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OUTREACH EDUCATION FOLLOW-UP INITIATIVE
Pediatric Critical Care

StEP
Stabilization Essentials in Pediatrics

SHOCK

Stabilization Essentials in Pediatrics (StEP) is an interdisciplinary two-day course with components of didactic lectures, high fidelity simulations and hands-on workshops, prepared and delivered by PICU faculty. The target audiences are MDs, RNs, and RTs who care for critically ill children over the short term, usually while they await transport. These practitioners may be part of different departments depending on local workflows (ie. ED4, Adult ICU or High Acuity Pediatric Units).

StEP Stabilization Essentials in Pediatrics

LEARNING OBJECTIVES

- ✓To review a case of a neonate presenting in shock
- ✓To review the approach to initial stabilization and management of shock
- ✓To describe differences in management according to suspected etiology of shock

CASE 1

StEP Stabilization Essentials in Pediatrics

6-day old term, 4 kg female presents with 2-day history of poor feeding and 1-day history of lethargy and increased work of breathing

Heart Rate	**194** bpm sinus
Blood Pressure	**55/38** mmHg
Respiratory Rate	**80** breaths/min
SpO2	**91%** in Room Air
Temperature	**36** degrees Celsius

Examination: Lethargic, CRT 5 secs, peripheral and central pulses weak, mottled

Signs of shock

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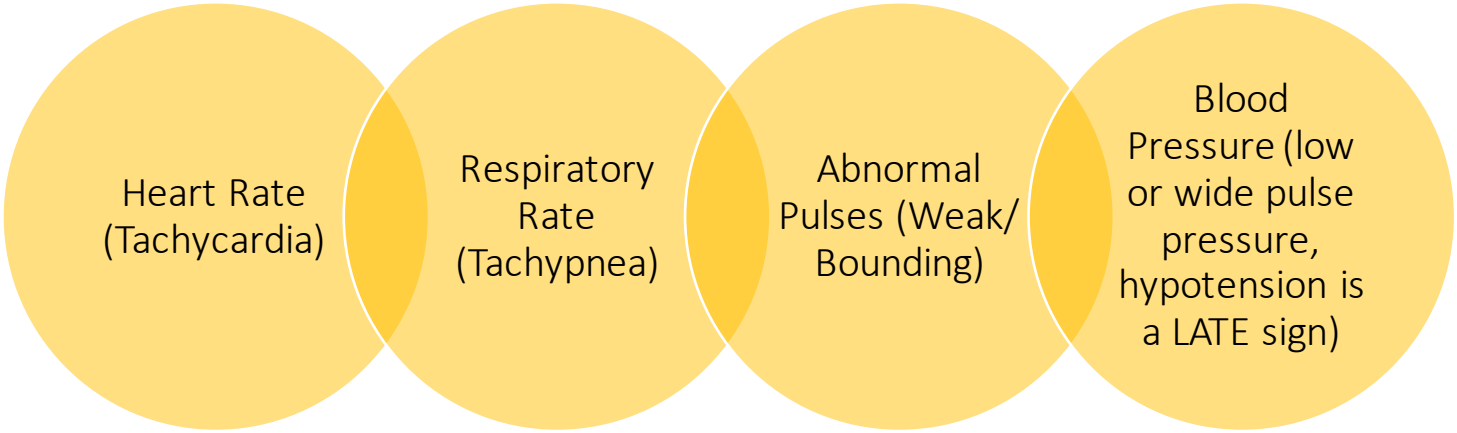

Signs of Poor Organ perfusion:

- **Brain** – altered level of consciousness
- **Skin** - Mottled, cool, or warm, Flash or prolonged capillary refill time
- **Kidneys**: decreased urine output (< 1 mL/kg/h)

Shock in Children

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- Hypotension is a LATE feature of shock in children
- Cardiac output in small infants is heart rate dependent (limited ability to increase their stroke volume)
- Vascular access may be difficult

Causes of shock

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DISTRIBUTIVE	HYPOVOLEMIC	CARDIOGENIC	OBSTRUCTIVE
• Anaphylaxis • Septic Shock	• Urine or gastrointestinal losses, inadequate oral intake • Hemorrhage	• Congenital Heart Disease • Arrhythmia • Myocarditis	• Pericardial Tamponade • Tension Pneumothorax

