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Original Research Article

Rising Antimicrobial Resistance of Gram-Positive Cocci Bloodstream Infections Among Cancer Patients: A Two-Year Retrospective Study at a Tertiary Care Cancer Centre in Eastern India

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Abstract

Background: Bloodstream infections (BSIs) are a major cause of morbidity and mortality in cancer patients because of their compromised immune status. Gram-positive cocci (GPC) are increasingly resistant to antimicrobial agents, complicating treatment. This study evaluated the frequency of GPC-associated BSI, the causative microorganisms, and their antimicrobial resistance patterns among cancer patients at a tertiary care cancer centre.

Methods: This two-year retrospective observational study (January 2022–December 2023) was conducted at a 600-bed tertiary care cancer hospital. Blood culture samples from hospitalised cancer patients were processed using the BD BACTEC automated blood culture system. Organism identification and antimicrobial susceptibility testing were performed using the BD Phoenix automated system along with conventional microbiological methods. Isolates were characterised by organism type, .antimicrobial resistance pattern and time to positivity (TTP).

Results: Of 1,291 blood cultures, 391 (30.38%) flagged positive. Gram-positive cocci (GPC) accounted for 225 (57.54%) of positive cultures, while Gram-negative bacilli and Candida species accounted for 162 (41.43%). The most common isolates were MRCONS (112), MSCONS (24), *Enterococcus spp.* (38, of which 18 were vancomycin-resistant), MSSA (10), and MRSA (41). High resistance was observed to clindamycin, cotrimoxazole, linezolid, and teicoplanin. TTP analysis showed that 208 isolates (92.44%) were identified within 48 hours, while 17 (7.56%) took longer, consistent with more severe infection and higher bacterial load in the earlier-positive group.

Conclusion: Drug-resistant GPC blood stream infections are common among cancer patients, underscoring the need for stronger infection control and antimicrobial stewardship in oncology. Early detection, targeted therapy, and continued surveillance are essential to manage BSI and limit the spread of resistant pathogens. Future research should focus on novel therapeutic approaches to counter antimicrobial resistance (AMR) in immunocompromised patients.

Keywords: Bloodstream infections, antimicrobial resistance, Gram-positive cocci, MRSA, MRCONS, vancomycin-resistant Enterococcus, cancer patients, time to positivity, antimicrobial stewardship.

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Introduction

Cancer patients usually have compromised immune systems as a result of their disease or its treatment, making bloodstream infections (BSIs) a leading cause of morbidity and mortality [1,2]. Neutropenia, prolonged hospital stays, recurrent hospitalization, invasive medical devices like chemo ports, central venous catheters, mucosal barrier injury, chronic or high dose steroid therapy and previous exposure to broad-spectrum antibiotics further increase susceptibility to infection and accelerate the

emergence of multidrug-resistant organisms [1,2]. Gram-positive cocci (GPC)—particularly *Staphylococcus aureus*, coagulase-negative Staphylococci (CONS), and *Enterococcus* species—cause a substantial proportion of bloodstream infections in oncology settings [3,4]. Rising antimicrobial resistance (AMR) among these organisms, driven largely by widespread antibiotic use in healthcare facilities, has narrowed treatment options and increased the risk of treatment failure [5,6]. The spread of methicillin-resistant *S. aureus* (MRSA) and methicillin-resistant CONS (MRCONS) has made nosocomial infections a growing concern, while the emergence of vancomycin-resistant *Enterococcus* (VRE) has further complicated the management of Gram-positive infections [4,5].

Bloodstream infections are particularly common among cancer patients due to immunosuppression and mucosal barrier damage caused by intense chemotherapy [2,7]. Local surveillance of antimicrobial resistance trends in this population is essential to guide empirical antibiotic selection, formulate infection-control policies and practice antimicrobial stewardship [6,7]. Time to positivity (TTP) of blood cultures was also assessed in this study, as it can indicate infection severity , prognosis and may inform the adequacy of first-line empirical therapy [8,9,10].

This two-year retrospective observational study was undertaken to determine the prevalence of Gram-positive cocci bloodstream infections their antimicrobial resistance pattern—including resistance to vancomycin, linezolid, teicoplanin, high-level gentamicin, ampicillin, clindamycin, erythromycin, and cotrimoxazole—and to examine the relationship between TTP and infection severity [3,8,11]. Given the substantial clinical and economic burden of drug-resistant BSIs in cancer care, the findings are intended to support more accurate empirical treatment, strengthen infection-control practices, and contribute local epidemiological data to track and contain antimicrobial resistance [6,7,11].

