

# Blood Stream Infections in a Tertiary Care Hospital of Kashmir: Bacterial Etiology and Antibiotic Susceptibility

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## ABSTRACT

**Background:** Bloodstream infections (BSI) remain a major cause of morbidity and mortality in patients among all age groups worldwide. The key to successful treatment and outcome of BSI is the knowledge of its changing aetiology and antibiotic sensitivity in a given geographical area.

**Material and methods:** This prospective study was conducted over two years in a tertiary care hospital in North India. All patients admitted to the hospital with documented BSI were included in the study. The demographic profile, clinical presentation, culture isolates and corresponding antibiogram were analyzed using SPSS software.

**Results:** Among a total of 136 patients with BSI enrolled in the study, 84(62%) were males and 52(38%) females. 41.2% of patients were more than 60 years of age. 104(76.5%) patients had hospital acquired and 32(23.5%) had community acquired BSI. Gram-negative organisms were isolated in 78.7% of patients and 18.4% of isolates were Gram-positive. The commonest Gram-positive organism was *S.aureus* (56%) and the commonest Gram-negative isolate was *B.cepecia* (38.3%). The most sensitive drugs for Gram-positive bacteria were vancomycin, linezolid and teicoplanin while Gram-negative isolates showed high sensitivity to colistin, tigecycline and amikacin.

**Conclusion:** Gram-negative bacteria are common pathogens for BSI in our population. A higher rate of antimicrobial resistance is an alarming issue, especially in patients with hospital-acquired infections.

**Keywords:** Bloodstream infections, drug susceptibility, sepsis, community-acquired, hospital-acquired.

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## INTRODUCTION

Blood stream infections are defined using modified Centers for Disease Control and Prevention (CDC) criteria which require at least one positive blood culture for all bacterial pathogens except common skin contaminants which require  $\geq 2$  positive blood cultures within 48 hours. Bloodstream infections are classified into community-acquired (CABSI) and hospital-acquired (HABSI) because their causative pathogens, resistance patterns and outcomes have been reported to be markedly different.<sup>1</sup> BSI is defined as community-acquired when it occurs within the first 48 hours of admission while hospital-acquired BSI is which occurs 48 hours after hospital admission.

In a population-based study, the incidence of BSI was found

to be 15.7/100 000 patients per year.<sup>2</sup> In India, *S.aureus*, Coagulase-negative staphylococci, and *E.faecalis* are the commonest Gram-positive bacteria while *E. coli*, *K. pneumoniae*, *Serratia*, *Pseudomonas* and *Acinetobacter baumannii* are the commonest Gram-negative bacteria causing BSI.<sup>3,4</sup> However, organisms vary with several factors such as type of health-care facility, presence and duration of a venous and arterial catheter, type of catheter used, organisms prevalent in the centre, immune competence of the host, extent of preventive measures

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undertaken as well as initial antimicrobial therapy used.<sup>3-9</sup> The goal of this study was to determine the aetiology of BSI in our community and lay a foundation for a much-needed guideline to treat patients admitted with BSI.

## MATERIALS AND METHODS

This was a prospective observational study conducted in the department of internal medicine at Sher-I-Kashmir Institute of Medical Sciences- a referral tertiary care hospital in Srinagar, Jammu and Kashmir. The study protocol was cleared by the ethical committee of the institute. Patients with evidence of bloodstream infections were recruited over two years from September 2017 to September 2019. All blood isolates during the study period from the hospital were reviewed for clinical significance before enrolling in the study.

### Subjects

Patients above 14 years of age who were admitted to the hospital with features of systemic inflammatory response syndrome (SIRS) and bacteremia were included in this study. SIRS was defined by the presence of at least two of the following signs and symptoms: tachycardia ( $>90$  b/min), tachypnea ( $>20$  /min), fever ( $>38^{\circ}\text{C}$ ) or hypothermia ( $<36^{\circ}\text{C}$ ), leukocytosis ( $>12,000/\mu\text{L}$ ) or leukopenia ( $<4,000/\mu\text{L}$ )<sup>1</sup>

### Data collection

The data about the demographic profile, clinical presentation, and organisms isolated with their respective drug sensitivity was noted in all the patients.

### Blood Cultures, Organism Identification and Susceptibility Testing

Blood samples were collected in a BACTEC broth media and subsequently incubated in BacTAlert3D, a fully automated culture system for the detection of growth in blood. Cultures were reported sterile if no growth was detected after 5 days of incubation. Isolates were identified by the Vitek-2 system and sensitivity testing was done using AST cards. The results were interpreted according to CLSI criteria.