Initial Management

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ABCDE approach independent of suspected cause

A
- Assess airway patency, suction secretions as needed

B
- Support breathing by providing supplemental FiO2 1.0 via pediatric non-rebreather mask

C
- Insert peripheral IV access x 2, consider IO after 5 minutes or 2 failed attempts at IV access
- Initiate fluid resuscitation 10-20 mL/kg normal saline over 10-20 minutes*

D
- Verify blood glucose and correct as needed if glucose <3.3mmol/L
- 5 mL/kg bolus D10W or D10NS IV

E
- Expose the patient and identify any visible rashes, measure temperature

CASE 1

Stabilization Essentials in Pediatrics

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Heart Rate	**194** bpm sinus
Blood Pressure	**55/38** mmHg
Respiratory Rate	**80** breaths/min
SpO2	**91%** in Room Air
Temperature	**39.6** degrees Celsius

precipitous delivery in the context of +ve GBS status, not treated with antibiotics, + maternal fever intra-partum

Examination: Lethargic, CRT 5 secs, peripheral and central pulses weak, mottled

CHBC Provincial Pediatric Sepsis Screening Tool

Sepsis is a MEDICAL EMERGENCY; Early Recognition and Treatment is Imperative for Survival

ARE THERE SIGNS OF SUSPECTED SEPSIS? (patient has 2 or more of the following in the context of infection)

- Looks sick or toxic (feels cold to touch, blotchy, blue or pale skin)
- Parental/caregiver concern
- Critical heart rate
- Temperature greater than 38° Celsius or less than 36° Celsius
- Altered mental state (drowsy, difficult to wake, irritable or confused)
- Tachypnea, increased work of breathing, cough, grunting, chest pain
- Decreased feeding
- Reduced urine output or other signs of dehydration
- Abdominal pain, distension, vomiting, diarrhea
- Joint pain or swelling, rash or other signs of skin infection

AND/OR

IS THE CHILD AT HIGH RISK OF COMPLICATIONS FROM SEPSIS?

- Age less than 3 months or born premature
- Immunocompromised
- Cardiac, respiratory, or neuromuscular disease
- Significant developmental delay
- Indwelling vascular access or medical device
- Recent surgery or hospitalization
- Recent inpatient episode of sepsis (within 6-12 weeks)
- Intravenous recreational drug use

NO

REMAIN ALERT

- Continue to monitor as per your health authority/ agency guidelines and clinical judgement
- Re-screen for sepsis as per BC PEWS prompts
- Notify Most Responsible Practitoner of any change or deterioration in patient condition
- Advise caregiver to notify Health Care Provider if any change in child's status
- Provide "Could It Be Sepsis" handout to parent or caregiver

AND/OR

ARE THERE SIGNS OF SEPTIC SHOCK?

Do not wait for hypotension to diagnose septic shock

- Looks sick or toxic
- Altered mental status (increased lethargy hypotonic)
- Tachycardia
- Capillary refill time greater than 3 seconds
- A weak thready pulse
- Decreased peripheral pulses
- Temperature greater than 38° Celsius or less than 36° Celsius
- Oxygen saturations less than 92% in children without known cyanotic heart disease
- Decreased urine output or other signs of dehydration

DON'T DELAY - TREAT FOR SEPSIS OR SEPTIC SHOCK

- Immediately notify Most Responsible Practitoner
- Proceed to CHBC Provincial Pediatric Sepsis Clinical Care Algorithm
- Consult local Pediatrician on-call; or CHARLiE via Zoom or phone; or higher level of care center via PTN

StEP Stabilization Essentials in Pediatrics

https://www.childhealthbc.ca/clinician-resources/pediatric-sepsis-0

Sepsis is a MEDICAL EMERGENCY: Early Recognition and Treatment is Imperative for Survival

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StEP Stabilization Essentials in Pediatrics

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Child Health BC Pediatric Sepsis Clinical Care Algorithm

Sepsis is a MEDICAL EMERGENCY; Early Recognition and Treatment is Imperative for Survival

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0 MINUTES

RECOGNITION
- Looks sick or toxic
- Critical heart rate
- Fever greater than 38°C or less than 36°C
- Poor perfusion/purpura/petechiae
- Altered mental status: confusion, lethargy or irritability
- Identified risk factors
- PEWS score increased by 2 or more

