APPROACH TO THE PATIENT WITH SHOCK

Prof Pham Nguyen Vinh, MD, PhD, FACC
Pham Ngoc Thach University of Medicine
Tam Duc Heart Hospital

Pham Nguyen Vinh

Definition of shock and Classification

- Clinical syndrome, results from inadequate tissue perfusion

⇒ Hypotension (mean arterial pressure [MAP] < 60 mmHg)

- Classification of shock

Hypovolemic	Septic
Traumatic Cardiogenic Intrinsic Compressive	Hyperdynamic (early) Hypodynamic (late) Neurogenic hypoadrenal

Source: Maier R V. Harrison's Principles of Internal Medicine, 19th ed, 2015, Mc Graw Hill, p 1744-1751

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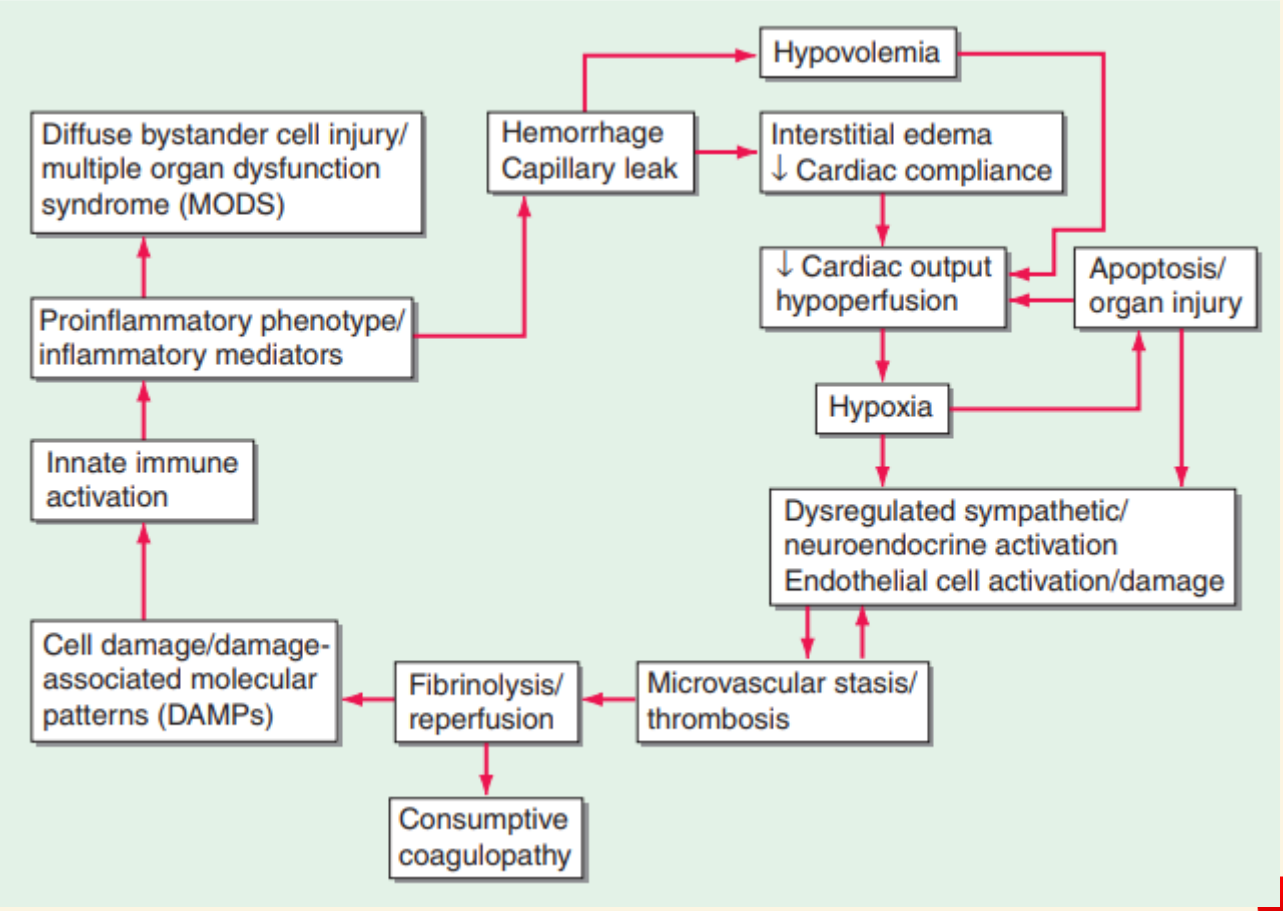
Shock induced vicious cycle



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Pathogenesis and organ response

- Microcirculation
  - Cellular response:
  - Mitochondrial dysfunction
- Accumulation of H+, lactate, reactive oxyen species
- Neuroendoerine response
  - Nor-epine phrone ↑; epinephrine↑
  - ACTH ↑, cortisol ↑ ➔ ↑ blood glucose
  - ↑ pancreatie secretion
  - ↑ renin, ↑ AGII
- Cardiovascular response
  - ↑ heart rate
  - BNP ↑
- Pulmonary response
- Renal respouse
- Metabolic derangemeats
- Inflammatory resfonses

