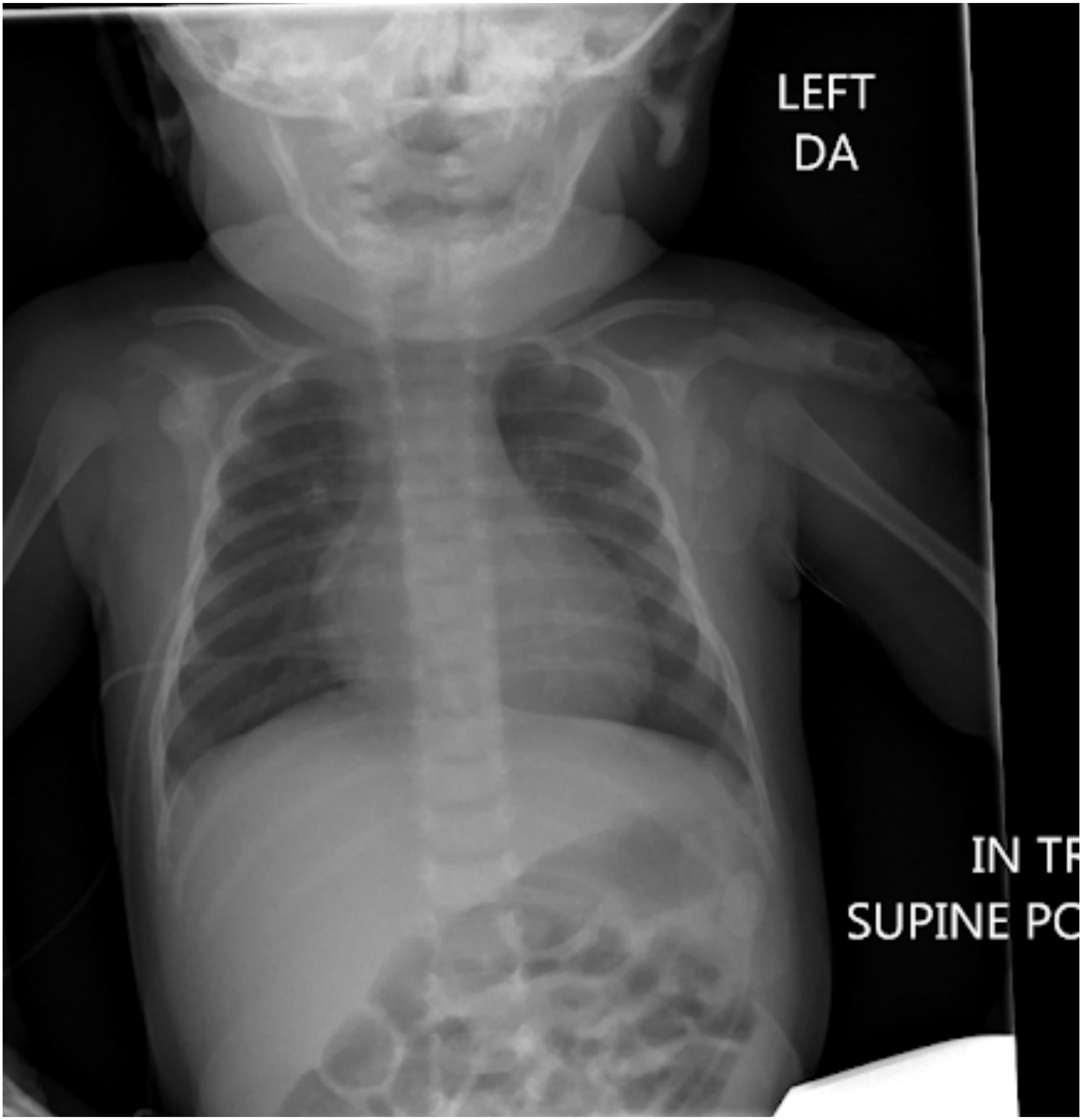
Supporting Files

Post-Cardioversion ECG



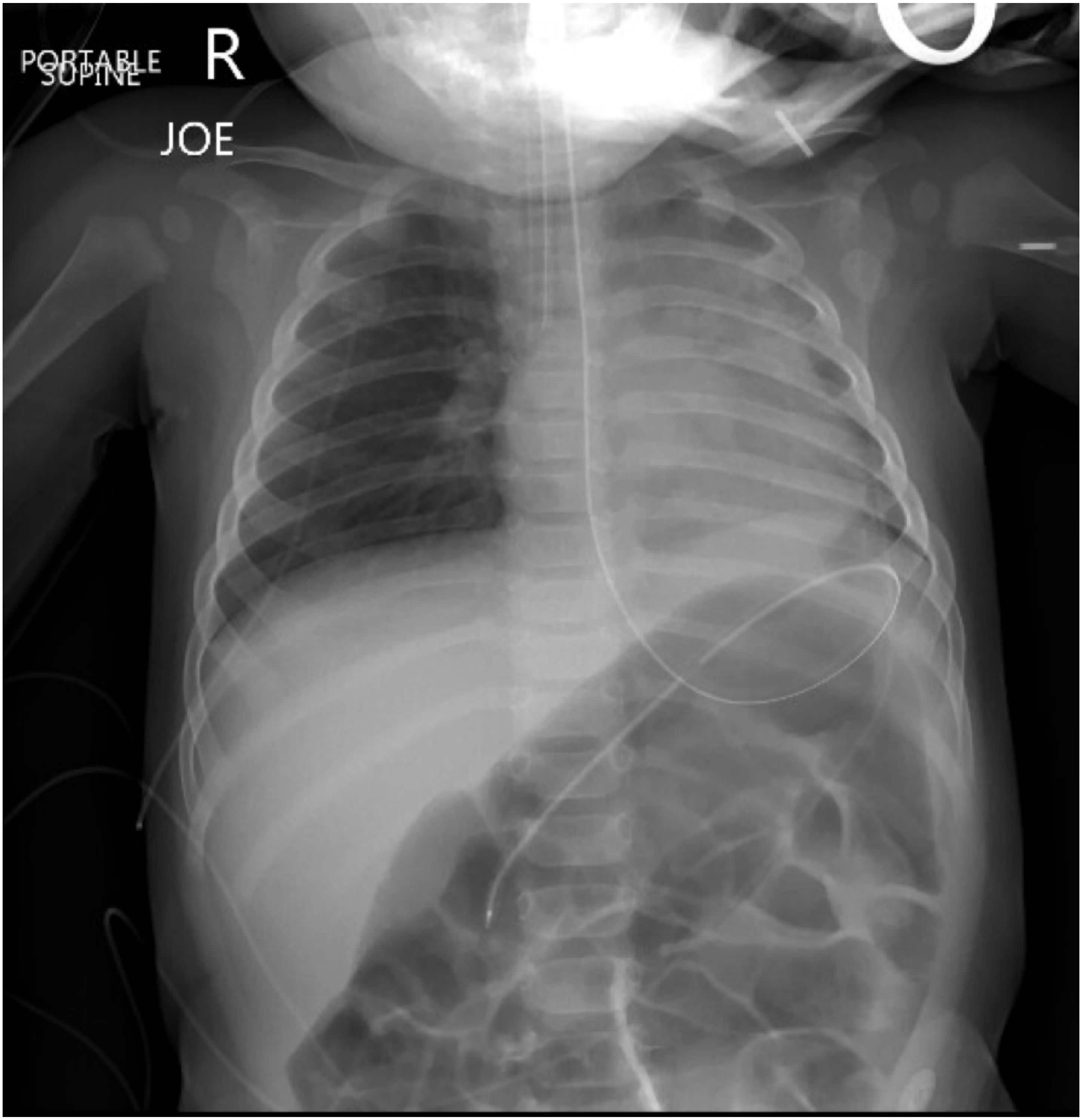
Supporting Files

Chest X-Ray



Supporting Files

Post-Intubation Chest X-Ray



Supporting Files

Notes

ECG Interpretation
Supraventricular tachycardia. Image from Dr. Michael Nguyen.

Post-Cardioversion ECG Interpretation
Sinus tachycardia. Image from Dr. Michael Nguyen.

Chest x-ray interpretation
Normal. Image from Dr. Rebekah Burns.

Post-Intubation Chest-xray interpretation
Endotracheal tube in place. Image from Dr. Rebekah Burns.

Supporting Files

Laboratory Results

Venous Blood Gas and Other Point of Care Labs

LABORATORY TEST	VALUE	UNITS
pH	7.204	
pCO_2	35	mmHg
pO_2	40	mmHg
HCO_3	10	mEq/L
Na	135	mEq/L
K	3.7	mEq/L
Cl	110	mEq/L
TCO_2	12	mEq/L
Glucose	120	mg/dL
BUN	13	mg/dL
Cr	0.2	mg/dL
Hct	37	%
HgB	12.3	g/dL

Feedback

Please complete our brief survey describing your experience.

