Sepsis & Septic Shock Management

NEMOURS CHILDREN'S HEALTH

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INCLUSION CRITERIA
- Suspected sepsis or septic shock

EXCLUSION CRITERIA
- Neonate ≤ 28 days
- NICU patient
- CICU/CCCU Patient

MEASURES
- Time from provider order of antibiotic to administration
- Percent of patients with blood culture collection prior to administration of first antibiotic
- Time to antibiotic
- Mortality rate
- Hospital length of stay

[1]HIGH RISK FOR SEPSIS
- Oncologic diagnosis
- BM/organ transplant
- Immunodeficiency
- Immunotherapy
- Asplenia/sickle cell
- Chronic encephalopathy
- Short gut syndrome
- Central venous line
- Technology dependence
- Prior sepsis

[2]SIGNS & SYMPTOMS OF SEPSIS
Fever/hypothermia with:
- Tachycardia
- Tachypnea
- Fatigue

[3]SIGNS & SYMPTOMS OF SEPTIC SHOCK
Fever/hypothermia with:
- Hypotension
- Altered mental status
- Delayed/flash cap refill
- Weak/bounding pulses
- Cool extremities
- Oliguria
- Petechiae/purpura/ erythroderma

[4]IV/IO Fluids
- Crystalloid as first line for initial resuscitation
- Symptoms of fluid overload: hypoxia, rales, hepatomegaly, edema

CONCERN FOR SEPSIS OR SEPTIC SHOCK
Patient risk factors [1]
Signs and symptoms of sepsis and septic shock[2, 3]
Shock score ≥ 45

Perform and Document Sepsis Huddle

Suspected septic shock[3]
Immediate evaluation & treatment within **60 min**

Suspected sepsis without shock[2]
Expedited evaluation for infection/organ dysfunction & treatment within **180 min**

No concern for sepsis or septic shock
Provide ongoing care & treat infections as indicated

Off Sepsis Pathway

Next Step
- Use Sepsis & Septic Shock Management Order set
- Support breathing/oxygen (goal SpO2 92-98%)
- Collect Labs: blood culture, VBG + lactate or critical care panel, POCT glucose, CBC, CMP, Mg, Phos, DIC panel, amylase/lipase, PCT, T&S, HCG, ScvO2 (if CVL in place)
- Initiate additional work up for source of infection as clinically indicated

Establish immediate access
- Insert 2 peripheral IVs or access CVL
- IO after 2 unsuccessful IV attempts

Interventions/Antibiotics
- Give antibiotics within **60 min** see pg 3 *(Do not delay antibiotics if unable to obtain cultures)*
- Treat hypoglycemia/hypocalcemia see pg 4
- Consider ICU

Fluid Resuscitation[4]
- 10-20 mL/kg of NS/LR/PL bolus via push/pull or rapid infuser
- Fluid resuscitation goal within **60 min**

>40-60 mL/kg and/or fluid overload?[4]
- No → Fluid Resuscitation[4]
- Reassess → >40-60 mL/kg and/or fluid overload?[4]

Persistent shock?[5]
- Yes → Next Step
- No → Disposition

Next Step
- Initiate vasoactive medication
- Repeat fluid for hypovolemia

Go to pg 2

Establish urgent access
- Insert peripheral IV or access CVL

Interventions/Antibiotics
- Give antibiotics within **180 min** *(but as soon as possible)* if work up supports bacterial infection or sepsis see pg 3
- For **sickle cell disease, oncologic diagnoses, or ED patient with CVL**, administer antibiotics within **60 min**

Fluid Resuscitation[4]
- 10-20 mL/kg NS/LR/PL bolus as needed for hypovolemia

Concern for Shock?
- Yes → Fluid Resuscitation[4]
- No → Disposition

Reassess every 15-30 min

Disposition
- Admit/transfer/reassess as clinically indicated

[5]Septic Shock Resuscitation Targets

Age	Heart Rate	SBP	MAP	DBP
29 days to < 1 year	100-160	> 65	> 45	> 30
1 to < 2 years	90-160	> 70	> 50	> 35
2 to 6 years	<1 40	> 85	> 55	> 40
6 to 12 years	< 130	> 85	> 60	> 45
≥ 13 years	< 110	> 90	> 65	> 50

