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Original Research Article

Epidemiology, Risk Factors And Resistance Profile Of Bacterial Isolates Recovered From Patients Seeking Cancer Care In A Dedicated Oncology Center In Northern UP, India

Dr. Manisha Gupta[1], Dr. Durgesh Kumar[2], Dr. Ankur Verma[3], Dr. Ashok Kumar Singh

[1]Assistant Professor, Department of Microbiology, Kalyan Singh Super Specialty Cancer Institute, Lucknow, Uttar Pradesh, India.
[2]Associate Professor, Department of Surgical Oncology, Kalyan Singh Super Specialty Cancer Institute, Lucknow, Uttar Pradesh, India.
[3]Associate Professor and Head, Department of Surgical Oncology, Kalyan Singh Super Specialty Cancer Institute Lucknow, Uttar Pradesh, India.
[4]Assistant Professor, Department of Surgical Oncology, Kalyan Singh Super Specialty Cancer Institute Lucknow, Uttar Pradesh, India.

Corresponding Author:
Dr. Manisha Gupta, Department of Microbiology, Kalyan Singh Super Specialty Cancer Institute, Lucknow, Uttar Pradesh, India.

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ABSTRACT

Background

Cancer patients are particularly vulnerable to infections due to their compromised immune systems, which can result from the malignancy itself or from treatments such as chemotherapy, radiotherapy, and bone marrow transplants. These therapies, while targeting cancer cells, also damage normal, rapidly dividing cells, including those in the bone marrow, reducing the production of white blood cells and leaving patients immunocompromised. This heightened vulnerability necessitates the frequent use of antibiotics to prevent and treat infections, but it also increases the risk of developing and spreading AMR. Antimicrobial resistance (AMR) is a significant and growing concern in the field of oncology, posing a serious threat to cancer patients' health outcomes

Aim

The aim of the study is to study the prevalence of antimicrobial resistance among gram negative organisms isolated from cancer patients seeking care at our hospital. The objective is to study

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bacterial susceptibility pattern in isolates recovered from cancer patients in our setting to optimise antimicrobial prescribing and optimize antimicrobial stewardship.

Methods

A Retrospective observational study from January 2022 - December 2022 conducted in Department of Microbiology, Kalyan Singh Super Speciality Cancer Institute a newly setup UP government autonomous dedicated tertiary Oncology Hospital. Consecutive non replicate samples received for culture in lab were processed as per standard guidelines and their antimicrobial susceptibility was determined as per CLSI 2022. A Total of 254 isolates were included and studied.

Result

In this study, Culture positivity was seen in 57% samples sent of which yield was highest from pus >sputum >urine >tissue. Gram negative isolates predominated over gram positive organism (72.16%) Pseudomonas aeruginosa was the most frequently isolated organism with highest susceptibility to aminoglycosides (76%) and lowest to ceftazidime(13%). E.coli showed highest susceptibility to amikacin (68%) and meropenem(68%) and least to ceftriaxone Carbapenem resistance ranged from 50- 68% and showed reduced susceptibility to third cephalosporins and fluoroquinolones in Gram negative isolates.

Conclusion

Antimicrobial resistance remains an important health problem in cancerpatients thereby posing diagnostic and therapeutic dilemma with respect to antibiotic therapy and continuation of cancer therapy. Multidrug-resistant isolates found in cancer patients and routine bacterial surveillance and study of their resistance patterns may guide successful antimicrobial therapy and improve the quality of care. Therefore, strict regulation of antibiotic stewardship and infection control programs should be considered in the study area

Key words: Antimicrobials, carbapenem resistance, antimicrobial stewardship.

