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Critical Care MCQs
Problem-based Learning



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CHAPTER

3 Shock

Nitin Rai, Anirban Bhattacharjee, Akshat Trivedi

Q.1. A 54-year-old male, chronic smoker, diabetic, hypertensive, and benign prostatic hyperplasia (BPH), presented to emergency department with complaints of burning micturition, difficulty in passing urine, and high-grade fever for 5 days (T_{max} = 104.5°C). On examination, he had respiratory rate of 35 breaths/min, blood pressure of 90/55 mm Hg, and heart rate of 140 beats/min. The patient was slightly drowsy but responded to painful stimuli. Respiratory and cardiovascular examination was unremarkable with no obvious focal neurological deficit. What would be the next step in management?

a. Screen the patient using quick sequential organ failure assessment (qSOFA) + measure lactate + fluid administration of 30 mL/kg body weight.
b. Screen the patient using qSOFA + measure lactate + fluid administration of 30 mL/kg body weight + antibiotics administration.
c. Screen the patient using qSOFA + measure lactate + fluid administration of 30 mL/kg body weight + antibiotics administration + paired blood cultures.
d. Screen the patient using systemic inflammatory response syndrome (SIRS) and qSOFA + measure lactate + fluid administration 30 mL/kg body weight resuscitation + antibiotics administration + paired blood cultures.

Ans. d

Explanation: qSOFA identifies patients with poor outcome or suspected infection. Positive qSOFA alarms the possibility of sepsis but given the poor sensitivity, it is advisable not to use qSOFA as a single screening tool. For screening purpose, combining multiple tools is a better approach.

Surviving sepsis campaign (SSC) bundles were revised from 6- to 3-h bundles in 2015. The guidelines published in 2018 state that this resuscitation bundle treatment should be initiated within 1 hour of the emergency department (ED) triage time or the earliest chart annotation if presenting from another care venue. The 1-h bundle is composed of the following five elements: (1) measuring the lactate level, (2) obtaining blood culture prior to administration of antibiotics, (3) administering broad-spectrum antibiotics, (4) beginning rapid administration of 30 mL/kg crystalloid fluid for hypotension or lactate ≥4 mmol/L, and (5) administering vasopressors if the patient is hypotensive during or after fluid resuscitation to maintain mean arterial pressure (MAP) at ≥65 mm Hg within 1 hour from sepsis recognition. The fixed dose of 30 mL/kg

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in all patients stems from three large interventional trials: the PROMISE, PROCESS, and ARISE trials where the volumes of prerandomization fluid given to patients were approximately 30 mL/kg ideal body weight.

Suggested Reading

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2. Seymour CW, Liu VX, Iwashyna TJ, Brunkhorst FM, Rea TD, Scherag A, et al. Assessment of clinical criteria for sepsis: for the third international consensus definitions for sepsis and septic shock (Sepsis-3). JAMA. 2016;315(8):762-74.

Q.2. A 66-year-old, 75-kg male was found unconscious in a park. On examination, he had a large abscess over left foot. No reliable history was found. His heart rate (HR) was 156 bpm, respiratory rate (RR) was 34 breaths/min, MAP was 45 mm Hg, and oxygen saturation (SpO_2) was 92% on 15 LPM oxygen. He received 2.5 L of Ringer's lactate. His MAP improved to 56. Which of the following is true regarding fluid management?

a. Starch/colloids can be used as initial resuscitation fluid.
b. Balanced crystalloid compared to saline reduce reduced 90-day mortality.
c. Fluid resuscitation should be guided by dynamic over static markers of resuscitation.
d. Normalizing of lactate and capillary refill time (CRT) has no relevance in fluid resuscitation.

Ans. c

Explanation: The surviving sepsis campaign (SSC) recommendation to "rapidly administer a minimum of 30 mL/kg (ideal body weight) crystalloid for hypotension or lactate ≥4 mmol/L" is a "strong recommendation, with a low quality of evidence". Indeed, this strong recommendation is based largely on expert opinion with minimal supporting clinical data. In addition to the lack of credible data demonstrating the benefit of such a strategy, recent studies have demonstrated the potential harms with such an approach. Furthermore, results from experimental, observational, and randomized clinical studies strongly suggest improved outcomes with a more restrictive approach to fluid resuscitation.

