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Original Article

# Incidence, Microbial Spectrum & Antimicrobial Pattern of Blood Stream Infection in Udaipur District, Southern Rajasthan: An Analytical Cross - Sectional Study

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## ABSTRACT

**Background**: The epidemiology of Blood stream infections (BSIs ) is dynamic . BSI caused by various pathogenic microorganisms are often associated with high morbidity and mortality. The changing epidemiology and the resistance pattern of microorganisms is a great set back for the clinicians in the management of these cases. The aim of the present study was to determine the incidence of Blood stream infection, the etiological agent & the antimicrobial profile of bacteria & fungi isolated from blood culture of clinically suspected septicaemia cases.

**Methods**: A cross-sectional analytical study conducted over 1500 blood cultures received from clinically suspected septicaemia cases of all ages & both sexes. Blood cultures received were subjected to BacT/Alert 3D system for pathogen alert. Blood cultures which flagged positive were subjected to identification and antimicrobial sensitivity testing using standard protocol for microbiological profiling. The pathogen profile and the antimicrobial sensitivity results were recorded and the data was analysed using descriptive statistics.

**Results**: A total of 1500 blood cultures received from patients were included in the study, Blood Stream Infection was observed in 19.8% (297) cases. The Incidence of BSIs was found to be more common in age group >6oyrs (23.7%). followed by age group b/w 13 to 60 yrs 20.2%. Majority of cases with BSIs were from ICUs 118 (39.7%), Oncology wards 43(14.5%) followed by PICU & NICU 37(12.5%). The microbiological analysis revealed Gram positive cocci accounted for 52.5%, Gram negative bacilli 43.4% and Yeasts around 3.7%. Of the pathogens causing Blood stream infections, Staphylococcus spp (38 %) followed by E.coli (16.1%) was the most commonly isolated. The least sensitivity to 2nd line antibiotic classes such as to 4th generation cephalosporins, aminoglycosides, fluoroquinolones & carbapenems was observed in Klebsiella pneumioniae & Acinetobacter spp. (38% - 64.7%). The Candida non-albicans showed less sensitivity to the antifugals tested compared to Candida albicans Among the WHO Bacterial Priority Pathogens (CRAB) Carbapenem Resistant Acinetobacter spp was (50%), Methicillin resistant Staphylococcus aureus (MRSA) was 78.6% & Vancomycin Resistant Enterococcus spp (VRE) was 22.2% in our study.

**Conclusion**: The Incidence of Blood stream infection was 19.8% in this study with Gram positive organisms being the predominant cause for BSIs. The decreasing

sensitivity to commonly prescribed antimicrobials & increasing trend of WHO Bacterial priority pathogens underscores the need for prudent use of antimicrobials & tailored antimicrobial stewardship. Hence a systematic approach i.e, culture from foci , use of automations for blood culture reporting by diagnostic microbiology laboratory is essential for rampant diagnosis, as evidence-based therapy is crucial in the management of BSI cases.



***Keywords****: Bloodstream Infection, Antimicrobial Resistance, Methicillin-Resistant Staphylococcus aureus, Carbapenem, Resistant Acinetobacter baumannii, Antimicrobial Stewardship.*

## INTRODUCTION

Blood stream infections (BSIs) caused by pathogenic bacteria & fungi are significant cause of morbidity and mortality worldwide (1). BSIs range from self-limiting to life –threatening (2). As per the global data by WHO, nearly 49 million individuals are affected and approximately 11 million deaths occur (3). The discovery of antibiotics had played a major role in fighting / treating these chronic infections (4). The epidemiology of BSIs is dynamic , influenced by various factors such as patient age and type of underlying infectious syndrome. However the pathogen profile of BSIs vary among regions and many bacterial pathogens has developed resistance to most classes of antibiotics. Timely identification of these pathogenic bacteria and fungi along with their antibiotic resistance pattern is crucial for the effective treatment and management of these cases as well as for the better patient outcome (5). The changing epidemiology and the resistance pattern of microorganisms is a great set back for the clinicians in the management of these cases. BSIs are more common among patients with Co-morbidities and among community patients with chronic infections (6). BSI requires immediate and prompt antimicrobial treatment for its appropriate management. Moreover the data profile of BSIs in countries like India are limited (7). The present study will provide valuable insights in to epidemiology of blood stream infections, including pathogen incidence, resistance patterns which is crucial for deciding appropriate empirical antibiotics, framing antibiotic policies & preventive measures. India being a developing economy and a hub for emerging infectious diseases, such studies are essential which will provide insights for better management of these cases that will reduce the hospital stay and cost of treatment burden on patients (8). Therefore this study was conducted to determine the incidence of Blood Stream Infections, analyse the microbial profile causing blood stream infections & the antimicrobial pattern of bacteria and fungi isolated from blood culture of clinically suspected septicaemia cases attending the tertiary care institute in Udaipur district, Southern Rajasthan.

