Paediatric Septic Shock

STG-001

Standard Treatment Guideline (STG)

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Standard Treatment Guidelines (STGs) for paediatric critical care are essential to ensure safe, evidence-based, ethical, and standardized management of critically ill children in Nepal. Given the wide variation in healthcare infrastructure, human resources, and availability of critical care services across the country, uniform clinical guidance is necessary to minimize unnecessary variations in practice and improve patient outcomes. These guidelines assist paediatricians, medical officers, residents, and other healthcare professionals in making timely, consistent, and appropriate clinical decisions, particularly in resource-limited settings. STGs also reinforce adherence to the Nepal Medical Council's Code of Ethics and Professional Conduct by promoting professional competence, patient safety, informed consent, appropriate documentation, and accountability. Furthermore, adherence to nationally accepted guidelines helps establish the expected standard of care, thereby reducing the risk of preventable errors, medico-legal disputes, and litigation while supporting defensible clinical practice. As practical bedside references, STGs facilitate rapid decision-making, enhance resident training, improve communication among multidisciplinary teams, and promote rational utilization of available resources. They also provide a framework for quality assurance, clinical audit, and continuous professional development. The adoption and implementation of national paediatric critical care STGs will strengthen clinical governance, promote equitable delivery of critical care services, and contribute to improved survival and health outcomes for critically ill children throughout Nepal.

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Introduction & Definitions

Sepsis is a clinical syndrome causing life-threatening organ dysfunction due to dysregulated host response to infection.

Sepsis in children is defined using Phoenix sepsis score which is a composite of four organ system model including cardiovascular, respiratory, neurological, and coagulation dysfunction as described in the table 1.

Sepsis is defined in children when the sepsis score is ≥2 points

Septic shock is defined in a subset of sepsis patients with cardiovascular dysfunction defined by cardiovascular score of at least 1 point

Table 1: Phoenix sepsis score

Variables	0 points	1 points	2 points	3 points
Respiratory (0-3 points)	PaO2:FiO2 ≥400 or SpO2:FiO2≥292	PaO2:FiO2 <400 on any respiratory support or SpO2:FiO2<292 on any respiratory support	PaO2:FiO2 =100-200 & IMV or SpO2:FiO2=148-220&IMV	PaO2:FiO2 <100 & IMV or SpO2:FiO2<148 &IMV
Cardiovascular (0-6 points)	No vasoactive medications Lactate<5 mmol/L MAP	**1 point each (upto 3)** One vasoactive medication Lactate5-10 mmol/L MAP	**2 Point each (upto 6)** ≥ 2 vasoactive medications Lactate≥ 11 mmol/L MAP	
Age based (MAP) <1 month 1-11 month 1-<2 years 2-<5 years 5-<12 years 12-17 years	MAP (mmHg) >30 >38 >43 >44 >48 >51	MAP (mmHg) 17-30 25-38 31-43 32-34 36-48 38-51	MAP (mmHg) <17 <25 <31 <32 <36 <38	
Coagulation (0-2 points)	Platelets≥100 x 10^3/µL INR≤1.3 D-dimer≤2 mg/L FEU Fibrinogen ≥100 mg/dL	**1 point each (Max 2 points)** Platelets<100 x 10^3/µL INR>1.3 D-dimer>2 mg/L FEU Fibrinogen <100 mg/dL		
Neurological (0-2 point)	GCS>10; pupils reactive	GCS≤10	Fixed pupils bilaterally	
Phoenix sepsis criteria **Sepsis**: Suspected infection & phoenix sepsis score ≥ 2 points **Septic shock**: Sepsis with ≥ 1 cardiovascular points				

PaO2- partial pressure of arterial oxygenation, FiO2- fraction of inspired oxygen, SpO2- peripheral oxygen saturation, IMV- Invasive mechanical ventilation, MAP=DBP+1/3 (SBP-DBP) or MAP=SBP+(2xDBP)/3, GCS- Glasgow coma scale

Clinical manifestations

Signs of inadequate tissue perfusion

Macrocirculatory: tachycardia[x], tachypnea[x], temperature instability, prolonged capillary refill time (>3 sec), oliguria, altered mental status. Hypotension (SBP or MAP less than 5th centile for age) is a late sign.

Microcirculatory: metabolic acidosis, elevated lactate (>5mmol/L)

[x]Reference value	<1 year	1-5 years	5-10years	10-16 years
Heart rate	180	140	120	100
Systolic BP (5th centile) mmHg	<70	70+ (age x2)	70+ (age x2)	90
Respiratory rate (breath/min)	50	40	30	30
Mean arterial pressure (MAP)= 40+(agex1.5)	40-45	45-55	50-65	60-75

Investigations

Routine	Complete blood count, Blood culture, Renal function test, blood sugar, calcium, lactate, Liver function test, Blood gas, urine -routine & culture, Chest x ray, PT/INR, D- dimer
If available	USG of specific organs, Lumbar puncture, hemodynamic Point of care ultrasound (POCUS) (based on availability)