The *SSC* recommends against using starches for initial resuscitation. Albumin may be used for patients who received large volumes of crystalloids. Regarding the choice of fluids for resuscitation, evidence is more in favor of balanced salt solution (BSS) over crystalloid without evident effect on mortality. The most recently published BaSICS trial showed no difference in 90-day mortality between Plasma-Lyte and 0.9% sodium chloride in 11,000 adult intensive care patients.

The SMART trial involving 15,000 adult intensive care unit (ICU) patients in 2018 showed a reduction in a composite outcome of death, new renal replacement therapy, and persistent renal dysfunction at 30 days, with balanced crystalloid use. The SPLIT trial in 2015 compared Plasma-Lyte to 0.9% sodium chloride in 2,278 critically ill patients. There was no difference in the primary outcome of proportion of patients with an acute kidney injury.

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Dynamic markers of fluid responsiveness such as stroke volume variation, pulse pressure variation, and passive leg raise test have better diagnostic accuracy compared with static techniques. Additionally, only approximately 50% of patients with septic shock will demonstrate fluid responsiveness by significant increase in stroke volume in response to a fluid bolus.

Moreover, calculation of maintenance fluid therapy after the initial 30 mL/kg administration should again be guided by dynamic markers of fluid responsiveness and measuring stroke volume and cardiac output. For adults with sepsis or septic shock, the adequacy of fluid resuscitation strategies should target decrease in elevated serum lactate levels or normalization of capillary refill time (CRT). The ANDROMEDA-SHOCK trial compared CRT normalization versus lactate clearance as resuscitation strategy. Targeting CRT has no effect on mortality, but CRT targeted during resuscitation is physiologically plausibility, cost-effective, and easy to adopt in clinical routine practice.

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2. Hernandez G, Ospina-Tascón GA, Damiani LP, Estenssoro E, Dubin A, Hurtado J, et al. Effect of a resuscitation strategy targeting peripheral perfusion status vs serum lactate levels on 28-day mortality among patients with septic shock: the ANDROMEDA-SHOCK Randomized Clinical Trial. JAMA. 2019;321(7):654-64.

Q.3. A 23-year-old male with a known chronic kidney disease (on maintenance hemodialysis, with last session done a day prior to presentation) presented with shortness of breath, bilateral lower limb pitting edema, and cough with low-grade fever for past 7 days. On examination, his vitals were stable. Initial laboratory tests were sent and results awaited. Decision was made to start the antibiotics. Which of the following statements is true?

a. Antimicrobials should be started immediately, ideally within 1 hour of presentation.
b. Defer antimicrobials while closely monitoring the patient.
c. Complete rapid investigation and if concern for infection persists, administer antibiotics within 3 hours.
d. Immediately take up the patient for hemodialysis.

Ans. c

Explanation: Delivering antibiotics in sepsis/septic shock is an important intervention. The mortality reduction with early antimicrobials is strongest in patients with septic shock; however, there is a weaker association in sepsis patients without shock. This patient presented with dyspnea and cough, possibly secondary to fluid overload. However, presence of fever points toward possible sepsis.

While possibility of fluid overload and requirement of dialysis still exist, sepsis should be ruled out at the onset and in absence of pending concerns over infectious etiology after thorough rapid assessment, history, and clinical examination, the plan to initiate dialysis can be taken. For this case, in lines with the new surviving sepsis

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guidelines, a rapid workup of infectious versus noninfectious etiologies should be undertaken within 3 hours, while closely monitoring the patient and if concern for infection persists, antibiotics should be administered. But time to administer antibiotics should not exceed 3–5 hours from hospital admission/sepsis recognition as mortality may increase, as suggested by various observational studies.

