Multisystem Concepts

By failing to prepare, you are preparing to fail.

—Benjamin Franklin

MULTISYSTEM TEST BLUEPRINT

Multisystem 14% of total test **21 questions**

→ Acid-base imbalance*
→ Bariatric complications**
→ Comorbidity in patients with transplant history
→ End-of-life care
→ Healthcare-associated conditions (e.g., VAE, CAUTI, CLABSI)
→ Hypotension
→ Infectious diseases
  - Influenza (e.g., pandemic or epidemic)
  - Multi-drug resistant organisms (e.g., MRSA, VRE, CRE)
→ Life-threatening maternal/fetal complications (e.g., eclampsia, HELLP syndrome, postpartum hemorrhage, amniotic embolism)
→ Multiple organ dysfunction syndrome (MODS)
→ Multisystem trauma

→ Pain: acute, chronic
→ Post-intensive care syndrome (PICS)
→ Sepsis
→ Septic shock
→ Shock states
  - Distributive (e.g., anaphylactic, neurogenic)
  - Hypovolemic
→ Sleep disruption (including sensory overload)
→ Thermoregulation
→ Toxic ingestion/inhalations (e.g., drug/alcohol overdose)
→ Toxin/drug exposure (including allergies)

*This topic is also covered in the Respiratory Concepts chapter of this book.

**This topic is covered in the Gastrointestinal Concepts chapter of this book.

MULTISYSTEM TESTABLE NURSING ACTIONS

- □ Manage continuous temperature monitoring
- □ Provide end-of-life and palliative care
- □ Recognize risk factors and manage malignant hyperthermia
- □ Recognize indications for, and manage, patients undergoing:
  - Continuous sedation
  - Intermittent sedation
  - Neuromuscular blockade agents

- Procedural sedation—minimal
- Procedural sedation—moderate
- Targeted temperature management (previously known as therapeutic hypothermia)

The number of questions in the multisystem section of the Adult CCRN test blueprint has significantly increased in recent years. There are now 21 multisystem-related questions on this exam (as opposed to only 12 previously). Therefore, plan on studying the content in this chapter for approximately 21 hours.

Shock

Overview

- Although blood pressure (hypotension) is generally thought of when discussing shock, shock is actually a **cellular disease** due to either inadequate perfusion (the oxygen demand is greater than the oxygen delivered) or the inability of cells to utilize the delivered oxygen (issues with oxygen utilization/consumption).
- Refer to Figure 5-1 to study the pathophysiology of shock.

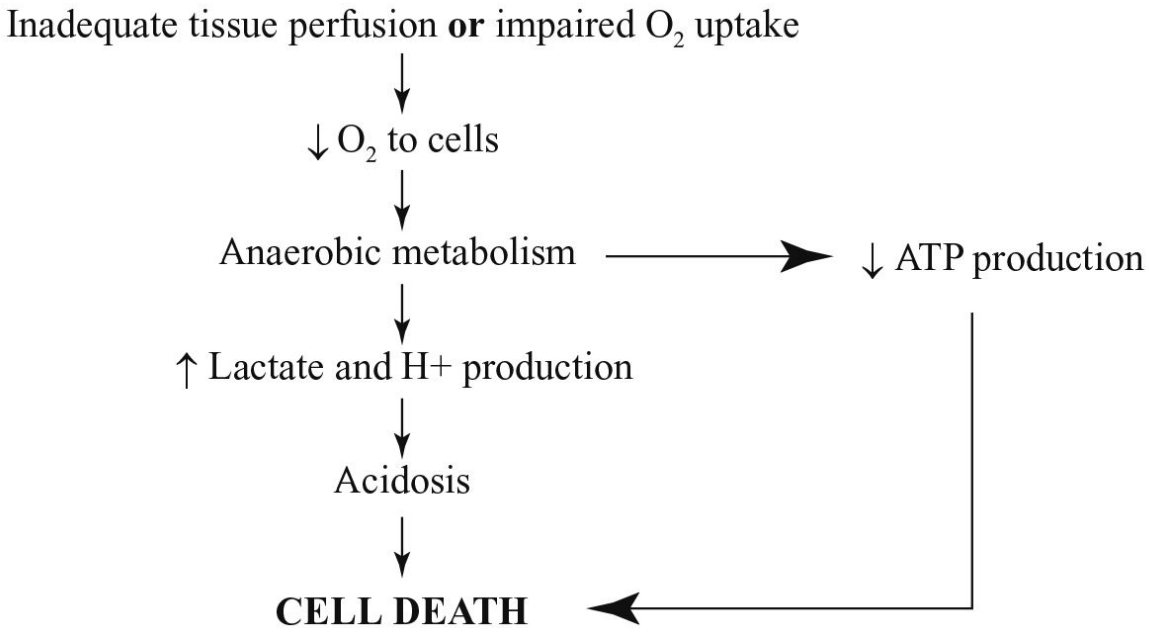

Figure 5-1. Pathophysiology of shock

- There are 3 stages of all types of shock:
  1. Compensatory
  2. Progressive
  3. Refractory

- The rapidity with which a patient progresses through these stages varies depending upon many factors.
- During the **compensatory stage** of shock (Figures 5-2 and 5-3), the blood pressure (BP) is maintained as a result of 2 mechanisms: stimulation of the sympathetic nervous system and activation of the renin-angiotensin-aldosterone system (RAAS).

Sympathetic Nervous System Stimulation

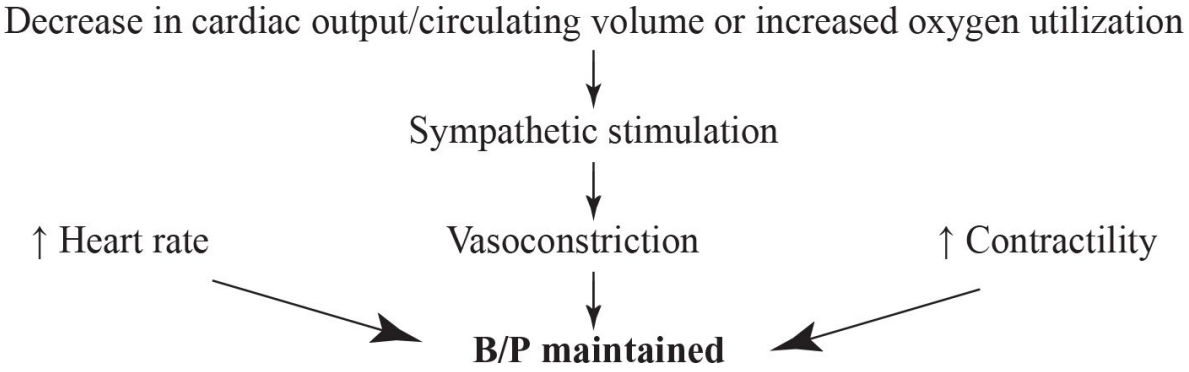

Figure 5-2. Physiology of compensatory stage of shock

Renin-Angiotensin-Aldosterone System (RAAS) Activation

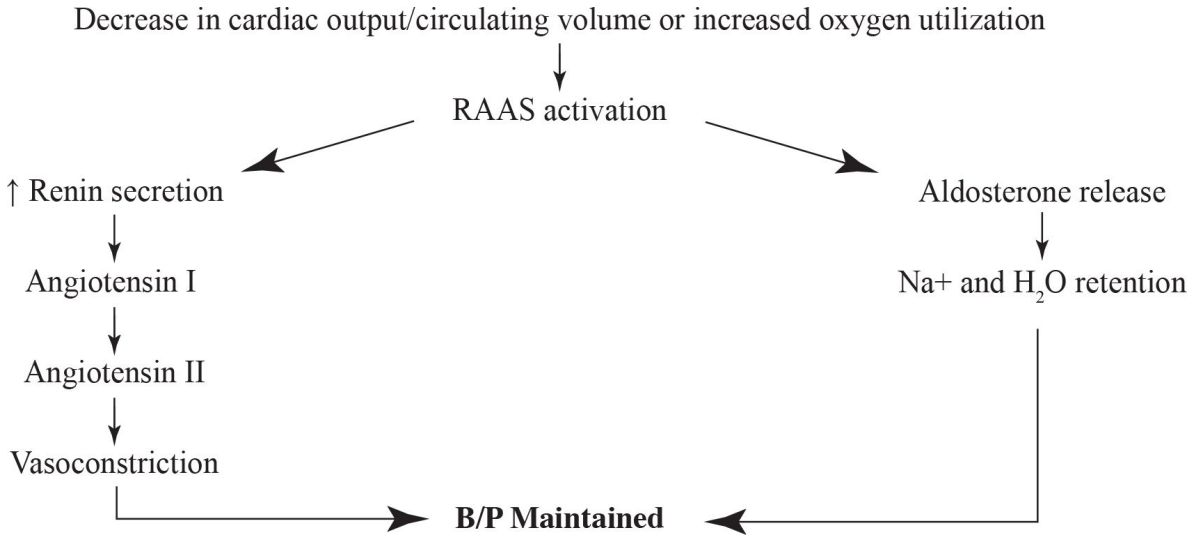

Figure 5-3. Compensatory stage of shock due to RAAS

Clinical Signs/Symptoms of the Stages of Shock

Compensatory Stage of Shock (Blood Pressure Maintained)

- Tachycardia
- Tachypnea, respiratory alkalosis
- Normal PaO_2
- Oliguria
- Skin is pale, cool (except in early sepsis)
- Restlessness, anxiety
- Complaints of thirst
- **Remember, BP maintained!**

Progressive Stage of Shock (Compensatory Mechanisms Failing)

- **Hypotension**
- Worsening tachycardia, tachypnea, oliguria
- Metabolic acidosis
- Decreased PaO_2
- Clammy, mottled skin
- Further change in LOC
- The patient may complain of nausea.

Refractory Stage of Shock

- The patient is not responsive to interventions.
- Severe systemic hypoperfusion, **multiple organ dysfunction syndrome (MODS)**

- The patient may survive shock, but die from failure of one or more organs.
  - Pulmonary (ARDS)
  - Kidney (acute tubular necrosis)
  - Heart (failure, ischemia)
  - Hematologic (disseminated intravascular coagulation)
  - Neurological (encephalopathy, stroke)
  - Liver (failure)

Types of Shock

- Hypovolemic
- Septic
- Anaphylactic
- Neurogenic (seldom tested on this exam)
- Cardiogenic (covered in the Cardiovascular Concepts chapter)
- Obstructive (covered in the Cardiovascular Concepts and Respiratory Concepts chapters)
  - Tension pneumothorax
  - Massive pulmonary embolism
  - Cardiac tamponade

Hypovolemic Shock

- Critical reduction in the circulating intravascular volume, leading to inadequate tissue perfusion
- Most common type of shock
  - Internal causes—third-spacing or pooling in the intravascular compartment
  - External causes—hemorrhage, GI or renal losses, burns, excessive diaphoresis
- Hypovolemia effects on pulse pressure:
  - Systolic decreases, diastolic maintains or elevates, NARROW pulse pressure
  - Example:
    - Baseline is 130/80
    - Volume loss → 110/80, 100/80, 90/70
- Hemodynamics
  - ↓ BP
  - ↓ Pulse pressure
  - ↓ Right atrial pressure (CVP)
  - ↓ Cardiac output, O_2 delivery
  - ↓ Left atrial pressure (PAOP)
  - ↓ SvO_2
  - ↑ Systemic vascular resistance (SVR)

Everything is decreased except SVR.

