Volume 2

Solved Papers Microbiology for PG

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Volume 1

Solved Papers Microbiology for PG Students

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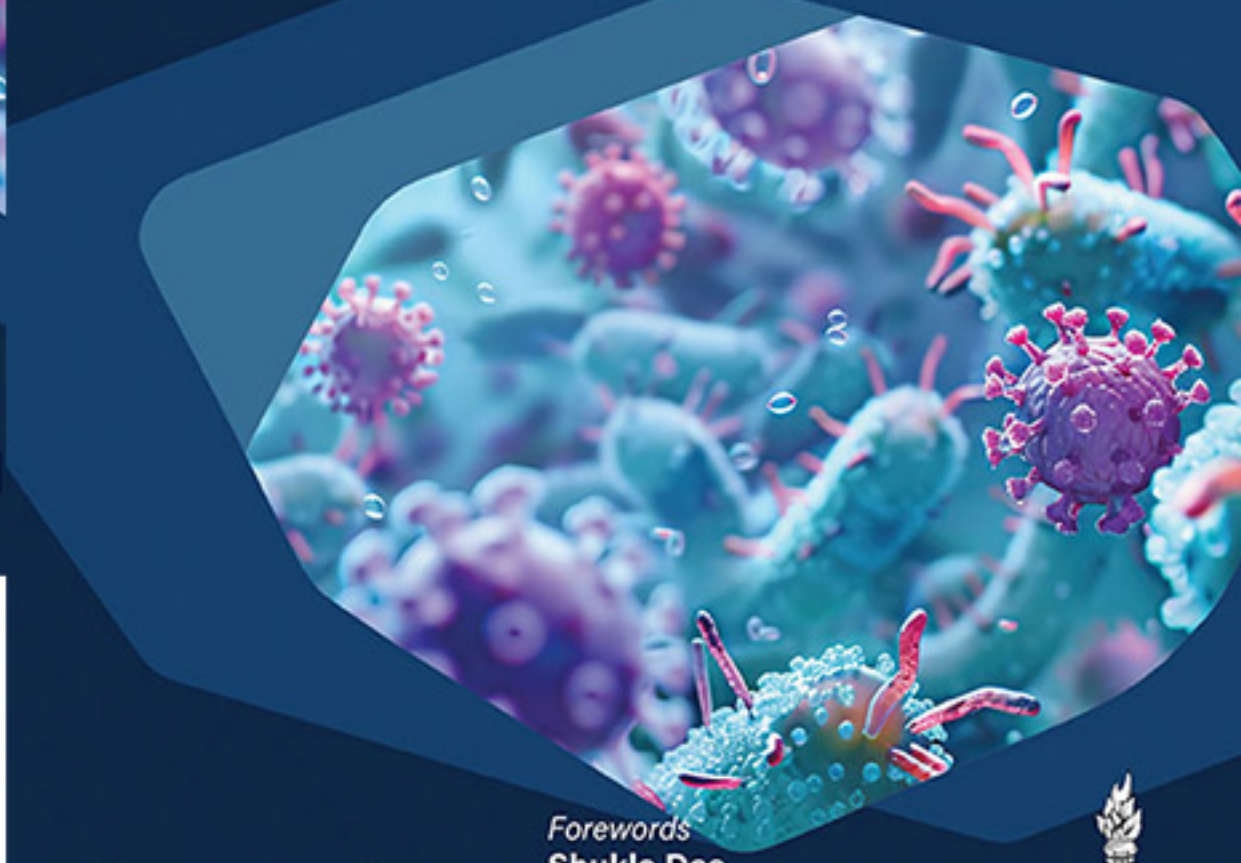

Forewords
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JAYPEE

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CHAPTER 2.2

Healthcare-associated Infections

HOSPITAL-ACQUIRED INFECTIONS/NOSOCOMIAL INFECTIONS

Q1. Define Healthcare-associated Infections (HAIs)/Nosocomial infections. Enumerate the common types of HAIs encountered in a tertiary care hospital along with their causative organisms. Discuss about the prevention and control of HAIs with special emphasis on device-associated infections.