Suggested Reading

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2. Seymour CW, Gesten F, Prescott HC, Friedrich ME, Iwashyna TJ, Phillips GS, et al. Time to treatment and mortality during mandated emergency care for sepsis. N Engl J Med. 2017;376(23):2235-44.

Q.4. A 58-year-old male gentleman with a diagnosed case of chronic obstructive pulmonary disease (COPD) and carcinoma rectum (on chemotherapy via chemo port inserted in right subclavian vein) has presented with acute onset shortness of breath, fever, and yellow-colored sputum production for 1 week. After initial stabilization with noninvasive ventilation and bronchodilators, the patient was planned to receive antimicrobials. Initial chest X-ray revealed right-sided lobar pneumonia. There is in addition a past history of exacerbation of COPD 2 months back where patient was admitted and received IV medications. In line with current case scenario, which is the appropriate antimicrobial choice?

a. Piperacillin–tazobactam
b. Piperacillin–tazobactam + Levofloxacin + Linezolid + Gentamycin
c. Piperacillin–tazobactam + Levofloxacin + Gentamycin
d. Piperacillin–tazobactam + Levofloxacin + Linezolid

Ans. d

Explanation: The decision to start empirical antibiotics against methicillin-resistant *Staphylococcus aureus* (MRSA) depends on presence of risk factors. Risk factors for MRSA infections are past history of MRSA infection/colonization, recurrent skin infections/chronic wounds, recent intravenous antibiotics, recent hospital admissions, presence of invasive devices like dialysis catheter or long-term chemotherapy port, hemodialysis recipients, and severity of illness. A delay of >24–48 hours for antibiotics administration in patients with proven MRSA infection is associated with increased mortality. However, extreme caution should be taken because administration of anti-MRSA antibiotics to patients without MRSA infection is associated with higher mortality. This patient received recent IV antibiotics during his past hospital stay and also harbors a chemotherapy port mandating anti-MRSA therapy initiation as an appropriate step.

It is recommended that the use of dual gram-negative coverage should be based on risk of multi-drug resistant (MDR) pathogens. Such risk factors include infection/colonization with MDR pathogen in preceding year, hospital-acquired infections, use of broad-spectrum antibiotic in the last 90 days, use of selective digestive

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decontamination, etc. History of IV antibiotics during last hospitalization places this patient in a high-risk category of MDR infection, hence dual gram-negative coverage is recommended here. A combination of dual gram-negative coverage piperacillin–tazobactam + levofloxacin along with anti-MRSA cover and linezolid is the most appropriate empirical antimicrobial choice.

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3. Rottier WC, Bamberg YR, Dorigo-Zetsma JW, van der Linden PD, Ammerlaan HS, Bonten MJ. Predictive value of prior colonization and antibiotic use for third-generation cephalosporin-resistant enterobacteriaceae bacteremia in patients with sepsis. Clin Infect Dis. 2015;60(11):1622-30.

Q.5. Which of the following is not true about vasoactive agents in septic shock?

a. Norepinephrine is the first-line agent over other vasopressors.
b. Adrenaline is the second line of vasopressor.
c. Vasopressin should be started when the dose of norepinephrine is 0.25–0.5 μg/kg/min.
d. Selepressin is a potential noncatecholamine vasopressor alternative to norepinephrine.

Ans. b

Explanation: Norepinephrine is the first-line agent in septic shock. It is α-1 and β-1 adrenergic receptors agonist, producing vasoconstriction and rise in MAP with minimal effect on heart rate.

At higher dose of noradrenaline (0.25–0.5 μg/kg/min) maximum number of alpha 1 receptors are already saturated, hence it is advisable to use a drug of different catagory with different mechanism of action. Vasopressin is the preferred drug in such cases.

Vasopressin is produced in the hypothalamus. It is an endogenous peptide hormone, and its dose is not titrated to response, but rather administered at a fixed dose of 0.03 units/min in septic shock. Catecholamine-sparing effect of vasopressin has been demonstrated in two large trials—VANISH and VASST trials. The threshold for adding vasopressin to norepinephrine varies between studies and remains unclear. It is suggested to start vasopressin when the dose of norepinephrine is 0.25–0.5 μg/kg/min.

