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Central Line-Associated Infections in Adults with Cancer: A Comprehensive Review

Yahya Ali Alabood[1], Hassan Ali Mohammed Albarakat [2], Zainab Issa Al Salem[3], Mohammad Salman Al.Abbad[4], Anwer Tawfiq Mohammed Albaqshi[5], Mustafa Ali Mohammed Albarakat [5], Miad Yousef Eid Abu Hamad[6], Ghanem Hassan Ghanem Al Ghanem[7], Bassam Hassan Ghanem Al Ghanem[7], Hamidah Jawad Alhassan[1], Hawra Yousuf Ali Aljamaan[8] , Mohammed Jawad Alabed[9], Ali Abdulahadi Alshiti [9], Ahmed Mustafa Nasser Alhamoud[10], Alaa Majeed Aleissa[11]

1.Nursing Diploma Al-Jafer General Hospital , Saudi Arabia.

2.Emergency Medical Services in Riyadh , Saudi Arabia.

3.Nursing Technician - King Salman Hospital in Riyadh , Saudi Arabia.

4.Nursing technician , Medical transportation in al.ahsa , Saudi Arabia.

5.Emergency Medical Services, Medical transportation in al.ahsa , Saudi Arabia.

6.Bachelor Degree Of General Nursing , Aljafer General Hospital , Saudi Arabia.

7.Diploma degree of nursing, ERADAH AND MENTAL COMPLEX , Saudi Arabia.

8.Bachelor degree of general nursing , Aljafer hospital , Saudi Arabia.

9.Nursing technician , Alhasa Health cluster- King Fahad hospital in alhofuf , Saudi Arabia.

10.Bachelor Degree Of General Nursing Eradah And Mental Complex , Saudi Arabia.

11.Nursing specialist, Alhsa Health Cluster - King Faisal General Hospital , Saudi Arabia.

ABSTRACT

Central line-associated bloodstream infections (CLABSI) are a significant concern among adults with cancer due to the frequent need for central venous access for chemotherapy, parenteral nutrition, and blood transfusions. Immunosuppression in cancer patients further increases their vulnerability to infections, making CLABSI a leading cause of morbidity and mortality in this population. This review explores the epidemiology, risk factors, microbial patterns, prevention strategies, and treatment options for CLABSI in adults with cancer, with insights from recent studies and guidelines.

Keywords: Central Line-Associated Infections, Adults with Cancer, CLABSI.

1. Introduction

Central venous catheters (CVCs) are indispensable in the management of cancer patients, providing reliable vascular access for treatment. However, their use is associated with complications, most notably central line-associated bloodstream infections (CLABSI). Defined by the CDC as a primary bloodstream infection occurring in a patient with a central line within 48 hours before the onset of infection, CLABSI poses a major challenge in oncology care. The unique immune and nutritional vulnerabilities in cancer patients exacerbate the risks and impact of these infections (1,2)

2. Epidemiology

Cancer patients account for a significant proportion of CLABSI cases reported in healthcare settings. Studies indicate that cancer patients with indwelling central lines experience CLABSI at rates ranging from 2.5 to 6.5 per 1,000 catheter days, which is higher than the general population (3). Hematological malignancies, such as leukemia and lymphoma, have a higher incidence compared to solid tumors, due to the prolonged neutropenic phases associated with treatment.

3. Risk Factors for CLABSI in Cancer Patients

Several factors contribute to the increased risk of CLABSI in adults with cancer:

- **Immunosuppression**
- Chemotherapy-induced neutropenia significantly reduces the body's ability to fight infections (4).
- **Prolonged CVC Use**
- Long-term catheterization increases the risk of biofilm formation on catheter surfaces, providing a niche for microbial colonization.
- **Hospital Environment**
- Frequent hospital admissions and exposure to multi-drug-resistant organisms (MDROs) elevate infection risk.
- **Comorbidities:** Conditions like diabetes, malnutrition, and prior infections can compound the risk.

4. Microbial Etiology

The microbial spectrum of CLABSI in cancer patients is diverse, including:

- **Gram-positive organisms:** Staphylococcus aureus, coagulase-negative Staphylococci (CoNS), and Enterococci are among the leading pathogens, often due to skin flora contamination during catheter insertion.
- **Gram-negative organisms:** Pseudomonas aeruginosa, Klebsiella pneumoniae, and Escherichia coli are significant contributors, particularly in neutropenic patients.
- **Fungal pathogens:** Candida species are frequently isolated, especially in patients with prolonged antibiotic use or total parenteral nutrition (5).

5. Prevention Strategies

Preventing CLABSI in cancer patients requires a combination of evidence-based interventions, outlined below:

5.1. Aseptic Insertion and Maintenance

- Adherence to sterile barrier precautions during catheter insertion reduces contamination.
- Routine disinfection of catheter hubs with antiseptic agents like chlorhexidine-based solutions is recommended .

5.2. Central Line Bundles

Central line bundles, consisting of standardized infection prevention protocols, have been shown to reduce CLABSI rates significantly. Elements include hand hygiene, appropriate catheter selection, and daily assessment of catheter necessity(6).

5.3. Antimicrobial Catheters and Coatings

The use of CVCs impregnated with antibiotics or antiseptics, such as silver sulfadiazine or minocycline, has demonstrated efficacy in reducing colonization and infection rates.

5.4. Regular Training of Healthcare Providers

Continuous education and simulation-based training for healthcare workers improve adherence to best practices for catheter care (7).

6. Treatment of CLABSI

Managing CLABSI involves prompt diagnosis, removal or salvage of the infected catheter, and appropriate antimicrobial therapy. Key considerations include:

6.1. Diagnosis

- Blood cultures from both the central line and a peripheral vein help identify the causative organism and confirm CLABSI.
- Molecular diagnostic techniques, such as polymerase chain reaction (PCR), are increasingly being used for rapid pathogen identification (8,9).

6.2. Antimicrobial Therapy

- Empirical therapy typically covers Gram-positive cocci, Gram-negative bacilli, and fungi until culture results are available.
- Antibiotic lock therapy may be used to sterilize catheters without removal, particularly for biofilm-associated infections.

6.3. Catheter Removal vs. Salvage

- Catheter removal is generally preferred in patients with septicemia, fungal infections, or persistent bacteremia.
- For stable patients, catheter salvage with antibiotic lock therapy can be considered .

7. Recent Advances and Research

7.1. Novel Diagnostic Tools

Automated blood culture systems and next-generation sequencing have improved the detection and identification of CLABSI pathogens.

7.2. Prophylactic Measures

Prophylactic use of ethanol locks and prophylactic antimicrobial-coated dressings are being studied for their role in reducing CLABSI rates.

7.3. Personalized Medicine

Risk stratification tools are being developed to personalize CLABSI prevention and treatment strategies for cancer patients based on their unique risk profiles.

Conclusion

Central line-associated bloodstream infections remain a critical challenge in the care of adults with cancer. While advances in infection prevention and management strategies have led to significant improvements, further research and innovation are needed to address the unique vulnerabilities of this population. Emphasizing adherence to evidence-based guidelines, enhancing provider education, and leveraging novel technologies can further reduce the burden of CLABSI in cancer patients.

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