Treatment of Hypovolemic Shock

- Identify the etiology and correct it, if possible.
- Replace volume appropriately, “Fill up the tank!”
  - Rapid and vigorous volume loading
  - Requires at least 2 large bore IV sites (hemorrhagic); a central line is not necessary but may assist fluid replacement.
  - Use a fluid warmer if > 2,000 mL of fluids are administered in 1 hour (ALL fluids for trauma patients).
- Avoid use of vasopressors.
- Fluid resuscitation: goal is to maintain O_2 delivery (DO_2) and O_2 uptake (VO_2) into tissue and sustain aerobic metabolism.
- Fluid resuscitate to clinical targets (e.g., decreased tachycardia, increased urine output)
  - Use isotonic fluid: 0.9 normal saline or lactated Ringer’s.
  - Which is better? There are advantages and disadvantages to each (Table 5-1).

Table 5-1. Comparison of Normal Saline and Lactated Ringer’s

Normal Saline	Lactated Ringer's
Isotonic crystalloid, effects last approximately 40 minutes, then leaves vascular space Disadvantage—large volumes may lead to hyperchloremic acidosis Do not give to those with hypernatremia or renal failure • Has 154 mmols Na^+ and 154 of Cl^-; does **NOT** contain any K^+, Ca^{++}, or lactate	Isotonic crystalloid, effects last approximately 40 minutes, then leaves vascular space Best mimics extracellular fluid (ECF) minus proteins, recommended resuscitation fluid by the ACS Committee on Trauma Has the potential to correct lactic acidosis; yet in severe hypoperfusion, it may promote lactic acidosis due to lactate accumulation Do not give through a blood product transfusion line or to those who should not receive K^+ or lactate • Has 130 mmols of Na^+, 109 Cl^-, 4 K^+, 2.7 Ca^{++}, 28 lactate

- Resuscitation endpoints
  - MAP ≥ 65 mmHg
  - CVP ~ 6 mmHg (not well-defined)
  - Urine OP 0.5 mL/kg/hr
  - Heart rate decreased
  - Hgb > 7.0 g/dL and coagulation/platelet abnormalities are corrected.
    - Hemoglobin and hematocrit measurements are not accurate during active blood loss.

NOTE

NO PRESSORS for hypovolemic shock! The SVR is already high due to compensatory mechanisms.

Hemorrhagic Shock

The severity of hemorrhagic shock is categorized into 4 classes (Table 5-2).

Table 5-2. Classification of Hemorrhagic Shock

	Class I	Class II	Class III	Class IV
Blood loss (mL)	Up to 750	750–1,500	1,500–2,000	> 2,000
Blood loss (% blood vol)	Up to 15%	15–30%	30–40%	> 40%
Heart rate	< 100	> 100	> 120	> 140
Blood pressure	Normal	Normal	Decreased*	Decreased
Pulse pressure	Normal or ↓	Decreased	Decreased	Decreased
Capillary refill	Normal	Decreased	Decreased	Decreased
Respiratory rate	14–20	20–30	30–40	> 40
Urine output (mL/hr)	> 30	20–30	5–15	Scant
Mental status	Slightly anxious	Mildly anxious	Anxious, confused	Confused, lethargic

*Note that the blood pressure does not decrease in hemorrhagic shock until Class III, a loss of 1,500–2,000 mL of blood.

- Class I: treat with crystalloids
- Class II: treat with crystalloids
- Class III: treat with crystalloids + blood
- Class IV: treat with crystalloids + blood

Treatment of Hemorrhagic (Hypovolemic) Shock

- STOP the bleeding.
- Blood transfusion
  - Optimal hemoglobin (Hgb) threshold remains controversial, and Hgb levels are NOT reliable during active bleeding.
  - 7.0 g/dL Hgb is fairly well established in the critically ill.
  - Goal may be higher in the presence of:
    - Active bleeding
    - Severe hypoxemia
    - Myocardial ischemia
    - Lactic acidosis
- Packed red blood cells (PRBCs), unlike whole blood, do not have plasma or platelets; therefore, the patient will need a replacement of the coagulation components of blood with a transfusion of multiple units of PRBCs.
  - Fresh frozen plasma
  - Platelets
  - Cryoprecipitate
- Risks of blood product administration
  - Hemolytic and non-hemolytic reactions
  - Transfusion-mediated immunomodulation
  - Viral infection transmission
  - Transfusion-related acute lung injury (TRALI)
  - Hypothermia—WARM blood products to prevent this
    - Consequences of hypothermia
      - ➤ Impairment of red cell deformability
      - ➤ Platelet dysfunction
      - ➤ Increase in affinity of hemoglobin to hold onto O_2

- Coagulopathy: monitor coagulation status, provide plasma and platelets
- Hypocalcemia, hypomagnesemia (citrate in transfused blood binds ionized Ca^{++} and Mg^{++})
- Banked blood does not have adequate 2,3-DPG. What is the consequence?
  - Shifts the oxyhemoglobin-dissociation curve to the LEFT (see the Respiratory Concepts chapter); increases the affinity of hemoglobin to hold onto O_2.

Massive Transfusion Protocols

- Designed to provide rapid infusion of large quantities of blood products to restore oxygen delivery (DO_2), oxygen utilization (VO_2), and tissue perfusion (blood pressure)
- Indications include traumatic injuries, ruptured abdominal aortic or thoracic aortic aneurysms, liver transplant, OB emergencies.
- Definition: 10 units of RBCs in 24 hours or 5 units in less than 3 hours
- Mortality > 50%
- Need to prevent the **triad of death**:
  - Hypothermia
  - Acidosis
  - Coagulopathy

Sepsis and Septic Shock

Most acute care settings have developed protocols for the treatment of sepsis and septic shock to provide timely, evidence-based, life-saving treatment for this patient population and to meet the requirements set forth by the Centers for Medicare and Medicaid Services (CMS). Whereas older medical studies stressed the importance of CVP and $ScvO_2$ measurements, more recent medical studies that discuss sepsis and septic shock place less importance on those measurements and instead stress fluid resuscitation, timeliness of obtaining blood cultures and serum lactate level measurements, the administration of antibiotics, and the initiation of vasopressors if necessary.

Overview

- There are at least 1.7 million incidences of sepsis in American adults annually, with ~ 270,000 deaths per year (as per the CDC, Sept. 2021).
- Sepsis is the #1 cause of death in the non-coronary ICUs.
- As per the CDC, 1 in 3 patients who die in a hospital have sepsis.
- Numbers are expected to increase due to high incidences of sepsis in the older adult population.
- The current Adult CCRN test blueprint expects you to understand sepsis and septic shock. Systemic inflammatory response syndrome (SIRS) and severe sepsis are not included in the latest blueprint (most likely due to the changes introduced in the Sepsis-3 definitions, which were published in 2016). Brief descriptions of all of these terms are provided in the following sections, but exam questions will most likely focus on sepsis and septic shock.

Systemic Inflammatory Response Syndrome (SIRS)

- SIRS is a systemic inflammatory response to a wide variety of severe clinical insults, manifested by 2 or more of the following:
  - Temperature ≥ 38°C or < 36°C
  - Heart rate > 90 bpm
  - Respiratory rate > 20 breaths/minute or $PaCO_2$ < 32 mmHg
  - WBC > 12,000 or < 4,000 **or** bands > 10% (shift to the left)
- A patient **may have SIRS without sepsis** (i.e., traumatic injury, pancreatitis, burns).
- Studies have shown that SIRS is a poor predictor of sepsis, and thus SIRS was eliminated from the Sepsis-3 definitions.

Sepsis

- Sepsis is a life-threatening organ dysfunction that is caused by an abnormal host response to an infection. Initially, the infection may be “suspected,” rather than “proven,” based on the clinical examination and the patient’s history.
- A “suspected” infection is the presence of one or more of the following:
  - Positive culture results from blood, sputum, urine, etc.
  - Receiving antibiotic, antifungal, or another anti-infective therapy
  - Altered mental status in the elderly
  - Possible pneumonia (infiltrate on the chest radiograph)
  - Nursing home patient with an indwelling urinary catheter
  - Pressure ulcers
  - Acute abdomen
  - Infected wounds, especially with a history of diabetes
  - Immunosuppression
- Sepsis = infection + organ dysfunction
- Organ dysfunction may be identified by assessing the patient’s qSOFA score or SOFA score.

Examples of Organ Dysfunction

- Hypotension
- Acute hypoxemia
- Acute drop in urine output (< 0.5 mL/kg)
- Lactate 2 mmol/L or greater
- Abrupt mental status change
- Platelets below 100,000
- Coagulopathy

qSOFA (Quick Sepsis Related Organ Failure Assessment) Score

- The qSOFA score is included in the Sepsis-3 definitions, but it is not currently included in the Adult CCRN test blueprint (although it could be added in the future).
- The qSOFA score is a bedside evaluation (without the need for labs) to identify patients with suspected **organ dysfunction**.
- The qSOFA score evaluates 3 criteria, assigning 1 point for each of the following:
  - Systolic BP ≤ 100 mmHg
  - Respiratory rate ≥ 22 breaths per minute
  - Glasgow coma scale < 15 (altered mentation)
- A qSOFA score of **2 or 3** indicates a high probability for organ dysfunction.

Severe Sepsis

- Severe sepsis (as defined prior to the publication of the Sepsis-3 definitions in 2016) is sepsis **PLUS** markers of organ dysfunction.
- Note that severe sepsis is not included in the Sepsis-3 definitions, and it has been eliminated from the Adult CCRN test blueprint.

NOTE

"Severe sepsis" is included in the Sepsis-2 definitions (from 2001) and is still used by the CMS, but it is not included in the Sepsis-3 definitions (from 2016) or in the current Adult CCRN test blueprint. The Sepsis-3 definition of "sepsis" includes organ dysfunction, whereas the Sepsis-2 definition instead calls it a "systemic response (SIRS positive) to an infection." Due to changing nomenclature and "bundles" of care (1-hour, 3-hour, 6-hour) as defined by various organizations, it is unlikely that "severe sepsis" will be mentioned in an exam question. However, just in case you need a quick refresher on the differences between the Sepsis-2 definitions and the Sepsis-3 definitions and how they define SIRS, sepsis, severe sepsis, and septic shock, refer to Table 5-3.