Selepressin is selective V1 agonist which acts by stimulating vascular smooth muscle producing vasoconstriction. However, unlike vasopressin, it has no effect on V1b and V2 receptors like release of corticosteroid and nitric oxide, increased procoagulant activity, and fluid retention. Selepressin (dose: 2.5 ng/kg/min) is a potential noncatecholamine vasopressor alternative to norepinephrine.

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Suggested Reading

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2. Gordon AC, Mason AJ, Thirunavukkarasu N, Perkins GD, Cecconi M, Cepkova M, et al. Effect of early vasopressin vs norepinephrine on kidney failure in patients with septic shock: the VANISH randomized clinical trial. JAMA. 2016;316(5):509-18.
3. Ukor IF, Walley KR. Vasopressin in vasodilatory shock. Crit Care Clin. 2019;35(2):247-61.

Q.6. A 35-year-old female visited the emergency department with pain abdomen in epigastric region. Ultrasonogram (USG) examination of abdomen showed features suggestive of acute pancreatitis due to gallstone disease. 1 week after admission, she started developing shortness of breath progressively associated with fall in saturation to 60% on nasal prongs. Chest X-ray showed bilateral diffuse lung opacities. Arterial blood gas on high-flow nasal cannula at 60 L/min and fraction of inspired oxygen (FiO_2) of 1.0:

pH	**7.32**
PO_2	**55**
PCO_2	**45**
HCO_3	**22**
BE	**–3.1**
Lactate	**1.3**

A decision was made to intubate and mechanically ventilate the patient. Which of the following is the best ventilator strategy for this patient?

a. Tidal volume 8 mL/kg body weight, high positive end-expiratory pressure (PEEP), plateau pressure <30 cmH_2O, prone ventilation of 8-hour duration, and routine recruitment maneuver.
b. Tidal volume 6 mL/kg body weight, high PEEP, plateau pressure <30 cmH_2O, prone ventilation of 16-hour duration, and avoiding routine recruitment maneuver.
c. Tidal volume 6 mL/kg body weight, high PEEP, plateau pressure <35 cmH_2O, prone ventilation of 16-hour duration, and routine recruitment maneuver.
d. Tidal volume 6 mL/kg body weight, high PEEP, plateau pressure <30 cmH_2O, prone ventilation of 8-hour duration, and avoiding routine recruitment maneuver.

Ans. b

Explanation: It is recommended to use lung-protective strategies for patients with acute respiratory distress syndrome (ARDS). A large trial comparing tidal volumes of 6 mL/kg with 12 mL/kg predicted body weight (PBW) in ARDS patients showed 9% absolute decrease in mortality. Tidal volume should be lowered even with plateau pressures ≤30 cmH_2O because lower plateau pressures were associated with reduced hospital mortality.

Mortality reduction is observed when low-tidal volume is combined with limited plateau pressure. A large international observational study (LUNGSAFE) also reported the importance of limiting plateau pressure by demonstrating its correlation with

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mortality. Therefore, it is recommended to keep the upper limit for plateau pressure to <30 cmH_2O.

Adopting open lung ventilation approach by applying high PEEP in ARDS patients may open lung units and help in improving gas exchange and increasing PaO_2. In patients with moderate or severe ARDS (PaO_2/FiO_2 ≤200 mm Hg), higher PEEP is associated with reduced mortality. The optimal method for selecting PEEP is not clear. PEEP titration can be done bedside by measuring thoracopulmonary compliance with the aim of achieving lowest driving pressure or best compliance. Other options are use of a $PEEP/FiO_2$ titration table, esophageal pressure-guided PEEP titration, using pressure volume loop, etc.

Severe hypoxemia patients may benefit from recruitment maneuvers in combination with higher PEEP, but the evidence to support its routine use in all ARDS patients is limited, so it is recommended for only moderate-to-severe refractory ARDS. Moreover, "traditional" recruitment maneuver like sustained continuous PEEP (e.g., 30–40 cmH_2O for 30–40 seconds) is preferred over "nontraditional" approach where lung recruitment with incremental followed by decremental PEEP levels is done titrating to achieve best respiratory static compliance or oxygen saturation.

