SEPTIC SHOCK MANAGEMENT

Sepsis backbone treatment:

- Appropriate and timely antimicrobial therapy
- Source control if indicated
- Fluid therapy with crystalloids – initial bolus of 30 ml/Kg followed by maintenance IVF with frequent reassessment
- Targeted vasopressors to keep MAP >65 mmHg and UO >0.5 ml/Kg/h

IV Fluids:

Use balanced crystalloids LR or Plasmalyte-Normosol as maintenance IV fluids and boluses as needed to achieve MAP target 65 mm Hg and UO >0.5 ml/Kg/h

- Initial IV balanced crystalloids infusion at 125 -150 ml/h
- IV bolus at 30 ml/Kg if the patient becomes hypotensive (MAP <65 or SBP <90 mmHg)
    - In patients with large cumulative positive fluid balance consider albumin 5% 250 ml bolus as needed
    - In patients with large cumulative positive fluid balance AND peripheral edema-third spacing, consider albumin 25% 50 ml IV q6h

The target ordered volume must be ordered and initiated within the specified time frame if initial hypotension or septic shock is present per CMS mandate.

- An IV bolus less than 30 mL/kg of crystalloid IVF is acceptable for the target ordered volume if all of the following criteria were met:
    - There is a physician/APN/PA order for the lesser volume of crystalloid IVF as either a specific volume (e.g., 1500 mL) or a weight-based volume (e.g., 25 mL/kg).
    - The ordering physician/APN/PA documented within a single source (e.g., note or order) in the medical record all of the following:
        - The volume of fluids to be administered as either a specific volume (e.g., 1500 mL) or a weight-based volume (e.g., 25 mL/kg)
        - AND a reason for ordering a volume less than 30 mL/kg of crystalloid fluids.
    - Reasons for lesser IV volume include and are not limited to concern for:
        - Fluid overload
        - Heart failure
        - Renal failure
        - Blood pressure responded to lesser volume
- If a portion of the crystalloid IVF volume was administered as colloids, there must be an order and documentation that colloids were started or noted as given
- Physician/APN/PA can use ideal body weight (IBW) to determine the target ordered volume if all of the following conditions are met
    - Physician/APN/PA documents the patient is obese (defined as BMI >30)
    - Physician/APN/PA documents IBW is used to determine target ordered volume

Vasopressors:

- Norepinephrine to titrate up to 35-90 µg/min to achieve MAP target 65 mm Hg
- Vasopressin 0.03 U/min if no response to norepinephrine at 30 µg/min. It can be increased to 0.04 U/min

- IV stress-dose steroids if no response to IVF and moderate to high-dose vasopressor therapy
    - IV hydrocortisone 200–300 mg/d as a continuous infusion or in divided doses or for 5–7 days with or without a taper
    - Fludrocortisone 50-µg enterally
- Epinephrine If MAP not at target as third agent up to 20-50 µg/min
- Phenylephrine If MAP not at target as fourth agent up to 200-300 µg/min
    - Usually not needed unless patient with atrial fibrillation

Miscellaneous:

- Consider femoral arterial line insertion
    - Radial arterial pressure waveforms often underestimate blood pressure in the context of severe hypovolemia and peripheral vasoconstriction.
- Consider lower the MAP target to 60 mmHg in patients older than 65 years especially if requiring high doses of multiple vasopressors

REFRACTORY SHOCK

Refractory shock is defined as persistent organ dysfunction and evidence of tissue hypoperfusion (e.g., hyperlactatemia, metabolic acidosis, oliguria, delayed capillary refill) despite a normal or high central mixed venous O2Sat (ScvO2) and normal central venous-to-arterial carbon dioxide partial pressure, the PCO2 gap ($P(v–a)CO_2$).

- Normal ScvO2 = 70-75%
- Normal v-aPCO2 = 2-5 mmHg

Rationality for using the $P(v–a)CO_2$, as a marker of blood perfusion and mitochondrial dysfunction.

- CO2 is the end product of aerobic metabolism
- pCO2 in the venous blood reflects the global tissue blood flow relative to metabolic demand
- CO2 is about 20 times more soluble than O2 so diffuses more reliably out of ischemic tissues into the venous effluent making it a sensitive marker of hypoperfusion
- $P(v–a)CO_2$ >6 mmHg suggests a persistent shock state that may be amenable to fluid resuscitation +/- inotrope support

Refractory shock usually indicates a marked microcirculatory disorder and/or mitochondrial dysfunction poorly responsive to macrohemodynamic therapeutic manipulations. This situation is more commonly seen during septic shock.

- A $P(v–a)CO_2$ >6 mmHg identifies patients for whom an increase in CO may be beneficial in sustaining organ perfusion despite a ScvO2>70%.
- If the $P(v–a)CO_2$ is <6 mmHg it is unlikely that increasing CO would reverse organ hypoperfusion

The $P(v–a)CO_2$ and $ScvO_2$ can also be used to assess fluid responsiveness in patients *without* refractory shock.

- After a 500 ml IVF bolus given in 15 min, the $P(v–a)CO_2$ decreases and $ScvO_2$ increases in fluid responders indicating improvement in stroke volume

PCO2 gap in different shock states (from Vallet et al (2013)

Shock type	Lactate	O2ER	ScvO2	cvaCO2gap
Cardiogenic or hypovolemic	HIGH	HIGH	LOW	HIGH
Anemic or hypoxemic	HIGH	HIGH	LOW	LOW
Distributive	HIGH	LOW	HIGH	HIGH
Cytopathic	HIGH	LOW	HIGH	LOW