Refer to: Provincial Pediatric Sepsis Guideline for detailed instructions for intervention and care

FIRST 5 MINUTES

IMMEDIATE ACTIONS
- Notify Most Responsible Practitioner
- Attach cardiorespiratory monitoring
- Initial assessment (HR, RR, BP, Temp, SpO2, Capillary Refill and LOC)
- Assess airway and administer oxygen to maintain saturations above 92%

Hypotension is a late and often terminal sign in pediatric septic shock

FIRST 60 MINUTES

ESTABLISH VASCULAR ACCESS, OBTAIN LAB WORK & ADMINISTER ANTIBIOTICS
- Secure IV/IO access
- Collect blood cultures
- Measure lactate
- Administer antibiotics IV/IO. IM if delayed access

If intravenous (IV) access is not secured within 5 minutes or after two attempts, use intraosseous (IO) access. In situations where rapid IV access may be difficult, IO access should occur concurrently with IV attempts to minimize delay to vascular access

FLUID ADMINISTRATION
- Administer Sodium Chloride 0.9% 10-20 mL/kg over 20-30 minutes
- Reassess response
- Prevent and treat hypothermia
- Check for and correct low glucose
- Check for and correct low calcium

Excessive fluid resuscitation can be harmful. Continually monitor for signs of fluid overload (e.g. increased work of breathing, crackles on auscultation, hepatomegaly or signs of cardiogenic shock).

PICU consultation should be considered if a total of more than 40mL/kg of fluid is required.

ONGOING CARE
- Reassess patient at a minimum of every 15 minutes (HR, RR, BP, Temp, SpO2, Capillary Refill and LOC)
- Administer dextrose containing maintenance fluids

MONITOR

IV ACCESS
LACTATE
BLOOD WORK
ANTIBIOTICS

FLUIDS

REASSESS

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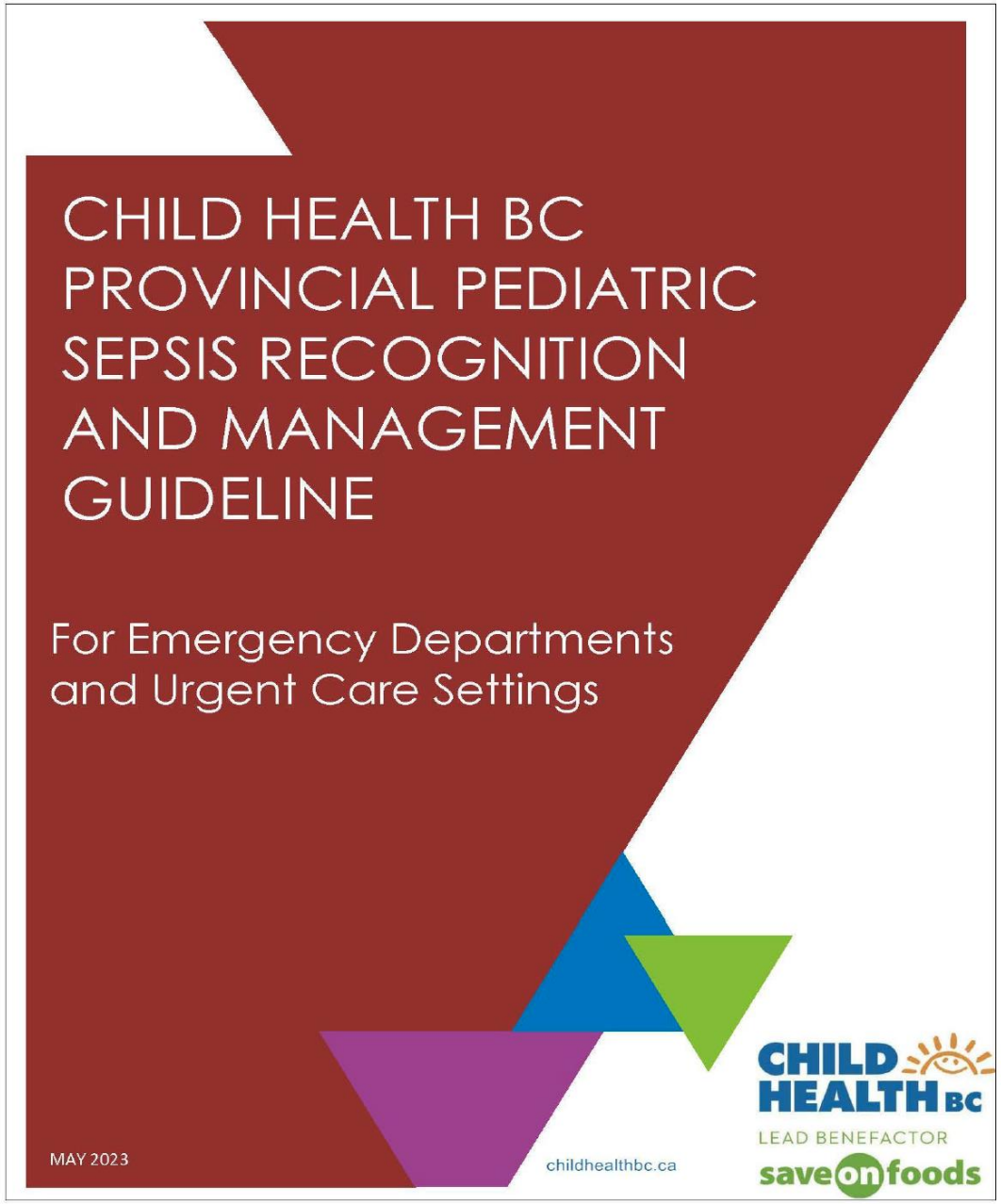
https://childhealthbc.ca/sepsis/algorithm/clinical_care



