



APPROACH TO THE SHOCK

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Definition

Inadequate tissue perfusion

Life threatening

Imbalance between the supply of and demand of oxygen and nutrients

Classification of shock states

Hypovolemic shock

Hemorrhage

Fluid loss/
dehydration

Cardiogenic shock

Pump failure

Valvular disorders

Cardiac dysrhythmia

Distributive shock

Sepsis

Anaphylaxis

Intoxications

Neurogenic shock

Spinal cord injury

Obstructive shock

Tension pneumothorax

Pericardial tamponade/
constrictive pericarditis

Massive pulmonary
embolus

Severe pulmonary
hypertension

Severe valvular stenosis

Physiologic parameters in shock

$$BP = SVR \times CO$$

$$HR \times SV$$

$$EDV - ESV$$

Anaphylactic Shock
Neurogenic Shock
Septic Shock
Vasodilator Drug
Induced Shock

Tachycardia Extremes
Bradycardia Extremes

Hypovolemic Shock

Cardiogenic Shock

BP = blood pressure, SVR = systemic vascular resistance, HR = heart rate, SV = stroke volume, EDV = end diastolic volume (i.e. preload), ESV = end systolic volume (i.e. contractility)

Physiologic parameters in shock

TABLE 12-1 Categories of Shock			
Type	Percentage*	Hemodynamic Changes	Etiologies†
Distributive	33%–50%	Decreased preload, decreased SVR, mixed CO	Sepsis, neurogenic shock, anaphylaxis
Hypovolemic	31%–36%	Decreased preload, increased SVR, decreased CO	Hemorrhage, capillary leak, GI losses, burns
Cardiogenic	14%–29%	Increased preload, increased afterload, increased SVR, decreased CO	MI, dysrhythmias, heart failure, valvular disease
Obstructive	1%	Decreased preload, increased SVR, decreased CO	PE, pericardial tamponade, tension PTX

Shock Index (SI)

$$SI = HR / SBP$$

Elevated early in shock

Normal 0.5 - 0.7

SI > 0.9 predicts:

- Acute hypovolemia in presence of normal HR & BP
- Marker of injury severity & mortality

Caution in Geriatrics

- May underestimate shock due to higher baseline SBP

Uses

- Prehospital use → triage
- Predict risk for mass transfusion?



Lactate

A measure of tissue hypoxia

Normal 1-2 mmol

> 4 mmol with metabolic acidosis
suggests tissue hypoxia

Lactate measurements need to be
repeated to evaluate if therapy is
effective and if the patient is improving

Hypovolemic shock

Mortality rate - 30% to 40%

responsible for almost 50% of deaths occurring within 24 hours of injury.

Resuscitation of shock, starting in the prehospital setting and continuing throughout the victim's care in the ED.

The goal of restoring the necessary level of tissue perfusion and oxygenation for survival.

Hypovolemic shock

The principal objectives of fluid and blood resuscitation in traumatic shock are:

Restore intravascular volume sufficient to maintain oxygen-carrying capacity and tissue perfusion for adequate cellular oxygen delivery.

Prevent or correct derangements in coagulation.

Age related considerations

Pediatric

- Increases cardiac output by increasing heart rate
- Sustains arterial pressure despite significant volume loss
- Loses 25% of circulating volume before signs of shock occur

Geriatric

- Shock progression is rapid
- Reduced compensatory mechanisms
- Preexisting disease states contribute to co-morbidities

Trauma-induced coagulopathy

It is a combination of factors:

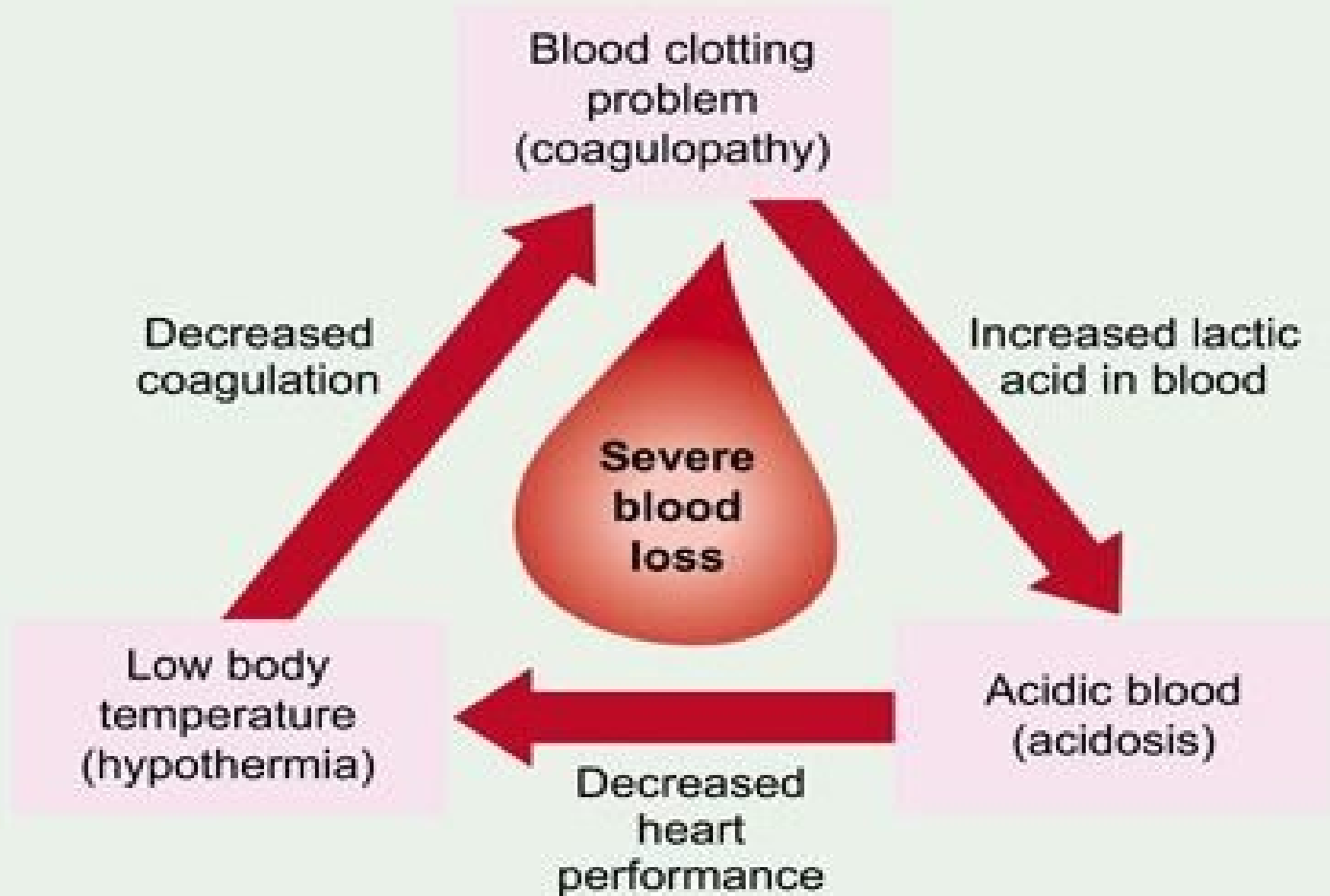
- Tissue hypoxia.

- Loss of coagulation factors from hemorrhage followed by hemodilution from crystalloid resuscitation.

- exacerbated by acidosis and hypothermia that occur during the course of ongoing hemorrhage and resuscitation.

However, acidosis does not, by itself, have a significant effect on coagulation until the pH decreases below 7.0.

Trauma Triad of Death



Clinical Features

It is depends on:

- The cause, rate, volume, and duration of volume loss or bleeding;
- The presence of other acute disorders;
- The effects of current medications;
- The patient's baseline physiologic status.

The hemodynamic response to acute severe hemorrhage-induced hypovolemia traditionally includes tachycardia, hypotension, and signs of poor peripheral perfusion (cool, pale, clammy extremities with weak peripheral pulses and prolonged capillary refill).

Clinical Features

Arterial and venous vasoconstriction leads to a narrowing of the pulse pressure.

Cerebral hypoperfusion causes alterations in mental status.