1. Define nosocomial infections. Write in detail about hospital infection control. MGR, Tamil Nadu, 2017
2. Write an essay on nosocomial infections. Odisha University, 2020
3. Hospital acquired infections. MGR, Tamil Nadu, November 2020
4. Define hospital-acquired infections (HAIs). MGR, Tamil Nadu, 2020
5. Define health care associated infections. Kerala University, May 2021
6. Enumerate the common hospital-acquired infections and the causative organisms. Discuss about diagnosis, control, and prevention of hospital-acquired infections. MGR, Tamil Nadu, July 2021
7. Enumerate nosocomial infections. Discuss the diagnosis, control and prevention of nosocomial infection. Kerala University, May 2022
8. Nosocomial infections. KNRUHS, Telangana, 2023
9. Discuss device-associated infections in the hospital and preventive bundles. KGMU, Lucknow, 2023
10. Define healthcare-associated infections (HAIs). Enumerate different types of HAIs seen in a tertiary care hospital. Discuss the approach toward the prevention and control of device-associated HAIs. University of Delhi, 2024

RESPONSE:

Definition of Healthcare-associated Infections (HAIs): HAIs, also known as nosocomial infections, are infections acquired by patients during the course of receiving treatment for other conditions in a healthcare setting. These infections:

- Occur after 48 hours of hospital admission,
- Are not present or incubating at the time of admission,
- May manifest after discharge, and
- Include occupational infections in healthcare workers.

According to the Centers for Disease Control and Prevention (CDC), HAIs affect 5–10% of hospitalized patients, significantly increasing morbidity, mortality, and economic burden.

Factors Contributing to HAIs

1. Patient-related factors:
   - Immunocompromised state (due to illness or hospital treatments)

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- Neonates and elderly individuals
- Prolonged hospitalization.

2. Environmental factors:
   - High microbial load in hospital settings
   - Contaminated surfaces, air, water, food.
3. Microbial factors:
   - Multidrug-resistant organisms (MDROs) thrive due to antibiotic pressure in hospitals.
4. Iatrogenic factors:
   - Invasive procedures (catheters, intubation)
   - Blood transfusions and parenteral nutrition.
5. Administrative lapses:
   - Inadequate infection control policies
   - Poor staff training or surveillance.

Sources of Infection

- Endogenous: Patient's own flora introduced during procedures.
- Exogenous: Contaminated equipment, hands of healthcare workers, other patients, or hospital environment.

Examples

- Healthcare workers may carry resistant strains like MRSA.
- Inanimate objects (catheters, ventilators, endoscopes) may act as fomites.

Common Microorganisms in HAIs

While HAIs can be caused by a wide variety of organisms, the following are most significant due to their resistance patterns and survival in hospital environments:

ESKAPE pathogens (major MDROs):

- *Enterococcus faecium*
- *Staphylococcus aureus*
- *Klebsiella pneumoniae*
- *Acinetobacter baumannii*
- *Pseudomonas aeruginosa*
- *Enterobacter* species

Others:

- *Escherichia coli*, *Candida albicans*, *Clostridioides difficile*, *Legionella pneumophila*, *Mycobacterium tuberculosis* (nosocomial TB), HIV, HBV, HCV (via blood exposure).

Major Types of HAIs in Tertiary Care Hospitals

Table 1: Major types of HAIs in tertiary care hospitals [with the first three collectively known as device-associated infections (DAIs)]

Type of HAI	*Approx prevalence*	*Key pathogens*	*Risk factors*
Catheter-associated urinary tract infection (CAUTI)	~33%	*E. coli*, other Gram-negative rods, *S. aureus*, *Enterococci*	Female gender, old age, catheter >2 days, serious comorbidities
Central line-associated bloodstream infection (CLABSI)	~13%	Coagulase-negative *staphylococci*, *S. aureus*, *Candida*, Gram-negative rods	Extremes of age, prolonged ICU stay, malnutrition, poor asepsis
Ventilator-associated pneumonia (VAP)	~15%	*Acinetobacter*, *Pseudomonas*, Gram-negative bacilli	Intubation, aspiration risk, ICU stay, supine position
Surgical site infection (SSI)	~31%	*S. aureus*, Gram-negative bacilli, anaerobes	Diabetes, obesity, preoperative shaving, poor technique, late prophylaxis

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Diagnosis of HAIs

- Clinical suspicion based on signs/symptoms and history of invasive procedures.
- Microbiological cultures from suspected sites (urine, blood, sputum, wound swabs).
- Imaging (chest X-ray for VAP, ultrasound for abscesses).
- Molecular and serological tests where appropriate (e.g., PCR for *Clostridioides difficile*).