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https://childhealthbc.ca/sepsis/guideline/recognition_management

Definitions

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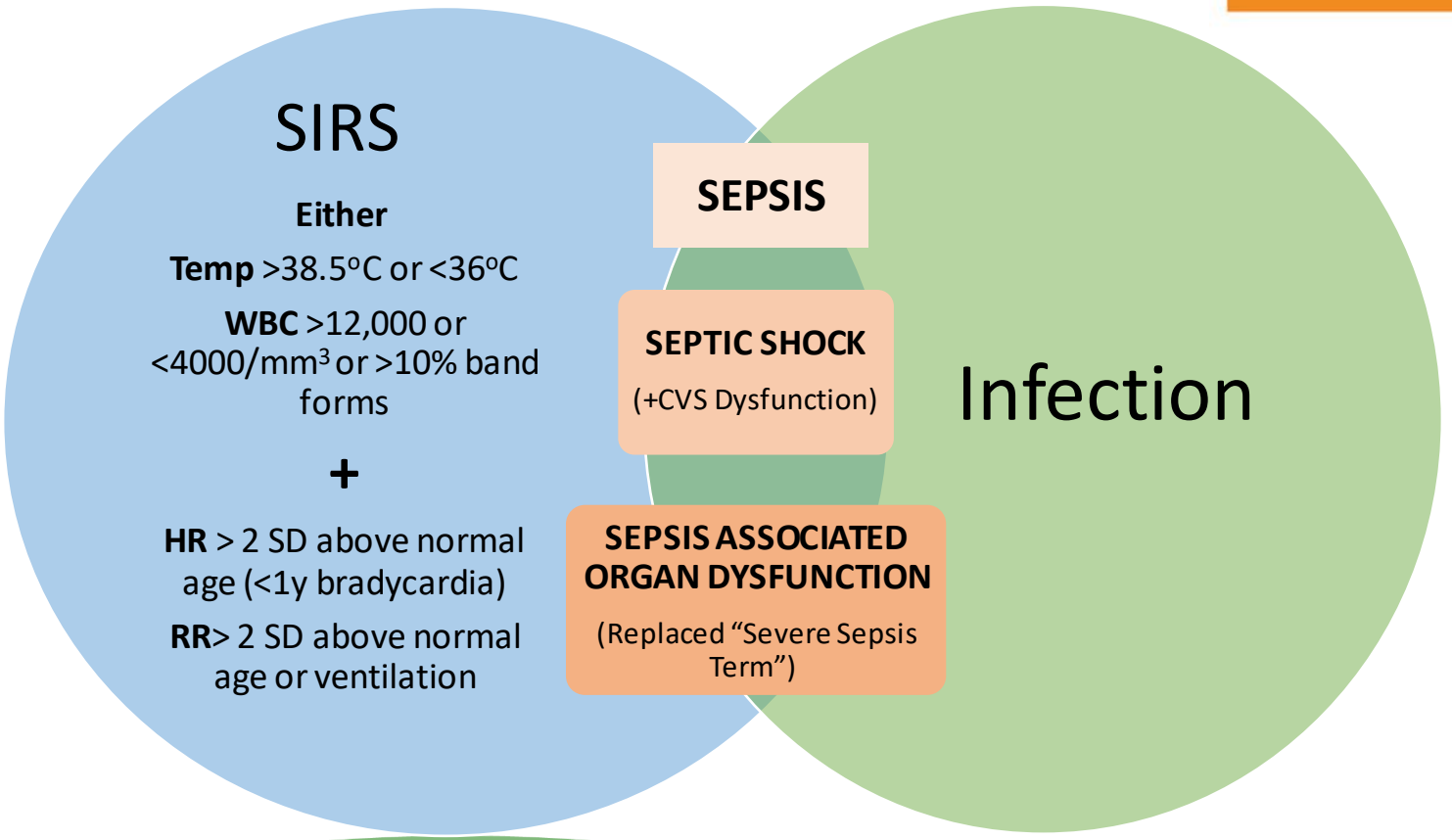