## MATERIALS & METHODS

A record based cross-sectional analytical study carried out between January 2025 to June 2025 in a tertiary care hospital in Udaipur district of southern Rajasthan.

**Study Population:** All blood cultures collected from peripheral line, indwelling intravenous line or central line catheter from patients of all ages, both sexes presenting with clinical signs and symptoms of sepsis or clinically suspected septicaemia cases , with history of Fever of Unknown Origin at the time of admission / during the hospital stay/ attending the Out Patient Departments during the study period received in the department of microbiology were included for the study. Detailed patient socio-demographic details such as age, sex, antibiotic history were recorded using a predesigned proforma. A total of 1500 blood culture samples received from study participants during the study duration was processed for routine microbiological profile & Antimicrobial Susceptibility Testing.

**Blood Culture :** The Blood culture bottles received were loaded to the automated blood culture system BacTAlert (Biomerieux, France )3D system for pathogen alert. Any blood culture bottle that flagged positive were subjected to routine bacterial and fungal pathogen identification by inoculation on to Blood Agar , Chocolate Agar, MacConkey Agar & Sabourad's dextrose Agar Plates following standard microbiological techniques. Agar plates with microbial growth were then identified conventionally based on colony morphology, Gram's staining and biochemical properties as per standard protocols (1). Antimicrobial Susceptibility Testing of the isolates were done using modified Kirby bauer disc diffusion methods on Mueller - Hinton Agar plates as per CLSI guidelines 2025 to determine the sensitivity and resistant trends. The microbiological profile & Antimicrobial Susceptibility Testing pattern of 1500 blood culture samples from study participants during the study duration was recorded. More than one blood culture specimen from same patient showing same pathogen growth were excluded from the study. Any Blood cultures positive with contaminants as per standard definitions (i.e, Blood cultures positive with contaminants such as isolation of skin-residing commensal organisms in a single blood culture set out of a series i.e *Staphylococcus epidermidis, Corynebacterium spp. diphtheroids ,Bacillus spp.* other than *B. anthracis , Micrococcus spp.)* were excluded from the study. The data was analyzed using descriptive statistics.