Classification of hemorrhage severity as a percentage of blood volume loss estimated based on systolic blood pressure, heart rate, and Glasgow Coma Scale is not reliable and should not be used to guide ED resuscitation.

Stage	I (compensated)	II (mild)	III (moderate)	IV (severe)
Blood loss	<15% (750 – 1,000 ml)	15% — <30% (1,000 – 1,500 ml)	30% — <40% (1,500 – 2,000 ml)	>40% (2,000 ml or more)
Heart rate	Normal (<100 bpm)	Tachycardia (>100 bpm)	Tachycardia (>120 bpm)	Tachycardia (>140 bpm)
BP	Normal; vasoconstriction redistributes blood flow, slight rise in diastolic pressure seen	Orthostatic changes in BP; vasoconstriction intensifies in non-critical organs (skin, muscles, gut)	Markedly decreased (SBP <90 mm Hg); vasoconstriction decreases perfusion to kidneys, pancreas, liver, and spleen	Profoundly decreased (SBP <80 mm Hg); decreased perfusion affects the brain and heart
Respiration	Normal	Rate mildly increased	Moderate tachypnea	Marked tachypnea; respiratory collapse
Capillary refill time	Normal (<2 seconds)	>2 seconds; clammy skin	Usually >3 seconds; cool, pale skin	>3 seconds; cold, mottled skin
Bowel sounds	Present, all four quadrants	Hypoactive	Absent (paralytic ileus)	Absent (paralytic ileus, mucosal necrosis)
Urinary output	>30 ml/hr	20 – 30 ml/hr	<20 ml/hr	None (anuria)
Mental status	Normal or slightly anxious	Mildly anxious or agitated	Confused, agitated	Obtunded

← Emergency



Normal
Vitals do not
R/O Occult
Hypo-
perfusion



Treatment

Resuscitation begins in the prehospital setting and continues in the ED.

The priority for prehospital care is treatment of life-threatening conditions and rapid transport to an appropriate facility.

For the hemorrhaging patient, this entails ensuring adequate ventilation and oxygenation (including securing an airway if necessary), controlling external bleeding (if present), and protecting the spinal cord (if potentially vulnerable).

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Treatment

In the ED, priorities are to:

- Restore intravascular volume to reverse or limit systemic and regional hypoperfusion,
- Maintain oxygen-carrying capacity,
- Limit ongoing blood loss,
- Prevent the development of coagulopathy.
- Prevent the development of hypothermia

Airway Control, Ventilation & Oxygenation

If spontaneous ventilation is not adequate, intubate and ventilate to achieve an arterial hemoglobin oxygen saturation of $\geq 94\%$.

Identify and treat potential respiratory conditions such as pneumothorax, tension pneumothorax, hemothorax, or upper airway obstruction.

Vascular Access & Monitoring

Establish adequate IV access concurrent with airway management.

- Large-bore (14- to 16-gauge) peripheral lines.
- Intraosseous lines, when peripheral IV access is problematic.

Monitor arterial blood pressure, mental status, and peripheral perfusion frequently.

Bedside FAST is useful to identify intraperitoneal bleeding, assess cardiac function and volume status, and assist in central venous cannulation.

Hemostatic-Hypotensive Resuscitation

A principle of hemostatic resuscitation is to limit intravascular volume expansion and avoid normalization of blood pressure.

Complete normalization of blood pressure will raise hydrostatic pressure and can increase hemorrhage, which is particularly evident in non compressible hemorrhage where raising blood pressure could potentially “pop the clot” and reestablish active hemorrhage.

Hemostatic-Hypotensive Resuscitation

Hypotensive resuscitation limits initial fluid resuscitation to an acceptable systolic blood pressure goal until surgical control of the bleeding is obtained, usually in the operating room.

Hypotensive resuscitation should not be used in patients with myocardial disease, cerebral ischemia, or traumatic brain injury.

Isotonic Crystalloid Solutions

Normal saline and lactated Ringer's solution are the most commonly used resuscitation fluids.

Concerns about each fluid are as follows:

- infusion of large volumes of crystalloid solution can cause increased neutrophil activation.

- lactated Ringer's solution can increase cytokine release and may increase lactic acidosis when given in large volumes.