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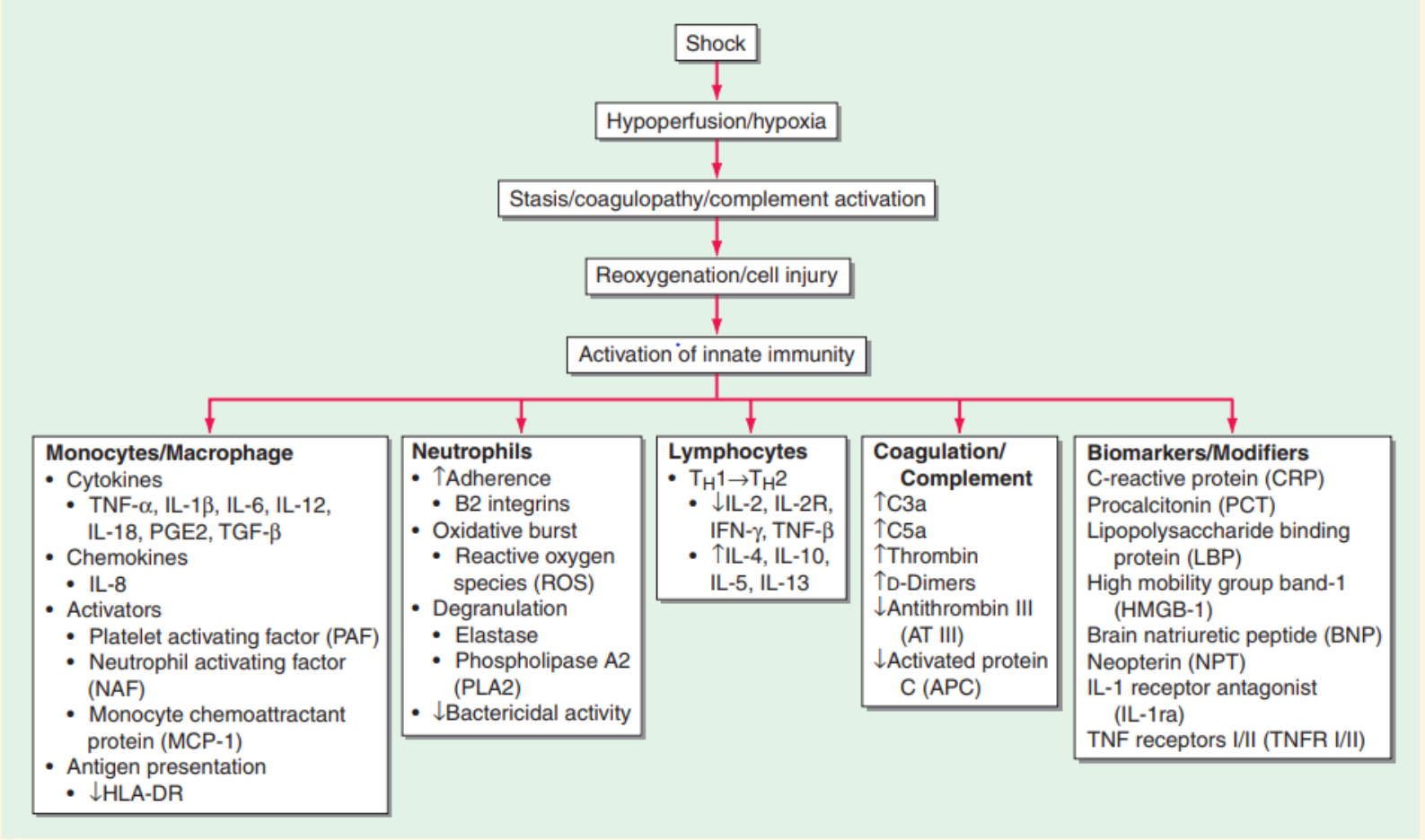
A schematic of the host immunoinflammatory response to shock



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Normal hemodynamic parameters

Parameter	Calculation	Normal Values
Cardiac output (CO)	SV × HR	4–8 L/min
Cardiac index (CI)	CO/BSA	2.6–4.2 (L/min)/m^2
Stroke volume (SV)	CO/HR	50–100 mL/beat
Systemic vascular resistance (SVR)	[(MAP – RAP)/CO] × 80	700–1600 dynes · s/cm^5
Pulmonary vascular resistance (PVR)	[(PAP_m – PCWP)/CO] × 80	20–130 dynes · s/cm^5
Left ventricular stroke work (LVSW)	SV(MAP – PCWP) × 0.0136	60–80 g-m/beat
Right ventricular stroke work (RVSW)	SV(PAP_m – RAP)	10–15 g-m/beat

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Physiologic characteristics of the various forms of shock

Type of Shock	CVP and PCWP	Cardiac Output	Systemic Vascular Resistance	Venous O_2 Saturation
Hypovolemic	↓	↓	↑	↓
Cardiogenic	↑	↓	↑	↓
Septic				
Hyperdynamic	↓↑	↑	↓	↑
Hypodynamic	↓↑	↓	↑	↑↓
Traumatic	↓	↓↑	↑↓	↓
Neurogenic	↓	↓	↓	↓
Hypoadrenal	↓↑	↓	=↓	↓

Abbreviations: CVP, central venous pressure; PCWP, pulmonary capillary wedge pressure.

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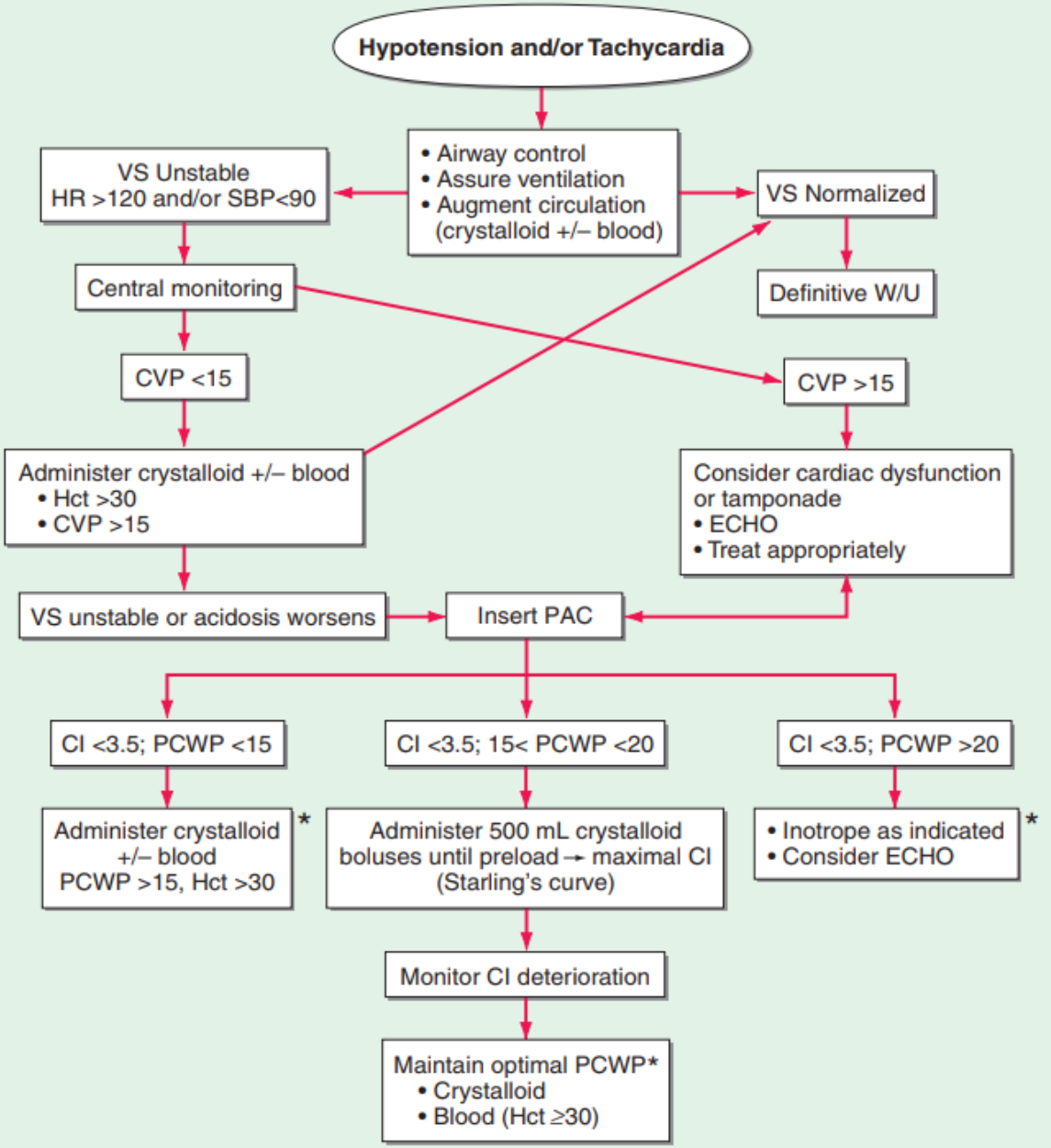
An algorithm for the resuscitation of the patient in shock