## RESULTS:

**Fig. No.1 : Incidence of BSI based on Blood culture positivity.**

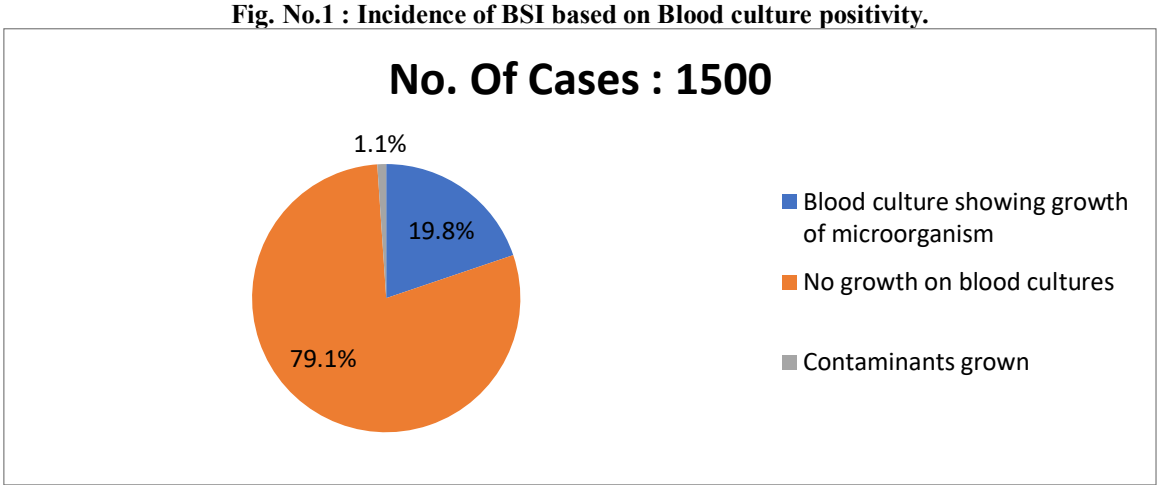



**Fig. No. 2 : Distribution of Blood culture Positive cases location wise in the hospital.**

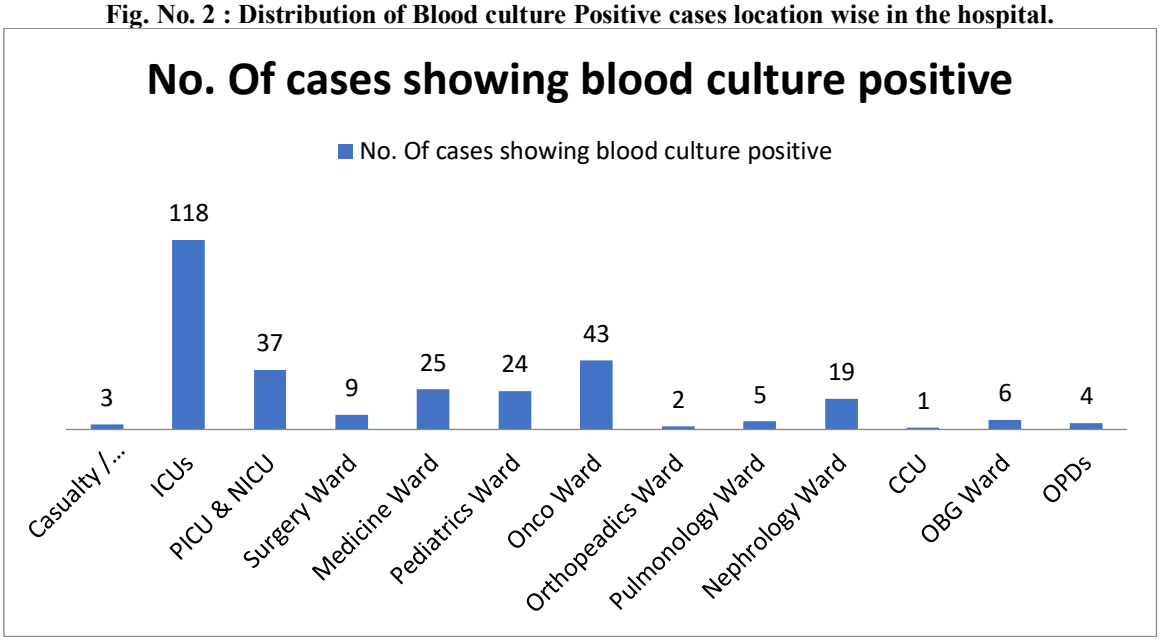



**Table No.1: Age wise Incidence of Blood Stream Infections.**

| S.No. | Age Group | No. of Blood culture positive cases (%) |
|---|---|---|
| 1. | Neonates (0-1) n=348 | 54 (15.5%) |
| 2. | Pediatric age group (1-12 yrs) n=120 | 23 (19.1%) |
| 3. | Adults (13-60 years) n= 674 | 135 (20.2%) |
| 4. | Geriatric age group (>60 yrs) n= 358 | 85 (23.7%) |