Prevention and Control of HAIs

Standard precautions (applied to all patients):

- Hand hygiene (alcohol rubs or soap-water)
- Use of PPE (gloves, gowns, masks)
- Environmental cleaning
- Safe injection practices

Transmission-based Precautions

Contact, droplet, and airborne precautions based on the mode of transmission.

Device-associated HAI-specific Prevention: (*Discussed in details as separate question)*

1. CAUTI:
   - Avoid unnecessary catheterization.
   - Use aseptic insertion and maintenance.
   - Early removal.
2. CLABSI:
   - Use maximal sterile barrier precautions during insertion.
   - Chlorhexidine skin prep.
   - Routine line care and timely removal.
3. VAP:
   - Elevate head of bed (30–45°),
   - Daily sedation interruption,
   - Oral care with chlorhexidine,
   - Subglottic secretion drainage.
4. SSI:
   - Preoperative skin antisepsis,
   - Timely antimicrobial prophylaxis (within 1 hour of incision),
   - Minimize shaving, maintain sterile technique.

SURGICAL SITE INFECTIONS

Q2. Define surgical site infections (SSIs) and outline the clinical criteria for their diagnosis. Discuss the surveillance methodology and diagnostic approaches for SSIs. Add a detailed account of preventive strategies, including SSI prevention bundles, as recommended in tertiary care settings.

1. Surgical site infection (SSI) bundles. NTR University, Vijayawada, 2019
2. SSI prevention bundles. NTR University, Vijayawada, 2021
3. Surgical site infection. Kerala University, December 2020
4. Clinical definition and surveillance methodology for SSI. AIIMS Bhubaneswar, April/May 2022
5. Define surgical site infections. Describe the methods of diagnosis and prevention of SSI. NBE, 2023
6. SSI and its prevention. KGMU, Lucknow, 2025

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RESPONSE:

Definition of Surgical Site Infection

Surgical site infection refers to an infection that occurs at or near the surgical incision site:

- Within 30 days of a procedure (or within 90 days for surgeries involving implants such as cardiac, orthopedic, or breast surgeries).
- SSIs are classified based on the depth of involvement into:
  - Superficial incisional SSI
  - Deep incisional SSI
  - Organ/space SSI

Clinical Criteria for Diagnosis of SSI

Diagnosis is based on:

- Purulent discharge from the surgical site
- Positive culture obtained aseptically from the site
- Signs of inflammation (redness, swelling, warmth, tenderness) at the incision site
- Diagnosis by surgeon/physician
- Spontaneous dehiscence or abscess formation on imaging or surgical exploration

Surveillance of SSIs

Surveillance involves systematic collection, analysis, interpretation, and dissemination of data regarding SSIs to guide infection control practices.

Types of Surveillance

- Hospital-wide or targeted (e.g., high-risk surgeries)
- Conducted using CDC/NHSN definitions
- Data expressed as:
  - SSI rate per 100 surgeries
  - Risk-adjusted comparison with benchmarks

Purpose of SSIs Surveillance

- Identify trends, outbreaks
- Measure impact of preventive interventions
- Provide feedback to surgical teams

Diagnostic Approaches

- Clinical examination and patient history
- Microbiological cultures from wound, aspirate, or tissue biopsy
- Imaging (e.g., ultrasound, CT scan) to detect deep or organ/space infections
- Laboratory parameters (e.g., elevated WBC, CRP)

Prevention Strategies for SSI

Preventive measures are grouped into three stages:

A. Preoperative measures:
   1. Preoperative bathing:
      - Using plain or antimicrobial soap to reduce microbial load on skin.
   2. MRSA decolonization:
      - Use mupirocin nasal ointment for known carriers undergoing surgery.
   3. Hair removal:
      - Avoided unless necessary; if required, done with electric clippers (not razors).
   4. Surgical antimicrobial prophylaxis (SAP):
      - Administered within 60–120 minutes before incision (preferably at induction of anesthesia).
      - Single dose typically sufficient; repeat only under certain conditions:
        - Surgery >4 hours

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- High blood loss
- Cardiac surgeries
- Drugs with short half-life

- Cefazolin or cefuroxime are usually recommended.