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Hypovolemic shock

Mild (<20% Blood Volume)	Moderate (20–40% Blood Volume)	Severe (>40% Blood Volume)
Cool extremities	Same, plus:	Same, plus:
Increased capillary refill time	Tachycardia	Hemodynamic instability
Diaphoresis	Tachypnea	Marked tachycardia
Collapsed veins	Oliguria	Hypotension
Anxiety	Postural changes	Mental status deterioration (coma)

Source: Maier R V. Harrison's Principles of Internal Medicine, 19th ed, 2015, Mc Graw Hill, p 1744-1751

Suy tim cấp

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Các yếu tố khởi kích suy tim cấp (1)

Acute coronary syndrome.
Tachyarrhythmia (e.g. atrial fibrillation, ventricular tachycardia).
Excessive rise in blood pressure.
Infection (e.g. pneumonia, infective endocarditis, sepsis).
Non-adherence with salt/fluid intake or medications.
Bradyarrhythmia.
Toxic substances (alcohol, recreational drugs).
Drugs (e.g. NSAIDs, corticosteroids, negative inotropic substances, cardiotoxic chemotherapeutics).

TL: Ponikowski P. 2016 ESC Guideline for the diagnosis and treatment of acute and chronic heart failure. Eur. H. J, May 20, 2016

Các yếu tố khởi kích suy tim cấp (2)

Exacerbation of chronic obstructive pulmonary disease.
Pulmonary embolism.
Surgery and perioperative complications.
Increased sympathetic drive, stress-related cardiomyopathy.
Metabolic/hormonal derangements (e.g. thyroid dysfunction, diabetic ketosis, adrenal dysfunction, pregnancy and peripartum related abnormalities).
Cerebrovascular insult.
Acute mechanical cause: myocardial rupture complicating ACS (free wall rupture, ventricular septal defect, acute mitral regurgitation), chest trauma or cardiac intervention, acute native or prosthetic valve incompetence secondary to endocarditis, aortic dissection or thrombosis.

ACS = acute coronary syndromes; NSAIDs = non-steroidal anti-inflammatory drugs.

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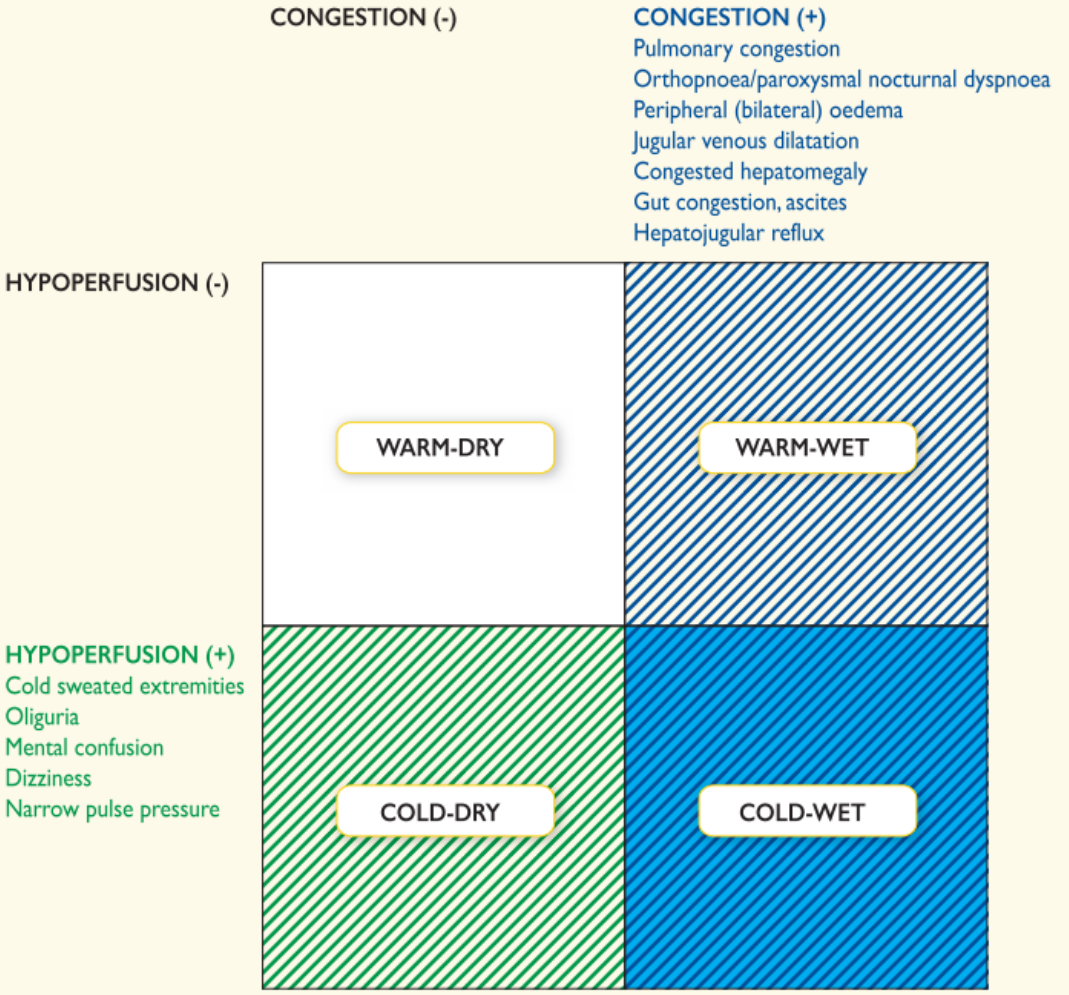
TL: Ponikowski P. 2016 ESC Guideline for the diagnosis and treatment of acute and chronic heart failure. Eur. H. J, May 20, 2016