**CHART NO.1 : Distribution of pathogens causing BSI.**

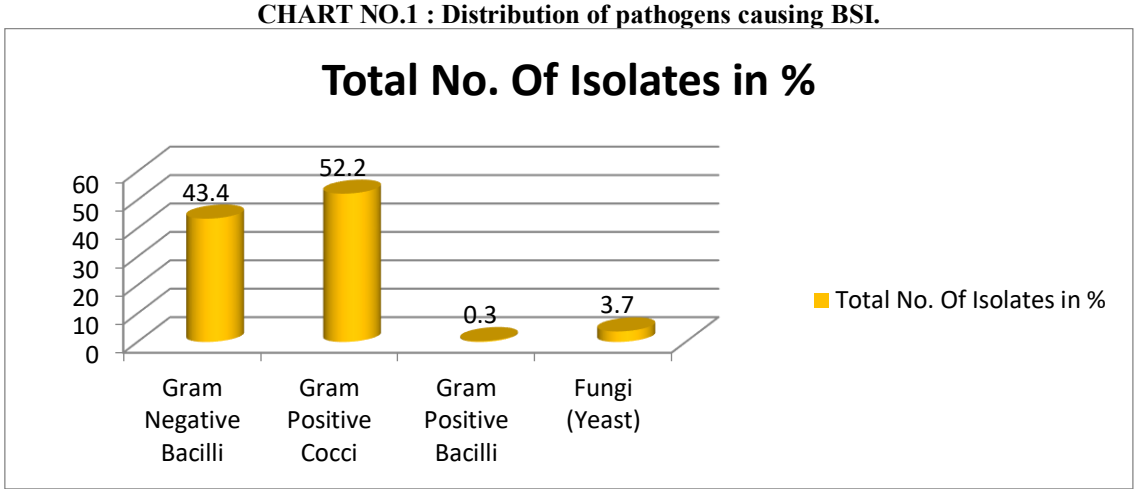


**Table No.2: Microbial Spectrum of pathogens causing BSI.**

| S.No. | Pathogens | Etiological agent | No. of isolates ( n=297) (%) |
|---|---|---|---|
| 1. | Gram Negative Bacilli ( Enterobacteriaceae) | Escherichia coli | 48 (16.1) |
| 2. | | Klebsiella Species | 34 (11.4) |
| 3. | Gram Negative Bacilli (Non- Enterobacteriaceae) | Pseudomonas Species | 23 (7.7) |
| 4. | | Acinetobacter Species | 24 (8.1) |