The use of prone compared with supine position within the first 36 hours of intubation, when performed for >12 hours a day, showed improved survival in ARDS and a PaO_2/FiO_2 ratio <200. Neuromuscular blocking agents (NMBAs) in ARDS help in improving chest wall compliance, preventing respiratory asynchrony, decreasing the work of breathing, and reducing peak airway pressures. Surviving sepsis guidelines suggest intermittent neuromuscular blocking agent boluses over continuous infusion. ROSE trial result demonstrated that continuous neuromuscular blocking agent infusion did not reduce mortality when compared with a light sedation strategy with intermittent neuromuscular blocking agent boluses.

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3. Laffey JG, Bellani G, Pham T, Fan E, Madotto F, Bajwa EK, et al. Potentially modifiable factors contributing to outcome from acute respiratory distress syndrome: The LUNG SAFE study. Intensive Care Med. 2016;42:1865-76.
4. National Heart, Lung, and Blood Institute PETAL Clinical Trials Network; Moss M, Huang DT, Brower RG, Ferguson ND, Ginde AA, et al. Early neuromuscular blockade in the acute respiratory distress syndrome. N Engl J Med. 2019;380:1997-2008.

Q.7. A 77-year-old male, postcoronary artery bypass graft (CABG), with a baseline left ventricular ejection fraction of 25%, is admitted to ICU following repair of perforated peritonitis. He continues to have high-grade fever (maximum temperature = 103.6°C), tachycardia of 130 beats/min, and hypotension (BP = 78/43 mm Hg) on noradrenaline infusion of 0.8 µg/kg/min. 1.5 L of

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Plasma-Lyte was given, but his blood pressure remained low for next 8 hours. Which is the next optimal strategy for this patient?

a. Increase noradrenaline infusion dose to 1.0 μg/kg/min.
b. Give 500 mL further fluid bolus as assess hemodynamic response.
c. Add IV hydrocortisone as 50 mg intravenously every 6 hours.
d. Add adrenaline.

Ans. c

Explanation: Steroids in sepsis should be reserved for those patients who are refractory to fluids and vasopressors. Rationale for steroids in sepsis includes reversal of relative adrenal insufficiency, reversal of inflammatory overactivity, "reprogramming" of the immune response, improved response to catecholamines, deactivation of nitric oxide synthase, improved cardiac tolerance of bacterial endotoxin, improved retention of resuscitation fluid, and repair of the endothelial glycocalyx. The commonly used corticosteroid in adult patients with septic shock is hydrocortisone given at a dose of 50 mg IV every 6 hours or as continuous infusion. It is suggested to initiate corticosteroid when dose of norepinephrine/epinephrine is ≥0.25 μg/kg/min for at least 4 hours after the initiation.

This patient being nonresponsive to fluid bolus, further fluid is less likely to be useful. Moreover, a conservative/restrictive fluid strategy should be employed with baseline left ventricular ejection fraction of 25%. When norepinephrine is used at higher concentrations, the α-1 receptors are already saturated and start to get downregulated. In this case, use of drugs which target different receptor is advisable, hence vasopressin is more adequate choice/second-line agent in this scenario.

The CORTICUS and ADRENAL trial showed no improvement in mortality; however, APROCCHSS study and multiple other meta-analyses showed accelerated resolution of shock and increase vasopressor-free days.

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3. Rygård SL, Butler E, Granholm A, Møller MH, Cohen J, Finfer S, et al. Low-dose corticosteroids for adult patients with septic shock: a systematic review with meta-analysis and trial sequential analysis. Intensive Care Med. 2018;44:1003-16.
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Q.8. Which of the following statements is true for a patient with septic shock?

a. Polymyxin B hemoperfusion is a useful adjunct for recovery of septic shock.
b. Use of intravenous (IV) immunoglobulins is recommended.