Các thể lâm sàng suy tim cấp dựa trên sung huyết và giảm tưới máu



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Định nghĩa các từ dùng trong suy tim cấp (1)

Term	Definition
Symptoms/signs of congestion (left-sided)	Orthopnoea, paroxysmal nocturnal dyspnoea, pulmonary rales (bilateral), peripheral oedema (bilateral).
Symptoms/signs of congestion (right-sided)	Jugular venous dilatation, peripheral oedema (bilateral), congested hepatomegaly, hepatojugular reflux, ascites, symptoms of gut congestion.
Symptoms/signs of hypoperfusion	Clinical: cold sweated extremities, oliguria, mental confusion, dizziness, narrow pulse pressure. Laboratory measures: metabolic acidosis, elevated serum lactate, elevated serum creatinine. Hypoperfusion is not synonymous with hypotension, but often hypoperfusion is accompanied by hypotension.
Hypotension	Systolic BP <90 mmHg
Bradycardia	Heart rate <40 bpm
Tachycardia	Heart rate >120 bpm

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Định nghĩa các từ dùng trong suy tim cấp (2)

Abnormal respiratory effort	Respiratory rate >25 breaths/min with use of accessory muscles for breathing, or respiratory rate <8 breaths/min despite dyspnoea.
Low O_2 saturation	O_2 saturation (SaO_2) <90% in pulse oximetry Normal SaO_2 neither excludes hypoxaemia (low PaO_2) nor tissue hypoxia.
Hypoxaemia	O_2 partial pressure (PaO_2) in arterial blood <80 mmHg (<10,67 kPa) (blood gas analysis).
Hypoxaemic respiratory failure (type I)	PaO_2 <60 mmHg (<8 kPa)
Hypercapnia	CO_2 partial pressure ($PaCO_2$) in arterial blood >45 mmHg (>6 kPa) (blood gas analysis).
Hypercapnic respiratory failure (type II)	$PaCO_2$ >50 mmHg (>6,65 kPa).
Acidosis	pH <7.35
Elevated blood lactate	>2 mmol/L
Oliguria	Urine output <0.5 mL/kg/h

BP = blood pressure; bpm = beats per minute; $PaCO_2$ = partial pressure of carbon dioxide in arterial blood; PaO_2 = partial pressure of oxygen in arterial blood; SaO_2 = oxygen saturation.

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Quy trình xử trí ban đầu suy tim cấp

- BNP < 100pg/ml
- NT-proBNP < 300 pg/ml

→ Ít khả năng suy tim cấp

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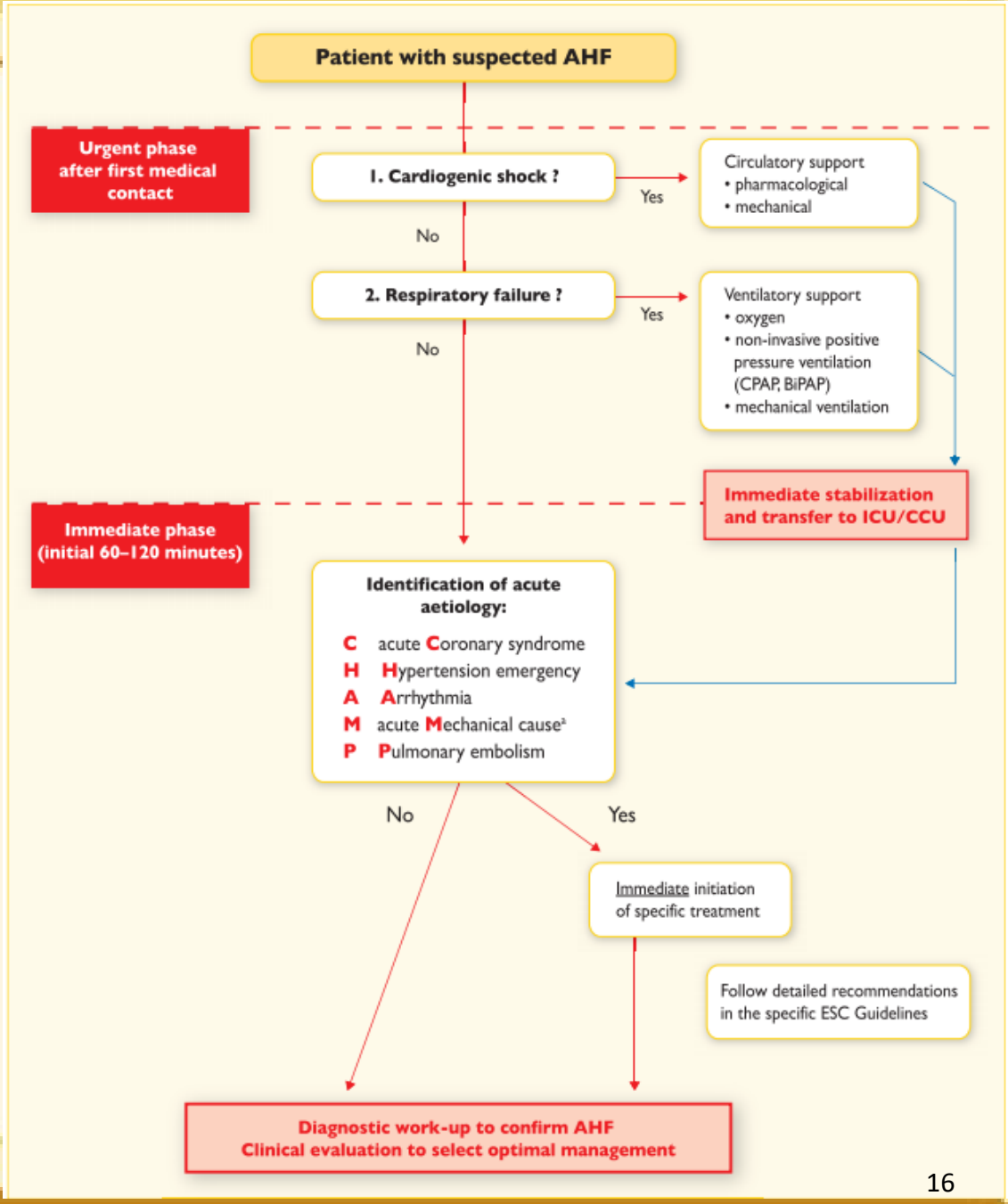