| 5. | Gram Positive Cocci | Staphylococcus aureus | 28 ( 9.4) |
| 6. | | Staphylococus Species | 113 (38) |
| 7. | | Streptococcus Species | 5 (1.7) |
| 8. | | Enterococcus Species | 9 (3) |
| 9. | Gram Positive Bacilli | Listeria Species | 1(0.3) |
| 10. | Yeast | Candida albicans | 3 (1) |
| 11. | | Candida non-albicans | 9 (3) |

**Fig. No. 3: Drug sensitivity Pattern of Gram Negative bacilli causing BSIs.**

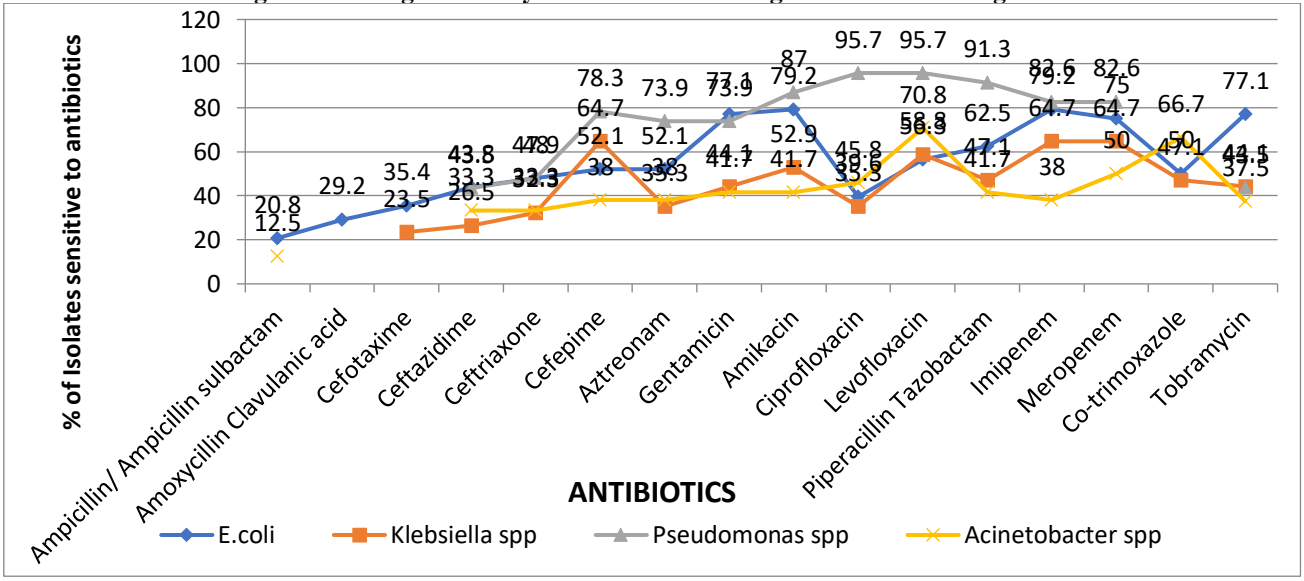
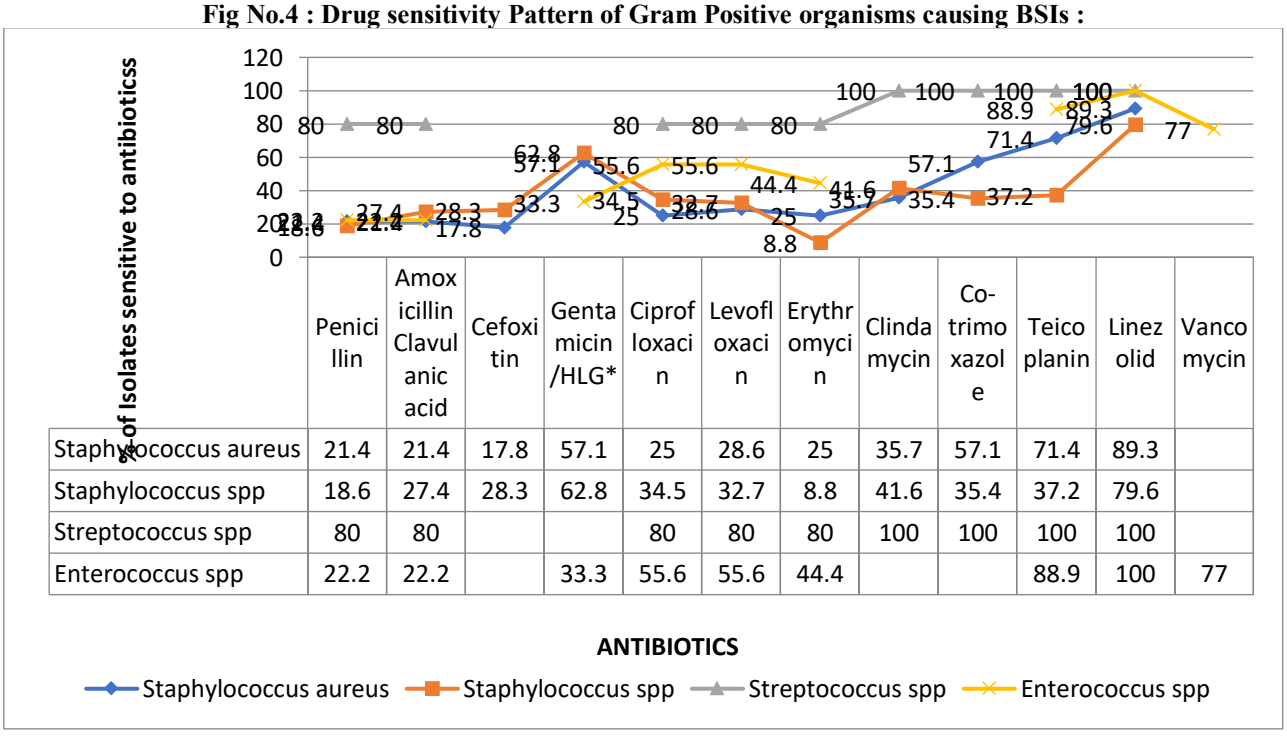