Methods

Study Design: This retrospective observational study was carried out at Microbiology Department of a 600-bed tertiary care cancer hospital from January 2022 to December 2023. The study analysed antimicrobial resistance among Gram-positive cocci causing bloodstream infections in cancer patients hospitalised for treatment. Patient records, laboratory results, and microbial culture reports were reviewed to characterise infection patterns over the study period.

Study Population: The study included cancer patients with suspected bloodstream infections whose blood culture samples were received for microbiological testing . Inclusion criteria were: (i) availability of complete medical records, including culture and susceptibility results, and (ii) a confirmed diagnosis of Gram-positive cocci bloodstream infection in adult or paediatric cancer patients. Patients with incomplete microbiological or medical records, those who could not be followed until treatment completion and cases with suspected blood culture contamination rather than true infection were excluded, in order to limit confounding and preserve data reliability.

Sample Collection and Processing: Blood samples were collected from patients with suspected bloodstream infection using aseptic venipuncture technique. A predetermined volume was inoculated into BD BACTEC Plus Aerobic/F and Anaerobic/F culture bottles. Bottles were monitored continuously by the automated system, which detects microbial growth by measuring CO_2 production. Positive cultures were subcultured onto Blood Agar, MacConkey Agar, and Chocolate Agar to isolate bacterial colonies and Gram staining was performed for initial microscopic identification and to guide further laboratory work.

Identification and Antimicrobial Susceptibility Testing: Organism identification and antimicrobial susceptibility testing were performed using the BD Phoenix automated system along with conventional disc diffusion (Kirby-Bauer) and broth microdilution methods. Antimicrobials tested included teicoplanin, vancomycin, linezolid, daptomycin, high-level gentamicin, ampicillin, clindamycin, erythromycin, and cotrimoxazole (for *Staphylococcus* species). Particular attention was given to the detection of methicillin-resistant Staphylococcus aureus and vancomycin-resistant organisms given their impact on patient outcomes.

Data Analysis: The frequency of GPC-associated bloodstream infections, resistance rates, and their clinical implications were analysed using SPSS version 29. Electronic medical records and microbiology lab records were used to retieve the demographic and microbiological data.Time to positivity (TTP) was categorised as (i) ≤48 hours or (ii) >48 hours, reflecting the principle that a shorter TTP generally indicates a higher bacterial load and a more severe infection, while a longer TTP may indicate slower-growing organisms or a lower bacterial burden. Associations between TTP and resistance patterns were explored to inform clinical decision-making, infection control, and empirical antibiotic therapy.

Results

Table 1: Blood Culture Results and Microbial Distribution

Category	Total Cases (N = 1291)	Percentage (%)
Positive Cultures	391	30.38%
Negative Cultures	894	69.24%
Contaminated Samples	6	0.46%

Of 1,291 blood cultures tested, 30.38% (391 cases) were positive, indicating a substantial burden of bloodstream infection among cancer patients. The high negative-culture rate (69.24%) may partly reflect prior antibiotic exposure suppressing bacterial growth before culture collection. The low contamination rate (0.46%, 6 cases) suggests careful specimen handling.

Table 2: Microbial Distribution in Bloodstream Infections

Microorganisms	Cases (N = 391)	Percentage (%)
Gram-positive cocci	225	57.54%
Gram-negative bacilli & Candida	166	42.46%
Polymicrobial infections	4	1.02%

Gram-positive cocci accounted for 57.54% (225/391) of positive cultures, while Gram-negative bacilli and fungal pathogens accounted for 41.43% (162/391). Polymicrobial infections were uncommon (1.02%, 4 cases) but clinically significant, as they typically require broad-spectrum antibiotic coverage.

Table 3: Gram-Positive Cocci Distribution

Gram-Positive Cocci	Cases (N = 225)	Percentage (%)
MRCONS	112	49.78%
MSCONS	24	10.67%
Enterococcus spp.	38	16.89%
- Vancomycin-resistant (VRE)	18	47.37% of Enterococcus cases
MSSA	10	4.44%
MRSA	41	18.22%

Methicillin-resistant coagulase-negative staphylococci (MRCONS) accounted for nearly half of all Gram-positive isolates (49.78%), making them the leading concern among immunocompromised cancer patients. MRSA was the second most common isolate (18.22%) and remains difficult to treat empirically. *Enterococcus* spp. caused 16.89% of GPC infections (38/225), of which 47.37% (18/38) were vancomycin-resistant a growing concern for hospital infection control. The comparatively low prevalence of methicillin-susceptible strains (MSSA 4.44%, MSCONS 10.67%) indicates that resistant strains dominate this population's Gram-positive bloodstream infections.