Các nguyên nhân gia tăng peptides bài natri (1)

Cardiac	Heart failure Acute coronary syndromes Pulmonary embolism Myocarditis Left ventricular hypertrophy Hypertrophic or restrictive cardiomyopathy Valvular heart disease Congenital heart disease Atrial and ventricular tachyarrhythmias Heart contusion Cardioversion, ICD shock Surgical procedures involving the heart Pulmonary hypertension

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Các nguyên nhân gia tăng peptides bài natri (2)

Non-cardiac	Advanced age Ischaemic stroke Subarachnoid haemorrhage Renal dysfunction Liver dysfunction (mainly liver cirrhosis with ascites) Paraneoplastic syndrome Chronic obstructive pulmonary disease Severe infections (including pneumonia and sepsis) Severe burns Anaemia Severe metabolic and hormone abnormalities (e.g. thyrotoxicosis, diabetic ketosis)

HFpEF = heart failure with preserved ejection fraction; HFrEF = heart failure with reduced ejection fraction; ICD = implantable cardioverter defibrillator.

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Khuyến cáo sử dụng các biện pháp chẩn đoán suy tim cấp

Recommendations	Class [a]	Level [b]	Ref [c]
Upon presentation a measurement of plasma natriuretic peptide level (BNP, NT-proBNP or MR-proANP) is recommended in all patients with acute dyspnoea and suspected AHF to help in the differentiation of AHF from non-cardiac causes of acute dyspnoea.	I	A	531–534
At admission in all patients presenting with suspected AHF, the following diagnostic tests are recommended:			
a. 12-lead ECG;	I	C	
b. chest X-ray to assess signs of pulmonary congestion and detect other cardiac or non-cardiac diseases that may cause or contribute to the patient's symptoms;	I	C	
c. the following laboratory assessments in the blood: cardiac troponins, BUN (or urea), creatinine, electrolytes (sodium, potassium), glucose, complete blood count, liver function tests and TSH.	I	C	
Echocardiography is recommended immediately in haemodynamically unstable AHF patients and within 48 hours when cardiac structure and function are either not known or may have changed since previous studies.	I	C	

AHF = acute heart failure; BNP = B-type natriuretic peptide; BUN = blood urea nitrogen; ECG = electrocardiogram; MR-proANP = mid-regional pro A-type natriuretic peptide; NT-proBNP = N-terminal pro-B type natriuretic peptide; TSH = thyroid-stimulating hormone

[a]Class of recommendation.

[b]Level of evidence.

[c]Reference(s) supporting recommendations.

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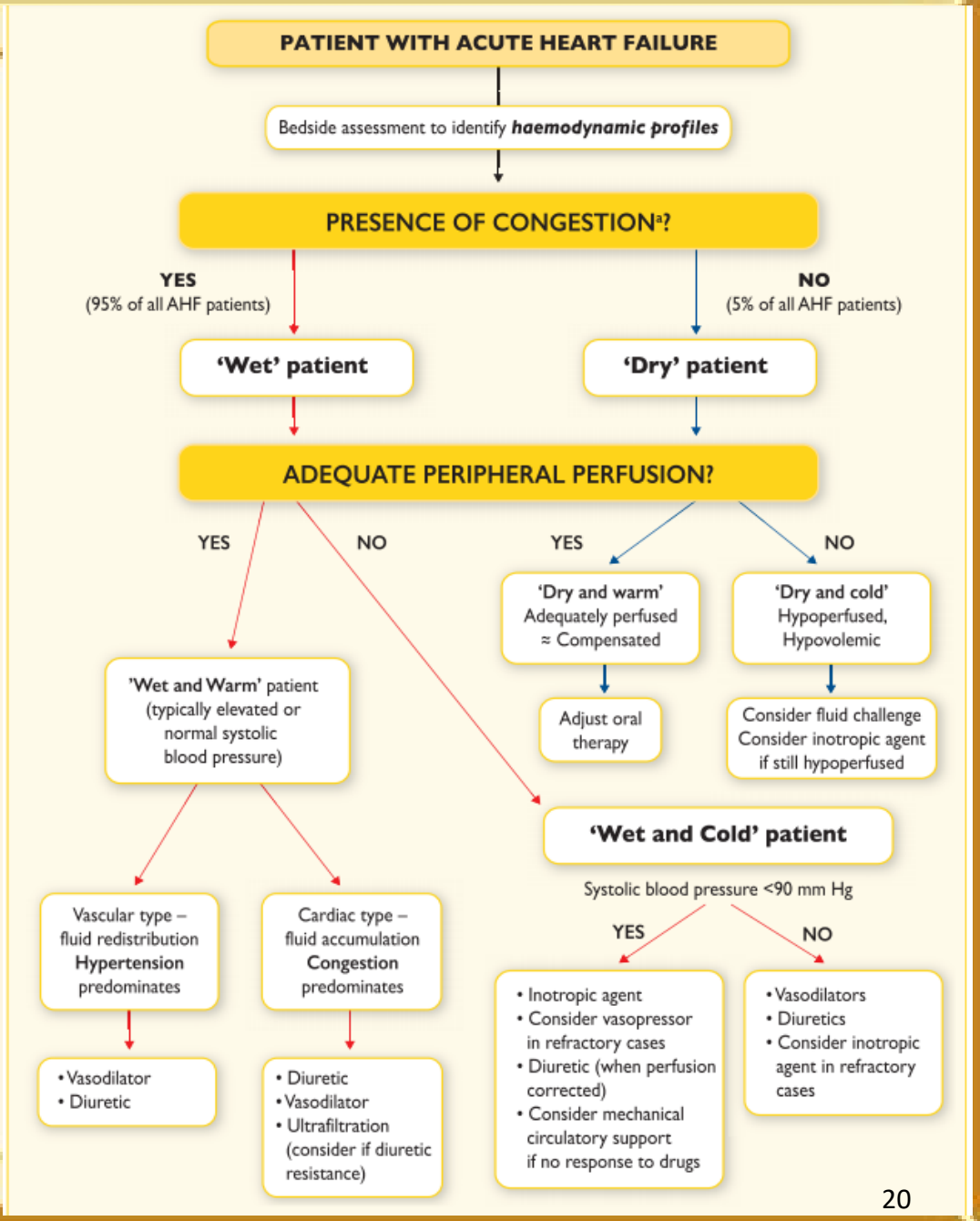
Điều trị suy tim cấp