**Fig No.4 : Drug sensitivity Pattern of Gram Positive organisms causing BSIs :**




| | Penicillin | Amoxicillin Clavulanic acid | Cefoxitin | Gentamicin /HLG* | Ciprofloxacin | Levofloxacin | Erythromycin | Clindamycin | Co-trimoxazole | Teicoplanin | Linezolid | Vancomycin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Staphylococcus aureus | 21.4 | 21.4 | 17.8 | 57.1 | 25 | 28.6 | 25 | 35.7 | 57.1 | 71.4 | 89.3 | |
| Staphylococcus spp | 18.6 | 27.4 | 28.3 | 62.8 | 34.5 | 32.7 | 8.8 | 41.6 | 35.4 | 37.2 | 79.6 | |
| Streptococcus spp | 80 | 80 | | | 80 | 80 | 80 | 100 | 100 | 100 | 100 | |
| Enterococcus spp | 22.2 | 22.2 | | 33.3 | 55.6 | 55.6 | 44.4 | | | 88.9 | 100 | 77 |

**Fig No.5: Drug sensitivity Pattern of Candida spp causing BSIs.**

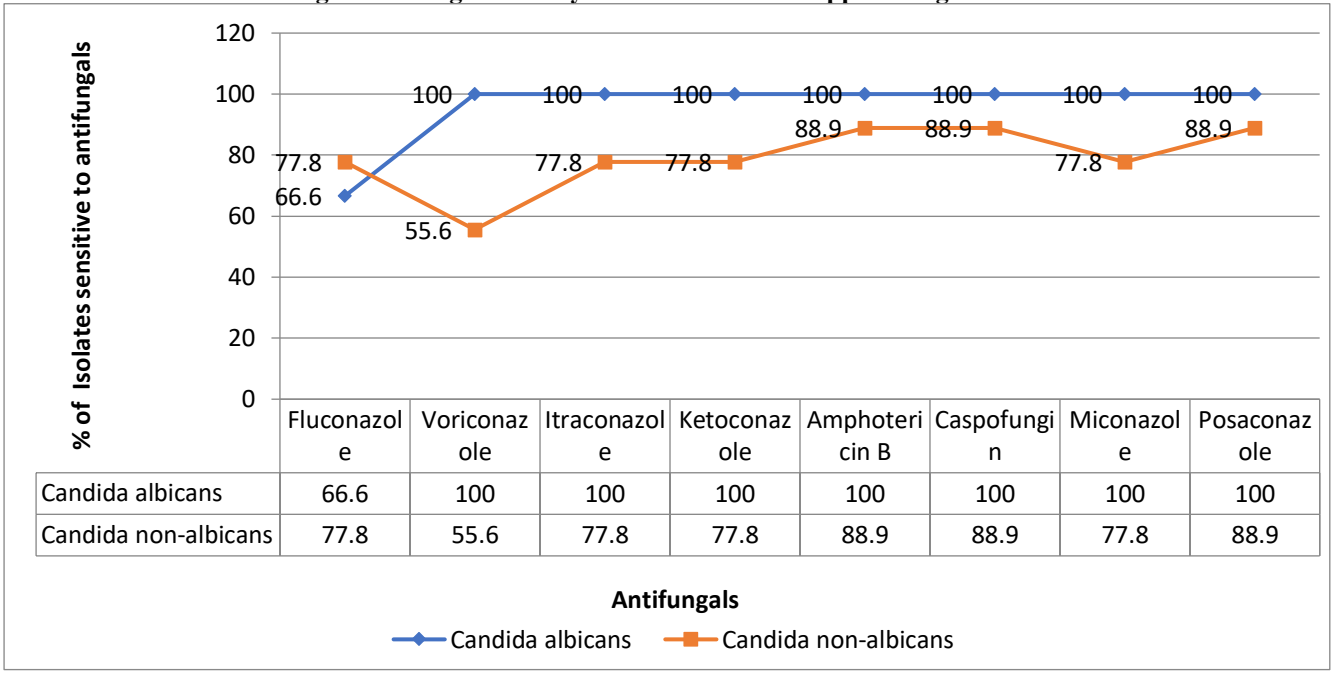



**Table No. 3 : Prevalence of Drug Resistant strains/Bacterial Priority Pathogens in BSIs:**

| S.No. | WHO Bacterial Priority Pathogen List | % Drug resistance |
|---|---|---|
| 1. | 3rd generation Cephalosporins Resistant E.coli (ESBL E.coli) | 56.3% |
| 2. | 3rd generation Cephalosporins Resistant Klebsiella pneumonia (ESBL Klebsiella pneumoniae) | 73.5% |
| 3. | Carbapenem Resistant E.coli | 22.9% |
| 4. | Carbapenem Resistant Klebsiella Pneumoniae (KPC) | 38.2% |
| 5. | Carbapenem Resistant Pseudomonas spp | 17.3% |
| 6. | Carbapenem Resistant Acinetobacter spp (CRAB) | 50% |
| 7. | Vancomycin Resistant Enterococcus spp (VRE) | 22.2% |
| 8. | Group A streptococci Macrolide Resistant | 20% |
| 9. | Methicillin Resistant Staphylococcus aureus (MRSA) | 78.6% |
| 10. | Methicillin Resistant Coagulase Negative Staphylococcus spp (MRCONS) | 71.7% |

A total of 1500 Blood cultures were included in this study based on the inclusion & exclusion criteria, Blood Stream Infection was observed in 19.8% (297) cases after exclusion of blood culture positive with contaminants (1.1%) as per standard definitions (Fig No.1). The Incidence of BSIs was found to be more common in age group >6oyrs followed by age group b/w 13 to 60 yrs in this study i.e., 23.7% (85) & 20.2% (135) respectively (Table No.1). Majority of cases with BSIs were from Intensive Care Units (ICUs) , Oncology wards followed by Pediatric ICU & Neonatal ICU 118 (39.7%), 43(14.5%) & 37(12.5%) respectively (Fig No.:2). Out of 1500 samples, nearly 297 (19.8%) blood cultures showed significant growth of bacterial & fungal pathogens. The microbiological analysis revealed a diverse range of pathogens causing BSI of which Gram Positive Cocci accounted for 52.5%, Gram Negative Bacilli accounted for 43.4% & Yeasts around 3.7%. Of the pathogens causing BSIs, *Staphylococcus spp* (38 %) followed by *E.coli* (16.1%) was the most commonly isolated. Other pathogens causing BSIs were *Klebsiella spp.* (11.4%), *Staphylococcus aureus* (9.4%), *Acinetobacter spp.* (8.1% ) & *Pseudomonas spp* (7.7%). Among the Gram positive pathogens *Staphyloccocus spp.* was the predominant pathogen 113 (38%) followed by *Staphylococcus aureus* i.e 28 (9.4%). Nearly in (3%) *Enterococcus spp.* & (1.7 %) *Streptococcus spp*. was the causative agent of BSI in this study. Among the fungal pathogens Candida non-albicans (3%) was predominant compared to Candida albicans (1%). The pathogens causing BSIs showed varying degrees of sensitivity to different antibiotics tested. Overall the GNBs exhibited a low degree to moderate sensitivity to most of the 1st line antibiotics such as Ampicillin, Amoxycillin, 2nd & 3rd generation cephalosporins i.e 12.5 % to 48% in a large. The least sensitivity to 2nd line antibiotic classes such as 4th generation cephalosporins, aminoglycosides, fluoroquinolones \& carbapenems was observed in *Klebsiella pneumioniae & Acinetobacter spp.* (38% to 64.7%). Antibiotics sensitivity pattern of various Gram positive organisms and Gram negative pathogens isolated from BSI cases is depicted in (Fig No.3 & 4). Majority of Gram positive pathogen isolated largely showed susceptibility to Vancomycin, Linezolid & Teicoplanin. In our study Gram positive cocci were found 71.4% to 100% sensitive to Linezolid and Teicoplanin. *Enterococcus spp* showed