Table 5-3. Differences Between the Sepsis-2 Definitions and the Sepsis-3 Definitions

Condition	Sepsis-2 Definitions	Sepsis-3 Definitions
SIRS	Systemic response to a wide variety of clinical insults (may or may not be an infection)	SIRS criteria is not assessed
Sepsis	Presence of an infection AND a systemic response (SIRS positive) to an infection	Presence of an infection AND **organ dysfunction**
Severe sepsis	Sepsis PLUS markers of **organ dysfunction**	Severe sepsis is not included in these definitions
Septic shock	Hypotension due to an infection; includes markers of hypoperfusion, which persists despite adequate fluid resuscitation; requires the administration of pressors	Hypotension due to an infection; includes markers of hypoperfusion, which persists despite adequate fluid resuscitation; requires the administration of pressors

Septic Shock

- Of all deaths in hospitals annually, more than 40% are the result of septic shock.
- Clinically identified by an infection, **PLUS**:
  - Vasopressor requirement to maintain a MAP of ≥ 65 mmHg, despite adequate fluid resuscitation
  - Serum lactate > 2 mmol/L, despite fluid resuscitation

Differentiation of Infection, Sepsis, and Septic Shock

Match the condition in the left-hand column with the clinical signs of patients in the right-hand column, each of which has a documented infection.

A. Infection	1. _____ BP 78/36 before fluids, 102/58 after a 500 mL fluid bolus, BE –5, pH 7.30, lactate 3 mmol/L, acute abdomen
B. Sepsis	2. _____ BP 110/80, BE –1, pH 7.34, lactate 1.5 mmol/L, temperature 39°C, WBC 15,000, acute abdomen
C. Septic shock	3. _____ BP 78/40 before fluids, 88/49 after a 500 mL fluid bolus × 4, BE –5, pH 7.31, lactate 6 mmol/L, acute abdomen

The answers are located at the end of the “Sepsis and Septic Shock” section on page 124.

Pathophysiology of Sepsis/Septic Shock

- Sepsis/septic shock is a process of malignant intravascular **inflammation**.

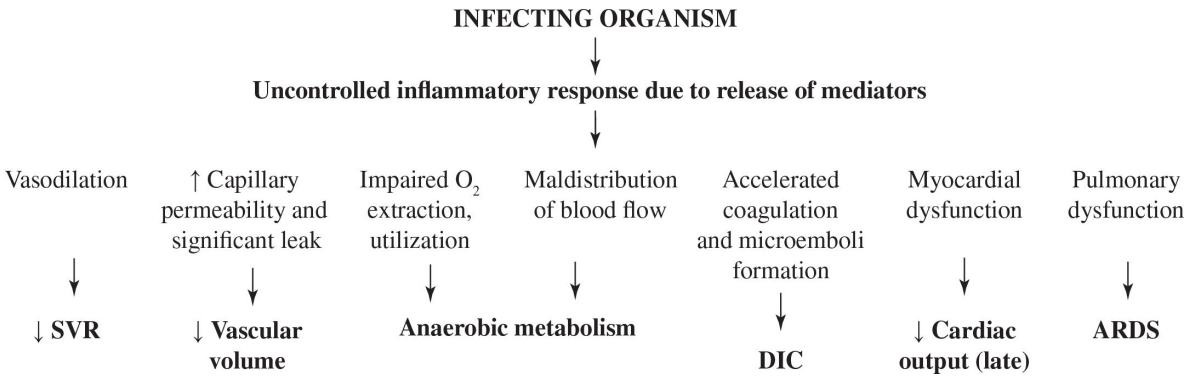

Figure 5-4. Pathophysiology of sepsis/septic shock

- Activation of coagulation, inflammatory cytokines, complement, and kinin cascades with the release of a variety of endogenous mediators
- Causative organisms include:
  - Gram-negative bacteria
  - Gram-positive bacteria
  - Fungi, viruses, *Rickettsia*, parasites

Risk Factors for Sepsis

- Extremes of age
- Chronic health problems
- Invasive procedures and devices
- Surgical wounds
- Genitourinary infections
- Prolonged hospitalizations
- Translocation of GI bacteria (NPO)
- Acquired immunodeficiency syndrome
- Use of cytotoxic and immunosuppressive agents
- Alcoholism
- Malignant neoplasms; bone marrow suppression
- Transplantation procedures
- History of a splenectomy

Signs/Symptoms of Early Septic Shock

- Tachycardia, bounding pulse
- BP is low, responsive to vasopressors
- Skin is warm, flushed
- Respirations are deep, somewhat fast
- Lactate > 2 mmol/L
- Confusion → mental status change (especially in elderly people)
- Oliguria
- Fever (temperature > 38°C)

Signs/Symptoms of Progressive (Later) Septic Shock

- Hypotension, may not be responsive to pressors
- Tachycardia, pulse is weak and thready
- Lactate 4 mmol/L or greater
- Skin is cool, pale
- Respirations are rapid *or* may be slow
- Lethargy, coma
- Anuria
- Hypothermia (temperature < 36°C)

MYTH

A patient with sepsis or septic shock always has a fever and an elevated WBC.

Table 5-4 shows the hemodynamics of septic shock. Table 5-5 lists the diagnostic test results that indicate septic shock.

Table 5-4. Hemodynamics of Septic Shock*

Early	Progressive (Late)
CO/CI ↑ RA, PA, PAOP ↓ SVR ↓ SvO_2 ↑ O_2 delivery ↑ O_2 consumption ↓	CO/CI ↓ RA, PA, PAOP ↑ SVR (variable) SvO_2 (variable) O_2 delivery ↓ O_2 consumption ↓
*Key: ↓ = decrease; ↑ = increase	

Table 5-5. Diagnostic Test Results That Indicate Septic Shock*

Early	Progressive (Late)
ABGs → respiratory alkalosis, mild ↓ PaO_2, or may have a combined respiratory alkalosis and metabolic acidosis	ABGs → metabolic acidosis, ↓ ↓ PaO_2
PT, PTT ~ or ↑	PT, PTT ↑ ↑
Platelets ~ or ↓	Platelets ↓ ↓
WBC ↑, ~, or ↓	WBC ↓
Bands ↑	Bands ↑↑
Glucose ↑	Glucose ↓
Lactate ↑	BUN, creatinine ↑
Troponin ↑	Liver enzymes ↑
	Lactate ↑
	Troponin ↑
*Key: ↓ = decrease; ↑ = increase; ~ = no change	

- Only 30–50% of patients who present with sepsis/septic shock have positive blood cultures.

Treatment for Sepsis/Septic Shock

MYTH

A patient with sepsis or septic shock always has positive blood cultures.

- Initial fluid challenge should be the administration of 30 mL/kg of crystalloid (2.1 L for a 70 kg or 154 pound person) **as early as possible** to achieve the goals listed below:
  - MAP ≥ 65 mmHg
  - UO ≥ 0.5 mL/kg/hr
  - Decrease in tachycardia
- If hypotension persists despite fluid resuscitation, start:
  - Vasopressor: pressor of choice is norepinephrine.
    - **Norepinephrine (Levophed)** is first-line.
    - **Epinephrine** (drip) is recommended when a second vasopressor agent is needed.
- IF the BP does not respond to high-dose initial pressor and fluids, the patient may have **catecholamine-refractory septic shock**, whereby alpha receptors in the arterial bed are not responsive to pressors.
  - Start a **vasopressin drip** at 0.03–0.04 units/min, generally not titrated.
    - **NOT** a first-line agent for hypotension
    - Used to enhance the effectiveness of the initial pressor that was used for treating septic shock
  - If vasopressin is not effective, consider extreme metabolic acidosis or corticosteroid insufficiency related to a critical illness; treatment with sodium bicarbonate or steroids may be considered, although neither have demonstrated that they can improve mortality rates.

- Obtain two **blood cultures as early as possible** that are drawn simultaneously from two different sites prior to antibiotic administration.
- Begin broad-spectrum **antibiotic therapy as early as possible** after recognizing sepsis/septic shock and **after** blood cultures are drawn; administer within 3 hours of recognition of sepsis/septic shock (preferably within 1 hour of recognition, if possible).
  - In one study, for every hour that the administration of antibiotics was delayed, there was an approximately 12% decrease in the probability of survival.
- Obtain serum lactate **as early as possible** and remeasure within 2–4 hours if the first lactate is > 2 mmol/L.
- Identify the source of infection ASAP (which may direct antibiotic and/or interventional therapy).
- If the MAP remains below 65 mmHg **OR** the lactate is 4 mmol/L or greater, **reassess the fluid status**.
  - Ask a licensed independent practitioner to complete a focused clinical assessment, **OR**
  - Perform an assessment of 2 of the following: measure the CVP; assess the patient's fluid responsiveness with either a passive leg raise or a fluid challenge; perform/assess a bedside ECHO; measure the $ScvO_2$.
- Inotropic therapy—**dobutamine** is recommended (by itself or in addition to a vasopressor) for patients with cardiac dysfunction, as evidenced by high filling pressures and low cardiac output, or clinical signs of hypoperfusion after successfully restoring the blood pressure with effective volume resuscitation.
- Oxygenation goals for septic shock
  - Maintain SpO_2 95% or greater

- Goal = $ScvO_2$ ≥ 70% or SvO_2 ≥ 65% (when CVP and MAP goals are met)
- If $ScvO_2$ or SvO_2 goals are not achieved:
  - Consider further fluids
  - Dobutamine infusion, max 20 mcg/kg/min
  - Consider a transfusion of PRBCs if the Hgb is 7.0 or less

Summary of Therapeutic Endpoints for Septic Shock

- MAP ≥ 65 mmHg
- Decreased lactate/improved base deficit
- Normalization of heart rate
- UO ≥ 0.5 mL/kg/hr
- Warm extremities
- Mental status return to baseline
- Source control
- Central venous oxygen saturation ($ScvO_2$) ≥ 70% or SvO_2 ≥ 65% (if CVP or PA line is available)
- CVP (if available), 8–12 mmHg

Differentiation of Infection, Sepsis, and Septic Shock Answers

A. Infection

B. Sepsis

C. Septic shock

1. __B__ BP 78/36 before fluids, 102/58 after a 500 mL fluid bolus, BE –5, pH 7.30, lactate 3 mmol/L, acute abdomen
2. __A__ BP 110/80, BE –1, pH 7.34, lactate 1.5 mmol/L, temperature 39°C, WBC 15,000, acute abdomen
3. __C__ BP 78/40 before fluids, 88/49 after a 500 mL fluid bolus × 4, BE –5, pH 7.31, lactate 6 mmol/L, acute abdomen

Anaphylactic Shock

- Anaphylaxis is an allergic reaction that is rapid in onset and may cause death.
- Usually occurs after previous exposure to the substance
- Hives, angioedema in ~ 88% of cases
- Respiratory tract involvement in ~ 50% of cases
- Shock occurs in ~ 30% of anaphylaxis cases.

Etiology

- **IgE-mediated** immediate hypersensitivity reaction to **protein** substances
  - Penicillin, contrast media, bee sting, foods, latex

An anaphylactoid response looks the same clinically but is NOT IgE-mediated. Previous exposure is not necessary (Figure 5-5).

