



Fluid Resuscitation in Sepsis

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Objectives

- After completion of this module, participants will:
 - Describe the initial therapy for fluid resuscitation in patients with sepsis and septic shock
 - Compare crystalloid and colloid therapy for fluid resuscitation
 - Identify the risk factors of fluid resuscitation
 - Describe techniques for intravascular volume assessment



New Definitions

Sepsis

- Life-threatening organ dysfunction caused by a dysregulated host response to infection
 - Defined by qSOFA + SOFA scores
 - Emphasizes organ dysfunction
 - De-emphasizes nonspecific systemic inflammation
 - No more “severe sepsis”

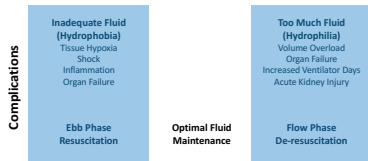
Septic shock

- Persistent hypotension requiring vasopressors AND lactate > 2
- A subset of sepsis in which underlying circulator and cellular/metabolic abnormalities are profound enough to substantially increase mortality
 - Hypotension = MAP < 65
 - Combination of ↓ BP and ↑ lactate:
 - » Significantly higher risk-adjusted mortality for combo (42.3%) vs. for pressors alone (30.1%), lactate > 2 alone (25.7%)

Singer M, et al. JAMA 2016;315(8):801-810.



The Ebb and Flow of Sepsis



Adapted from: Jaehne and Rivers. Crit Care Med 2016;46:2263-9.



2016 Sepsis and Septic Shock Initial Management

3 HOUR BUNDLE

1. Measure lactate
2. Obtain blood cultures prior to antibiotics
3. Administer broad spectrum antibiotics
4. Administer 30 mL/kg crystalloid for hypotension or lactate of ≥ 4 mmol/L

6 HOUR BUNDLE

5. Apply vasopressors (not respond to fluid)
 - Goal MAP ≥ 65
6. Persistent hypotension despite fluid or ↑ lactate
 - Measure CVP
 - Measure SvO2
7. Re-measure lactate if initial lactate was elevated

Dellinger, et al. Crit Care Med 2013;41:980-937.
 Rhodes A, et al. Crit Care Med 2017;45(3):486-502.



Resuscitation Fluids

Solution	Volume expansion* (%)	Duration of volume expansion (h)
Sodium chloride 0.9%	20-25	1-4
Lactated Ringer's/PlasmaLyte	20-25	1-4
5% Albumin	70-100	12-24
25% Albumin	300-500	12-24

* Expressed as a percentage of administered volume
 Am J Resp Crit Care Med 2004;170:1247-1259



Initial Resuscitation

- Sepsis and septic shock are medical emergencies, and we recommend that treatment and resuscitation begin immediately (BPS).
- We recommend that, in the resuscitation from sepsis-induced hypoperfusion, at least 30 mL/kg of IV crystalloid fluid be given within the first 3 hours (strong recommendation, low quality of evidence).
- We recommend that, following initial fluid resuscitation, additional fluids be guided by frequent reassessment of hemodynamic status (BPS).

Rivkin A, et al. Crit Care Med 2017;45(3):488-502.
Rivkin A, et al. Intensive Care Med 2017;43(3):304-317.



Intravascular Volume Assessment

- We recommend further hemodynamic assessment (such as assessing cardiac function) to determine the type of shock if the clinical examination does not lead to a clear diagnosis (BPS).
- We suggest that dynamic over static variables be used to predict fluid responsiveness, where available (weak recommendation, low quality of evidence).
- We recommend an initial target mean arterial pressure (MAP) of 65 mmHg in patients with septic shock requiring vasopressors (strong recommendation, moderate quality of evidence).
- We suggest guiding resuscitation to normalize lactate in patients with elevated lactate levels as a marker of tissue hypoperfusion (weak recommendation, low quality of evidence).

Rivkin A, et al. Crit Care Med 2017;45(3):488-502.
Rivkin A, et al. Intensive Care Med 2017;43(3):304-317.



Ongoing Fluid Therapy

- We recommend that a fluid challenge technique be applied where fluid administration is continued as long as hemodynamic factors continue to improve (BPS).
- We recommend crystalloids as the fluid of choice for initial resuscitation and subsequent intravascular volume replacement in patients with sepsis and septic shock (strong recommendation, moderate quality of evidence).
- We suggest using either balanced crystalloids or saline for fluid resuscitation of patients with sepsis and septic shock (weak recommendation, low quality of evidence).
- We suggest using albumin in addition to crystalloids for initial resuscitation and subsequent intravascular volume replacement in patients with sepsis and septic shock when patients require substantial amounts of crystalloids (weak recommendation, low quality of evidence).

Rivkin A, et al. Crit Care Med 2017;45(3):488-502.
Rivkin A, et al. Intensive Care Med 2017;43(3):304-317.



Too Much Fluid is Too Much...

- Studies suggest that continued fluid therapy after initial fluid resuscitation is harmful
 - Retrospective review (n=350) of fluid resuscitation in septic shock
 - A more positive fluid balance at 24 hours is suggestive of increase mortality; 42% vs 56% [HR 1.519 (1.353 – 1.685)]
 - Prospective study (n=50) evaluated fluid boluses over 3 days after initial resuscitation
 - Cumulative fluid balance was associated with worsening SOFA scores, lung injury scores, & PaO2/FiO2 ratio

Sadaka F, et al. Journal of Intensive Care Medicine 2013;10:1-5.
Bihari S, et al. Shock 2013;40:28-34.



The Case Against Too Much Fluid

- Positive fluid balance associated with worse outcome
 - Prospective, observational trial using SOAP network
 - 3147 patients with ALI

	Survivors (n=239)	Non-survivors (n=153)	P Value
Higher tidal volume	80 (33.5)	68 (44.4)	0.019
Higher plateau pressure	32 (13.4)	25 (16.3)	0.419
Fluid balance			
Admission	1.0 ± 2.6	1.6 ± 2.6	0.03
48 hr	1.7 ± 4.1	2.9 ± 4.6	0.005
72 hr	1.8 ± 5.4	3.6 ± 6.4	0.002
96 hr	1.4 ± 6.5	3.9 ± 7.8	0.001
Mean daily	-0.3 ± 1.1	0.9 ± 1.9	< 0.001
Total	-3.0 ± 17.8	4.4 ± 23.6	< 0.001

Sakr Y, et al. Chest 2005;128:3098-3108.



Fluid and Outcomes

- Fluid overload is an independent risk factor for increased mortality and morbidity in critically ill patients
- Fluid overload increases reintubation rate and AKI
- Fluid-conservative approach improves ventilator-free and ICU-free days in patients with ARDS

Sakr Y, et al. Chest 2005;128:3098-108.
Sadaka F, et al. J Intensive Care Med 2014;29:213-7.
Bihari S, et al. Shock 2013;40:28-34.



Fluid Resuscitation

- Early aggressive resuscitation in severe sepsis may improve outcomes
- Normalization of lactate is associated with improved outcomes
- Over aggressive continued resuscitation may do more harm than good
- Crystalloids as the initial fluid of choice
- Albumin can be used when patients require substantial amounts of crystalloids
- Avoid starches and gelatins in sepsis and septic shock



Interprofessional Education Module to Learn, Teach, and Optimize the Treatment of Sepsis

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- Renee Dixon, MD
- Joan M. Davenport, RN, PhD
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