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Khuyến cáo xử trí sốc tim (1)

Recommendations	Class [a]	Level [b]	Ref [c]
In all patients with suspected cardiogenic shock, immediate ECG and echocardiography are recommended.	I	C	
All patients with cardiogenic shock should be rapidly transferred to a tertiary care center which has a 24/7 service of cardiac catheterization, and a dedicated ICU/CCU with availability of short-term mechanical circulatory support.	I	C	
In patients with cardiogenic shock complicating ACS an immediate coronary angiography is recommended (within 2 hours from hospital admission) with an intent to perform coronary revascularization.	I	C	
Continous ECG and blood pressure monitoring are recommended.	I	C	
Invasive monitoring with an arterial line is recommended.	I	C	
Fluid challenge (saline or Ringer's lactate, >200 ml/15–30 min) is recommended as the first-line treatment if there is no sign of overt fluid overload.	I	C	

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Khuyến cáo xử trí sốc tim (2)

Intravenous inotropic agents (dobutamine) may be considered to increase cardiac output.	IIb	C	
Vasopressors (norepinephrine preferable over dopamine) may be considered if there is a need to maintain SBP in the presence of persistent hypoperfusion.	IIb	B	558
IABP is not routinely recommended in cardiogenic shock.	III	B	585, 586
Short-term mechanical circulatory support may be considered in refractory cardiogenic shock depending on patient age, comorbidities and neurological function.	IIb	C	

ACS = acute coronary syndrome; CCU = coronary care unit; ECG = electrocardiogram; IABP = intra-aortic balloon pump; ICU = intensive care unit; SBP = systolic blood pressure.

[a]Class of recommendation.

[b]Level of evidence.

[c]Reference(s) supporting recommendations.

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Khuyến cáo cách theo dõi b/n nhập viện điều trị suy tim cấp (1)

Recommendations	Class [a]	Level [b]
Standard non-invasive monitoring of heart rate, rhythm, respiratory rate, oxygen saturation and blood pressure is recommended.	I	C
It is recommended that patients should be weighed daily and have an accurate fluid balance chart completed.	I	C
It is recommended to evaluate signs and symptoms relevant to HF (e.g. dyspnoea, pulmonary rales, peripheral oedema, weight) daily to assess correction of fluid overload.	I	C
Frequent, often daily,measurement of renal function (blood urea, creatinine) and electrolytes (potassium, sodium) during i.v. therapy and when renin-angiotensin-aldosterone system antagonists are initiated is recommended.	I	C

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Khuyến cáo cách theo dõi b/n nhập viện điều trị suy tim cấp (2)

Intra-arterial line should be considered in patients with hypotension and persistent symptoms despite treatment.	IIa	C
Pulmonary artery catheter may be considered in patients who, despite pharmacological treatment present refractory symptoms (particularly with hypotension and hypoperfusion).	IIb	C

HF = heart failure; i.v. = intravenous.
[a]Class of recommendation.
[b]Level of evidence.

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Mục tiêu điều trị suy tim cấp (1)

Immediate (ED/ICU/CCU)
Improve haemodynamics and organ perfusion.
Restore oxygenation.
Alleviate symptoms.
Limit cardiac and renal damage.
Prevent thrombo-embolism.
Minimize ICU length of stay.

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Mục tiêu điều trị suy tim cấp (2)

Intermediate (in hospital)
Identify aetiology and relevant co-morbidities.
Titrate therapy to control symptoms and congestion and optimize blood pressure.
Initiate and up-titrate disease-modifying pharmacological therapy.
Consider device therapy in appropriate patients.
Pre-discharge and long-term management
Develop a careplan that provides: o A schedule for up-titration and monitoring of pharmacological therapy. o Need and timing for review for device therapy. o Who will see the patient for follow-up and when.
Enrol in disease management programme, educate, and initiate appropriate lifestyle adjustments.
Prevent early readmission.
Improve symptoms, quality of life, and survival.

CCU = coronary care unit; ED = emergency department; ICU = intensive care unit.

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Các từ mô tả chỉ định thực hiện biện pháp trợ giúp tuần hoàn cơ học

Bridge to decision (BTD)/ Bridge to bridge (BTB)	Use of short-term MCS (e.g. ECLS or ECMO) in patients with cardiogenic shock until haemodynamics and end-organ perfusion are stabilized, contra-indications for long-term MCS are excluded (brain damage after resuscitation) and additional therapeutic options including long-term VAD therapy or heart transplant can be evaluated.
Bridge to candidacy (BTC)	Use of MCS (usually LVAD) to improve end-organ function in order to make an ineligible patient eligible for heart transplantation.
Bridge to transplantation (BTT)	Use of MCS (LVAD or BiVAD) to keep patient alive who is otherwise at high risk of death before transplantation until a donor organ becomes available.
Bridge to recovery (BTR)	Use of MCS (typically LVAD) to keep patient alive until cardiac function recovers sufficiently to remove MCS.
Destination therapy (DT)	Long-term use of MCS (LVAD) as an alternative to transplantation in patients with end-stage HF ineligible for transplantation or long-term waiting for heart transplantation.