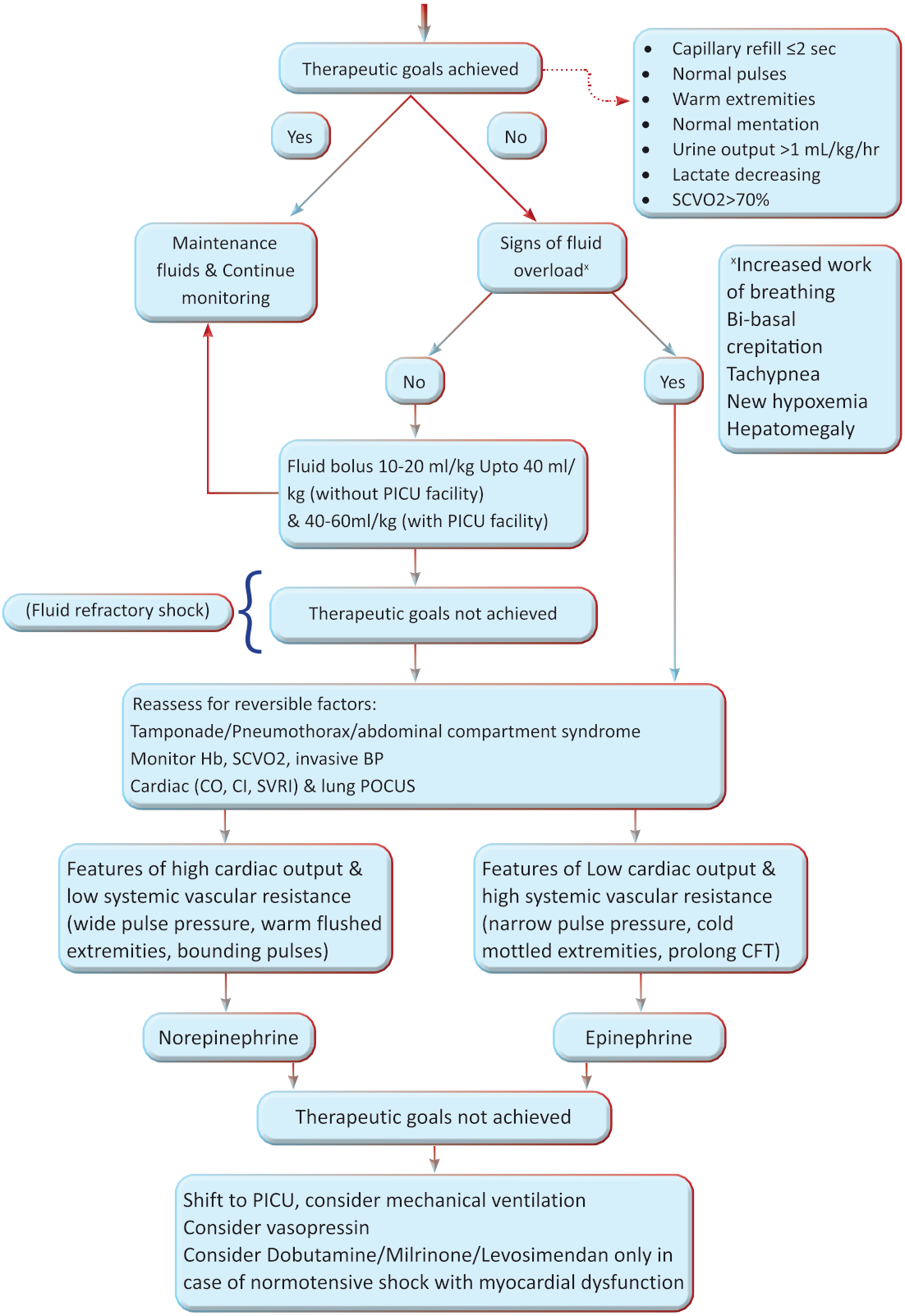
Management

0-5 minutes

- Recognize signs of poor perfusion in a febrile child
- Attach monitor, start O2 via non rebreathing mask (NRM) at 10-15 L/min or high flow devices
- Obtain IV/IO access and send lab investigations as mentioned.
- Correct metabolic derangements like hypoglycemia/hypocalcemia
- Start empiric broad spectrum antibiotics
- Hypotensive shock (SBP<5th centile): NS 10-20 ml/kg in first hour
- Normotensive shock: No fluid bolus, start on maintenance fluids

5-60 minutes

- Normal saline/Ringers lactate/Plasmalyte bolus 10-20 ml/kg in 1st hour
- Monitor clinical signs of resolution of shock/fluid overload: heart rate, capillary refill time, Temperature, blood pressure, urine output, sensorium, liver span, respiratory rate, basal rales & POCUS guided cardiac monitoring