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c. Stress ulcer prophylaxis is suggested.
d. Use of vitamin C does not reduce mortality.

Ans. c

Explanation: Substantial uncertainty exits regarding any beneficial effect of polymyxin B hemoperfusion. Polymyxin B hemoperfusion is not cost-effective and availability is limited. Recently performed sensitivity analyses also observed occurrence of undesirable side effects. So, for adults with sepsis or septic shock, using polymyxin B hemoperfusion is not recommended.

Sepsis/septic shock is a condition of hyperinflammation and immune suppression. However, high-quality studies are lacking, which examine the effect of intravenous immunoglobulins (IVIg) on the outcomes in sepsis/septic shock. So, use of intravenous (IV) immunoglobulins is not recommended.

Vitamin C has anti-inflammatory properties. But multiple studies including an analysis of seven randomized controlled trials (RCTs) and two additional RCTs of vitamin C versus placebo reported no reduced mortality or difference of other outcomes like of time alive and vasopressor-free days. There is a weak recommendation against using vitamin C in sepsis/septic shock.

Stress ulcers develop in gastrointestinal (GI) tract of critically ill patients and are associated with significant morbidity and mortality. There is a modest reduction in gastrointestinal hemorrhage with the use of stress ulcer prophylaxis (SUP). Patients with risk factors for clinically important GI bleeding (coagulopathy, shock, and chronic liver disease) are particularly benefited from SUP.

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4. Zhou F, Peng Z, Murugan R, Kellum JA. Blood purification and mortality in sepsis: A meta-analysis of randomized trials. Crit Care Med. 2013;41:2209-20.

Q.9. Blood transfusion is an important adjunct in sepsis/septic shock. Which of the following statements is true regarding blood transfusion practices in such scenario?

a. Restricted transfusion protocol is associated with reduced mortality.
b. Liberal transfusion is associated with lower mortality and ischemic events.
c. A restrictive transfusion strategy includes a hemoglobin trigger of 8 g/dL.
d. Restrictive transfusion strategy is preferred over liberal strategy.

Ans. d

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Explanation: TRISS trial (Transfusion Requirements in Septic Shock) compared a transfusion threshold of 7 g/dL versus 9 g/dL in patients with septic shock in ICU. There were a similar 90-day mortality, use of life support, and ischemic events in both the groups. TRICC trial (Transfusion requirements in Critical Care) compared transfusion threshold of 7 g/dL versus 10 g/dL in euvolemic ICU patients. There was a similar 30-day mortality in both the groups. TRICOP trial (Transfusion Requirements in Critically Ill Oncologic Patients) compared liberal (Hb threshold <9 g/dL) or restrictive strategy (Hb threshold <7 g/dL) in adult cancer patients with septic shock. 28-day mortality rate in the liberal group was 45% versus 56% in the restrictive group with similar ICU and hospital length of stay. But 90-day mortality was lower in liberal group (59%) compared with restrictive group (70%). Based on the trials performed, restrictive transfusion strategy typically involves an Hb concentration transfusion trigger of 7 g/dL.

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3. Holst LB, Haase N, Wetterslev J, Wernerman J, Guttormsen AB, Karlsson S, et al.; TRISS Trial Group; Scandinavian Critical Care Trials Group. Lower versus higher hemoglobin threshold for transfusion in septic shock. N Engl J Med. 2014;371:1381-91.