INTRODUCTION

Antimicrobial resistance (AMR) exerts a significant negative effect on cancer management due to cancerpatients' high reliance on antibiotics for infection prevention and treatment. Although advancements in medical care have considerably increased cancer patient survival rates, current therapeutics continuously increase the risk of infection and the development of AMR.[1,2] Immunotherapies involving checkpoint inhibitors and immunosuppressants, such as steroids and tumor necrosis factor (TNF) inhibitors, increase cancer patients' susceptibility to infections. Various cancer therapies, including surgery, bone marrow transplantation, radiotherapy, and chemotherapy, further suppress the immune system. The emergence of drug-resistant microbes renders existing antimicrobial treatments ineffective, increasing the risk of life-threatening infections during medical procedures such as surgery, organ transplantation, and cancer chemotherapy. Neutropenia, advanced life-support facilities, altered gut flora, disrupted skin, and damaged epithelial surfaces increase cancer patients' susceptibility to infection.[3,4] AMR occurs when microorganisms, such as bacteria, viruses, fungi, and parasites, acquire genetic mutations

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over time, subsequently developing resistance against therapeutic interventions. This makes treating microbial infections challenging and inhibits the chain of microbial transmission. The World Health Organization (WHO) declared AMR one of the top ten global public health threats. Inappropriate or overuse of antimicrobial medicines primarily contributes to AMR development. Treating bacterial infections in cancer patients is clinically challenging due to increasing antibiotic resistance levels for most antibiotics used for empiric therapy. Rapid and reliable detection of pathogens and their antibiotic susceptibility patterns is crucial in managing septic patients.[5] Therefore, understanding bacterial profiles and antibiotic resistance for bloodstream infections (BSIs) is imperative to inform clinical practice and stewardship regarding the appropriate use of antibiotics in cancer patients. The purpose of this retrospective observational study is to examine the prevalence of antimicrobial resistance among gram-negative organisms isolated from cancer patients seeking care at our hospital.

AIM

The aim of the study is to investigate the prevalence of antimicrobial resistance among gram-negative organisms isolated from cancer patients seeking care at our hospital.

OBJECTIVES

To study antimicrobial susceptibility patterns in pus isolates recovered from cancer patients in our setting to optimize antimicrobial prescribing and stewardship.

MATERIALS & METHODS

The study was conducted at a tertiary Head & Neck oncology center, a Uttar Pradesh Government Autonomous specialized hospital located in Lucknow city, India, providing surgical, medical, pediatric, gynecologic oncologic, radiation, and palliative services. It is a multidisciplinary specialized hospital with 1200 inpatient beds, currently functional at 250 beds. We received 647 samples, of which a total of 254 consecutive non- replicating samples were culture-positive and included in this study. The total study duration was one year. Samples were sent for primary evaluation for infection in patients visiting the OPD in head and neck oncology.

Methodology

A retrospective observational study was conducted in a specialist cancer hospital in India from January 2022 to December 2022. The study included patients with both hematological and solid organ malignancies. All data were retrieved retrospectively from the Department of Microbiology database and then evaluated. Collected and evaluated data included pus samples received, culture dates, identified microorganisms, and their susceptibility to antimicrobials. Pus and exudates were collected using sterile cotton swabs.

Pus samples were aseptically collected using sterile swabs in test tubes and inoculated onto blood agar and MacConkey agar. Plates were incubated at 37°C for 24 hours. Organisms were identified using a series of biochemical reactions following standard procedures.

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Antimicrobial susceptibility testing was performed using Mueller-Hinton agar plates by the disc diffusion method. The samples were promptly transported to the Microbiology Laboratory for further processing. Bacteria identification and antibiotic susceptibilities were performed using VITEK 2 (bioMérieux, Marcy-l'Étoile, France), and the results were interpreted according to the 2022 Clinical and Laboratory Standards Institute (CLSI) criteria.

Gram-stained smears and cultures were carried out following laboratory protocols for each specimen.

Escherichia coli ATCC 25922, Pseudomonas aeruginosaATCC 27853, Staphylococcus aureusATCC 25923, and Enterococcus faecalisATCC 29212 were used as quality control strains. Five percent (5%) of the prepared culture media were randomly selected and incubated aerobically for 24 hours at 37°C to check the sterility of culture media. Inoculation of culture media, colony characterization, and susceptibility test measurements were checked by an experienced microbiologist.