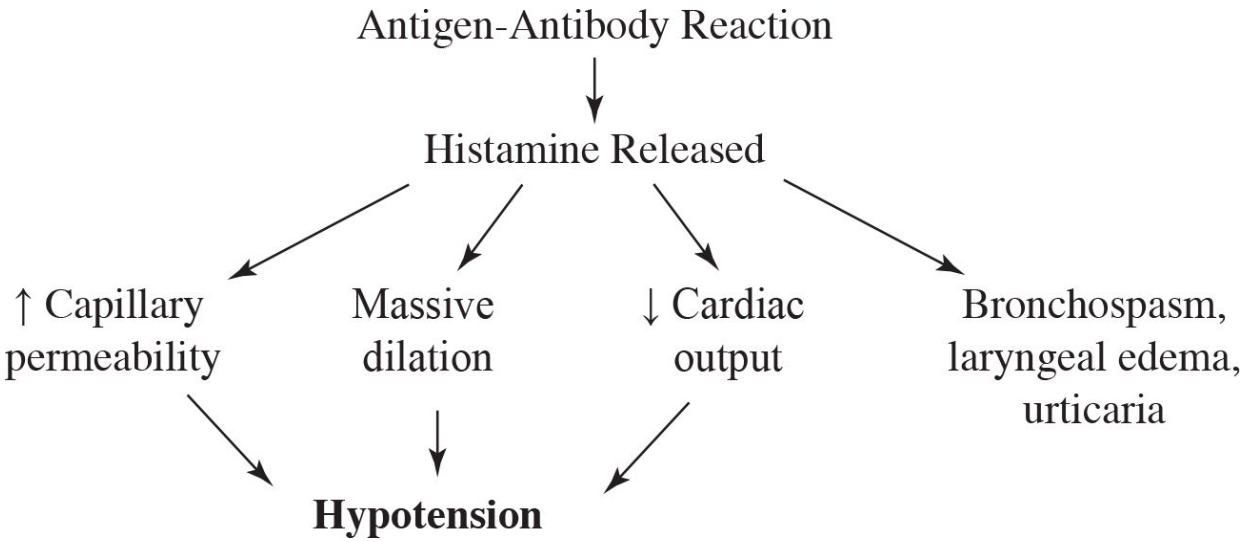

Figure 5-5. Pathophysiology of anaphylactic shock

Treatment

- Removal of offensive agent, if able
- O_2
- 0.3–0.5 mg of 1:1,000 epinephrine **IM** (more rapid absorption than subcutaneous) to decrease dilation, bronchospasm
- Aggressive fluid resuscitation (1–4 L) to treat the relative hypovolemia
- Antihistamine: diphenhydramine (Benadryl) 25–50 mg IV to decrease allergic response
- Inhaled beta-adrenergic agents to decrease bronchospasm
- Steroids IV (high-dose): peaks in 4–6 hours, give ASAP to get “on board” to decrease inflammatory response

Multiple Organ Dysfunction Syndrome (MODS)

- Multiple organ dysfunction syndrome (MODS), which is sometimes referred to as multi-organ dysfunction syndrome, is the progressive insufficiency of 2 or more organs in an acutely ill patient, such that homeostasis cannot be maintained without intervention (Table 5-6).

Table 5-6. Markers of Multiple Organ Dysfunction Syndrome (MODS)

Cardiovascular	Pulmonary	Renal
Hypotension Tachycardia Dysrhythmias Need for vasopressor support Decreased systemic vascular resistance Abnormal CVP (low or high) Positive troponin	Tachypnea Dyspnea Hypoxemia	Elevated creatinine Decreased GFR Oliguria Life-threatening electrolyte imbalances
	Neurological	**Endocrine**
	Confusion Delirium Disorientation Lethargy, coma Seizure	Hyperglycemia or hypoglycemia Adrenal insufficiency
Hepatic	**Hematologic**	**Metabolic**
Elevated liver enzymes Hypoglycemia Decreased albumin Jaundice	Thrombocytopenia Coagulopathy Increased D-dimer levels Decreased protein C levels	Metabolic acidosis Elevated lactate

- MODS may be the result of any type of shock.
  - The greater the number of organs involved, the higher the mortality
  - Accounts for ~ 80% of all ICU deaths annually

Sequential Organ Failure Assessment (SOFA) Scoring System

- Unlike the bedside qSOFA evaluation, the SOFA utilizes lab results to assess the extent of a patient's organ dysfunction. Six organ systems are evaluated, and each is assigned a score from 0 to 4 based on results to obtain the total score:
    1. Hypotension (cardiovascular)
    2. Glasgow Coma Scale score (neurological)
    3. PaO_2/FiO_2 (pulmonary)
    4. Serum creatinine or urine output (renal)
    5. Bilirubin level (hepatic)
    6. Platelet count (hematologic)

- The total score may be useful for predicting the clinical outcome of critically ill patients. Studies have shown that mortality rates are associated with the SOFA score: the mortality rate is 50% if the score increases in the first 96 hours after admission; the mortality rate is 25% if the score remains the same in the first 96 hours after admission; and the mortality rate is less than 25% if the score decreases in the first 96 hours after admission.

Trauma

- Trauma is included in the Adult CCRN test blueprint. However, questions related to trauma are generally very straightforward.
- Make sure you know the trauma first-line assessment and second-line assessment.

Trauma First-Line Assessment (A, B, C, D, E)

- **A**irway: ensure a patent airway—consider intubation (stabilize the cervical spine if a spinal cord injury is suspected).
- **B**reathing: provide 100% oxygen and ventilation.
- **C**irculation: two large bore IVs with warm isotonic lactated Ringer's
- **D**isability: perform a quick neurological exam—LOC, motor, pupils.
  - Glasgow Coma Scale score is part of the neurological exam, not ALL of it.
- **E**xpose/**E**nvironmental: remove the patient's clothes, provide warmth/cooling as needed.

Trauma Second-Line Assessment (F, G, H, I)

- **F**ull set of vital signs
  - Focused adjuncts: ECG monitor, pulse oximeter, CO_2 detector, urinary catheter, gastric tube, radiography, FAST, CT, DPL, labs
  - Family presence
- **G**ive comfort measures (pain management)
- **H**istory
- **I**nspect posterior: turn the patient over!

Providing Sedation to the Critically Ill

The Adult CCRN test blueprint has included treatment of pain and the use of sedation agents in the multisystem section; management of agitated behavior is also included in the behavioral/psychosocial section of the blueprint.

Overview of Sedation

- A patient who is agitated (even a patient with a medical, rather than a surgical, diagnosis) should first receive an analgesic (**analgesia-first sedation**) before receiving anxiolytics. (Analgesic agents will be covered in the next section of this chapter after the following discussion of anxiolytics.)
- The degree of sedation (the sedation goal) should be based on the needs of the patient and should be agreed upon by and communicated to all members of the health care team. This sedation goal applies to the sedation provided during a procedure and to the sedation provided as part of the therapeutic plan of care.
- Maintaining **light levels** of sedation in adult ICU patients is associated with improved clinical outcomes (i.e., a shorter duration of mechanical ventilation and a shorter ICU length of stay).
- When sedation is provided on an as-needed, PRN basis, there is less of a possibility of oversedation than there is when sedation is provided with a continuous infusion.
- Daily interruptions of continuous infusions of sedation agents allows for an assessment of further need for the sedation agent and a neurological assessment of the patient.
- Nonpharmacological treatment (massage, music, cold therapy, and relaxation techniques) should be considered before using an anxiolytic agent, especially for mild anxiety and agitation.
- The levels of sedation are:
  - **Minimal (Light) Sedation:** The patient responds normally to verbal commands.
  - **Moderate Sedation:** The patient responds purposefully to verbal commands, either alone or accompanied by light tactile stimulation.

The patient is able to maintain a patent airway.

- **Deep Sedation:** The patient cannot be easily aroused but responds purposefully to repeated or painful stimulation. The patient may require assistance in maintaining a patent airway. Deep sedation is generally only used during a procedure by providers with specialized privileges or is ongoing for a patient receiving mechanical ventilation.
- **General Anesthesia:** This is a loss of consciousness during which patients are not arousable, even by painful stimulation.

- The level of sedation may exceed the level intended; therefore, the RN needs to be able to identify when this occurs and act accordingly.

Assessment of Agitation and Sedation

- Rule out hypoxemia, hemodynamic instability, and pain as causes of agitation. If any of these is present, treat accordingly.
- Assess for additional etiologies (Table 5-7).

Table 5-7. Causes of Agitation in Critically Ill Patients

Physiological	Pharmacological	Emotional	Environmental
Hypoxemia Hemodynamic instability (shock) Pain DELIRIUM (hyperactive) Withdrawal from ETOH, drugs Dyspnea Immobility Sleep deprivation	Anesthetics Sedatives Analgesics Steroids Bronchodilators	Preexisting anxiety disorders Preexisting psychoses Dementia Fear Anger	Noise, alarms Lights Too cold or warm Restraints Tubes, lines Odors Isolation Sensory deprivation Sensory overload

- Use a valid and reliable sedation assessment tool for measuring the quality and depth of sedation before and after treatment.
  - The Richmond Agitation-Sedation Scale (RASS) and the Sedation-Agitation Scale (SAS) are valid and reliable sedation assessment tools that are used for adult critical care patients.

Treatment with Select Sedation Agents

- See Table 5-8 for select sedation agents that are commonly used for an acute/critically ill patient. **The dose that is given may vary depending upon unit protocols.**

Table 5-8. Dosing and Nursing Implications for Select Sedation Agents

Agent	Start Dose	Titration Time/Dose	Usual Dose Range	Nursing Implications
Dexmedetomidine (Precedex)	**Continuous Infusion:** Begin at 0.2–0.4 mcg/kg/hr, titrate to goal RASS score	If goal RASS score is not achieved, titrate by 0.1 mcg/kg/hr q 15 min	0.2–1.7 mcg/kg/hr	• Loading dose not recommended due to risk of hypotension and bradycardia • Do NOT paralyze patients while they're on dexmedetomidine • The patient may not need to be mechanically ventilated while on this medication • Sedation vacation may not be indicated
Ketamine (Ketalar)	**IV Bolus:** 1–2 mg/kg IV over 1 min followed by 0.25–0.5 mg/kg IV q 5–10 min if needed **Continuous Infusion:** 0.5–1 mg/kg/hr	**Continuous Infusion:** Titrate by 0.25 mg/kg/hr q 30 min; max infusion dose 3 mg/kg/hr for sedation	**Sedation:** 0.5–2 mg/kg/hr **Refractory Status Epilepticus:** 0.5–5 mg/kg/hr	• Give slow IV push over at least 1 min; faster rates of administration may cause respiratory depression • May cause increase in BP and/or HR or hypersalivation • May produce psychosis, including auditory and visual hallucinations; pretreatment with a benzodiazepine reduces incidences of psychosis
Lorazepam (Ativan)	**Loading Dose:** 1–4 mg IVP q 30 min until goal RASS score or CIWA score **Continuous Infusion:** 1–2 mg/hr	**Intermittent Bolus:** Titrate by 1–2 mg/hr q 1 hr until sedation goal is achieved; if RASS score or CIWA score is not achieved, re-bolus with MIDAZOLAM 2 mg IV q 10 min to a max infusion rate of 10 mg/hr	1–20 mg/hr	• Contact the physician if a rate > 10 mg/hr is needed • Turn off daily and assess unless a contraindication exists for sedation vacation; attempt to manage sedation with PRN dosing with midazolam; if you need to resume the infusion, resume at half the previous dose • Use a 0.22-micron filter for continuous infusions • Consider checking the serum osmolarity if > 10 mg/hr is needed • Doses > 20 mg/hr have been associated with metabolic acidosis and renal insufficiency due to solvent, propylene glycol
Midazolam (Versed)	**Loading Dose:** 1–4 mg IV q 5–15 min until goal level of sedation is achieved **Continuous Infusion:** 1–2 mg/hr	**Intermittent Bolus:** Titrate by 1–2 mg/hr every hour until goal sedation score is achieved; if RASS score or CIWA score is not achieved, re-bolus 2 mg IV q 10 min to a max infusion rate of 10 mg/hr	1–20 mg/hr	• Contact the physician if a rate > 10 mg/hr is needed • Turn off daily and assess unless a contraindication exists for sedation vacation • Attempt to manage sedation with PRN dosing with midazolam; if you need to resume the infusion, resume at half the previous dose
Propofol (Diprivan)	**Continuous Infusion:** 10 mcg/kg/min **Loading Dose:** Not recommended due to risk of hypotension	Titrate by 5 mcg/kg/min q 10 min until goal sedation score is achieved	5–80 mcg/kg/min **Status Epilepticus:** Rates up to 150 mcg/kg/min may be appropriate	• Turn off daily and assess unless a contraindication exists for sedation vacation; attempt to manage sedation with PRN dosing with midazolam; if you need to resume the infusion, resume at half the previous dose • Only use for ventilated patients • Do not paralyze • No analgesic properties • Propofol infusion syndrome may occur with prolonged use or in higher doses • Monitor triglycerides at baseline and q 48 hours during the infusion • Change the tubing every time a bottle is changed OR a minimum of q 12 hours • Count as a source of calories (lipids)