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INVESTIGATION OF SEPTIC SHOCK

First Line Investigations

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First Line Lab Investigations in Pediatric Sepsis	
Blood culture	**Prioritize over other blood tests. It is recommended to obtain blood cultures before initiating antimicrobial therapy in situations where this does not substantially delay antimicrobial administration.**[15] Culture sensitivity increases with blood volume. Recommended volume to collect is 1mL/kg max 40mL.[26,27]
Blood gas	Base deficit more than 5.0 mEq/L marker of possible sepsis[16]
Complete blood count	WBC can be normal, high or low in early sepsis.[16] Platelet count less than 100,000 uL in sepsis or disseminated intravascular coagulation (DIC).[16]
Lactate	Do **NOT** attribute increased lactate to difficult venipuncture. Lactate more than 2.0 mmol/L marker of possible sepsis.[16] Repeat lactate (q2h) if greater than 2mmol/L. Lactate greater than 4 mmol/L requires urgent action.[16]
Electrolytes, glucose, urea and creatinine	Include sodium, potassium, chloride, ionized *or* total calcium, magnesium, phosphate, glucose, urea and creatinine. C Reactive Protein: low value does not exclude early sepsis.[16]
Urinalysis, urine culture and sensitivity	Obtain via in and out/indwelling catheter.

Second Line Investigations

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Second Line Investigations in Pediatric Sepsis	
Blood group and screen	If indicated.
Liver function tests	Total bilirubin, AST, ALT. Increased bilirubin or alanine aminotransferase (ALT) in sepsis.[16]
Coagulation studies	PT (INR), PTT, fibrinogen if clinical evidence of bleeding or Disseminated Intravascular Coagulation (DIC). Altered values in the context of sepsis with thrombocytopenia indicative of DIC.[16]
Lumbar puncture & cerebrospinal fluid investigations	Recommended for neonates with suspected sepsis as long as clinically stable. For older children, lumbar puncture may be considered if meningitis is suspected and the child is clinically stable (i.e. no signs of increased ICP, coagulopathy or hemodynamic compromise).[16,19] Can do WBC and PCR for meningitis diagnosis on CSF from delayed LP[16] • cell count with differential • gram stain and culture • glucose • protein level Nucleic acid testing (NAT) for HSV and other potential pathogens.
Cultures & Swabs	If diarrhea present, stool for culture and virology if available. Nasopharyngeal Flocked Swab; Respiratory Nucleic Acid Testing (NAT) panel. Culture & Sensitivity of wound that appears infected.
Radiology	Consider Chest x-ray for respiratory distress or signs on examination. Other imaging as directed by the focus of infection e.g. septic joint.[16]
Cardiac	Electrocardiogram 12 Lead. Echocardiogram.