Therapeutic goals achieved
Capillary refill ≤2 sec
Normal pulses
Warm extremities
Normal mentation
Urine output >1 mL/kg/hr
Lactate decreasing
SCVO2>70%
Yes
No
Maintenance fluids & Continue monitoring
Signs of fluid overload[x]
[x]Increased work of breathing
Bi-basal crepitation
Tachypnea
New hypoxemia
Hepatomegaly
No
Yes
Fluid bolus 10-20 ml/kg Upto 40 ml/kg (without PICU facility)
& 40-60ml/kg (with PICU facility)
(Fluid refractory shock)
Therapeutic goals not achieved
Reassess for reversible factors:
Tamponade/Pneumothorax/abdominal compartment syndrome
Monitor Hb, SCVO2, invasive BP
Cardiac (CO, CI, SVRI) & lung POCUS
Features of high cardiac output & low systemic vascular resistance (wide pulse pressure, warm flushed extremities, bounding pulses)
Features of Low cardiac output & high systemic vascular resistance (narrow pulse pressure, cold mottled extremities, prolong CFT)
Norepinephrine
Epinephrine
Therapeutic goals not achieved
Shift to PICU, consider mechanical ventilation
Consider vasopressin
Consider Dobutamine/Milrinone/Levosimendan only in case of normotensive shock with myocardial dysfunction

Rule out- Pneumothorax, cardiac tamponade, abdominal compartment syndrome

SBP/MAP still below 5th centile

Consider CRRT for fluid overload/cytokine storm/AKI
Consider ECMO

Flowchart: Management of septic shock in infants and children

Table 3: Normal ranges for advanced monitoring

Variable	Formula	Normal Range	
Cardiac Index (CI)	CO/BSA	3.5-5.5	L/min/m2
Stroke Index (SI)	CI/HR	30-60	ml/m2
Systemic vascular resistance index (SVRI)	80X(MAP-CVP)/CI	800-1600	dyne.s/cm5/m2

CO-Cardiac output, BSA- Body surface area, HR- Heart rate, CVP- Central venous pressure

Supportive Management

Antibiotics	• Blood culture before starting antibiotics • Broad spectrum (preferably 3rd generation cephalosporin) within 1st hour • Consider adding anti staphylococcal agent in case of skin infection, TSS, pneumatocele or spontaneous pneumothorax in chest x- ray. • Consider adding clindamycin for deep seated skin infection, necrotizing fasciitis, TSS • Pre-existing immunocompromised state: antipseudomonal, MRSA and antifungal agents as per clinical situation. • Daily assessment for timely de- escalation of antimicrobials as per culture & sensitivity report • Duration of antimicrobials as per site, etiology, treatment response and control of source
Ventilation	• A trial of Noninvasive ventilation (NIV) over invasive ventilation in children with Pediatric Acute Respiratory Distress Syndrome (PARDS) • Intubation can be considered in children with fluid refractory, catecholamine resistant shock • Low tidal volume (6ml/kg) & high Positive End Expiratory Pressure (PEEP) in sepsis induced PARDS • Trial of prone positioning in PARDS • Use of inhaled nitric oxide (iNO) as rescue therapy (if available) • Use of neuromuscular blockade in severe PARDS

Source control	• Implementation of source control strategy for prevention of infection as early as possible • Removal of intravascular line which are confirmed source of infection after establishing alternative vascular access
Nutrition	• Maintain euglycemia • Partial or full enteral feeding via nasogastric tube preferably within 48 hours
Transfusion	• Transfusion of Packed red blood cells (PRBC) if Hemoglobin<7 gm/L in hemodynamically unstable children • Consider transfusion of platelets in high risk children(eg.Oncological conditions) with platelets of <10,000/mm3) • Consider transfusion of fresh frozen plasma only if clinical bleeds
Steroids	• Can be considered in children with suspected or proven adrenal insufficiency
Adjunctive therapy	• Intravenous immunoglobulin (IVIG) can be considered in case of toxic shock syndrome, necrotizing fasciitis
Extracorporeal support (If available)	• Continuous renal replacement therapy (CRRT) in case of fluid overload or cytokine storm, acute kidney injury • Extracorporeal membrane oxygen (ECMO): Veno venous (VV)- ECMO for respiratory support alone & Veno arterial (VA)-ECMO for both respiratory & circulatory support
Monitoring	• Clinical monitoring: after every intervention & hourly • Use advanced hemodynamic monitoring tools like cardiac output, cardiac index, SCVO2, SVRI, IBP in addition to clinical parameters • Use of serial trends of lactate rather than single isolated value

SCVO2: Central venous oxygen saturation; SVRI: Systemic vascular resistance index,
IBP: Invasive blood pressure

Dosing of vasoactive drugs

Drug	Dose (mcg/kg/min)	Dilution in 50 ml dextrose 5%	IV infusion rate
Dopamine	5-20	30mg/kg	1ml/hr=10 mcg/kg/min
Dobutamine	5-20	30mg/kg	1ml/hr=10 mcg/kg/min
Adrenaline	0.05-1.0	0.3mg/kg	1ml/hr=0.1 mcg/kg/min
Nor- adrenaline (vasopressor)	0.05-0.5	0.3mg/kg	1ml/hr=0.1mcg/kg/min
Vasopressin (vasopressor)	0.5-2milli U/kg/min	3milli U/kg	1ml/hr=1milli U/kg/min
Milrinone (Inodilator)	0.25-1.0	1.5 mg/kg	1ml/hr=0.5mcg/kg/min
Levosimendan (Inodilator)	0.05-0.2	0.3mg/kg	1ml/hr=0.1 mcg/kg/min

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