- normal saline can exacerbate intracellular potassium depletion and cause hyperchloremic acidosis.

Isotonic Crystalloid Solutions

Common modifications of isotonic fluids include use of acetate instead of lactate in Ringer's solution, Hartmann's solution, and Plasma-Lyte.

Solutions containing lactate or acetate are considered balanced crystalloids because they are buffered and have a lower chloride concentration compared to normal saline.

Colloids

The one advantage of colloids is that achievement of hemodynamic goals requires less volume to be infused.

serious consideration should be given to severely restricting the use of crystalloids and instead beginning the early use of blood products in blunt trauma victims, especially if ongoing hemorrhage is expected or operative repair is going to be delayed.

	Packed Red Blood Cells	Plasma	Platelets
Action	Carries Oxygen No clotting factors	Coagulation Factors	Aggregation
1 unit	~300 ml (Hct 55%)	~250 ml	~25 ml individual unit ~150 pooled unit
Dose	↑ Hgb by 1 g/dl ↑ Hct by 3 % In the non-bleeding pt	↑ coags by 2.5% (Need at least 4 u for significant change)	1 unit Apheresis (pooled) ↑ 25,000-50,000 per u
Storage	-4 C <u>Progression:</u> Emerg Uncrossmatched (immediate) Type Specific (20 min) Cross Matched (60 min)	<u>Non Trauma Center</u> Frozen thaw time 2 u in 30 minutes <u>Trauma Center</u> Room Temp Good for 5 days Monitor wastage	Room temp Agitated



If it doesn't
carry
oxygen or it
doesn't clot!

Don't give it
to me!

Cardiogenic Shock

Causes of Cardiogenic Shock include:

- Myocardial infarction
- Cardiomyopathy
- Dysrhythmias
- Trauma
- Structural abnormalities
 - Valvular abnormality
 - Ventricular septal rupture

Clinical manifestation

Cardiovascular

- ↑ HR, ↓ BP,
- Decreased capillary refill
- May have chest pain

Pulmonary

- Tachypnea
- Cyanosis
- Crackles
- rhonchi

Skin

- Pallor
- Cool, clammy

Renal

- ↑ sodium and water retention
- ↓ renal blood flow
- ↓ urine output

Neurologic

- ↓ cerebral perfusion

Anxiety

Confusion

agitation

Gastrointestinal

- ↓ bowel sounds
- Nausea/vomiting

Diagnosis

Diagnostic findings

- ↑ cardiac markers
- ↑ blood glucose
- ↑ BUN
- Dysrhythmias
- Pulmonary infiltrates on chest x-ray
- Left ventricular dysfunction on echocardiogram

Management

Airway Control, Ventilation & Oxygenation:

- If spontaneous ventilation is not adequate, intubate and ventilate to achieve $\text{Sat O}_2 \geq 94\%$.
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Management

Correct dysrhythmias

Drug Therapy:

- Fluids
- Inotropes
- ASA
- β -blockers and nitrates should be avoided in acute phase

Septic Shock

Systemic Inflammatory Response Syndrome (SIRS)

- Temp > 38 or < 36
- HR > 90
- RR > 20 or PaCO₂ < 32
- WBC > 12 or < 4 or Bands $> 10\%$

Two out of four criteria
acute change from baseline

Sepsis

- The systemic inflammatory response to infection.

Severe Sepsis

- Organ dysfunction secondary to Sepsis.
- e.g. acute lung injury, encephalopathy, acute kidney injury, coagulopathy.

Septic Shock

- Hypotension secondary to Sepsis that is resistant to adequate fluid administration and associated with hypoperfusion.

Septic Shock

TABLE 151-1

The Third International Consensus Definitions for Sepsis and Septic Shock

Condition	Definition	Criteria
Sepsis	Life-threatening organ dysfunction caused by a dysregulated host response to infection	Suspected or proven infection <i>and</i> Increase in Sequential Organ Failure Assessment (SOFA) score of 2 or more from baseline*
Septic shock	A subset of sepsis in which underlying circulatory and cellular metabolism abnormalities are profound enough to substantially increase mortality	Sepsis <i>and</i> Vasopressor therapy required to maintain a mean arterial pressure ≥ 65 mm Hg <i>and</i> Lactate > 2 mmol/L despite adequate fluid therapy

*Can be assumed to be 0 in patients without known prior organ dysfunction.