only 77.8% sensitivity to Vancomycin. The Antifungal susceptibility testing results of fungal isolates is denoted in (Fig.No 5). Candida non-albicans showed less sensitivity to the antifugals tested compared to Candida albicans in this study. The WHO critical pathogens / Bacterial Priority Pathogens was found to be significantly high i.e, (CRAB) Carbapenem Resistant *Acinetobacter spp* (50%), 3rd generation cephalosporins resistant *E.coli* (56.3% ) & *Klebsiella spp* (73.5%), Carbapenem resistant *E.coli* (22.9%) & *Klebsiella spp* (38.2%), whereas Carbapenem Resistant *Pseudomonas spp.* (17.3%) was comparatively low in our study. The high priority pathogens among Gram Positive Bacteria such as Methicillin Resistant *Staphylococcus aureus* (MRSA) (78.6%) was found to be very high & Vancomycin Resistant *Enterococcus spp. (*VRE) (22.2%) in our study (Table No.3).

**DISCUSSION:**

BSIs require prompt and quick treatment as their prevalence, etiology, antimicrobial susceptibilities differ from one geographical location to other. BSIs pose a significant challenge, the widespread use of advanced medical technologies & indwelling devices alter the clinical outcomes of BSIs (8). A total of 1500 blood culture samples received from clinically suspected septicaemia and Fever of Unknown Origin cases from various clinical OPDs , wards & ICUs were processed. The BSI incidence in our study (19.8%) was found to be slightly higher compared to a previous study from a tertiary care hospital in Udaipur (17.37%) (3). Prevalence of BSI in various parts of India has been found to be 7%-44% (3,7,8,9,10,11,12,13,14). In our study Blood culture were positive in 297 (19.8%) cases.The positivity rate was much higher in studies by Khanal et al 44% (15), Robinson et al 45.58% (8) & Sultana et al 49.28 % (16). the difference in positivity rate can be attributed to a well established fact that prior antibiotic administration can reduce the pathogen detection in blood cultures and collection of two or multiple blood culture sets with appropriate blood volume per bottle expands the chance of pathogen isolation. The other factors such as patient age, fever intensity and source of infection also impacts the positivity rates (17).

The Incidence of BSIs was found to be more common in age group >6oyrs followed by age group between 13 to 60yrs in this study i.e., 23.7% (85) & 20.2% (135) respectively. These findings were consistent with previous other studies (8,18). The BSI cases was widely distributed among inpatients of which majority were from ICUs 118 (39.7%), Oncology wards 43 (14.5%) followed by PICU & NICU 37(12.5%). The high incidence of BSIs in ICUs, Oncology wards, NICUs & PICUs can be correlated with the increasing use of Central venous catheters (CVC)/ Intra venous catheters (IVC) as well as patients with chronic illness such as Carcinoma & trauma (2,4,5).

In our study Gram positive cocci (52.2%) were predominantly isolated compared to Gram negative bacilli (43.4%) which was in contrast to studies by Robinson et al , Gram positive cocci (26.02%) & Gram negative bacilli (71.42%) (8). The predominance of Gram negative pathogens in BSIs was also reported by Latif et al (72.1%) (19), Garg A et al (65.5%) (20) & Prashanth et al (70.5%) (21). The Gram Positive pathogens were more prevalent in causing BSI compared to Gram Negative pathogens in our study, which was in concurrence with several other findings (3,4 6,7) . The BSI pathogens isolated in our study & other studies from different parts of the country was found to be similar with variation only in the % prevalence. In the present study among the various pathogens of BSI, *Staphylococcus spp* (38%) was found to be the predominant pathogen or leading cause of BSIs followed by *E.coli (16.1%).* These findings were consistent with Mehdinejad et al study *E.coli* (20.6%) (22). However few studies contradicts these findings (9,12). The Candida spp. isolated in our study was around (3.7%), Various studies have reported 1.19% to 3.1% Candida spp. in BSI cases (8,16,23)

Antimicrobial susceptibility test results revealed most Gram negative bacteria showed significantly low to moderate sensitivity to most commonly used antibiotic classes such as Ampicillin, Amoxycillin, 2nd & 3rd generation Cephalosporins i.e 12.5 % to 48% in a large. Among the GNBs *Klebsiella pneumonia, Acinetobacter spp* showed very low to NIL sensitivity to multiple classes of antibiotics. These findings were reverberated in similar other studies by Sharma et al & Rao et al (3,12) which underscores the need for prudent use of antibiotics and tailored antimicrobial stewardship. *E.coli* isolated in this study showed fairly good sensitivity to Aminoglycosides & Carbapenems. These findings was in agreement with other recent studies from various parts of country (14, 18, 20, 24).