5. Hand disinfection:
   - Performed using chlorhexidine soap or alcohol-based hand rub before donning sterile gloves.
6. Surgical site preparation:
   - Use alcohol-based chlorhexidine antiseptic for skin disinfection before incision.

B. Perioperative measures:
1. Maintain physiological parameters:
   - Oxygenation (FiO_2 ~80%)
   - Normothermia
   - Normovolemia
   - Blood glucose <200 mg/dL
   - Nutritional support during and immediately after surgery

C. Postoperative measures:
1. Wound dressing:
   - Perform hand hygiene before and after dressing changes. Remove discharge and change dressing daily.
2. Operating theater (OT) disinfection:
   - Inter-case cleaning and terminal cleaning with high-level disinfectants.
3. Environmental monitoring:
   - Air quality in OT should be monitored regularly for:
     - Air exchanges
     - Humidity, temperature, pressure
     - Microbial contamination
4. Avoid prolonged SAP:
   - Not recommended for patients with wound drains or catheters, to prevent AMR development.

SSI Prevention Bundle Approach

A care bundle is a small set (usually 3–5) of evidence-based practices that, when implemented together consistently, lead to significantly better outcomes.

Principles of Bundle Approach

All elements must be complied with; non-compliance with even one component renders the bundle ineffective ("all-or-none" adherence).

Table 2: Key components of SSI prevention bundle

Bundle stage	*Components*
Preoperative	• Antiseptic bathing • MRSA screening and decolonization • Avoid shaving; use clippers if necessary • Administer SAP within 1–2 hours before incision
Perioperative	• Surgical hand scrubbing • Skin prep with alcohol-based chlorhexidine • Maintain normothermia, oxygenation, and normoglycemia • Adequate fluid and nutrition
Postoperative	• Aseptic wound dressing • OT disinfection between and after cases • Air quality surveillance • Avoid unnecessary continuation of antibiotics

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BUNDLE CARE APPROACH IN INFECTION PREVENTION

Q3. Define the bundle care approach in infection prevention. Describe the role of care bundles in preventing nosocomial infections, with specific emphasis on device-associated infections. Explain the key components of care bundles used for CAUTI, VAP, and SSI in healthcare settings.

1. Discuss bundle care approach in prevention of nosocomial infections. Baba Farid University, Punjab, 2015
2. Discuss bundle care approach in prevention of nosocomial infections. Bharti Vidyapeeth, Pune, 2018
3. Discuss bundle care approach in preventing device related infections. AIIMS, Bhubaneswar, April/May 2022
4. Discuss bundle care approach to prevent device associated infections in healthcare settings. AIIMS, Bhubaneswar, June/July 2023
5. Care bundles. MGR, Tamil Nadu, July 2023
6. Define bundle care approach. Discuss the different types of bundle care approaches for CAUTI, SSI, and VAP. AIIMS, Bibinagar, 2025

RESPONSE:

Definition: Bundle Care Approach

A care bundle is a structured set of evidence-based practices (usually 3 to 5 elements) that, when performed collectively and consistently, lead to significantly better outcomes than when implemented individually.

Key features:

- Evidence-based: Each element has proven effectiveness
- Simple and practical: Easily adoptable at the bedside
- Measurable: Compliance can be monitored
- Multidisciplinary: Involves nurses, doctors, infection control teams

Concept was developed by the Institute for Healthcare Improvement (IHI) and has since been widely adopted in infection control practices.

Role of Care Bundles in Preventing Nosocomial Infections

Care bundles are a cornerstone of infection prevention, especially in high-risk environments like ICUs, operation theaters, and surgical wards.

Benefits:

- Standardizes care across providers and shifts
- Reduces variability and improves adherence to best practices
- Decreases rates of HAIs, particularly device-associated infections
- Enhances accountability and facilitates audit/feedback

Bundles have been most successful in reducing:

- Catheter-associated urinary tract infections (CAUTI)
- Ventilator-associated pneumonia (VAP)
- Surgical site infections (SSI)
- Central line-associated bloodstream infections (CLABSI)

Bundle Components for Specific Infections

A. CAUTI (Catheter-associated Urinary Tract Infection)

1. Insertion bundle:
    - Insert urinary catheter only if indicated (e.g., acute urinary retention).
    - Use only sterile equipment for catheterization.
    - Follow non-touch technique under strict aseptic conditions.
    - Maintain a closed drainage system throughout.