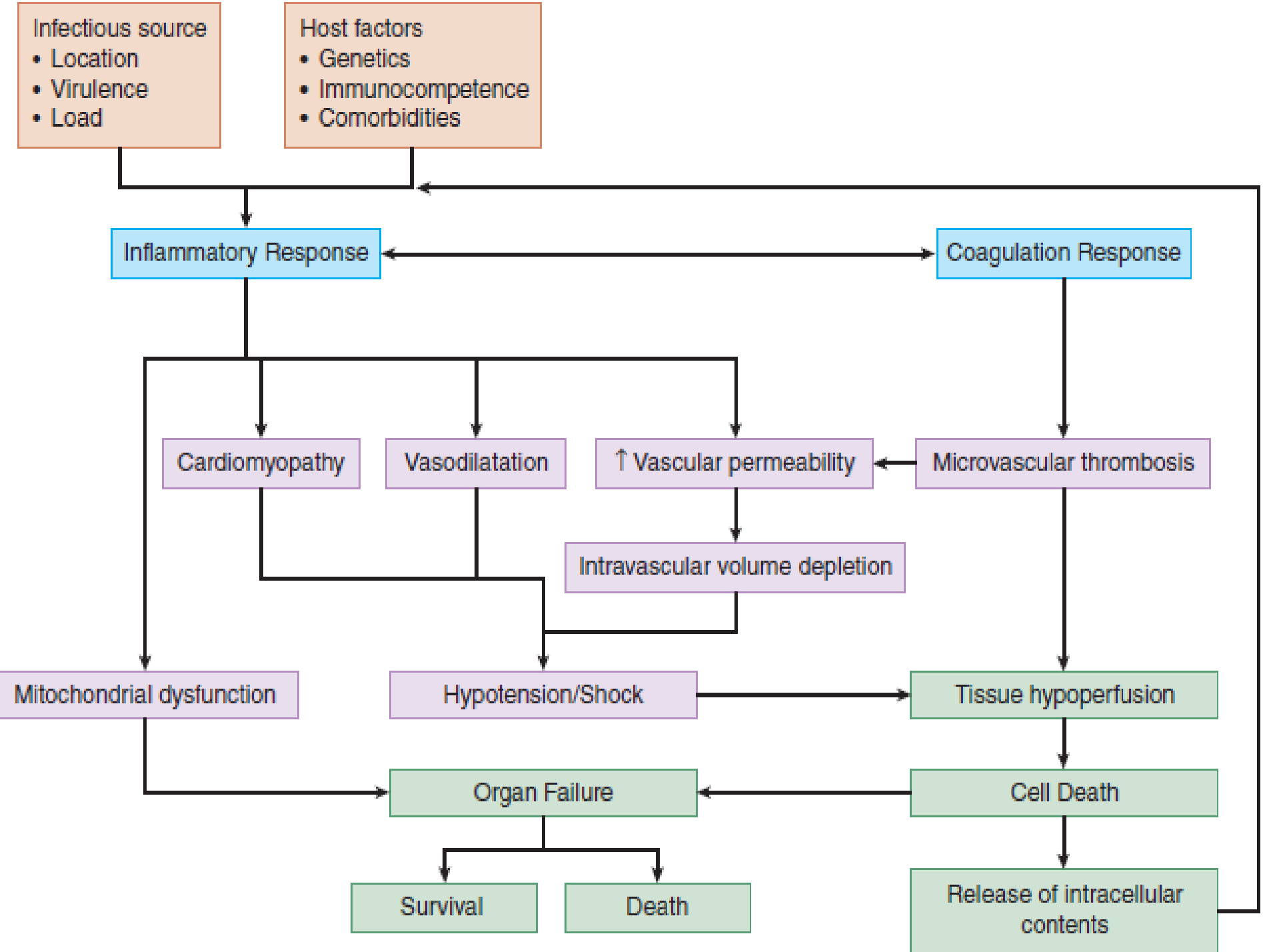
Quick Sequential Organ Failure Assessment (qSOFA)

simple screening tool derived to identify patients at higher risk of death.