RESULTS

A total of 254 bacterial isolates were included in the study, of which 60.3% were males, and 64.17% of samples were from inpatients. The age group of the patients ranged from 25 years to 54 years. Site-wise distribution o pus samples showed the most common site of bacterial isolation was CA buccal mucosa, Tongue, Retromolar Trigone (RMT), Alveolus, Gingiobuccal sulcus, and Lip. The frequency of isolation of bacteria was as follows: Pseudomonas- 107, E.coli- 73, Klebsiella- 42, Proteus- 11, Acinetobacter- 07, Citrobacter- 05, Serratia- 03, Providentia- 03, Edwardsiella- 01, Morgenella- 01, and Nil Fermenting Gram Negative- 01. Antimicrobial susceptibility of the most frequently isolated three organisms is elaborated. In Pseudomonas aeruginosa, Amikacin showed 82% susceptibility, Ceftazidime 64%, Imipenem 72%, Meropenem 82%, and Piperacillin +Tazobactam 76%. In Klebsiellapneumoniae, Amikacin showed 71% susceptibility, Gentamicin 73%, Imipenem 57%, Meropenem 64%, Piperacillin + Tazobactam 64%, Ceftriaxone 38%, and Cotrimoxazole 47%. In E.coli, Amikacin showed 68% susceptibility, Gentamicin 63%, Imipenem 68%, Meropenem 64%, Piperacillin+ Tazobactam 31%, Ceftriaxone 0.09%, Ertapenem 49%, and Cotrimoxazole. In this study, the prevalence of MDR isolates was 17.1%

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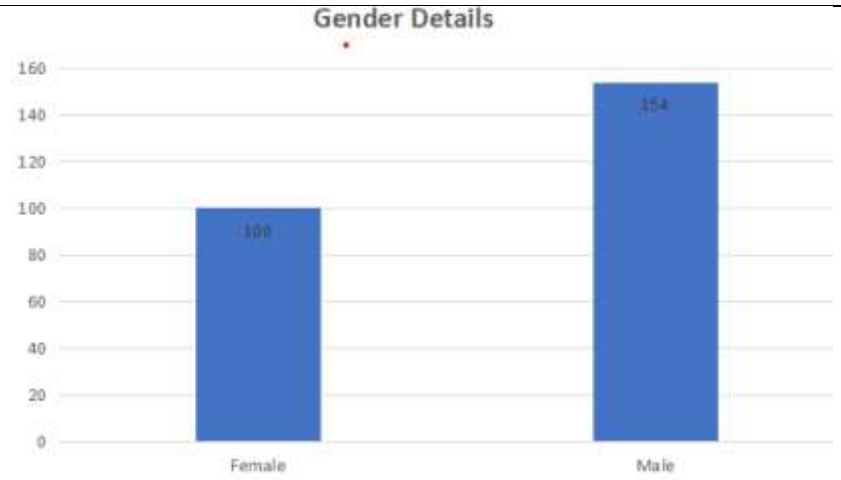
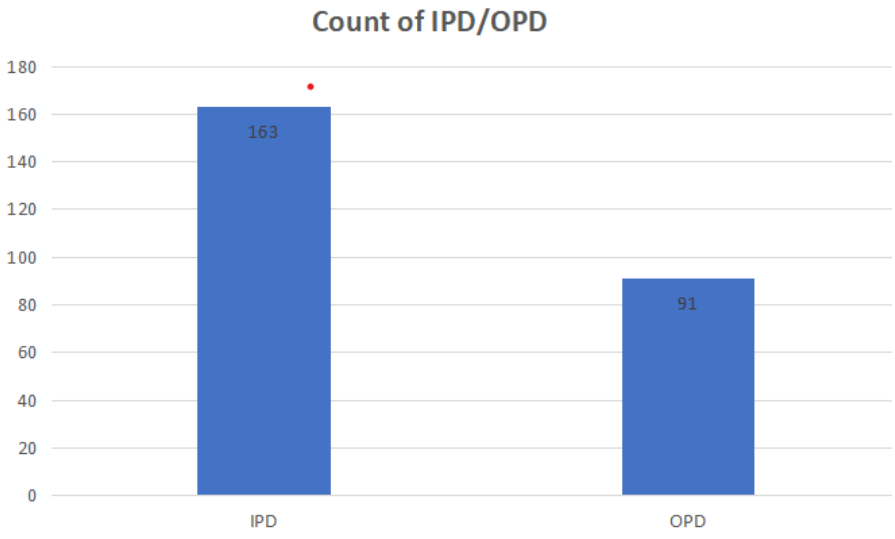