Reassess for mental status, capillary refill, pulse strength, and extremity temperature

[6]CVL PLACEMENT FOR VASOACTIVES

- Unable to wean vasoactive after 6-8 hours of infusion
- Need for high dose therapy or more than 1 vasoactive
- Unable to maintain 2 PIVs and run infusion into large bore vein

ADJUVANT THERAPIES

See page 5

- Nutrition
- IVIG
- Plasma Exchange

Additional Tables

See page 5 & 6

- Subsequent Labs
- Blood Products
- Abbreviation reference

[2]Septic Shock Resuscitation Targets

Age	Heart Rate	SBP	MAP	DBP
29 days to < 1 year	100-160	> 65	> 45	> 30
1 to < 2 years	90-160	> 70	> 50	> 35
2 to 6 years	<1 40	> 85	> 55	> 40
6 to 12 years	< 130	> 85	> 60	> 45
≥ 13 years	< 110	> 90	> 65	> 50

Reassess for mental status, capillary refill, pulse strength, and extremity temperature

PICU Management

Persistent shock?[2] — No

Yes

Next Step
- Obtain cardiac POCUS (if available)
- Start or titrate epinephrine or norepinephrine based on assessment page 4
- Consider CVL[6]
- Respiratory support (notify RT)

Persistent shock?[2] — No

Yes

Next Step
- Repeat cardiac POCUS (if available)
- Consider arterial line and urinary catheter
- Titrate epinephrine or norepinephrine
- Consider PRBCs see pg 5

Persistent shock?[2] — No

Yes

Consider hydrocortisone see pg 4

Persistent shock?[2] — No

Yes

Next Step
- Consider additional vasoactives page 4
- If not already placed, consider CVL[6]

Evaluate for:
- Infection source
- Pericardial effusion
- Pneumothorax
- Intra-abdominal hypertension
- Primary cardiac dysfunction

Consider	Consult	Reassess
Consider ECMO for persistent septic shock	Consult ID or other specialists as needed	Reassess and provide care as clinically appropriate

Sepsis & Septic Shock Management
Empiric Antimicrobials

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Ask ALLERGY Question FIRST: Does patient have IgE mediated penicillin or cephalosporin allergy[1] or other severe reactions[2]?

NO: Follow algorithm below

- **YES** to penicillins →May use 3rd or 4th generation cephalosporins per algorithm
- **YES** to cephalosporins → Consult with pharmacy; May use meropenem instead of beta-lactam

Group 1: Lower risk *for resistant organisms*

Generally healthy population
OR any one of the following:
- Oncology patient without neutropenia
- Sickle cell disease
- Other condition based on individual patient assessment

Suspected septic shock

Ceftriaxone
(give first)
+
Vancomycin

If suspected intra-abdominal infection
Add metronidazole

Additional drug considerations[6]
+/- Clindamycin
+/- Antiviral

Suspected sepsis WITHOUT shock

Ceftriaxone

If suspected intra-abdominal infection
Add metronidazole

Additional drug considerations[6]
+/- Vancomycin
+/- Clindamycin
+/- Antiviral

Group 2: Higher risk *for resistant organisms*

Any one of the following:
- Prescence of specific chronic conditions[3]
- Indwelling central venous line
- Other condition based on individual patient assessment

Suspected septic shock

Cefepime
(give first)
+
Vancomycin

If suspected intra-abdominal infection
Add metronidazole

Additional drug considerations[6]
+/- Clindamycin
+/- Antiviral
+/- Antifungal

Suspected sepsis WITHOUT shock

Cefepime

If suspected intra-abdominal infection
Add metronidazole

Risk for enterococcus (i.e. short bowel, acute biliary disease)
Piperacillin/ tazobactam[6]

Additional drug considerations[6]
+/- Vancomycin
+/- Clindamycin
+/- Antiviral
+/- Antifungal

Group 3: Highest Risk for resistant orgamisms

Any one of the following:
- Known history of multi-drug resistant Gram-negative (MDR-GN) organisms
- New sepsis episode while on a broad spectrum antibiotic

Suspected sepsis or septic shock

Meropenem[7]
(give first)
+
Vancomycin

Additional drug considerations[6]
+/- Clindamycin
+/- Antiviral
+/- Antifungal

[7]If patient has history of GN organisms with carbapenem resistance, use:

DE region: Use meropenem + amikacin and contact ID
FL region: Use meropenem + gentamicin and contact ID

[6]IMPORTANT additional antimicrobial drug considerations

- Add IV vancomycin per indications[4]
- Add IV clindamycin if suspected toxic shock syndrome or necrotizing fasciitis
- Piperacillin/tazobactam: Consider in patients with increased enterococcus risk; Do not use if CNS infection suspected/possible
- Add antiviral: Oseltamivir (influenza); remdesivir (COVID); other antivirals – contact ID
- Add antifungal if increased risk – contact ID
- Add doxycycline if suspected rickettsiae (with appropriate epidemiology) – contact ID

Definition of broad spectrum antibiotics (prior to meropenem)

- Ceftazidime, Cefepime, Piperacillin/tazobactam, Ertapenem

[1]IgE Mediated (Type 1) Allergy

- Allergist-confirmed allergy
- History of urticaria, angioedema, wheezing, respiratory distress or anaphylaxis

[2]Other life threatening and/ or severe hypersensitivity reactions

- History of serum sickness or like reactions, erythema multiforme, SJS/TEN/ DRESS – Contact ID

[3]Chronic Medical Conditions with increased Pseudomonas infection risk

- Fever/Neutropenia
- Certain immunocompromised states
- Tracheostomy or ventilator
- Certain device-associated infections
- Short bowel syndrome
- Long term care resident
- Cystic Fibrosis

[4]Indications for Vancomycin

- Recent (<12mos) MRSA history
- Skin/soft tissue infections
- Necrotizing pneumonia/ empyema
- Bacterial meningitis or CNS abscess
- Indwelling CVL
- Mucositis in oncology patient

[5]Risks for Invasive Fungal Infection Consult with ID Team

- Prolonged neutropenia
- Chronic TPN
- Intestinal perforation (small bowel)
- Certain immunocompromised states
- Prior invasive fungal infection

Medication Dosing			
Medication	Route	Dosage	Max. per Dose
Calcium chloride	IV / IO	10 to 20 mg/kg/dose	1000 mg/dose
Calcium gluconate	IV / IO	50 to 100 mg/kg/dose	2000 mg/dose
Dextrose solution	IV / IO	0.5 to 1 g/kg/dose	25 g/dose
Epinephrine	IV / IO	Titrate according to institutional policy	
Norepinephrine	IV / IO	Titrate according to institutional policy	
Hydrocortisone loading dose	IV / IO	100 mg/m^2/day (or 4 mg/kg/day)	200 mg/day
Hydrocortisone maintenance dose	IV / IO	25 mg/m^2/dose	50 mg every 6 hours
See Electrolyte Replacement & Infusions Policy and order set for administration decision support.			

Antibiotic Dosing			
Medication	Route	Dosage	Max. per Dose
Ceftriaxone	**IV Push 5 min** (OK to give IM)	75 mg/kg/dose every 24 hours (For meningitis, give 50 mg/kg/dose every 12 hours)	2000 mg/dose
Cefepime	**IV Push 5 min** (OK to give IM)	50 mg/kg/dose every 8 hours	2000 mg/dose
Clindamycin	**IV Push 10 min** (OK to give IM)	13.3 mg/kg/dose every 8 hours	900 mg/dose
Metronidazole	**IV Infusion**	10 mg/kg/dose every 8 hours	500 mg/dose
Meropenem	**IV Push 5 min** (if > 3 m/o)	20 mg/kg/dose every 8 hours (For meningitis, give 40 mg/kg/dose every 8 hours)	2000 mg/dose
Piperacillin/tazobactam	**IV infusion**	100 mg/kg/dose every 6 hours	4000 mg/dose
Amikacin	**IV Infusion** (OK to give IM)	20 mg/kg/dose every 24 hours	
Gentamicin	**IV Infusion**	2.5mg/kg/dose IV once (Consult pharmacy for subsequent doses)	
Vancomycin	**IV Infusion**	Dosing varies by patient age and renal function.	