***Consider sending ammonia level in neonate with suspected sepsis**

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MANAGEMENT OF SEPTIC SHOCK

Management of Septic Shock

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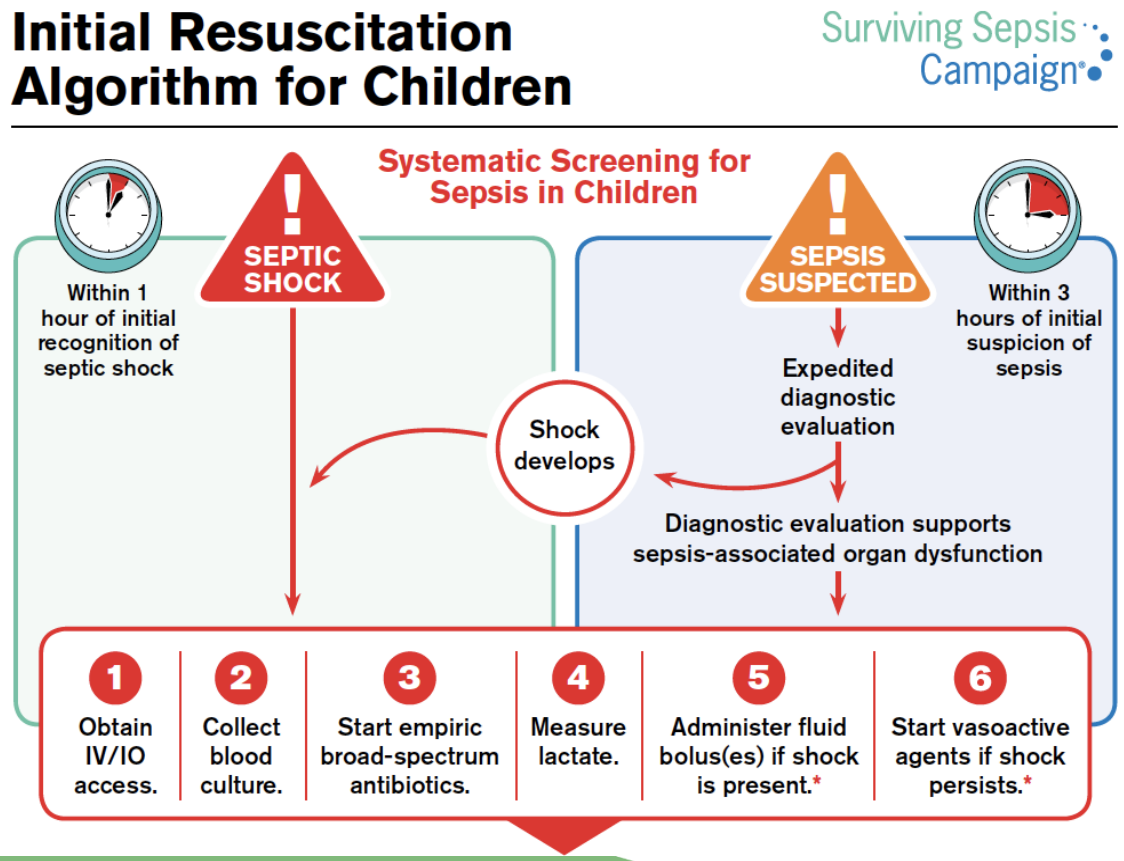

FLUID RESUSCITATION

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Intravenous Fluid
10-20 mL/kg crystalloids over 5-20 minutes

Titrate to markers of cardiac output:
improved mentation, heart rate, capillary refill time, urine output

Reassess closely after each bolus markers of cardiac output and signs of fluid overload

Up to 40-60ml/kg in the first hour*

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EMPIRIC ANTIMICROBIAL THERAPY

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Should be started **as soon as possible**, ideally within 1 hour of sepsis recognition

Obtain blood cultures before initiating antimicrobials,if does not delay their administration

Empiric broad-spectrum therapy to cover all likely pathogens

Narrow empiric anti-microbials once the pathogen and sensitivities are identified

If no pathogen is identified, antimicrobials should be narrowed or stopped according to clinical presentation, site of infection, patient risk factors, clinical improvement

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EMPIRIC ANTIMICROBIAL THERAPY