Table 4: Antimicrobial Resistance Patterns in Gram-Positive Cocci

Pathogen	Resistant Antibiotics
MRCONS & MRSA	Clindamycin, Penicillin, Erythromycin, Cotrimoxazole, Gentamicin, Amikacin, Teicoplanin, Linezolid
Enterococcus spp.	High-level Gentamicin, Ampicillin, Linezolid, Teicoplanin

MRCONS and MRSA isolates showed limited treatment options owing to resistance against clindamycin, penicillin, erythromycin, cotrimoxazole, gentamicin, amikacin, teicoplanin, and linezolid. *Enterococcus* spp. isolates were resistant to high-level gentamicin, ampicillin, linezolid, and teicoplanin, further narrowing therapeutic options. These findings underline the urgent need for antimicrobial stewardship programmes to optimise antibiotic use and contain resistance in oncology settings.

Table 5: Time to Positivity (TTP) of Blood Cultures

TTP Interval	Cases (N = 225)	Percentage (%)
≤48 hours	208	92.44%
≥48 hours	17	7.56%

Most bloodstream infections (92.44%, 208 cases) became positive within 48 hours, suggesting fast-growing organisms or a high bacterial load. The remaining 7.56% (17 cases) required more than 48 hours to become positive, which may reflect a lower bacterial burden or slower-growing organisms such

as *Enterococcus* spp. The predominance of short TTP values suggests that bloodstream infections in this population tend to progress rapidly, reinforcing the need for early detection and prompt empirical therapy.

Table 6: Patient Demographics

Category	Cases	Percentage
Male	119	52.89%
Female	106	47.11%

The slight male predominance (52.89% vs. 47.11%) suggests that gender-specific risk factors may warrant further investigation.

Table 7: Hospital Location

Category	Cases (N = 225)	Percentage (%)
ICU	53	23.56%
Inpatient Department (IPD)	166	73.78%
Bone Marrow Transplant (BMT) Unit	3	1.33%
Outpatient Department (OPD)	3	1.33%

Most affected patients (73.78%) were hospitalised in inpatient wards, consistent with the association between prolonged admission and bloodstream infection risk, while the 23.56% ICU admission rate reflects the severity of illness in critically ill cancer patients requiring close monitoring for sepsis. The small numbers of cases in the BMT unit and outpatient department (1.33% each) likely reflect smaller patient volumes in these settings rather than lower underlying risk.

Table 8: Malignancy Type in Bloodstream Infection Cases

Malignancy Type	Cases (N = 225)	Percentage (%)
Solid Tumours	186	82.67%
Haematological Malignancies	39	17.33%

Patients with solid tumours accounted for most bloodstream infections (82.67%), likely reflecting the larger proportion of solid-tumour patients undergoing chemotherapy or radiotherapy at this centre. Although haematological malignancies accounted for a smaller share of cases (17.33%), these patients are prone to prolonged immunosuppression and are at risk of particularly severe infections.

Discussion

Rising Incidence of Drug-Resistant Gram-Positive Cocci: The rising incidence of drug-resistant Gram-positive cocci BSIs in cancer patients is a major concern in oncology, particularly among patients undergoing chemotherapy or haematopoietic stem cell transplantation. MRCONS(49.78%) and MRSA(18.22%) were the most common Gram-positive pathogens in this study. Whereas a six year retrospective study in cancer patients from Jiangxi, China showed Gram-negative bacilli (62.79%) being the most prevalent BSI while Gram positive bacteria accounted for 37.21% of isolates [3]. The high prevalence of MRCONS (49.78%) in our study likely reflects its opportunistic behaviour in patients with central venous catheters and prolonged hospital stays. In a similar study from central India by Sonali et al MRCONS comprised 60% and MRSA 64% of all Gram-positive isolates [4]. MRSA remains notoriously difficult to treat empirically because methicillin resistance rules out beta-lactam therapy, leaving vancomycin, teicoplanin, or linezolid as the main options [4,5]. Rising resistance to these agents further narrows the therapeutic options and underscores the need for enhanced infection prevention control policies, implementation of antimicrobial stewardship and development of newer therapeutic agents targeting resistant Gram-positive strains [5,6].