☆ Note that memorization of exact dosing is not generally needed for this exam. You need to understand how to manage a patient who requires types of sedation: intermittent, continuous, and procedural (minimal and moderate).

Benzodiazepine Reversal with Flumazenil (Romazicon)

- Reverse the effects of benzodiazepines with flumazenil (Romazicon) 0.2 mg IV over 15 seconds for moderate sedation/over 30 seconds for overdosage.
- Repeat doses, 0.2 mg at 1-minute intervals, maximum of 4 doses, until patient awakens.
- For resedation, give repeat doses at 20-minute intervals as needed, 0.2 mg per minute to a maximum of 1 mg total, and 3 mg total in 1 hour.
- Onset of action of flumazenil is 1–2 minutes, 30% response within 3 minutes, peak effect in 6–10 minutes.
- Resedation occurs after approximately 1 hour; the duration of flumazenil is related to the dose given and the benzodiazepine plasma concentrations.

☆ Note that the reversal effects of flumazenil may wear off before the effects of the benzodiazepine. Therefore, monitor for a return of sedation and respiratory depression for at least 2 hours and until the patient is stable and resedation is unlikely.

- Use with caution for those with a history of prolonged use. A seizure may occur with reversal.

Daily Sedation Withdrawal (Spontaneous Awakening Trial)

An evidence-based strategy for preventing oversedation and its complications is to withhold the sedation for patients who are receiving a **continuous drip** in order to perform a neurological assessment and determine whether the continuous sedation drip is still clinically beneficial. The daily spontaneous awakening trial (SAT), or sedation vacation, is best done in conjunction with the daily spontaneous breathing trial (SBT). Suggested guidelines for performing the daily SAT are as follows:

1. Screen the patient prior to the spontaneous awakening trial.
    - No myocardial ischemia
    - No active seizures
    - No alcohol withdrawal
    - No paralytic drip
    - Stable intracranial pressure
    - No recent increase in the sedation drip dose to maintain the goal RASS score
2. Turn off the sedation drip.
    - If the sedation agent is propofol, consider weaning down every 5 minutes to prevent sudden agitation.
3. Monitor the patient for awakening and tolerance to drug withdrawal.
    - Assess the patient's neurological status, discomfort, and pain.
    - Assess the level of sedation/agitation with a sedation tool.
    - Signs of SAT failure include:
        - Dangerous agitation
        - Sustained tachypnea, increased work of breathing

    - Sustained drop in SpO_2 to < 90%
    - Acute arrhythmia
    - Hypotension
4. Determine whether the sedation drip should be discontinued and replaced with PRN dosing, restarted at half the dose, or returned to the pre-SAT dose.

Providing Analgesia to the Acutely and Critically Ill

Overview of Pain

- Pain has adverse physiological and psychological effects, including activation of the physiological stress response, depression, and delirium.
- Etiologies of pain in the acutely and critically ill include the obvious sources and the not-so-obvious sources (Table 5-9).

Table 5-9. Causes of Pain/Discomfort in an Acutely or Critically Ill Patient

Obvious Causes of Pain	Less Obvious Causes of Pain
Incisions Invasive procedures Trauma, fractures Prolonged immobility	Monitoring and therapeutic devices (catheters, drains, endotracheal tubes, noninvasive ventilating devices) Routine nursing care (airway suctioning, dressing changes, physical therapy)

Pain Assessment

- It is recommended that pain be routinely assessed in all adult ICU patients.
- Attempt to obtain the patient's self-report of pain using the Numerical Rating Scale (NRS), pointing, and head nodding.
- The Behavioral Pain Scale (BPS) is recommended for a patient who is receiving mechanical ventilation and is unable to self-report pain. The Critical-Care Pain Observation Tool (CPOT) is recommended for assessing the pain of a patient who is unable to self-report pain, with or without mechanical ventilation.
- Vital signs alone should not be used for pain assessment in critically ill adults, but they can be used as a cue to assess pain further.
- Consider asking a family member or friend who knows the patient well (a proxy reporter) whether the patient's behavior may indicate the presence of pain.

Pain Management

- Intravenous (IV) opioids are the first-line choice to treat non-neuropathic pain in critically ill patients. All available IV opioids, when titrated to similar pain intensity endpoints, are equally effective (Table 5-10). **The dose that is given may vary depending upon unit protocols.**
- **Prevent** pain as you are able to by using:
  - Preemptive analgesia prior to procedures that are likely to cause pain
  - Nonpharmacological interventions (distraction, relaxation therapy)
- If the patient is agitated, treat pain first and then sedate.

Table 5-10. Pharmacology of Select Opioid Analgesics

Agent	Start Dose	Titration Time/Dose	Usual Dose Range	Nursing Implications
Fentanyl (Sublimaze)	**Loading Dose:** 25–100 mcg slow IV push over 1–2 min q 10–15 min until pain is controlled (using NRS or BPS) **Continuous Infusion:** 25–50 mcg/hr	If the goal pain score is not achieved, give 25–50 mcg IV push and then increase the rate of infusion by 25 mcg/hr; contact the physician if the rate exceeds 200 mcg/hr or if higher doses are needed	25–200 mcg/hr	• If a patient is receiving this agent regularly for > 1 week, do not suddenly stop; taper gradually by ~ 10–25% daily in order to prevent withdrawal • Weaning is not needed if fentanyl is replaced with an equianalgesic dose by an alternate route • If the patient is not mechanically ventilated, decrease dosing requirements for those with sleep apnea, those with significant cardiovascular/pulmonary disease, those who are elderly, and those who are obese (correlates with sleep apnea) • Consider a sedation vacation, if appropriate
Hydromorphone (Dilaudid)	**Loading Dose:** 0.2–0.5 mg q 5–15 min until pain is controlled (using NRS or BPS) **Continuous Infusion:** 0.2–0.5 mg/hr; Caution: 1 mg of hydromorphone is equivalent to 7–10 mg of morphine	If the goal pain score is not achieved, give 0.2–0.5 mg IV push and then increase the infusion by 0.2–0.3 mg/hr q 30 min; contact the physician if the rate exceeds 3 mg/hr or if higher doses are needed	0.2–3.0 mg/hr	• If a patient is receiving this agent regularly for > 1 week, do not suddenly stop; taper gradually by ~ 10–25% daily in order to prevent withdrawal • Weaning is not needed if hydromorphone is replaced with an equianalgesic dose by an alternate route • If the patient is not mechanically ventilated, decrease dosing requirements for those with sleep apnea, those with significant cardiovascular/pulmonary disease, those who are elderly, and those who are obese (correlates with sleep apnea) • Consider a sedation vacation, if appropriate
Morphine	**Loading Dose:** 2–4 mg IV push q 5–15 min until pain is controlled (using NRS or BPS) **Continuous Infusion:** 1–2 mg/hr	If the goal pain score is not achieved, give 2–4 mg IV push and then increase the rate by 1–2 mg/hr q 30 min; contact the physician if the rate exceeds 10 mg/hr or if higher doses are needed	1–10 mg/hr	• If a patient is receiving this agent regularly for > 1 week, do not suddenly stop; taper gradually by ~ 10–25% daily in order to prevent withdrawal • Weaning is not needed if morphine is replaced with an equianalgesic dose by an alternate route • If the patient is not mechanically ventilated, decrease dosing requirements for those with sleep apnea, those with significant cardiovascular/pulmonary disease, those who are elderly, and those who are obese (correlates with sleep apnea) • Consider a sedation vacation, if appropriate • If the patient is elderly, active metabolite may accumulate, resulting in renal insufficiency and increased sedation • Monitor the duration of therapy; possibly consider an alternate opioid

Opioid Reversal with Naloxone

- Give 0.4 to 2 mg IV every 2 minutes until effect to a maximum of 10 mg.
- Duration of naloxone action is 1 to 2 hours; repeated doses may be needed for a long-acting opioid.

Targeted Temperature Management (TTM)

Overview

- Targeted Temperature Management (TTM) is a treatment that lowers the patient's core body temperature in order to prevent the neurological effects of an ischemic injury in the brain of survivors of sudden cardiac death.
- Assess patients after cardiac arrest for inclusion criteria and exclusion criteria (Table 5-11).

Table 5-11. Inclusion Criteria and Exclusion Criteria for the Use of Targeted Temperature Management

Inclusion Criteria	Exclusion Criteria
Cardiac arrest with a return of spontaneous circulation Unresponsive or not following commands after cardiac arrest Witnessed arrest with downtime of less than 60 minutes	Pregnancy Core temperature of less than 35°C Age < 18 or > 85 Existing DNR status or terminal disease Chronic renal failure Sustained refractory ventricular arrhythmias Active bleeding Shock Hemodynamic instability Drug intoxication

This therapy involves 3 phases:

1. Induction phase: lower the patient's temperature to 32–36°C (as ordered by the provider); start this cooling ASAP.
    - The RN should initiate this cooling within 90 minutes of the patient going into arrest; the cooling may last for as long as 6

hours after the arrest.

2. Maintenance phase: keep the patient at the target temperature (32–36°C) for 24 hours.
3. Rewarming phase: slowly increase the patient's temperature to 36.5–37°C (as ordered by the provider).