Nutrition

- Enteral nutrition is the preferred method of feeding, either orally or via gastric tube. A post-pyloric feeding tube may be considered for patients at high risk for aspiration or evidence of slow gastric emptying.
- Enteral nutrition should begin as early as safe/feasible either with initial hypocaloric (e.g., trophic) feeding or full enteral feeding, as per best clinical judgment. Use PICU Enteral Continuous Tube Feeding order set, if applicable.
- Enteral feeding should not be withheld solely on the basis of vasoactive medications *after* adequate hemodynamic resuscitation so long as the patient no longer requires escalating doses of vasoactive agents. However, risks of enteral feeding increase for patients on escalating doses of vasoactive medications, doses of epinephrine/norepinephrine ≥0.2 mcg/kg/min, or any dose of vasopressin for shock.
- For patients unable to tolerate enteral nutrition, parenteral nutrition (TPN) should be started on day 5-7 following sepsis onset. Earlier initiation of parenteral nutrition has not been associated with benefit.

IVIG

- Routine use of IVIG in septic pediatric patients is NOT recommended.
- IVIG could be considered for patients with primary humoral immunodeficiency and/or immune compromised with documented low IgG.
- IVIG could also be considered for patients with toxic shock, specifically streptococcal toxic shock syndrome.

Plasma Exchange

If plasma exchange is considered, it has been shown the most benefit occurs when performed early (within 30 hours) after sepsis and organ dysfunction onset.

- May be considered for patients with:
  - Thrombocytopenia-associated multisystem organ failure (TAMOF)
  - Defined as ≥ 3 organ system failures and thrombocytopenia (platelet count < 100,000)
  - Septic shock with estimated mortality > 35%
- Mortality rates > 35% have been reported in pediatric patients with septic shock requiring:
  - > 1 vasoactive infusion
  - Invasive mechanical ventilation
  - AND at least one additional severe organ dysfunction (e.g., renal, hepatic, hematologic, neurologic)

Laboratory Studies

Lab	Frequency
Critical care panel with lactate (or venous blood gas + lactate)	Every hour while critically ill; if stable consider every 6 hours
POC blood glucose	Every 1-2 hours if requiring insulin
CBC with differential DIC panel Magnesium Phosphorous	Every 12 hours
CMP	Every 24 hours (AM)
BMP	Every 24 hours (PM)
Procalcitonin	Every 24 hours
Type and screen	Every 72 hours
Ferritin	If concern for severe multiorgan dysfunction
ADAMTS-13	If concern for TAMOF
BNP	If concern for cardiac dysfunction
Consider additional infectious source specific labs as indicated.	

Blood Products

Product	Considerations
PRBC	Hgb < 7-10 and persistent shock
FFP	Invasive procedure and INR/PTT elevated or DIC with active bleeding
Platelets	PLT <50,000 with active bleeding or need for invasive procedure

Abbreviations			
Abbreviation	**Terminology**	**Abbreviation**	**Terminology**
VBG	Venous blood Gas	**MAP**	Mean Arterial Pressure
PCT	Procalcitonin	**DBP**	Diastolic Blood Pressure
CBC	Complete Blood Count	**RT**	Respiratory therapy
CMP	Complete Metabolic Panel	**ECMO**	Extracorporeal Membrane Oxygenation
Mg	Magnesium	**ID**	Infectious Disease
Phos	Phosphorous	**IVIG**	Intravenous Immunoglobulins
DIC	Disseminated Intravascular Coagulation	**PIV**	Peripheral IV
T&S	Type & Screen	**POCUS**	Point of Care Ultrasound
HCG	Human Chorionic Gonadotropin	**PRBC**	Packed Red Blood Cells
ScvO2	Central venous Oxygen Saturation	**TPN**	Total Parenteral Nutrition
CVL	Central Venous Line	**MRSA**	Multi-resistant Staph aureus
IV/IO	Intravenous Intraosseous	**SJS**	Steven-Johnson Syndrome
NS	Normal Saline	**TEN**	Toxic Epidermal Necrolysis
LR	Lactated Ringers	**DRESS**	Drug Reaction with Eosinophilia and Systemic Symptoms
PL	Plasmalyte	**mg**	Milligrams
ICU	Intensive Care Unit	**g**	Grams
ED	Emergency Department	**kg**	Kilograms
SBP	Systolic Blood Pressure		

VERSION MANAGEMENT

- Version 1.0 (5/29/2024): Go Live.

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