Antibiotic Resistance Trends and Clinical Implications: Nearly half of *Enterococcus* isolates in this study were vancomycin-resistant (47.37%), rendering key treatment for severe enterococcal infection largely ineffective; resistance to high-level gentamicin, ampicillin, linezolid, and teicoplanin further complicates management of BSIs causedby Gram-positive cocci [4,7]. Widespread resistance among MRCONS and MRSA isolates to gentamicin, amikacin, penicillin, erythromycin, and cotrimoxazole reflects broader patterns of multidrug resistance that reduce the efficacy of routinely used agents in oncology [3,6]. Rising resistance to linezolid and teicoplanin, both considered last-resort options for drug-resistant Gram-positive infections, highlights the need for newer antimicrobials, combination regimens, and adjunctive strategies such as bacteriophage therapy [6,7]. Because empirical antibiotic selection in cancer patients must often precede susceptibility results, local resistance surveillance is essential to guide treatment and limit reliance on broad-spectrum agents [7,8].

Time to Positivity (TTP) and Clinical Relevance: Blood culture TTP can indicate the severity and course of infection. In this study, 92.44% of cultures became positive within 48 hours, consistent with a high bacterial load and rapid infection progression, warranting prompt antibiotic intervention in immunocompromised patients [9,10]. The remaining 7.56% of cases had a delayed TTP (>48 hours), which has been associated in other cohorts with slower-growing organisms and, in some cases, with lower-grade or contaminant growth rather than true infection particularly for coagulase-negative staphylococci [10,11]. These findings support the use of TTP alongside rapid diagnostic and molecular techniques to help distinguish true bacteraemia from contamination and to guide antibiotic de-escalation [9,11].

Comparison with Previous Studies: Previous studies of bloodstream infection in cancer patients have similarly identified MRCONS, MRSA, and *Enterococcus* species, including VRE, among the leading Gram-positive pathogens, and have reported comparable resistance patterns across different healthcare settings [3,4,5]. Reports from other oncology and haematology centres have likewise noted a shift toward Gram-positive predominance in BSI and have emphasised the value of local resistance surveillance for guiding empirical therapy [4,7]. TTP-based studies in febrile neutropenic patients have similarly linked shorter TTP with higher bacterial burden and more severe infection, supporting the use of TTP as an adjunct to clinical decision-making in this population [8,9,10].

Implications for Clinical Practice and Infection Control: The rising prevalence of multidrug-resistant Gram-positive cocci in this cohort supports revisiting empirical antibiotic protocols and strengthening antimicrobial stewardship to optimise antibiotic use, reduce resistance, and improve outcomes. Infection-control measures including hand hygiene, catheter care, and isolation of patients with multidrug-resistant organisms remain essential to limiting nosocomial spread [6,7]. Timely blood culture and susceptibility testing can support more targeted antibiotic selection and reduce reliance on broad-spectrum agents, while rapid molecular diagnostics and whole-genome sequencing, where available, may further improve early detection of resistant infections [8,11]. Regularly updated, locally derived antimicrobial guidelines, informed by ongoing surveillance, would help ensure that empirical therapy in this setting remains effective [6,11].

Conclusion

This study highlights the challenges of managing bloodstream infections caused by drug-resistant Gram-positive cocci in cancer patients at a tertiary care oncology centre in Bihar, India. The high prevalence of MRSA and MRCONS narrows available treatment options, while the substantial proportion of vancomycin-resistant *Enterococcus* adds to clinical concern, since vancomycin is typically reserved for the most severe Gram-positive infections. Resistance to clindamycin, cotrimoxazole, linezolid, and teicoplanin further complicates treatment decisions and underscores the need for updated, locally tailored antimicrobial stewardship programmes. Strengthening infection control through hand hygiene, catheter care, judicious antibiotic use, and isolation of colonised or infected patients—together with rapid diagnostic testing and ongoing resistance surveillance, is essential to improve early detection and treatment outcomes. Continued longitudinal surveillance, alongside research into new antimicrobials, combination therapies, and alternative approaches such as antimicrobial peptides and bacteriophage therapy, will be important for managing drug-resistant Gram-positive infections in immunocompromised cancer patients and improving survival from bloodstream infection in this population.

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