Induction Phase

- Set the goal time to the target temperature.
- Monitor the core temperature (pulmonary artery catheter, esophageal, bladder, rectal)..
- Apply the device (external pads or internal central venous catheter).
- The goal systolic BP is generally > 90 mmHg, and the goal MAP is generally > 70 mmHg.
- Obtain baseline labs and generally complete a metabolic panel, a complete blood count, a coagulation panel, a check of the patient's serum magnesium and phosphorus levels, and an arterial blood gas.
- Get a baseline bedside blood glucose measurement.
- Obtain a 12-lead ECG.
- Initiate deep sedation.
- Manage shivering by covering the head, hands, and feet or by using meperidine (Demerol); use a neuromuscular agent if shivering is not controlled with meperidine (Demerol).
- Monitor/manage the systemic effects of hypothermia.

Systemic Effects of Hypothermia

- Insulin resistance → hyperglycemia
- Electrolyte and fluid shifts
- Shivering
- Skin breakdown
- Pupil and corneal reflexes may be absent due to hypothermia
- Decreased cardiac output
  - Up to 25%
- Alteration in coagulation
  - Platelet dysfunction

- Increased risk for infection
  - Neutrophil and macrophage functions decrease at temperatures less than 35°C.

Maintenance Phase (Duration 24 Hours)

- Continuously monitor the core temperature (bladder, rectal); the core temperature should not be lower than the specified goal (32–36°C).
- Monitor vital signs (at least hourly).
- Obtain routine bedside blood glucose measurements and initiate an insulin drip as needed.
- Monitor train-of-four (TOF) every hour if a paralytic is used and ensure a goal of 1–2 twitches to prevent prolonged paralysis.
- Repeat labs (same as baseline labs) every 8 hours until the patient is rewarmed.

Rewarming Phase

- Perform passive rewarming to 36.5–37°C.
- Program the cooling unit to increase the target temperature by 1 degree per hour.
- Stop all potassium administration 8 hours prior to rewarming.
  - Rewarming causes rebound hyperkalemia.
- Discontinue paralytics (if they were being used) after the patient is warmed to 36.5°C.
- Repeat labs (same as baseline) when the patient is rewarmed.
- Perform a close neurological assessment; pupil and corneal reflexes may continue to be absent for a time.

Toxin/Drug Exposure

The Adult CCRN exam may include 1 question related to toxin/drug exposure.

General Points

- Toxin/drug exposure may be accidental or intentional.
  ☆ Initial management—always assess ABCs (airway, breathing, circulation).

- If the patient is comatose, be prepared to give 50% dextrose 50 mL, thiamine 50–100 mg, naloxone 2 mg IV.
- To prevent absorption of the toxin/drug, give activated charcoal 1 gm/kg via gastric lavage.
  - Contraindicated with hydrocarbon or corrosive ingestions
  - Not necessary for the ingestion of iron, lithium, or alcohols
- Facilitate the removal of the drug—urine alkalization, hemodialysis.
- Administer an antidote, if indicated (e.g., naloxone).
- Monitor for arrhythmias.
- Monitor the urine output.
- If there is a **chemical exposure**, give an antidote (if possible), remove the chemical (if it is a powder, brush it away; if it is a liquid, flush it with saline or water), do not rub the affected area, and cover the affected area with a sterile damp dressing.

Management of Toxin/Drug Exposure

- See Table 5-12 for the management of specific toxin/drug exposure.

Table 5-12. Signs, Symptoms, and Treatment of Specific Toxic Agents

Drug	Signs/Symptoms	Treatment
Acetaminophen (Tylenol)	Nausea, vomiting, perhaps none early on	N-acetylcysteine dosing is effective for 8 hours after ingestion • 140 mg/kg loading dose, then • 70 mg/kg every 4 hrs for 17 doses • Give ALL drug doses, regardless of drug level
	Later RUQ pain, abnormal liver function test results, mental status changes	GI lavage with activated charcoal within 4 hours after ingestion
Benzodiazepines	Drowsiness, confusion, slurred speech, respiratory depression, hypotension, aspiration	Support the airway
		Flumazenil (Romazicon) 0.2 mg slow IV push; then 0.3 mg IV; then 0.5 mg IV at 1-minute intervals, total 3 mg
		Short half-life; watch for reoccurrence of symptoms
		Gastric lavage with activated charcoal
		Fluid resuscitation
Beta blockers	Bradycardia	Glucagon, epinephrine, insulin plus dextrose, sodium bicarbonate
	Hypotension	
	CV collapse	
Calcium channel blockers	Bradycardia	Calcium gluconate, epinephrine, insulin plus dextrose, sodium bicarbonate
	Hypotension	
	CV collapse	
Cocaine	Seizure activity, agitation, hyperthermia, rhabdomyolysis	Activated charcoal
		Fluids, glucose, thiamine IV
		Benzodiazepines for sedation, seizures
		Vasopressin is preferred over epinephrine in full arrest
		Vasodilators for hypertension
		Nitrates, calcium channel blockers for ischemia; NO beta blockers
		Cooling for hyperthermia
Ethylene glycol	Intoxication behavior	Gastric lavage
	Vomiting	Sodium bicarbonate
	Metabolic acidosis, anion gap	Antidotes: ethanol or fomepizole
	Renal failure	Dialysis
ETOH	Stupor, respiratory depression, aspiration risk	Support, protect the airway
		Fluid resuscitation
		Multivitamin and thiamine 100 mg IV
		Electrolyte replacement PRN (Mg^{++}, Ph^{++}, K^{+})
	Intermittent agitation	Prevention of delirium tremens: benzodiazepines, CIWA protocol
Methamphetamine	Fever, tachycardia, hypertension, seizure,	Fluids, cooling
		Benzodiazepines, haloperidol

	agitation, renal failure	Physical restraints: protect self and others
Opioids	Drowsiness, hypoventilation, hypotension, hypothermia, deep sedation, pinpoint pupils	Support the airway
		Naloxone (Narcan) 0.4–2 mg IV every 2 minutes until effect to a maximum of 10 mg
		Gastric lavage with activated charcoal
Phencyclidine (PCP)	Blank stare, rapid involuntary eye movement, hallucinations, severe mood disorder, flushing, sweating, hypertension, tachycardia, seizure, coma	Support the airway
		Provide a calm environment; do not leave the patient alone due to a high possibility of harm to self and others
		Benzodiazepines for agitation
		Fluids, cooling, monitor renal function
Salicylates	Vomiting, tinnitus, confusion, hyperthermia, respiratory alkalosis, metabolic acidosis, multiple organ failure	Activated charcoal
		Urine alkalization
		Dialysis, regardless of admission renal function, to PREVENT acute kidney injury
Tricyclic antidepressants	CV signs: arrhythmias, shock	Sodium bicarbonate, activated charcoal, fluids, cardiac monitoring
	Neurological signs: drowsiness, delirium, seizures, coma	
	Anticholinergic signs: blurred vision, fever, twitching	

Healthcare-Associated Infections (HAIs)

Healthcare-associated infections (HAIs), also known as healthcare-associated conditions, were recently added to the Adult CCRN test blueprint. Be prepared to understand the role of the nurse in the prevention of these infections, which are considered indicators of the quality of care that is provided to patients. In general, an infection that develops more than 48 hours after admission to the hospital is considered healthcare-associated; if the infection is identified within 48 hours after admission to the hospital, it is considered community-acquired. Hospitals are now required to report cases of HAIs to government agencies, and some cases are publicly reported.

Guidelines for the prevention of ventilator-associated pneumonia (VAP), central line-associated bloodstream infections (CLABSIs), and catheter-associated urinary tract infections (CAUTIs) have been provided by several national organizations, including the Centers for Disease Control and Prevention (CDC), the Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), and the Association for Professionals in Infection Control and Epidemiology (APIC). “Care bundles” are sets of evidence-based practices that lead to improved outcomes **if** all elements are completed.

Ventilator-Associated Event (VAE)

- VAEs are complications that may occur as a result of mechanical ventilation. Complications include pneumonia, barotrauma, ARDS, atelectasis, and/or fluid overload.
- VAE is a term that was created by the CDC to better describe an occurrence of ventilator-associated pneumonia (VAP). VAP is a type of VAE. For the Adult CCRN exam, you will be expected to understand VAP and strategies to prevent VAP; you will not be expected to understand the complex VAE algorithm.
- Refer to page 90 of the Respiratory Concepts chapter of this book for a review of the ways to prevent VAP.

Central Line-Associated Bloodstream Infection (CLABSI)

A central line-associated bloodstream infection (CLABSI) is a laboratory-confirmed bloodstream infection that develops within 48 hours of a central line placement and is not related to an infection at any other sites. A CLABSI results in longer hospital stays, increased costs, and an increased risk of death. CLABSI mortality rates of 12% to 25% have been reported.

The guidelines for the prevention of CLABSIs are as follows:

- Develop standardized, evidence-based policies/procedures with indications for central line use, insertion, and maintenance.
- Insertion
  - Ensure that processes are in place for insertion according to the guidelines (e.g., central line cart, checklists).
  - Optimize site selection (subclavian vein) as able; avoid femoral or internal jugular site if at all possible.
  - Ensure that the team utilizes aseptic technique during insertion.
  - Utilize maximal barrier precautions and personal protective equipment during insertion.
  - Prepare the skin using chlorhexidine skin antisepsis.
  - Use chlorhexidine patch/gel dressing over the insertion site (unless there is an allergy).
- Maintenance
  - Practice hand hygiene prior to line manipulation/care.

    - Provide a head-to-toe chlorhexidine bath daily for ICU patients.
    - Disinfect catheter hubs, needleless connectors, and injection ports with mechanical friction for no less than 5 seconds with an antiseptic before accessing the catheter.
    - Ensure the patency of the dressing, and change the dressing and tubing according to hospital policy.
    - Do not routinely replace central lines (e.g., every 72 hours) unless it is known that the insertion was performed emergently without antisepsis.
    - Discontinue a central line if there are signs of an infection.
    - Perform a daily review of line necessity.
    - Use aseptic technique for dressing changes, ensuring dressing patency at all times.
    - Ensure that there is an appropriate nurse-to-patient ratio and limit the use of float nurses in ICUs.
- Monitoring
    - Perform root cause analyses on line infections and develop action plans for improvement accordingly.
    - Develop processes for measuring compliance with policies/procedures.
    - Share quality monitoring and infection results with the staff.
    - Assess competency of the staff who insert/care for lines.
- Require that all health care personnel, who are involved in the insertion, care, and maintenance of central venous catheters (CVCs), be educated about CLABSI prevention.

Catheter-Associated Urinary Tract Infection (CAUTI)

The Centers for Disease Control and Prevention (CDC) defines a catheter-associated urinary tract infection (CAUTI) as an infection of the urinary tract, where an indwelling urinary catheter was in place for more than 2 consecutive days in an inpatient location on the date of event, with day of device placement being Day 1 AND an indwelling urinary catheter in place on the date of event or the day before.