Graph 1



Graph 2

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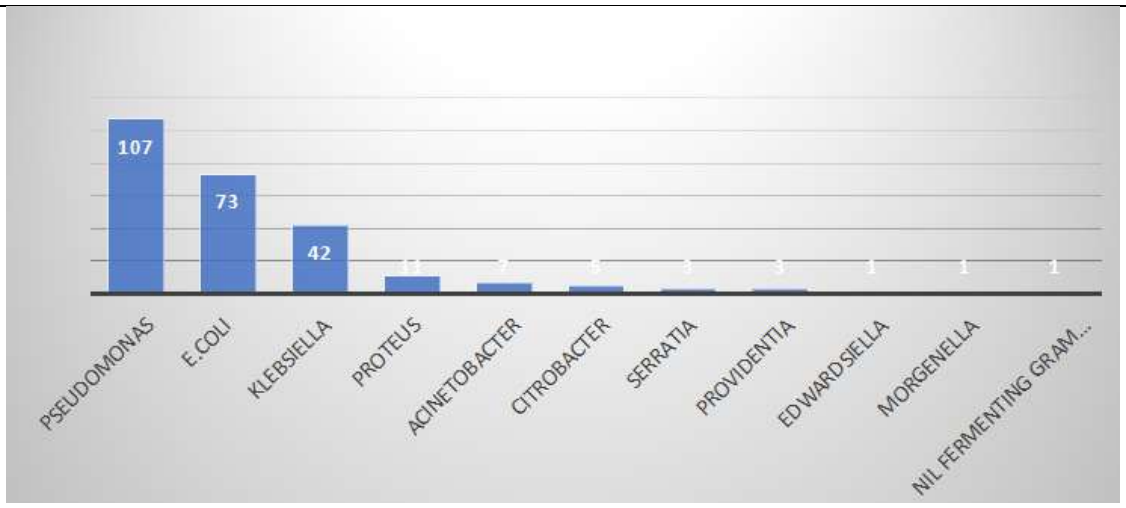
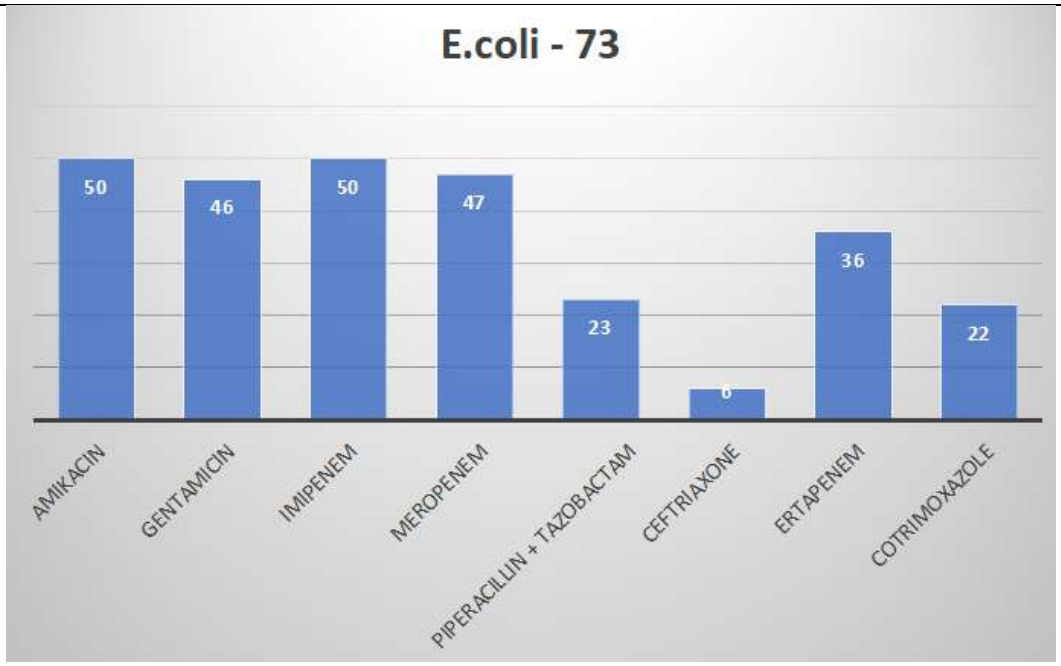