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- Use appropriate catheter size.
- Secure catheter properly (e.g., plaster-tube-plaster method).

2. Maintenance bundle:
   - Perform daily meatal or vaginal hygiene using sterile gloves and hand hygiene.
   - Ensure catheter remains secured at all times.
   - Keep urine bag below bladder level but off the floor.
   - Continue closed drainage without breaks.
   - For urine collection:
     - Hand hygiene and glove change between patients.
     - Use separate jugs per patient.
     - Disinfect drainage port with alcohol swabs.
   - Assess and document daily need for catheter removal.

B. VAP (Ventilator-associated Pneumonia)

Maintenance bundle:

- Practice strict hand hygiene.
- Keep head of bed elevated (30–45°) to reduce aspiration risk.
- Provide daily oral care using 2% chlorhexidine.
- Evaluate daily for Peptic Ulcer Disease (PUD) prophylaxis; if required, use sucralfate only.
- Provide Deep Vein Thrombosis (DVT) prophylaxis when needed.
- Assess readiness to wean off ventilator each day.

C. Surgical Site Infection

Preventive measures span preoperative, perioperative, and postoperative phases.

1. Preoperative Measures
   - Pre-surgical bathing using plain or antimicrobial soap.
   - Nasal MRSA decolonization with mupirocin in known carriers.
   - Avoid shaving the operative site; if necessary, use clippers only.
   - Surgical Antimicrobial Prophylaxis (SAP):
     - Administer within 60–120 minutes prior to incision.
     - Prefer agents like cefazolin or cefuroxime.
     - Repeat dose only if surgery >4 hours or in cardiac cases.
     - Avoid SAP prolongation or ESBL-targeted antibiotics unless strongly indicated.
2. Perioperative measures
   - Perform surgical hand disinfection with chlorhexidine or alcohol-based rubs.
   - Disinfect surgical site with alcohol-based chlorhexidine solution.
   - Maintain:
     - Normothermia
     - Oxygenation (FiO_2 80%)
     - Normoglycemia (blood glucose <200 mg/dL)
     - Normovolemia
     - Adequate nutrition
3. Postoperative measures
   - Ensure aseptic wound care and dressing changes.
   - Conduct routine OT disinfection between procedures and terminally.
   - Perform air quality surveillance for:
     - Temperature, humidity, pressure
     - Number of air exchanges
     - Microbial contamination
   - Avoid prolonged SAP, even with wound drains.

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VENTILATOR ASSOCIATED PNEUMONIA

Q4. Define Ventilator-associated pneumonia (VAP). Discuss its pathogenesis, clinical diagnosis, and various respiratory sampling techniques used in diagnosis. Explain the surveillance methods for VAP and elaborate on the bundle care approach for its prevention in healthcare settings.

1. Ventilator associated pneumonia (VAP)—prevention bundles. NTR University, Vijayawada, 2020
2. Care bundle for prevention of VAP. Baba Farid University, Punjab, 2021
3. Ventilator associated pneumonia bundles. NTR University, Vijayawada, 2021
4. Ventilator associated pneumonia. GGSIP Univ, Delhi, 2021
5. Ventilator associated pneumonia. University of Delhi, 2015; MGR, Tamil Nadu, 2020; MGR University, Tamil Nadu, 2015/December 2023; KGMU, Lucknow, 2023
6. Describe the respiratory sampling techniques in VAP and a brief note on VAP bundles. Odisha University, 2023
7. Health care associated pneumonia. MGR, Tamil Nadu, July 2023
8. VAP—definition, diagnosis and management. PGI Chandigarh, December 2024
9. Define and describe the surveillance of VAP. What is a care bundle and how it can be used with reference to control of VAP? National Board of Examinations, 2024

RESPONSE:

Definition

Ventilator-associated pneumonia (VAP) is a type of hospital-acquired pneumonia (HAP) that develops 48 hours or more after endotracheal intubation and initiation of mechanical ventilation in patients with no evidence of pneumonia at the time of intubation.

It is a major cause of morbidity and mortality in intensive care units (ICUs) and is associated with increased hospital stay, healthcare costs, and risk of multidrug-resistant organism (MDRO) infections.

Pathogenesis

VAP occurs due to the aspiration of contaminated secretions or colonized organisms from the oropharynx or GI tract into the lower respiratory tract via the endotracheal tube.