The guidelines for the prevention of CAUTIs are as follows:

- Develop standardized, evidence-based policies/procedures with criteria for catheter use.
- Utilization practices
  - Avoid inserting an indwelling urinary catheter, if at all possible.
  - Develop standardized, evidence-based reasons for insertion such as select operative procedures, acute urinary retention or bladder outlet obstruction, gross hematuria, a need for an accurate measurement of urine output, to assist in the healing of open sacral or perineal wounds in incontinent patients, or for patients who require prolonged immobilization (e.g., potentially unstable thoracic or lumbar spine, multiple traumatic injuries such as pelvic fractures).
  - Perform a daily review of catheter need based on agreed upon hospital standardized criteria.

    - Remove catheters as soon as they are no longer necessary; as per the CDC, when a catheter is placed during surgery and remains in place post-op, remove the catheter as soon as possible, preferably within 24 hours, unless there are appropriate indications for continued use.
    - Implement a nurse-driven protocol to empower nurses to evaluate and discontinue unnecessary urinary catheters.
    - Utilize alternative strategies (external catheters, intermittent straight catheterization as able).
- Insertion and maintenance practices
    - Use aseptic technique during insertion
    - Make insertion a 2-person activity to reduce breaks in aseptic technique during insertion.
    - Practice hand hygiene prior to/following catheter manipulation/care.
    - Utilize standard precautions, including the use of gloves and gowns, as appropriate.
    - Employ routine catheter care, cleansing the meatal area (antiseptic solution is not needed); replace basin bathing with plain wipes.
    - Maintain an unobstructed urine flow (e.g., ensure proper securement of the catheter, maintain tubing free of kinks or dependent loops, maintain the collection bag below the level of the bladder).
    - Do not disconnect/reconnect system components.
    - Collect urine samples from the sampling port using aseptic technique.
- Process measures

- Assess the competency of the clinicians who insert catheters; provide periodic training and competency assessments.
- Identify unit “CAUTI champions,” whose role is to monitor patients with indwelling urinary catheters and ensure that standards for infection prevention are utilized by caregivers.
- Develop quality measures and share outcomes with the staff.
- Perform a root cause analysis for each infection and implement action plans based on those analyses.

Multi-Drug Resistant Organisms (MDROs)

- Patients who are vulnerable to colonization and an infection with MDROs include the critically ill, especially those with compromised host defenses from underlying medical conditions, recent surgery, or the presence of indwelling medical devices (e.g., urinary catheters, central lines).
- The following are the most common organisms that are found in hospitals, long-term care facilities, and at times, in the community:
  - Methicillin-resistant *Staphylococcus aureus* (MRSA)
  - Vancomycin-resistant enterococci (VRE)
  - *Clostridium difficile* (*C. diff*)
  - Carbapenem-resistant enterobacteriaceae (CRE)
- The following strategies are used to prevent infections caused by multi-drug resistant organisms (MDROs):
  - Establish a culture where hand hygiene is expected of all caregivers.
  - Develop an antibiotic stewardship and an antibiotic de-escalation program.
  - Provide universal decolonization of ICU patients through chlorhexidine bathing and nasal decolonization.
  - Focus on the rapid identification of MDROs and the development of a strong containment program.
  - Utilize team rounding/huddles to ensure that VAP/CLABSI/CAUTI evidence-based interventions (bundles) are followed and that antibiotic stewardship is practiced.

- Conduct a root cause analysis of infections that occur.
- Develop a process to assess that clinicians utilize contact precautions according to hospital policy.
- Develop processes for reliable cleaning of equipment and surfaces.
- Provide education regarding hand hygiene and when **soap and water** (rather than hand gel) is required: following contact with patients with *C*. *difficile*, when the clinician's hands are visibly soiled, after the clinician has used the restroom, and before the clinician eats.

Palliative Care, Hospice Care, and End-of-Life Care

Palliative Care

- Palliative care is the prevention and treatment of the symptoms and side effects of a serious illness. Physiological, emotional, social, and spiritual problems are considered.
  - Palliative care can be initiated anytime during a disease or life-threatening illness.
  - This type of care has been found to be most beneficial when it is initiated early.
  - Symptom management may include the management of pain, anxiety, dyspnea, urticaria, nausea/vomiting, constipation, and diarrhea, among other symptoms.
- Aggressive treatment may be continued.
- All critically ill patients deserve palliative care.
- Palliative care has been shown to improve survival, decrease resource utilization, and decrease hospital readmissions and the cost of care.

Hospice Care

- Hospice care is the provision of symptom management for those with a **terminal** illness. It includes palliative care, but disease-modifying treatments are discontinued unless they may provide symptom management.
- Grief and bereavement services are included.

End-of-Life Care

- End-of-Life (EOL) care supports the needs of patients and their families at the time of imminent death. It is always a part of hospice care, and it may or may not be a part of palliative care. It is provided to all patients who are at the end of their lives, regardless of whether or not palliative care or hospice care were initiated.
  - EOL care avoids prolongation of the dying process.
  - EOL care provides support to the patient’s family.

Similarities Between Palliative Care, Hospice Care, and End-of-Life Care

All three of these types of care involve:

- Advance care planning
- Focusing on patient/family wishes
- Optimizing quality of life

Now that you have reviewed the key multisystem concepts, go to the Practice Questions. Answer the questions, and then check your answers. Continue to review the information until you answer 80% of the practice questions correctly.

Practice Questions

1. Which medications are most often prescribed for anaphylaxis after initial therapy with IM epinephrine?

   (A) antihistamines and corticosteroids
   (B) vasopressors and inotropes
   (C) antihistamines and antibiotics
   (D) corticosteroids and vasopressors

2. Which of the following would most likely result in an SvO_2 of 82%?

   (A) hypovolemic shock
   (B) anaphylactic shock
   (C) septic shock
   (D) cardiogenic shock

3. The initial management of any drug intoxication is to:

   (A) prevent further absorption of the drug.
   (B) increase excretion of the drug.
   (C) administer an antidote when appropriate.
   (D) ensure a patent airway and adequate breathing.

4. A patient is being treated for sepsis with fluid resuscitation, but the MAP is 55 mmHg and norepinephrine is ordered. What

primary beneficial effect will norepinephrine provide for this patient?

(A) It will maintain renal blood flow.
(B) It will increase coronary artery blood flow.
(C) It will increase venous return and preload.
(D) It will restore vascular tone and afterload.

5. Which of the following would be an indicator that fluid resuscitation is adequate?

(A) The CVP is 2 mmHg.
(B) The heart rate is decreasing.
(C) The pulse pressure is narrowing.
(D) The serum lactate is 4.1 mmol/L.

6. Which of the following is TRUE in regard to shock?

(A) The MAP is adequate in the compensatory phase of shock.
(B) The blood pressure is maintained in Class III hemorrhagic shock.
(C) An elevated lactate level occurs late in septic shock.
(D) Serum bicarbonate is elevated in shock.

7. A patient with upper GI bleeding received procedural sedation with midazolam during his endoscopy procedure. He required higher doses to maintain sedation and screened positive for obstructive sleep apnea (OSA). Which of the following is TRUE regarding this patient's plan of care?

(A) Respiratory depression will generally precede sedation.
(B) Pulse oximetry will detect early hypoventilation.
(C) Waveform capnography monitoring is indicated for this patient post-procedure.
(D) The maximum dose of flumazenil (Romazicon) for midazolam reversal is 0.2 mg IV.

8. A patient is receiving a continuous sedation infusion of propofol (Diprivan) at 30 mcg/kg/min. Which of the following is an appropriate intervention for this patient?

(A) Reverse the side effects with flumazenil (Romazicon).
(B) Provide a daily spontaneous awakening trial.
(C) Avoid administering analgesia.
(D) Monitor the patient closely for hypertension.

9. Which of the following statements is TRUE in relation to the treatment of sepsis?

(A) Special protocols, “bundles” of interventions, are indicated for the presence of an infection with evidence of organ dysfunction.
(B) Administering pressors is required for treating sepsis.
(C) By definition, a patient with systemic inflammatory response syndrome (SIRS) has an infection.
(D) Positive cultures are required in order to make the diagnosis of septic shock.

10. Which of the following statements regarding targeted temperature management (TTM) is CORRECT?

    (A) TTM should be provided for all patients status post ventricular fibrillation.
    (B) Potassium infusions will most likely be required during rewarming.
    (C) Shivering is expected and is generally self-limiting.
    (D) Insulin infusions are often required during the maintenance phase.

11. A patient who has sustained traumatic injuries, including a pelvic fracture and soft tissue injuries, has required a transfusion of 7 units of packed red blood cells (PRBCs). Which of the following is TRUE related to the care of this patient?

    (A) Pressors will most likely be required.
    (B) The patient will need to be monitored for hypercalcemia.
    (C) Blood products and crystalloids should be warmed.
    (D) Platelets will need to be given if the platelet count drops.

12. A patient is receiving mechanical ventilation and is able to write notes to communicate. Which of the following is the most appropriate intervention related to the management of pain for this patient?

(A) Coach the patient in the use of self-reporting with the numerical rating scale (NRS).
(B) Initiate pain medication during procedures when the patient first demonstrates pain behaviors.
(C) Disregard the use of nonpharmacological interventions for pain since the patient is receiving mechanical ventilation.
(D) Ensure that the mean arterial pressure (MAP) is greater than 60 mmHg before providing intravenous opiates.

13. A 38-year-old female patient was admitted with multiple traumatic injuries, including flail chest, a ruptured spleen, and a crush injury to her left leg. She is receiving mechanical ventilation. The nurse considers requesting a palliative care consult, knowing that the benefits of palliative care include all of the following EXCEPT:

(A) improved survival.
(B) symptom management.
(C) improved quality of care.
(D) increased cost of care.

14. It is usually important to decrease the number of days that a patient has an indwelling urinary catheter in place. Which of the following statements presents a valid reason for maintaining this type of catheter?

(A) The patient is receiving mechanical ventilation.
(B) The catheter was inserted yesterday during renal surgery.
(C) It is painful for the patient to use the bedpan.
(D) The patient is receiving medications that may cause urine retention.

15. A patient requires the insertion of a chest tube, and the physician plans for moderate sedation with fentanyl. During the procedure, the RN notices that the patient only responds to repeated vigorous shaking. Which of the following choices provides an accurate assessment of this situation and describes the proper intervention that is indicated?

    (A) A patient assessment reveals a level of general anesthesia; the proper intervention is to call the anesthesiologist for intubation.
    (B) A patient assessment reveals a level of moderate sedation; the proper intervention is to ask for a flumazenil (Romazicon) order.
    (C) A patient assessment reveals a level of deep sedation; the proper intervention is to assess the patient's oxygenation/ventilation.
    (D) The proper interventions are to alert the physician to the level of sedation and to begin assisting the patient's ventilation with a bag/mask.

16. Which of the following is TRUE for a patient who has SIRS (meaning that the patient has 2 or more of the 4 criteria) or has

a positive qSOFA score (meaning that the patient has 2 or 3 of the criteria)?

(A) An assessment of the qSOFA score requires laboratory testing.
(B) Both SIRS and the qSOFA score are markers of an infection.
(C) SIRS is a component of the Sepsis-3 definitions, and the qSOFA score is a component of the Sepsis-2 definitions.
(D) SIRS is a marker of inflammation, and the qSOFA score is a marker of organ dysfunction.