Learner

Facilitator

Standardized Patient Script

For the embedded participant playing the patient's parent

Case Background Information

Your daughter is having an episode of supraventricular tachycardia or SVT. This is when there is a very fast heartbeat coming from the top chambers of the heart. Babies may be fussy, pale or even become unresponsive and need medicine called adenosine to return the rhythm to a normal rhythm. If the medicine doesn't work, the baby needs electricity from a defibrillator machine to fix the rhythm.
You are bringing your daughter to the Emergency Department because she has been fussy and not wanting to eat for the past 8 hours. This is very unusual for her and has never happened before.

Who are the Learners?

Emergency medicine residents

This case is specifically aimed at interns who are in their first year of specialty training and may have experience in gathering information from patients and families, and standard medical treatments and procedures. They may be less familiar with escalating medical therapies when first measures are not successful.

Standardized Patient Information

You brought your daughter to the Emergency Department because she has refused to eat for much of the day and has been very fussy and pale. She was fine when she first woke up. This is very atypical for her. You are worried she is sick but do not know with what.

Your demeanor is concerned but relatively calm. You do not want to obstruct care but want to know what is happening. Do not interrupt them if they are thinking out loud or discussing care with one another but ask questions when possible if they don't explain what they are doing.

Patient Information

(Please remember not to offer any of this information, but when asked please respond while remaining in character.)

- CHIEF COMPLAINT (your response to open-ended questions such as "what's going on?" or "what can we do for you? Or "what happened?"): "She hasn't wanted to eat in the past 8 hours."

- AGE: 6 months old

- ADDITIONAL HISTORY: You first noticed the fussiness around 7 AM this morning. She woke up at 6:30 AM normally had a good feed. At 7 AM, she became fussy. At first, you didn't think much of it because she occasionally gets fussy. Normally this improves after a diaper change, playing a song on her music toy, or some cuddles and a pacifier. She had a wet diaper at that time which was normal. None of your usual calming methods worked. She went to sleep at 10:30 AM for her normal late morning nap but woke up after 30 minutes fussy again. You have also noticed that she looks more pale than normal (this you just noticed over the past 4 hours). She also seems a little sweaty now. She has not had fevers, cough, congestion, emesis, or diarrhea. She has not received any medications. There are no medications other than acetaminophen and ibuprofen at home. She has not had any falls or injuries at home.

- PAST MEDICAL HISTORY: Born at 37-weeks' gestation. Spent 3 days in the hospital. Received oxygen but was not intubated at that time.

- SOCIAL HISTORY: Lives with both parents. No pets. No smoke exposure. Attends daycare 5 days a week since 4 months of age. No travel.

- FAMILY HISTORY: Unremarkable

- PAST SURGICAL HISTORY: None

- MEDICATIONS: None

- ALLERGIES: No known drug allergies.

- IMMUNIZATIONS: Up-to-date through 6 months

- FEEDINGS: Normally takes 8 ounces of formula every 4 hours. Started table food last month and has had mashed peas, sweet potatoes, and avocados without issues.

- WET DIAPERS: Only one wet diaper in past 12 hours

- BIRTH HISTORY: Born by spontaneous vaginal delivery at 37 weeks to a 32 yo G1P1 woman. Normal prenatal care, no complications during pregnancy or delivery. Discharged home from hospital on day 2 of life with mom. Prior history of admission for bronchiolitis at 2 months of age.

Potential Dialogue

IMPORTANT: Do not offer unsolicited information. Please allow the learners to ask questions. Do not offer information unless they ask you.

Things you could say without being asked:
- "I have never seen her this fussy before. She won't take a bottle. All the normal things I do to calm her down like rock her and give her a pacifier aren't working."
- "She is normally such a good eater and a pretty mellow baby."

Things you might say triggered by events in the scenario:

EVENT	YOUR POTENTIAL RESPONSE
If they place a bag of ice on your child's face or tip the baby upside down without explaining to you what they are doing	"Why does this have to be done?"
After they give adenosine	"Did that work?"
If they start using a bag mask to help your child breath without telling you what they are doing	"Is she not breathing?"
If they start CPR	"Is she going to die?!"

Emergency Medicine Resident Simulation Curriculum for Pediatrics

(EM ReSCu Peds)