Majority of Gram positive pathogen isolated largely showed susceptibility to Vancomycin, Linezolid & Teicoplanin. In our study Gram positive cocci were found 71.4% to 100% sensitive to Linezolid and Teicoplanin. A similar sensitivity pattern among Gram positive cocci was observed in several other studies in the country (4, 8, 22, 25). *Enterococcus spp* isolated in the study showed only 77.8% sensitivity to Vancomycin. The decreasing sensitivity to Vancomycin and rising trends to Vancomycin resistance in *Enterococcus spp* (2 to 17%) is being reported widely (25, 26). Sadar et al reported 2.4% *Enterococcus spp* resistant to Vancomycin in his study (27). A significant decrease in sensitivity to 3rd generation Cephalosporins & Fluoroquinolones was observed among both Gram positive and Gram negative pathogens isolated in this study. This remains a matter of concern as broad spectrum antibiotic option becomes limited in treating these cases. This pattern discloses the need for targeted antimicrobial strategies in the management of BSI cases. The above findings were critically important in framing the antibiogram & structuring the empirical in our setting.

Fungus isolated in our study showed fairly good sensitivity to most commonly prescribed antifungal agents such as Amphotericin B, Caspofungin, Voriconazole except to Fluconazole. In the present study Candida non- albicans showed

significantly less sensitivity to most antifungals compared to Candida albicans isolated. This data provides insight into the antimicrobial trends addressing the need for such studies in framing the management of BSIs , being the major cause for mortality which in large is a public health issues.

Among the WHO critical pathogens /Bacterial Priority Pathogens (CRAB) Carbapenem Resistant *Acinetobacter spp* (50%), 3rd generation Cephalosporins resistant *E.coli* & *Klebsiella spp* (56.3 ,73.5% respectively), Carbapenem resistant *E.coli* (22.9%) & *Klebsiella spp* (38.2%) was found to be significantly high, whereas Carbapenem Resistant *Pseudomonas spp* (17.3%) was comparatively less in our study. Similar type of significant rise in resistance among these Bacterial priority pathogens was reported by Khanal B et al in a 10 year study from eastern Nepal (28). The high priority pathogens among Gram positive bacteria such as Methicillin Resistant Staphylococcus aureus (MRSA) was found to be very high 78.6% & (VRE) Vancomycin Resistant – *Enterococcus spp* was 22.2% in our study. Meshram P et al reported 75% MRSA in BSI cases in his study (7). Khanal B et al in their study reported 44% MRSA and 17% VRE (28). Robinson et al observed 33.3% MRSA in BSI cases (8). A pooled prevalence of 38.2% MRSA (29) and higher MRSA rates 68.2% in BSI cases was reported by Deva et al (30). The decreasing sensitivity to majority of the commonly prescribed antimicrobials and increasing trend of Bacterial priority pathogens signifies intense challenges in the management of BSIs, especially in developing countries with under- resourced settings. This study also signifies evidence based therapy is crucial in the management of septicaemia / BSI cases due to dramatic increase in Bacterial Priority / critical Pathogens. These findings contribute to the global effort to combat antimicrobial resistance thereby to improve patient care.

**Limitations of the study :** The present study targeting septicemia cases from a single tertiary care hospital limits the findings underestimating the true infection rates of this geographical region.

**CONCLUSION:**

The incidence of BSI was 19.8 % , with predominance in Gram positive pathogens of which *Staphylococcus spp* being the most common cause for BSI in our study. BSIs generally secondary to systemic infections, most often the primary site remains indistinct and the pathogen isolated from blood culture is the mainstay for the treatment. Hence blood culture, the most critical method and its reporting by diagnostic microbiology laboratory could only aid in the better management of BSI cases. The Incidence of BSIs was found to be more common in age group >6oyrs with cases widely distributed among inpatients from ICUs , Oncology wards , PICU & NICU that can be attributed to the increasing use of Central Venous catheters / Intra- venous Catheters, patients with chronic illness such as Carcinoma & trauma. The varying degrees of resistance signifies the need for targeted and judicious antimicrobial use. The rising prevalence of WHO Bacterial priority pathogens in BSI cases is quiet alarming that signifies the growing challenges in the management of septicemia / cases with BSI.

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**Conflict of Interest** : None declared
**Ethical Approval:** This study was approved by IEC (AIIMSUDR/7635).

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