Key mechanisms:

1. Microaspiration: Leakage of colonized secretions around the cuff of the endotracheal tube.
2. Biofilm formation: Microorganisms adhere to the inner surface of the tube forming biofilms, which act as a reservoir.
3. Impaired host defenses:
   - Loss of mucociliary clearance
   - Impaired cough reflex
4. Contaminated respiratory equipment: Improperly sterilized nebulizers, humidifiers, etc.
5. Supine position: Increases risk of aspiration.

Common pathogens:

- Gram-negative bacilli: *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, *Klebsiella pneumoniae*, *E. coli*
- Gram-positive cocci: *Staphylococcus aureus* (including MRSA)
- Fungi: *Candida* species (rarely causes true VAP but may colonize)
- Viruses: CMV, HSV (in immunocompromised)

Clinical Diagnosis

Diagnosis of VAP is clinical and often supported by radiological and microbiological evidence.

A. Clinical features:
   - Fever ≥38°C or hypothermia <36°C

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- Purulent tracheal secretions
- Leukocytosis or leukopenia
- New or worsening infiltrates on chest X-ray
- Hypoxia or worsening oxygenation

B. Clinical scoring systems:
   - Clinical pulmonary infection score (CPIS): Includes temperature, WBC count, oxygenation status, chest radiograph, and culture results. CPIS ≥6 is suggestive of VAP.

Respiratory Sampling Techniques for Diagnosis

Respiratory samples are essential for microbiological confirmation. Both non-invasive and invasive techniques are used:

A. Non-invasive methods:
   1. Endotracheal aspirate (ETA):
      - Easy and bedside technique
      - Moderate sensitivity, high contamination risk
      - Semi-quantitative cultures

B. Invasive methods:
   1. Bronchoalveolar lavage (BAL):
      - Involves instillation and retrieval of saline from distal airways
      - Quantitative culture ≥10^4 CFU/mL suggestive of VAP
   2. Protected specimen brush (PSB):
      - Reduces contamination by using a brush protected by a sheath
      - Quantitative culture ≥10^3 CFU/mL indicates infection
   3. Mini-BAL:
      - Blind technique using suction catheter to obtain distal airway samples
      - Less invasive than bronchoscopy
   4. Blood cultures:
      - Especially useful when systemic signs like sepsis are present
   5. Other markers (optional adjuncts):
      - Procalcitonin, CRP (non-specific)

Surveillance Methods for Ventilator-associated Pneumonia

Surveillance of VAP in healthcare settings has evolved to a more structured and objective approach, largely guided by the National Healthcare Safety Network (NHSN) criteria. Instead of directly identifying VAP—which is often challenging due to its complex clinical and radiologic features—NHSN proposes a tiered system for Ventilator-Associated Events (VAE) that focuses on objective changes in a patient's respiratory status and evidence of infection. This three-tiered algorithm is widely used for surveillance and quality monitoring in intensive care units (ICUs).

1. Ventilator-associated Condition

Device Requirement: Patient must have been mechanically ventilated for at least two consecutive calendar days.

Oxygenation Criteria: A baseline period is established where minimum daily values of FiO_2 (fraction of inspired oxygen) and PEEP (positive end-expiratory pressure) are either stable or decreasing for a minimum of 2 days.

This is then followed by evidence of worsening oxygenation, defined as either:

- An increase in FiO_2 by ≥20%, or
- An increase in PEEP by ≥3 cm H_2O, persisting for at least 2 consecutive days.

This stage serves as an early signal for a potential complication during mechanical ventilation but does not imply infection.

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2. Infection-related Ventilator-associated Complication

This stage includes all VAC criteria plus indicators of possible infection.

Clinical Indicators (any one of the following):

- Fever (>38°C) or
- Hypothermia (<36°C) or
- Leukocytosis (WBC count ≥12,000 cells/mm^3) or
- Leukopenia (WBC count ≤4,000 cells/mm^3)

Antibiotic Use Criteria: A new antimicrobial agent must be initiated and continued for at least 4 days, suggesting that the clinical team suspects infection and is treating accordingly.

This level of surveillance points to a ventilator-associated complication likely caused by infection, even though microbiological confirmation is not yet established.

3. Possible Ventilator-associated Pneumonia

This is the most specific tier and builds upon IVAC by incorporating microbiological confirmation.