BiVAD = biventricular assist device; BTB = bridge to bridge; BTC = bridge to candidacy; BTD = bridge to decision; BTR = bridge to recovery; BTT = bridge to transplantation; DT = destination therapy; ECLS = extracorporeal life support; ECMO = extracorporeal membrane oxygenation; HF = heart failure; LVAD = left ventricular assist device; MCS = mechanical circulatory support; VAD = ventricular assist device.

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ĐIỀU TRỊ SHOCK
(MANAGEMENT OF SHOCK PATIENT)

Pham
Nguyen
Vinh

Normal hemodynamic parameters

Parameter	Calculation	Normal Values
Cardiac output (CO)	SV × HR	4–8 L/min
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Stroke volume (SV)	CO/HR	50–100 mL/beat
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Pulmonary vascular resistance (PVR)	[(PAP_m – PCWP)/CO] × 80	20–130 dynes·s/cm^5
Left ventricular stroke work (LVSW)	SV(MAP – PCWP) × 0.0136	60–80 g-m/beat
Right ventricular stroke work (RVSW)	SV(PAP_m – RAP)	10–15 g-m/beat

Abbreviations: BSA, body surface area; HR, heart rate; MAP, mean arterial pressure; PAP_m, pulmonary artery pressure—mean; PCWP, pulmonary capillary wedge pressure; RAP, right atrial pressure.

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TL: Maier RV. Harrison's Principles of Internal Medicine, 18th ed, 2012, McGraw Hill, p 2215-2222.

Physiologic Characteristics of the Various Forms of Shock

Type of Shock	CVP and PCWP	Cardiac Output	Systemic Vascular Resistance	Venous O_2 Saturation
Hypovolemic	↓	↓	↑	↓
Cardiogenic	↑	↓	↑	↓
Septic				
Hyperdynamic	↓↑	↑	↓	↑
Hypodynamic	↓↑	↓	↑	↑↓
Traumatic	↓	↓↑	↑↓	↓
Neurogenic	↓	↓	↓	↓
Hypoadrenal	↓↑	↓	=↓	↓

Abbreviations: CVP, central venous pressure; PCWP, pulmonary capillary wedge pressure.

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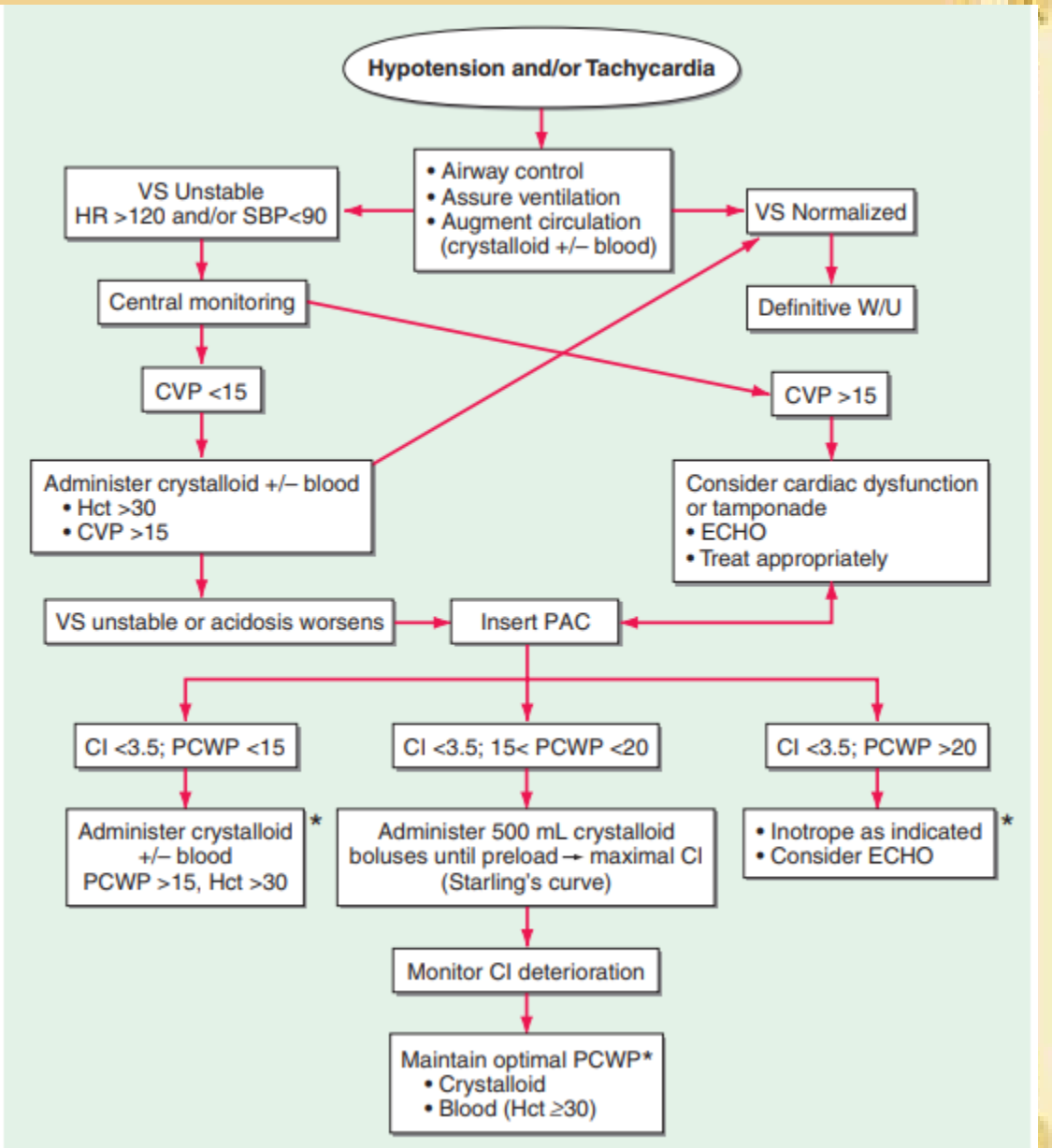
An algorithm for the resuscitation of the patient in shock



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Hypovolemic shock

Mild (<20% Blood Volume)	Moderate (20–40% Blood Volume)	Severe (>40% Blood Volume)
Cool extremities	Same, plus:	Same, plus:
Increased capillary refill time	Tachycardia	Hemodynamic instability
Diaphoresis	Tachypnea	Marked tachycardia
Collapsed veins	Oliguria	Hypotension
Anxiety	Postural changes	Mental status deterioration (coma)