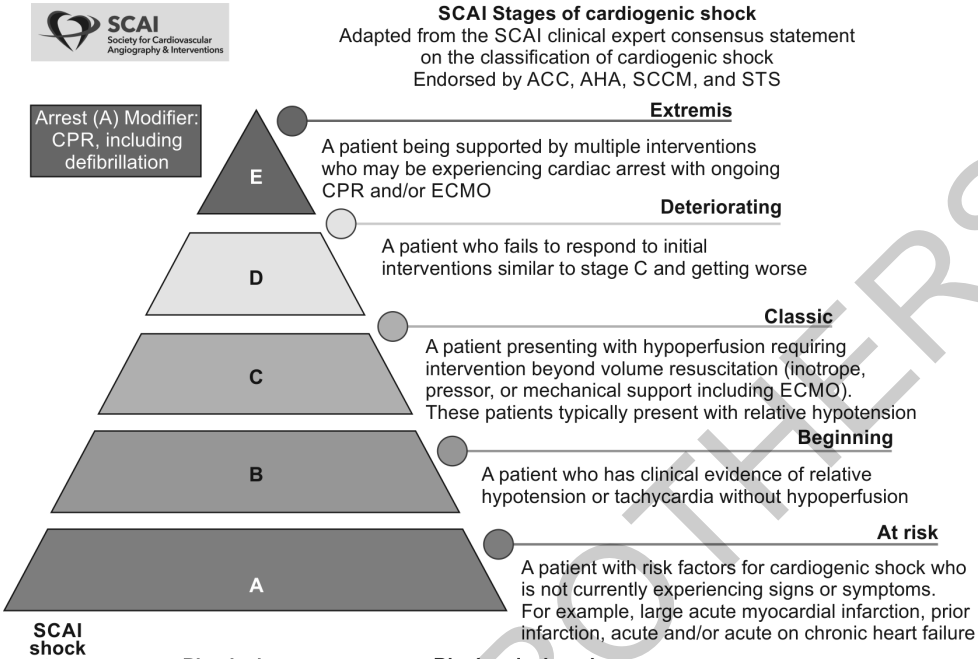
Q.10. A 62-year-old female presented with altered mental status, hypotension, diminished pulses, dyspnea, peripheral edema, jugular venous distention, and orthopnea. The patient is a known case of acute coronary syndrome on dual antiplatelets. A clinical suspicion of cardiogenic shock (CS) is made. Which of the following definitions is consistent with the diagnosis of CS?

a. SBP <90 mm Hg for <30 minutes or supportive intervention to maintain SBP >90 mm Hg.
b. SBP <90 mm Hg with appropriate fluid resuscitation without clinical and laboratory evidence of end-organ damage.
c. MAP >70 mm Hg or SBP >100 mm Hg after adequate fluid resuscitation (at least 1 L of crystalloids or 500 mL of colloids).
d. SBP <90 mm Hg for >30 minutes or vasopressor support to maintain SBP >90 mm Hg and hemodynamic criteria: CI <2.2 and PCWP >15 mm Hg.

Ans. d

Explanation: The clinical criteria for the diagnosis of cardiogenic shock based on the SHOCK (Should We Emergently Revascularize Occluded Coronaries For Cardiogenic Shock) and the IABP-SHOCK II (Intra-aortic Balloon Pump in Cardiogenic Shock II) trials were defined by systolic blood pressure (SBP) <90 mm Hg for >30 minutes, use of mechanical or pharmacologic support to maintain SBP >90 mm Hg, urine

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SCAI shock stage	Physical exam	Biochemical markers	Hemodynamics
A	• Normal JVP • Lung sounds clear • Strong distal pulses • Normal mentation	• Normal renal function • Normal lactic acid	Normotensive (SBP>100 or normal for pt.) If hemodynamics done: • Cardiac index ≥2.5 • CVP <10 • PA Sat ≤65%
B	• Elevated JVP • Rales in lung fields • Strong distal pulses • Normal mentation	• Normal lactate • Minimal renal function impairment • Elevated BNP	SBP <90 OR MAP <60 OR >30 mm Hg drop Pulse >100 If hemodynamics done: • Cardiac Index >2.2 • PA Sat >65%
C	• Ashen, mottled, dusky • Volume overload • Extensive Rales • Killip class 3 or 4 • BiPap or mechanical ventilation • Acute alteration in mental status	• Lactate ≥2 • Creatinine doubling OR >50% drop in GFR • Increased LFTs • Elevated BNP • Urine Output <30 mL/h	Drugs/device used to maintain BP above stage B values. • Cardiac Index <2.2 • PCWP >15 • RAP/PCWP ≥0.8 • PAPI <1.85 • Cardiac power output ≤0.6
D	Any of stage C	• Any of stage C AND deteriorating	Any of stage C AND Requiring multiple pressors OR addition of mechanical circulatory support devices to maintain perfusion
E	• Near pulselessness • Cardiac collapse • Mechanical ventilation • Defibrillator used	• Lactate ≥5 • pH ≤7.2	• No SBP without resuscitation • PEA or Refractory VT/VF • Hypotension despite maximal support