StEP Stabilization Essentials in Pediatrics

Antibiotic Recommendations*		
Age	**Unknown Source** **CNS Infection *Not* Suspected**	**Suspected CNS Infection**
Term neonate less than 29 days of life	All infants under 28 days presenting with suspected sepsis should be treated for suspected CNS infection until proven otherwise →	ampicillin **AND** cefotaxime **AND** acyclovir
29 days of life to 17 years of age less 1 day	cefTRIAXone** **PLUS OR MINUS** vancomycin***	cefTRIAXone ** **AND** vancomycin*** **PLUS OR MINUS** acyclovir

*Consult infectious diseases for antibiotic recommendations for children with allergies or contraindications to recommended antimicrobial therapies

**If ceftriaxone unavailable substitute with cefotaxime

***Consult pharmacy for therapeutic drug monitoring recommendations should duration of vancomycin be greater than 48 hours (sooner in patients with renal impairment)

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VASOACTIVE MEDICATIONS

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Consider after 40-60mL/kg IV fluids

- Avoid excessive fluid resuscitation
- Additional fluid resuscitation may be concurrent

1st line: Epinephrine or Norepinephrine

- Should be based on individual patient physiology
- May both be administered via PIV/IO*

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VENTILATION IN SEPTIC SHOCK

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Positive pressure ventilation may be indicated in patients with fluid- and catecholamine-refractory shock to **decrease metabolic demand and support cardiac output**

Lower doses of induction drugs should be used given risk of hypotension/cardiac arrest

Non-Invasive Ventilation may be appropriate in patients responding to initial therapy who have respiratory distress due to fluid overload, evolving ARDS

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ADDITIONAL THERAPIES

StEP Stabilization Essentials in Pediatrics

STEROIDS

✓If known corticosteroid deficiency

✓Consider in fluid and catecholamine refractory shock

GLUCOSE CONTROL

✓Tight glycemic control is **NOT** recommended

✓Lack of benefit and risk of hypoglycemia

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ADDITIONAL THERAPIES

StEP Stabilization Essentials in Pediatrics

CALCIUM

✓Measure and replace calcium as needed

INTRAVENOUS IMMUNOGLOBULIN (IVIg)

✓IVIG may be of benefit in **Toxic Shock Syndrome** and suspected MIS-C (not routinely indicated in sepsis)

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Resuscitation Targets?

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“Normalize” global perfusion

HR to normal range for age

BP to low normal range

(5th to 50th percentile)