Microbiological Criteria: There must be isolation of a pathogenic organism in significant quantity from lower respiratory tract samples such as:

- Endotracheal aspirates,
- Bronchoalveolar lavage (BAL),
- Protected specimen brush, etc.

This stage approximates a clinical diagnosis of VAP and is used as a proxy for actual pneumonia in surveillance systems.

Bundle Care Approach for Prevention of VAP

A VAP prevention bundle is a set of evidence-based practices that, when implemented together, reduce the incidence of VAP significantly.

Table 3: Core components of the VAP bundle

Element	*Rationale*
Elevation of head of bed to 30–45°	Prevents aspiration of secretions
Daily sedation vacation and assessment for extubation	Reduces duration of mechanical ventilation
Oral care with chlorhexidine	Decreases oropharyngeal colonization
Peptic ulcer prophylaxis	Prevents stress ulcers and bleeding
Deep vein thrombosis (DVT) prophylaxis	Prevents complications during prolonged immobilization

Optional additional measures:

- Subglottic secretion drainage endotracheal tubes
- Avoiding circuit disconnections
- Closed suctioning systems
- Strict hand hygiene and use of personal protective equipment (PPE)

CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTION

Q5. Define central line-associated bloodstream infection (CLABSI). Discuss the risk factors, clinical diagnosis, and infection control measures for the prevention of catheter-related bloodstream infections. Describe in detail the components of care bundle approach for insertion and maintenance of central venous catheters. Add a note on the approach to a patient with central venous catheter who develops fever after 48–72 hours.

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1. Central line-associated bloodstream infections (CLABSI). University of Delhi, 2015
2. Discuss the infection control measures used in prevention of catheter-related bloodstream infections. Kerala University, May 2021
3. Catheter-related bloodstream infections (CR-BSI). MGR, Tamil Nadu, May 2022
4. Care bundle for prevention of CLABSI. Baba Farid University, Punjab, 2022
5. Central line-associated bloodstream infection. Baba Farid University, Punjab, 2022
6. Define central line associated bloodstream infection (CLABSI). Describe the methods of surveillance and prevention of CLABSI in ICU set up. Rajasthan University (RUHS), 2022
7. Catheter associated bloodstream infection. Rajasthan University (RUHS), 2022
8. Patient on central venous catheter develops fever after 3 days. MGR, Tamil Nadu, July 2023
9. Central line infections. GGSIP Univ, Delhi, 2023
10. Discuss the components of care bundle approach for placement and maintenance of central venous catheter. JIPMER, November/December 2024
11. CLABSI and bundle approach for its prevention. University of Delhi, supple, 2024
12. Central line infections. University of Delhi, 2025

RESPONSE:

Definition

Central line-associated bloodstream infection (CLABSI) is a nosocomial bloodstream infection that occurs in a patient who has had a central venous catheter (CVC) in place for more than 2 calendar days at the time of diagnosis, with no other identifiable source of infection. It represents a laboratory-confirmed bloodstream infection (LCBI) directly linked to the central line and is a major cause of morbidity, mortality, and increased healthcare costs in intensive care settings.

Surveillance Criteria (as per NHSN guidelines)

To classify an infection as CLABSI, the following two components must be met:

- Device Criterion: The central line must be in place for more than two calendar days, with the day of insertion considered Day 1.
- Laboratory-Confirmed Bloodstream Infection (LCBI): An LCBI must be identified, based on microbiological and clinical parameters as outlined below.

Types of Laboratory-Confirmed Bloodstream Infections

1. LCBI-1 (Any Age Group)
   - Blood culture criteria: Isolation of a recognized pathogen from one or more blood cultures.
   - Clinical criteria: No clinical symptoms are required for confirmation.
2. LCBI-2 (Infants <1 year of age)
   - Blood culture criteria: Isolation of common commensals (e.g., *coagulase-negative staphylococci*) from two or more separate blood cultures.
   - Clinical criteria: Presence of any one of the following:
     - Fever
     - Chills
     - Hypotension
3. LCBI-3 (Infants <1 year, born >7 days ago)
   - Blood culture criteria: Same as LCBI-2—detection of commensal organisms in two separate cultures.
   - Clinical Criteria: At least one of the following clinical signs:
     - Fever
     - Hypothermia
     - Bradycardia
     - Apnea

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Classification Based on Device Association

- If LCBI occurs in a patient who meets the catheter criteria, it is labeled as CLABSI.
- If LCBI occurs without a central line in place for >2 days, it is termed non-CLABSI.