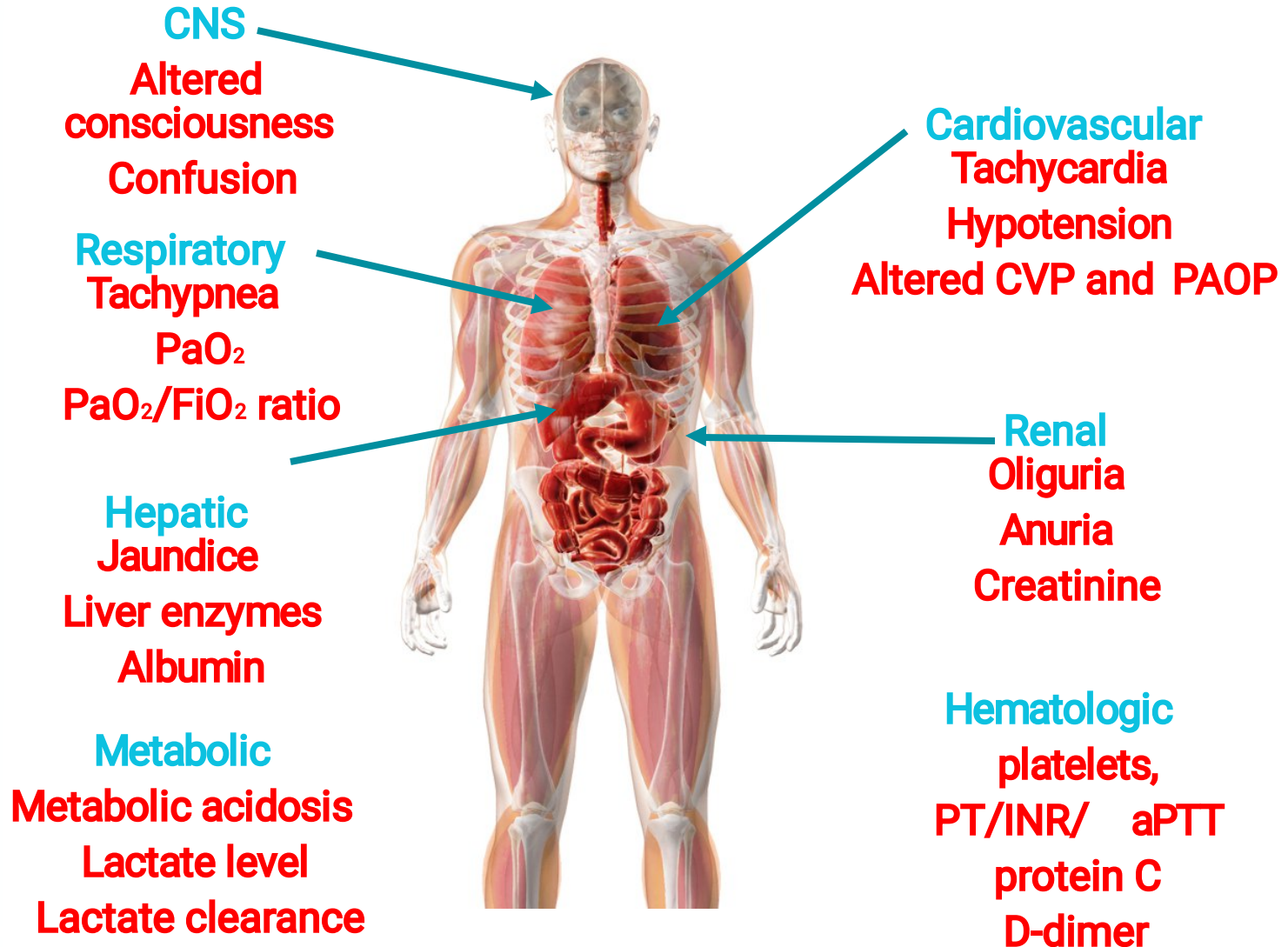
Criteria include:

- altered mental status,
- respiratory rate ≥ 22 breaths/min,
- systolic blood pressure ≤ 100 mm Hg,

with a score ≥ 2 indicating a high risk for poor outcome.