(BNP: brain natriuretic peptide; CPR: cardiopulmonary resuscitation; CVP: central venous pressure; ECMO: extracorporeal membrane oxygenation; GFR: glomerular filtration rate; JVP: jugular venous pressure; LFT: liver function test; MAP: mean arterial pressure; PCWP: pulmonary capillary wedge pressure; RAP: right atrial pressure; SBP: systolic blood pressure)

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output <30 mL/hour, cardiac index (CI) <2.2 L/min/m^2, pulmonary capillary wedge pressure (PCWP) >15 mm Hg, and lactate >2 mmol/L.

The 2016 European Society of Cardiology Heart Failure guidelines include clinical criteria along with hemodynamic criteria in the definition of cardiogenic shock: SBP <90 mm Hg despite appropriate fluid resuscitation with clinical and laboratory evidence of end-organ damage. Clinical criteria were defined as cold extremities, oliguria, altered mental status change, and narrow pulse pressure, and laboratory abnormalities included metabolic acidosis, elevated serum lactate, and elevated creatinine.

The Society for Angiography and Cardiovascular Interventions (SCAI) has recently proposed a classification system for cardiogenic shock encompassing clinical, biochemical, and hemodynamic parameters to guide treatment and classify outcomes.

Suggested Reading

1. Baran DA, Grines CL, Bailey S, Burkhoff D, Hall SA, Henry TD, et al. SCAI clinical expert consensus statement on the classification of cardiogenic shock. Catheter Cardiovasc Interv. 2019;94:29-37.
2. Hochman JS, Buller CE, Sleeper LA, Boland J, Dzavik V, Sanborn TA, et al. Cardiogenic shock complicating acute myocardial infarction–etiologies, management and outcome: a report from the SHOCK trial registry. Should we emergently revascularize occluded coronaries for cardiogenic shock? J Am Coll Cardiol. 2000;36:1063-70.

Q.11. A 62-year-old diabetic, known case of chronic kidney disease (CKD) on maintenance hemodialysis, presented with chest pain and dyspnea for last 7 days, with acute worsening of dyspnea over last 1 day. On examination, he was found to have Beck's triad. Bedside POCUS revealed a large pericardial effusion causing compression of right ventricle. The components of Beck's triad are all, except:

a. Hypotension
b. Muffled heart sound
c. Low-voltage QRS complexes on ECG
d. Elevated jugular venous pressure

Ans. a

Explanation: Cardiac tamponade is the term given to hemodynamic instability caused by compression of cardiac chambers by increased pericardial pressure due to accumulation of fluid, blood, or gas in pericardium. Beck's triad was described by American cardiothoracic surgeon Claude Beck as the presence of hypotension, muffled heart sounds on auscultation, and a raised jugular venous pressure (JVP). ECG often shows low-voltage complexes and pulsus paradoxus, i.e., inspiratory fall in SBP of more than 10 mm Hg during spontaneous breathing, may be seen. The diagnosis is made by echocardiography showing variable amount of pleural effusion with compression of right ventricular outflow tract in early diastole, and/or right atrium at end diastole. Treatment is urgent pericardiocentesis with hemodynamic management with fluid resuscitation and vasopressor infusions.

Suggested Reading

1. Mekontso Dessap A, Chew MS. Cardiac tamponade. Intensive Care Med. 2018;44(6):936-9.
2. Sternbach G. Claude Beck: cardiac compression triads. J Emerg Med. 1988;6(5):417-9.

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- Ambiguity and the use of imprecise terms have been avoided throughout book.

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