Significance of CLABSI Surveillance

Surveillance for CLABSI is essential for:

- Identifying infection trends,
- Implementing infection prevention strategies,
- Benchmarking hospital performance,
- Reducing unnecessary antibiotic use,
- Improving patient safety and healthcare outcomes.

Risk Factors of CLABSI

A. Patient-related:
   - Immunosuppression
   - Extreme age (neonates, elderly)
   - Malnutrition
   - Prolonged ICU stay
   - Chronic illnesses

B. Catheter-related:
   - Use of non-tunneled catheters
   - Femoral site of insertion (higher infection risk)
   - Multiple lumens
   - Prolonged indwelling time

C. Healthcare-related:
   - Inadequate aseptic technique during insertion
   - Poor catheter hub hygiene
   - Improper dressing changes
   - Infrequent hand hygiene

Clinical Diagnosis

A. Signs and symptoms:
   - Fever, chills, rigors
   - Hypotension
   - Erythema, tenderness, or discharge at catheter site

B. Microbiological criteria (CDC/NHSN Guidelines):
   - Blood cultures:
     - From both peripheral vein and catheter lumen
     - Same organism isolated from both samples
     - Differential time to positivity (DTP) >2 hours suggests catheter source
   - Catheter tip culture:
     - Semiquantitative (>15 CFU/segment) or quantitative (>10^3 CFU/mL)
   - Exclusion of other infection sources

Common Pathogens

- Coagulase-negative staphylococci (CoNS)
- *Staphylococcus aureus* (including MRSA)
- *Candida* species
- Gram-negative bacilli (*Klebsiella, Pseudomonas, Acinetobacter*)

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Infection Control Measures for Prevention

A. General principles:
- Hand hygiene before and after catheter contact
- Strict aseptic technique during insertion and maintenance
- Use of maximum barrier precautions

B. Antisepsis:
- Skin antisepsis using chlorhexidine-alcohol solution
- Avoid iodine or povidone-iodine as first-line unless allergic to chlorhexidine

C. Catheter site selection:
- Prefer subclavian vein over femoral or jugular sites (if feasible)

D. Maintenance measures:
- Daily assessment of catheter necessity → Prompt removal when not needed
- Use of transparent sterile dressings
- Proper disinfection of catheter hubs and ports with alcohol or chlorhexidine

Care Bundle Approach for CLABSI Prevention

CLABSI care bundle includes a set of evidence-based interventions, divided into insertion and maintenance bundles.

A. Insertion bundle (To be applied at time of catheter insertion)

Component	*Purpose*
Hand hygiene	Prevents cross-transmission
Maximal barrier precautions	Sterile gown, gloves, mask, large drape
Skin antisepsis	Chlorhexidine 2% in alcohol-based solution
Optimal site selection	Subclavian > Internal jugular > Femoral
Checklist and documentation	Ensures compliance during insertion

B. Maintenance bundle (to be applied during catheter use)

Component	*Purpose*
Daily review of catheter necessity	Remove unnecessary catheters early
Hand hygiene before and after handling lines	Reduces contamination
Aseptic dressing changes	Use of sterile technique and transparent dressing
Disinfection of catheter hub and ports	"Scrub the hub" technique before access
Regular monitoring for infection signs	Early identification of CLABSI

Approach to a Patient with Central Venous Catheter and Fever after 48–72 Hours

When a patient with a CVC develops fever within 2–3 days, CLABSI should be suspected, and the following approach is recommended:

Step 1: Clinical assessment
- Look for signs at catheter insertion site: redness, discharge, tenderness
- Assess for other foci of infection (lungs, urinary tract, abdomen)

Step 2: Laboratory investigations
- Paired blood cultures:
  - One from catheter lumen and one from peripheral vein
  - Check for differential time to positivity (>2 hours indicates catheter source)
- CBC, CRP, procalcitonin: supportive markers
- Culture of catheter tip (if removed)

Step 3: Management
- Start empirical antibiotics covering Gram-positive cocci (e.g., vancomycin) ± Gram-negative organisms
- Modify based on culture results and antimicrobial susceptibility

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