Any Organ Can be Affected by Sepsis. If any organ shows signs of dysfunction related to the infection, sepsis is now called severe sepsis



Immediate Measures

Maintain Airway and Ventilation

Establish Adequacy of Circulation

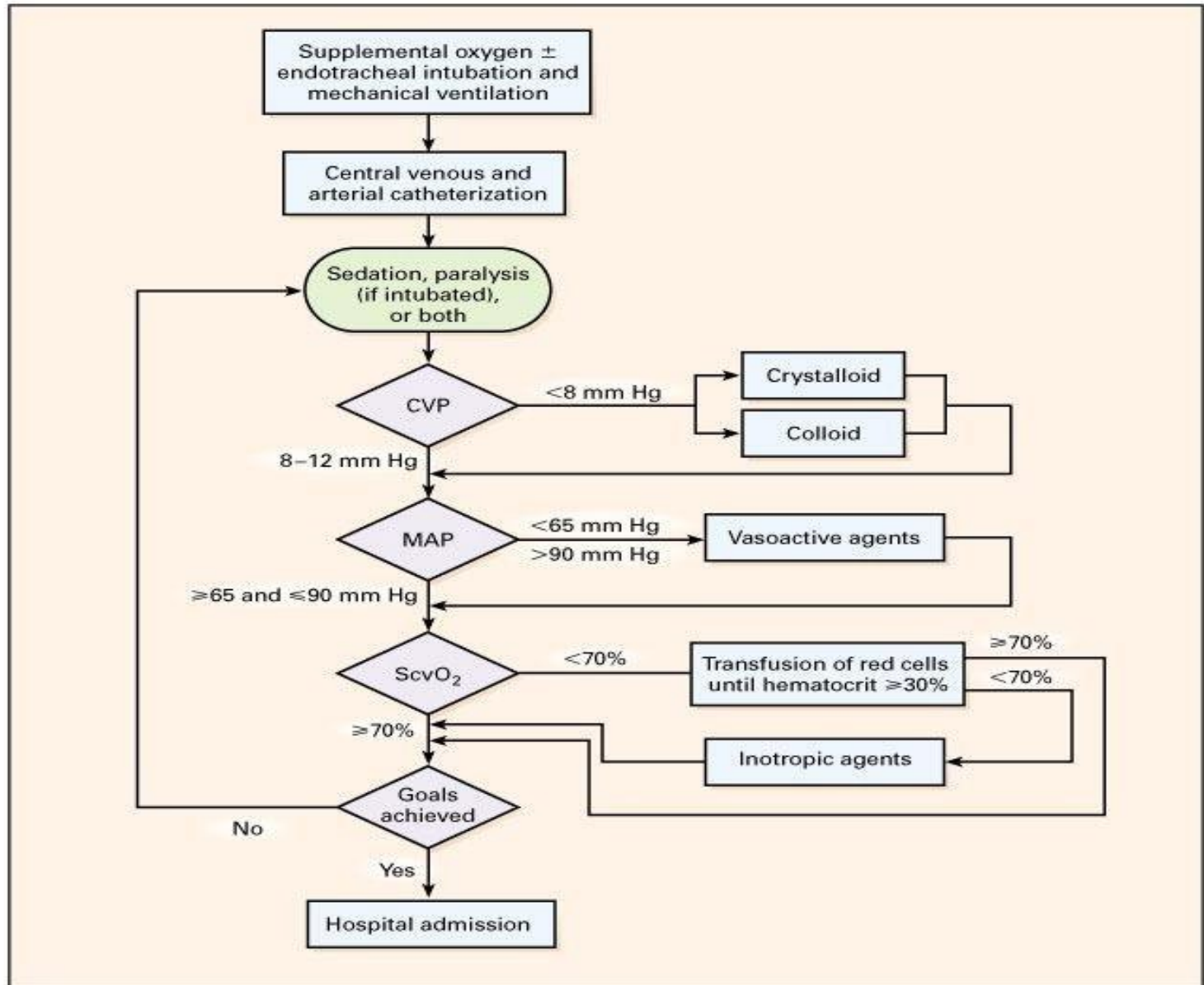
Early Goal-Directed Therapy (EGDT)