Warm extremities

Cap refill ≤ 2-3 seconds

"Normalize” end organ perfusion

Urine output >1mL/kg/hr

Normal mental status

Lactate < 2

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CASE 2

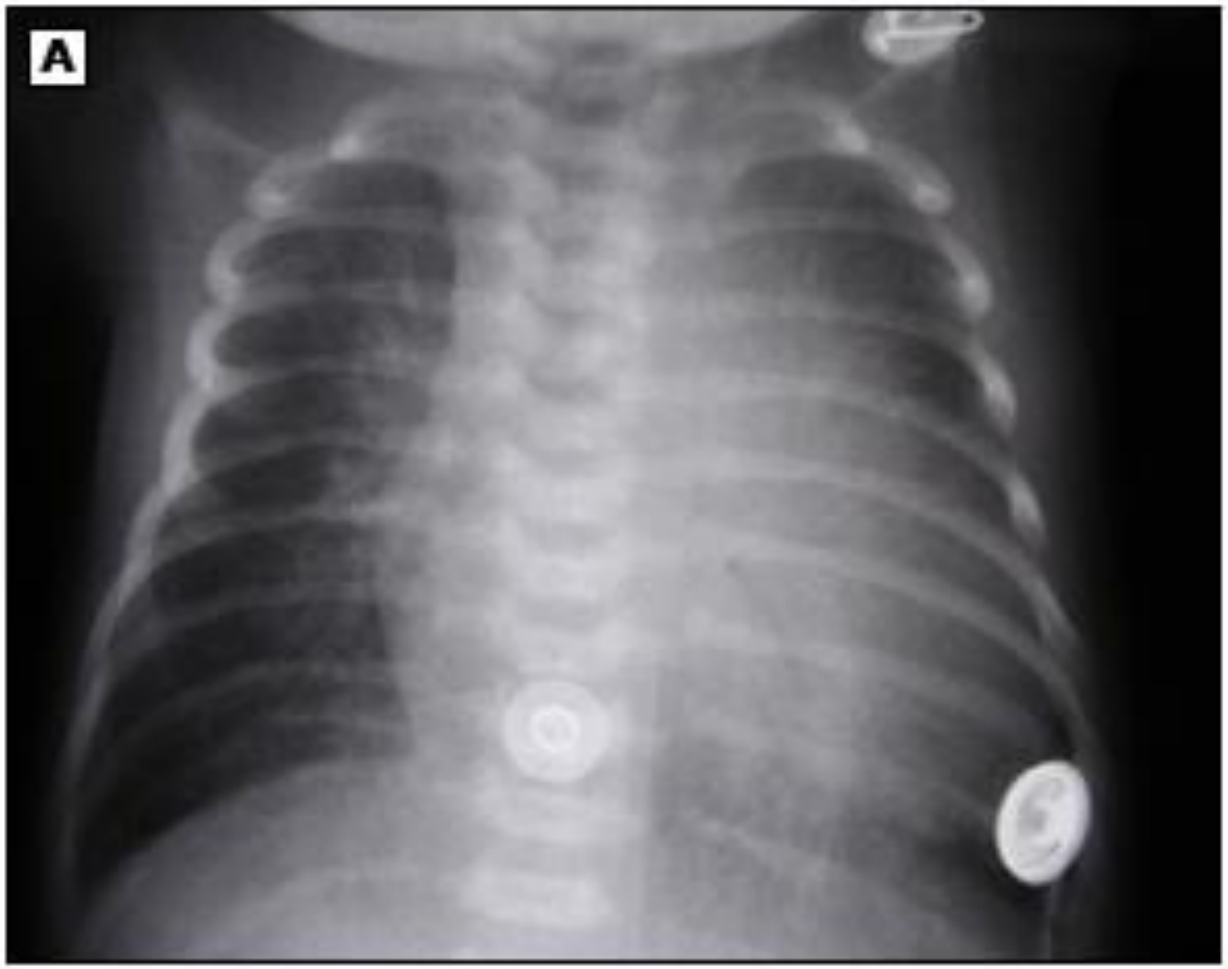
Stabilization Essentials in Pediatrics

6-day old term, 4 kg female presents with 2-day history of poor feeding and 1-day history of lethargy and increased work of breathing

Heart Rate	**194** bpm sinus
Blood Pressure	**55/38** mmHg
Respiratory Rate	**80** breaths/min
SpO2	**91%** in Room Air
Temperature	**36** degrees Celsius

Physical Exam: CRT 5 seconds, peripheral and central pulses weak, mottled, Lower limb blood pressure not measurable, femoral pulses not palpable

CXR: Cardiomegaly



UpToDate, 2023

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Management of Suspected Cardiogenic Shock

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Prostaglandin E1: 0.05 to 0.1 mcg/kg/min*

Epinephrine infusion initiated at: 0.05 mcg/kg/min

Fluid resuscitation: 5-10 mL/kg over 20 minutes

Positive pressure ventilation (PPV) to minimize metabolic demand and support cardiac output

Non-invasive PPV while preparing for intubation

Reduced doses of induction medications given potential for cardiac arrest

e.g., Ketamine 0.5mg/kg/dose, Rocuronium 1mg/kg/dose

***Consultation with Pediatric Cardiology and Intensive Care**

CASE 3

Stabilization Essentials in Pediatrics

6-day old female presents with 2-day history of poor feeding, profuse watery diarrhea since birth, and 1-day history of lethargy

Heart Rate	**194** bpm sinus
Blood Pressure	**55/38** mmHg
Respiratory Rate	**80** breaths/min
SpO2	**91%** in Room Air
Temperature	**36** degrees Celsius

Physical Exam: CRT 5 seconds, peripheral and central pulses weak, mottled with cool extremities
Decreased skin turgor

Management of Suspected Hypovolemic Shock

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In the presence of a clinical history suggestive of **hypovolemia**, fluid resuscitation should be undertaken rapidly and titrated to clinical response (improved heart rate, urine output, perfusion, and mentation)

Glucose should be checked and corrected

Electrolytes (e.g., K+) should be measured and corrected as needed

References

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