Graph 3: Spectrum distribution of gram negative organisms isolated from Pus samples



Graph 4

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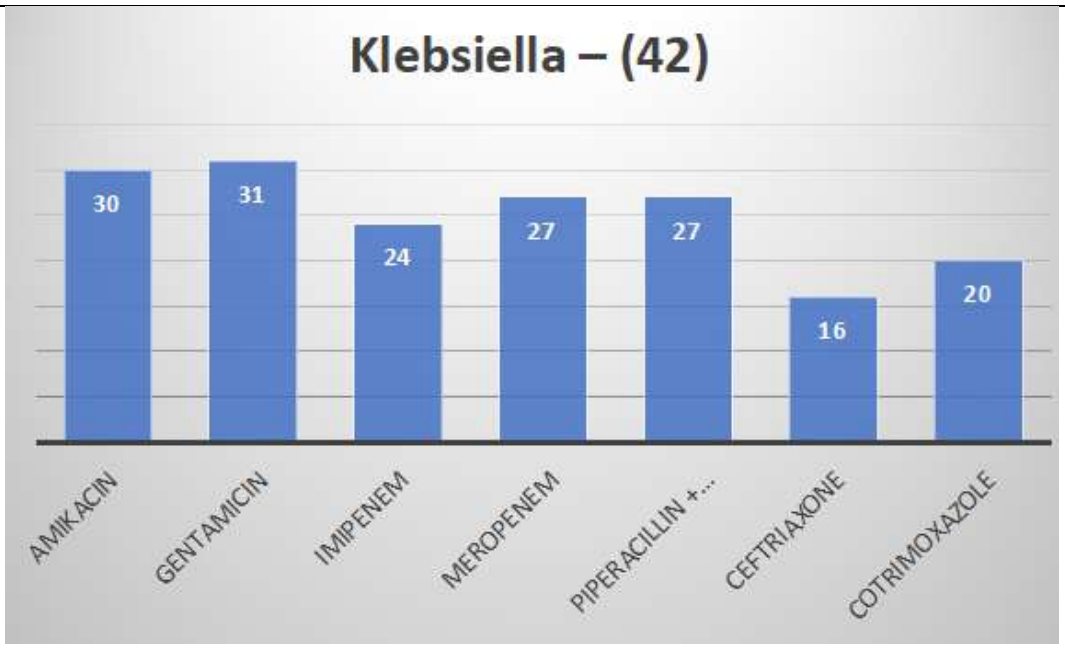
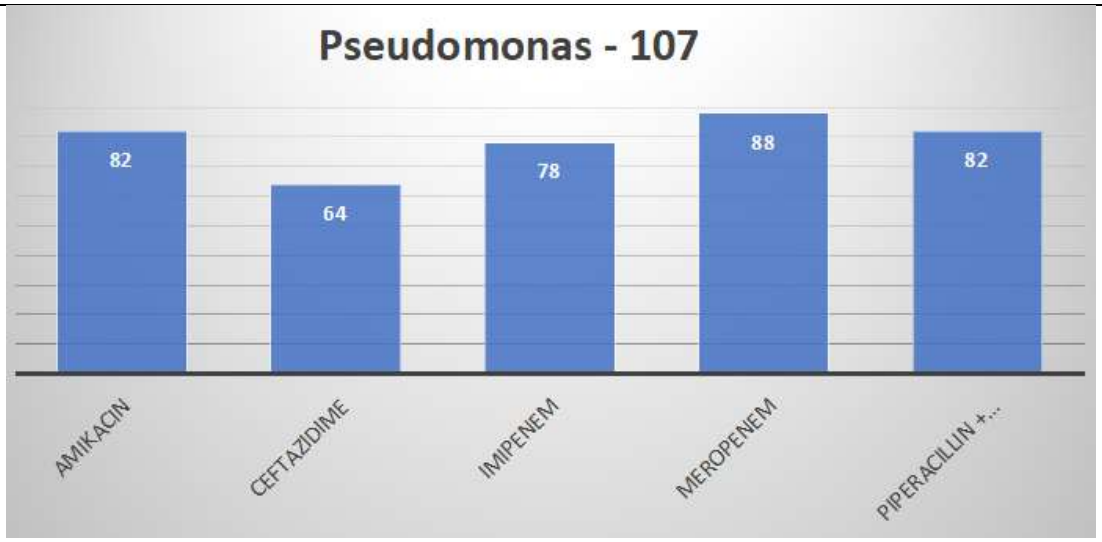