Antibiotic Therapy

Source Control

Adjunctive Therapies

Early Goal-Directed Therapy



Anaphylactic Shock

Acute and life-threatening allergic reaction to a sensitizing substance

Immediate response causing massive vasodilation, release of vasoactive mediators, and an increase in capillary permeability

Can lead to respiratory distress d/t laryngeal edema or severe bronchospasm, and circulatory failure d/t vasodilation

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Clinical manifestation

Cardiovascular

- Chest pain
- Third spacing of fluid

Pulmonary

- Swelling to tongue and lips
- Shortness of breath
- Edema of larynx and epiglottis
- Wheezing
- Rhinitis
- Stridor

Renal

- ↓ urine output

Skin

- Flushing
- Pruritus
- Urticaria
- angioedema

Neurologic

- Anxiety
- Decreased LOC

Gastrointestinal

- Nausea/vomiting
- Abdominal pain/
Cramping
- Diarrhea

IMMEDIATE ACTIONS

Stop / remove suspect allergen (e.g. drug infusion)
Adrenaline I.M. (lateral thigh) 0.01 mg/kg up to 0.5 mg (1:1000)
I.V. access and NS
Lie flat / elevate legs
Elevate Torso if S.O.B.
High flow oxygen
Airway and Ventilation Support

AIRWAY OBSTRUCTION NEBULIZED ADRENALINE (5MG)

PREPARE FOR DIFFICULT
AIRWAY INCLUDING EARLY
SURGICAL AIRWAY

BRONCHOSPASM

Continuous Salbutamol neb
I.V. **Hydrocortisone** 5mg/kg

HYPOTENSION

Wide bore I.V. access
NS bolus 20 ml/kg over 1–2 min

INADEQUATE RESPONSE, IMMEDIATE LIFE THREAT, or DETERIORATION

I.V. Adrenaline infusion 1 mg in 1000 ML Saline (or standard infusion if immediately available)
Start at 6ml/kg/hour = 0.1 mcg/kg/min, and increase by the starting rate every 2 min if needed **OR**
Repeat I.M. Adrenaline every 3–5 min **OR**
For imminent life threat: Dilute Adrenaline 1 mg into 20 ml and give I.V. 1 ml boluses (50 mcg)

ANAPHYLACTIC CARDIAC ARREST

Follow cardiac arrest protocol AND

- Immediate Adrenaline
- Rapid escalation to high dose Adrenaline (3–5 mg every 2–3 min) might be effective
- Ensure high volume I.V. fluid resuscitation as above

HYPOTENSION - Inadequate response

Repeat NS boluses 10–20 ml/kg, up to 50 ml/kg total over the first 30 min

Consider the following ;

Severe bradycardia - I.V. **Atropine** 20 mcg/kg

I.V. **Metaraminol** 2–10 mg in adults.

I.V. **Glucagon** and/or balloon pump if β -blocked or heart failure: Glucagon dose in adult: load with 1–5 mg over 5 min, followed by 5–15 mcg/min



TAKE A BREATH

Case scenario

A 73-year-old woman is brought to ED complaining of chills and a productive cough for several days. . The patient has a history of dementia, HTN, and DM. In the past 24 hours she has become weaker and does not want to get out of bed.

The physical examination reveals a thin, elderly woman who is somnolent. T-36.0°C, P-118, BP-84/50 mm Hg, RR-22.

Her mucous membranes are dry. She has crackles at her right lung base with a scant wheeze. Her abdomen is soft and nontender. The extremities feel cool. The patient is moving all extremities, without focal deficits.

Case scenario

A 35-year-old woman is brought to ED after collapsing at home. She had been seen by her regular doctor earlier in the day and prescribed amoxillin for sinusitis.

Her vital signs were BP-70/30 mm Hg, HR-140, RR- 40, and O₂Sat-76%.

On physical examination, the patient is obtunded with perioral cyanosis, tongue swelling, stidor, wheezing, and labored breathing. Her skin is cool and clammy with large urticarial lesions.

References

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Thank you