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Septic Shock

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Vinh

Definitions used to Describe the Condition of Septic Shock (1)

Bacteremia	Presence of bacteria in blood, as evidenced by positive blood cultures
Septicemia	Presence of microbes or their toxins in blood
Systemic inflammatory response syndrome (SIRS)	Two or more of the following conditions: (1) fever (oral temperature >38°C) or hypothermia (<36°C); (2) tachypnea (>24 breaths/min); (3) tachycardia (heart rate >90 beats/min); (4) leukocytosis (>12,000/μL), leukopenia (<4,000/μL), or >10% bands; may have a noninfectious etiology
Sepsis	SIRS that has a proven or suspected microbial etiology
Severe sepsis (similar to "sepsis syndrome")	Sepsis with one or more signs of organ dysfunction—for example: 1. *Cardiovascular:* Arterial systolic blood pressure ≤90 mmHg or mean arterial pressure ≤70 mmHg that responds to administration of intravenous fluid 2. *Renal:* Urine output <0.5 mL/kg per hour for 1 h despite adequate fluid resuscitation 3. *Respiratory:* Pa_{O_2}/FI_{O_2} ≤250 or, if the lung is the only dysfunctional organ, ≤200 4. *Hematologic:* Platelet count <80,000/μL or 50% decrease in platelet count from highest value recorded over previous 3 days 5. *Unexplained metabolic acidosis:* A pH ≤7.30 or a base deficit ≥5.0 mEq/L and a plasma lactate level >1.5 times upper limit of normal for reporting lab 6. *Adequate fluid resuscitation:* Pulmonary artery wedge pressure ≥12 mmHg or central venous pressure ≥8 mmHg

TL: Munford RS. Harrison's Principles of Internal Medicine, 18th ed, 2012, McGraw Hill, p 2223-2232

Definitions used to Describe the Condition of Septic Shock (2)

Septic shock	Sepsis with hypotension (arterial blood pressure <90 mmHg systolic, or 40 mmHg less than patient's normal blood pressure) for at least 1 h despite adequate fluid resuscitation; *or* Need for vasopressors to maintain systolic blood pressure ≥90 mmHg *or* mean arterial pressure ≥70 mmHg
Refractory septic shock	Septic shock that lasts for >1 h and does not respond to fluid or pressor administration
Multiple-organ dysfunction syndrome (MODS)	Dysfunction of more than one organ, requiring intervention to maintain homeostasis
Predisposition–infection–response–organ dysfunction (PIRO)	A grading system that stratifies patients according to four key aspects of illness; attempts to define subgroups of patients, reducing heterogeneity in clinical trials
Critical illness– related corticosteroid insufficiency (CIRCI)	Inadequate corticosteroid activity for the patient's severity of illness; should be suspected when hypotension is not relieved by fluid administration

TL: Munford RS. Harrison's Principles of Internal Medicine, 18th ed, 2012, McGraw Hill, p 2223-2232

Microorganisms involved in Episodes of severe at Eight Academic Medical Centers

Microorganisms	Episodes with Bloodstream Infection, % ($n = 436$)	Episodes with Documented Infection but No Bloodstream Infection, % ($n = 430$)	Total Episodes, % ($n = 866$)
Gram-negative bacteria[a]	35	44	40
Gram-positive bacteria[b]	40	24	31
Fungi	7	5	6
Polymicrobial	11	21	16
Classic pathogens[c]	<5	<5	<5

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Treatment of Septic Shock

- Antimicrobial agents
- Removal of the source of infection
- Hemodynamic, respiratory and metabolic support
- General support

Initial Antimicrobial Therapy for severe Sepsis with No Obvious Source in Adults with Normal Renal Function (1)

Clinical Condition	Antimicrobial Regimens (Intravenous Therapy)
Immunocompetent adult	The many acceptable regimens include (1) piperacillin-tazobactam (3.375 g q4–6h); (2) imipenem-cilastatin (0.5 g q6h) or meropenem (1 g q8h); or (3) cefepime (2 g q12h). If the patient is allergic to β-lactam agents, use ciprofloxacin (400 mg q12h) or levofloxacin (500–750 mg q12h) plus clindamycin (600 mg q8h). Vancomycin (15 mg/kg q12h) should be added to each of the above regimens.
Neutropenia (<500 neutrophils/μL)	Regimens include (1) imipenem-cilastatin (0.5 g q6h) or meropenem (1 g q8h) or cefepime (2 g q8h); (2) piperacillin-tazobactam (3.375 g q4h) plus tobramycin (5–7 mg/kg q24h). Vancomycin (15 mg/kg q12h) should be added if the patient has an indwelling vascular catheter, has received quinolone prophylaxis, or has received intensive chemotherapy that produces mucosal damage; if staphylococci are suspected; if the institution has a high incidence of MRSA infections; or if there is a high prevalence of MRSA isolates in the community. Empirical antifungal therapy with an echinocandin (for caspofungin: a 70-mg loading dose, then 50 mg daily) or a lipid formulation of amphotericin B should be added if the patient is hypotensive or has been receiving broad-spectrum antibacterial drugs.

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TL: Munford RS. Harrison's Principles of Internal Medicine, 18th ed, 2012, McGraw Hill, p 2223-2232

Initial Antimicrobial Therapy for severe Sepsis with No Obvious Source in Adults with Normal Renal Function (2)

Clinical Condition	Antimicrobial Regimens (Intravenous Therapy)
Splenectomy	Cefotaxime (2 g q6–8h) or ceftriaxone (2 g q12h) should be used. If the local prevalence of cephalosporin-resistant pneumococci is high, add vancomycin. If the patient is allergic to β-lactam drugs, vancomycin (15 mg/kg q12h) plus either moxifloxacin (400 mg q24h) or levofloxacin (750 mg q24h) or aztreonam (2 g q8h) should be used.
IV drug user	Vancomycin (15 mg/kg q12h)
AIDS	Cefepime (2 g q8h) or piperacillin-tazobactam (3.375 g q4h) plus tobramycin (5–7 mg/kg q24h) should be used. If the patient is allergic to β-lactam drugs, ciprofloxacin (400 mg q12h) or levofloxacin (750 mg q12h) plus vancomycin (15 mg/kg q12h) plus tobramycin should be used.

TL: Munford RS. Harrison's Principles of Internal Medicine, 18th ed, 2012, McGraw Hill, p 2223-2232