Graph 5



Graph 6

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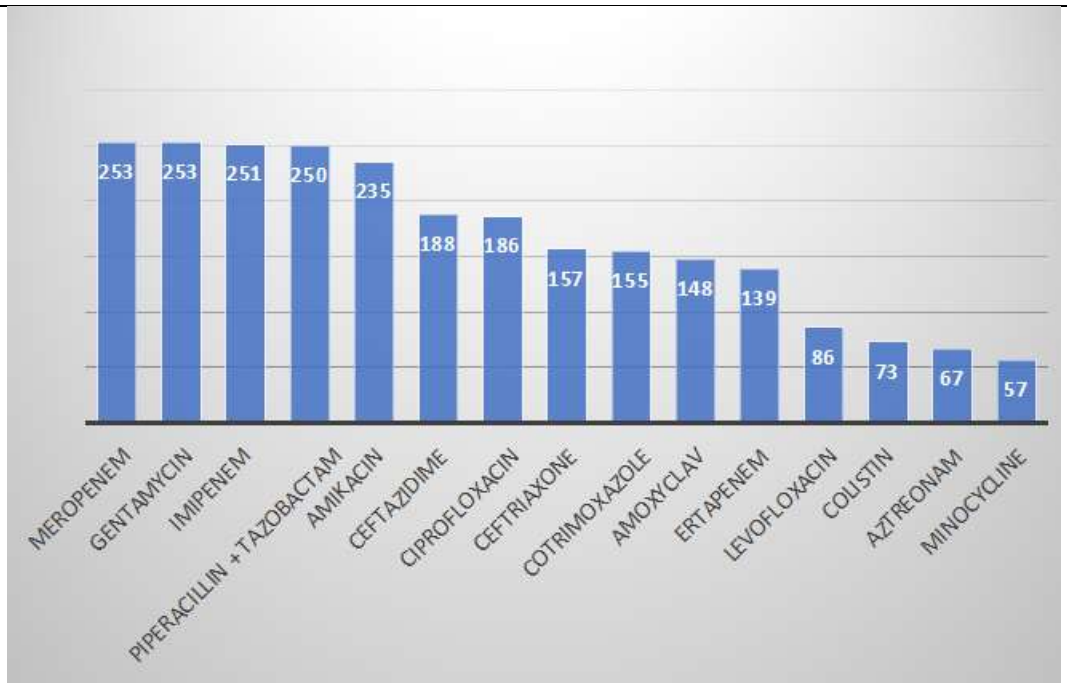

Graph 7: (Cumulative antimicrobial susceptibility to antimicrobial agents in Pus sample)

DISCUSSION

This study comprehensively addresses the microbial spectrum and drug susceptibility patterns of pathogens in cancer patients in the study area. In patients with solid tumors, chemotherapy- or radiation therapy-related neutropenia, anatomic barrier disruption by medical devices or surgical procedures, and obstruction due to primary or metastatic tumors are major causes of infection.[6,7] AMR-mediated reduction in antibiotic effectiveness significantly increases healthcare costs for both patients and hospitals, leading to prolonged therapy, delayed discharge, death, and increased infection control measures[8,9]. The most common reasons for antibiotic-resistant infections include pre-existing health conditions, previous antibiotic therapies, urinary catheters, or other sources associated with urinary infections.[10]

Factors affecting the epidemiology of bacterial infections include geographic location, sample size, diagnostic technique, local organism prevalence and resistance patterns, antimicrobial prescribing practices, and implementation of antimicrobial stewardship and infection control policies in hospitals. The high level of resistance to third-generation cephalosporins and the rate of carbapenem resistance seen in our center could be due to their extensive use in cancer patients.[11,12] Third-generation cephalosporins and beta-lactam beta-lactam inhibitors are the most commonly prescribed antimicrobials in our setting. By virtue of being a newly commissioned hospital, the resistance pattern and pathogen isolation in our hospital compare well with recent data from Tata Medical Center published in 2023; however, carbapenem resistance in our setting is lower than reported by TMC.