17. Within the past 2 weeks, 3 patients developed VRE in 1 critical care unit. Which of the following strategies has been demonstrated to be effective in the prevention of additional cases of VRE?

(A) Perform a root cause analysis of the 3 known cases of VRE.
(B) Screen all newly admitted patients for VRE.
(C) Administer vancomycin prophylactically to all patients within the unit.
(D) Tape posters about hand washing on the doors of all patient rooms.

18. A patient is being treated for a confirmed salicylate overdose. Which of the following interventions should the nurse anticipate?

(A) Closely monitor for respiratory depression.
(B) Prepare for hemodialysis.
(C) Administer thiamine 100 mg IV.
(D) Administer all doses of N-acetylcysteine, regardless of subsequent salicylate levels.

19. If a patient's death appears imminent, which of the following should be the focus of care for the health care team?

(A) a palliative care consult
(B) hospice placement
(C) completion of an advance directive
(D) supporting the patient/the patient's family

20. A patient is being treated for septic shock. Four hours after the identification of sepsis, the serum lactate is 5.2 mmol/L. Based on this information, which of the following steps is indicated?

(A) Perform a passive leg raise.
(B) Initiate vasopressin.
(C) Reevaluate the choice of antibiotic.
(D) Increase FiO_2.

21. Which of the following strategies is used to reduce central line-associated bloodstream infections (CLABSIs)?

(A) Avoid the subclavian insertion site.
(B) Ensure that the patient’s chest is covered with sterile towels during insertion of the central line.
(C) If possible, avoid frequent blood draws from the central line.
(D) Always wash your hands with soap and water before entering the room.

Answer Key

1. **A**
2. **C**
3. **D**
4. **D**
5. **B**
6. **A**
7. **C**
8. **B**
9. **A**
10. **D**
11. **C**
12. **A**
13. **D**
14. **B**
15. **C**
16. **D**
17. **A**
18. **B**
19. **D**
20. **A**
21. **C**

Answers and Explanations

1. **(A)** An antihistamine will help halt the allergic response, and a corticosteroid will help halt the inflammatory response. Vasopressors, inotropes, and antibiotics are not helpful for anaphylactic shock.
2. **(C)** The normal SvO_2 is 60% to 75%. In septic shock, oxygen delivery (DO_2) is adequate, but oxygen utilization (VO_2) at the cellular level is low. A sign of poor oxygen utilization when oxygen delivery is adequate is an elevated SvO_2. Oxygen is not being used, despite its availability, and blood is returning to the pulmonary artery with more oxygen than expected. The other 3 types of shock result in poor oxygen delivery, which causes low oxygen utilization with a low SvO_2. In summary, poor oxygen utilization may result in a low SvO_2 when delivery of oxygen is low and an elevated SvO_2 when the oxygen delivery is adequate or high.
3. **(D)** If the intoxication affects the patient's airway and breathing, the other 3 interventions listed will be of no use since the patient will not survive.
4. **(D)** The problem in sepsis/septic shock is massive dilation (low SVR) and capillary leak (resulting in relative hypovolemia). If needed, pressors (such as norepinephrine) cause vasoconstriction and increase SVR (afterload). Although pressors may also increase preload and renal blood flow, these are secondary effects. The primary effect of pressors is the

restoration of afterload. Although septic shock may result in ventricular damage with resultant elevated troponin, myocardial damage is not due to a drop in coronary artery blood flow; rather, the damage is due to the effects that endotoxins have on cardiac muscles.

5. **(B)** As vascular volume is restored and preload is increased, there is less need for compensatory mechanisms (an increase in heart rate). A CVP of 2 mmHg, narrowing of the pulse pressure, and an elevated lactate (anaerobic metabolism) are all signs that filling pressures have not been optimized.
6. **(A)** Since compensatory mechanisms are working, the MAP is maintained in the compensatory phase. If these mechanisms fail, the MAP drops and hypotension results (progressive phase). In Class III hemorrhagic shock, the blood pressure decreases and is no longer maintained. In septic shock, lactate rises early on during sepsis, not later on. Serum bicarbonate is decreased (not elevated) in shock due to lactic acidosis.
7. **(C)** Waveform capnography is indicated during and after procedural sedation in order to identify EARLY hypoventilation. Longer monitoring may be required for a patient with a history of obstructive sleep apnea (OSA). Sedation usually precedes respiratory depression. SpO_2 will not decrease until the $PaCO_2$ is very high. Flumazenil reverses benzodiazepines. However, resedation may occur, and subsequent doses of flumazenil may be necessary.
8. **(B)** Studies have shown improved patient outcomes, shorter ventilator times, and less risk of oversedation when “awakening trials” are done for a patient who is on a continuous sedation

infusion. Propofol is not reversed with flumazenil. Analgesia should be used for agitation, not avoided. Propofol is more likely to cause hypotension, not hypertension.

9. **(A)** “Sepsis bundles” are indicated for the presence of an infection with signs of organ dysfunction, since these cases result in increased mortality. Sepsis, by definition, does not require pressor administration. SIRS may be present without an infection (e.g., trauma, pancreatitis). In addition, only 30–50% of patients with sepsis/septic shock present with positive cultures.
10. **(D)** Targeted temperature management (TTM) may result in hyperglycemia, which will necessitate insulin infusions to maintain normoglycemia during the maintenance phase of TTM. Targeted temperature management is only indicated for an unresponsive patient s/p cardiac arrest, not for ALL patients. Potassium is required during the maintenance phase of TTM to correct hypokalemia. However, during rewarming, potassium replacement needs to be stopped. Shivering will prevent temperature reduction, is not self-limiting, and will need to be treated with either meperidine or neuromuscular blocking agents.
11. **(C)** It is important to prevent hypothermia and its resultant adverse consequences during fluid/transfusion resuscitation. Therefore, fluids and blood products need to be warmed. Pressors are not indicated in hypovolemic shock since the afterload in hypovolemic shock is already abnormally high due to compensation for volume loss. The problem needs to be addressed by “filling up the tank” to restore circulation volume. HYPOCALCEMIA (not hypercalcemia) secondary to calcium

binding to citrate in stored blood is a potential problem related to the transfusion of PRBCs. Platelets are not in PRBCs and should be replaced regardless of platelet count when a large volume of PRBCs is administered. Replacing platelets will prevent thrombocytopenia and coagulation problems.

12. **(A)** Self-reporting pain is always preferred. In the scenario described, the patient is capable of providing a pain intensity number. Preemptive analgesia is preferred for procedures that are likely to be painful rather than waiting until pain is experienced. Nonpharmacological interventions are always appropriate. Hypotensive patients still require pain management. Pain should not be used to “keep up the BP.” An opiate (such as fentanyl) may be used because it is less likely to cause a further drop in blood pressure, and the hypotension can be treated as needed.
13. **(D)** Palliative care consults have been shown to decrease, not increase, the cost of care, especially when they occur early during a hospital stay. Choices (A), (B), and (C) ARE benefits of palliative care consults.
14. **(B)** A patient who is only 1 day post-op renal surgery needs an indwelling catheter until the surgeon has determined that the patient’s condition would not be adversely impacted by removing the catheter. Mechanical ventilation (choice (A)) itself is not a criterion for an indwelling urinary catheter; the need for an indwelling urinary catheter should be based on further assessments for one of the CDC criteria for catheter use. Pain with mobility (as described in choice (C)) could be controlled, and the risks associated with a Foley catheter outweigh patient

discomfort, which can be managed. If the patient is receiving medications that may lead to acute urine retention (choice (D)), the patient should be monitored for urine retention. Even if that does occur, the patient may be a candidate for intermittent straight catheterization, or the medications may be able to be changed to alternative agents.

15. **(C)** The need for vigorous shaking in order to elicit a response is evidence of deep sedation, and the first priority is for the nurse to ensure that the patient has adequate ventilation and oxygenation. This patient is not evidencing general anesthesia (choice (A)), and intubation is most likely not going to be needed since a reversal agent could be given and the patient's ventilation could be temporarily assisted. The patient assessment would not reveal moderate sedation (choice (B)), and flumazenil is not the reversal agent for fentanyl. Naloxone (Narcan) is the reversal agent for the opioid fentanyl. This scenario does not describe the signs of inadequate ventilation that require immediate assistance (choice (D)), although the physician does need to be alerted to the level of sedation.
16. **(D)** SIRS is a marker of inflammation and is not necessarily associated with organ dysfunction or an infection. The qSOFA score is a marker of organ dysfunction. The remaining choices are not true.
17. **(A)** It is important to understand the reason for MDRO infections in order to look for patterns and to correct gaps in infection control so as to prevent future infections. A root cause analysis, led by quality improvement staff, often provides the

answers in terms of the cause of these infections. The remaining 3 strategies have not been demonstrated to prevent the development of MDROs. Screening for VRE (choice (B)) has not been demonstrated to be successful, nor is it cost-effective. Providing vancomycin (choice (C)) is not good antibiotic stewardship. Displaying posters has not been shown to be an enduring strategy; there may be an initial impact, but over time, the posters are not often noticed by clinicians.

18. **(B)** Salicylate toxicity will require dialysis in order to prevent acute renal failure, even if the renal lab values are normal upon admission. The remaining 3 choices are not anticipated interventions for a salicylate overdose.
19. **(D)** When the health care team expects that a patient's death is imminent, the focus of care shifts to end-of-life care. Family support, avoiding the prolongation of death, and bereavement services become the focus. A palliative care consult (choice (A)) is done as early as possible in the event of an acute, severe illness. Hospice placement (choice (B)) is indicated as soon as the disease is determined to be terminal, not when death is imminent. Completing an advance directive (choice (C)) should ideally be done by all
patients (with their primary care provider) prior to developing an acute illness.
20. **(A)** A component of the 3-hour bundle for sepsis is to remeasure the lactate 2–4 hours after the initial lactate if the initial lactate is > 2 mmol/L. If the second lactate is ≥ 4 mmol/L (or if the MAP remains ≤ 65 mmHg), the patient's fluid status should be reassessed. A passive leg raise is a strategy that is

used to evaluate whether or not the patient will respond to additional fluids. Vasopressin administration (choice (B)) is indicated when the MAP is not responsive, despite the infusion of higher doses of a vasopressor. Reevaluating the choice of antibiotic (choice (C)) is not generally indicated until cultures are available or until further testing indicates an infectious source that is different than what was initially suspected. An increase in FiO_2 (choice (D)) is indicated as soon as hypoxemia is identified, but it is not determined by serum lactate.

21. **(C)** Manipulating the central line may increase the risk of contamination. Even if the central line is completely flushed, blood draws may result in increased colonization. The subclavian insertion site (choice (A)) is the preferred location for the insertion of a central line, whereas the femoral site is the least preferred site of insertion. During the insertion of a central line, full body draping with sterile towels, not just covering the patient's chest with sterile towels (choice (B)), is preferred. Hand hygiene should be practiced with either gel **or** soap and water. The use of soap and water is required after working with a patient with *C*. *difficile* or a known infectious diarrhea (norovirus), after using the restroom, when hands are visibly dirty, and before eating. Other than these instances, gel may be used for hand hygiene, and soap and water do not need to be used.