The commonest reasons for hospital admissions of cancer patients are either elective (surgery, intensivechemotherapy, transplantation) or emergent (sepsis, respiratory distress,

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hemorrhages, organ failure). During these admission episodes, antimicrobial treatment is common. In addition, cancer patients may be debilitated from disease and comorbidities (e.g., diabetes, malnutrition, chronic kidney/liver diseases) or procedures (colostomy, urostomy, tracheotomy, urinary catheterization) along with restricted mobility and compromised personal hygiene. Long-term central venous catheters (percutaneously inserted central venous catheter-PICC line; chemo port; Hickman catheter) are often required for chemotherapy and total parenteral nutrition.[12,13] During chemotherapy, transplantation, and intensive radiotherapy (e.g., total body irradiation as part of conditioning for bone marrow transplantation), severe and prolonged episodes of neutropenia (<500 cells/microliter) are common. Mucosal barrier injury laboratory-confirmed bloodstream infections (MBI-LCBI) and management of graft-versus-host disease by immunosuppressants also contribute to infections.[14]

The choice of antimicrobials for a suspected infection should be based on local microbiological data; this type of study will always remain of critical importance to allow guidance for the choice of appropriate antimicrobial treatment for patients in such need. Antimicrobial stewardship plays a significant role in improving patient outcomes, decreasing inappropriate antibiotic use and resistance, and lowering healthcare costs[15]. AMS aids in reducing inappropriate antibiotic use to preserve crucial antibiotics' efficacy while ensuring the right antibiotic is used at the right time. There is an overall extensive increase in drug resistance and a dearth of new drugs in the antibiotic pipeline, indicating an urgent need for antibiotic research and development. This single-center study presents the microbiological characteristics and antimicrobial susceptibility profile that clinicians should always be aware of, allowing the selection of appropriate antimicrobials for infection management. Prevention of infection acquisition and resistance in the hospital setting requires robust infection control measures along with robust antimicrobial stewardship. Head and neck cancer interfere with some basic life functions, with a known gender predisposition toward men. Major predisposing factors include excess consumption of alcohol and tobacco, requiring a multidisciplinary approach with surgery, radiotherapy, chemotherapy, reconstructive surgery, speech therapy, and psychological support. However, prognosis is greatly affected when there is an active infection causing increased treatment cost, prolonged hospital stays, and delayed treatments such as chemotherapy or radiotherapy. To initiate appropriate antimicrobial prophylaxis, the flora causing SSIs must be known, along with its antimicrobial resistance pattern. Therefore, this study was undertaken to investigate the pathogens infecting head and neck cancer patients and their antimicrobial resistance pattern. In our study, even though gram- negative bacilli outnumbered, Pseudomonas species was the predominant pathogen.

CONCLUSION

Antimicrobial resistance remains an important health problem in cancer patients, with gram-negative bacteria being more common as etiologic agents. Meropenem was the most effective antibiotic for the treatment of gram-negative bacteria; however, carbapenem-sparing regimens should be preferred to curb resistance development. Routine bacterial cultures and a standard

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practice of culture investigation before initiating antibiotics will go a long way in preventing untoward antimicrobial resistance. Strict regulation of antibiotic stewardship and infection control programs should be implemented to prevent additional costs to the hospital and optimize cancer care outcomes in oncology practice. In this study, we have investigated the pathogens causing infections in head and neck cancer patients visiting our hospital. This study has helped identify bacterial spectrum and antibiotic susceptibility of isolates in head and neck cancer patients. This data is critical for managing infections in cancer patients empirically.

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