### Statistical analysis

The categorical variables were analyzed by Pearson's Chi-Square and Fisher's Exact test using SPSS software version 22. A P-value of  $<0.05$  was considered statistically

significant.

## RESULTS

### Socio-demographic characteristics, Clinical Profile

Study enrolled 136 patients with 84(62%) males and 52(38%) females. 56(41.2%) patients with bacteremia in our study were  $\geq 60$  years of age. Fever (87%) was the most common clinical feature in patients with bacteremia in our study followed by Breathlessness (41%) and Hypotension (31%). The risk factors for BSI in our patient cohort included instrumentation (42.65%) followed by trauma (27.94%), immunosuppression (26.47%) and recent surgery (25.74%).

**Table-1:** Demographic profile and clinical presentation in patients with Bloodstream infection.

| Characteristics       |                 | n(%)        |
|-----------------------|-----------------|-------------|
| Gender                | Male            | 84 (62)     |
|                       | Female          | 54 (38)     |
| Age                   | < 30 years      | 34 (25)     |
|                       | 30-60 years     | 46(33.8)    |
|                       | > 60 years      | 56 (41.2)   |
| Clinical presentation | Fever           | 111 (86.76) |
|                       | Breathlessness  | 56 (41.18)  |
|                       | Cough           | 36 (26.47)  |
|                       | Nausea/vomiting | 35 (25.74)  |
|                       | Dysuria         | 34 (25)     |
|                       | Pain abdomen    | 21 (15.44)  |
|                       | Loose stools    | 8 (5.88)    |
|                       | Hypotension     | 42 (30.88)  |
|                       | Encephalopathy  | 27 (19.85)  |

### Spectrum of cultural isolates

Hospital acquired BSI (76.5%) were more common than community acquired 32(23.5%) in this study (Table 2). Gram negative bacteria were common isolates than Gram positive bacteria. Burkholderiacepeceia (30%) was the commonest pathogen in BSI followed by E. coli, Acinetobacter baumannii, Enterococcus faecium, Klebsiella pneumonia and Salmonella.

Among 32 cases of CA-BSI, salmonella (34.4%) was most common pathogen isolated followed by E coli, Staphylococcus aureus, Enterococcus faecium, Brucella melitensis and Pseudomonas aeruginosa (3.1%). (Table-2)

*Burkholderia cepacia* (37.5%) was most common pathogen found in HA-BSI followed by *Acinetobacter baumannii*, *Klebsiella pneumonia*, *E. coli*, *Enterococcus faecium*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Acinetobacter lwoffii*, *Candida albicans* and *Enterococcus cloacae*.

**Table-2:** Bacterial isolates in community-acquired and hospital-acquired BSI.

| Causative pathogen                | Frequency (%) | Community acquired, n(%) | Hospital acquired, n (%) |
|-----------------------------------|---------------|--------------------------|--------------------------|
| <i>Burkholderia cepacia</i>       | 41 (30.1)     | 2 (6.3)                  | 39 (37.5)                |
| <i>E. coli</i>                    | 16 (11.8%)    | 6 (15.7)                 | 10 (9.6)                 |
| <i>Acinetobacter baumannii</i>    | 14 (10.3)     | 1 (3.1)                  | 13 (12.5)                |
| <i>Enterococcus faecium</i>       | 14 (10.3)     | 4 (12.5)                 | 10 (9.6)                 |
| <i>Klebsiella pneumonia</i>       | 12 (8.8)      | -                        | 12 (11.5)                |
| <i>Salmonella Typhi/paratyphi</i> | 11 (8.1)      | 11 (34.4)                |                          |
| <i>Staphylococcus aureus</i>      | 11 (8.1)      | 5 (15.6)                 | 6 (5.8)                  |
| <i>Pseudomonas aeruginosa</i>     | 7 (5.1)       | 1 (3.1)                  | 6 (5.8)                  |
| <i>Acinetobacter lwoffii</i>      | 4 (2.9)       | -                        | 4 (3.8)                  |
| <i>Brucella melitensis</i>        | 2 (1.5)       | 2 (6.3)                  |                          |
| <i>Candida Albicans</i>           | 2 (1.5)       | -                        | 2 (1.9)                  |
| <i>Enterobacter cloacae</i>       | 2 (1.5)       | -                        | 2 (1.9)                  |
| Gram-Negative organisms           | 107 (78.7)    | 21 (65.6)                | 86 (82.7)                |
| Gram-Positive organisms           | 25 (18.4)     | 9 (28.1)                 | 16 (15.4)                |
| Total                             | 136 (100)     | 32 (100)                 | 104 (100)                |

#### Antibiotic susceptibility of Gram-positive bacteria

We had 14 cases of BSI positive for *Enterococcus faecium*, among which 4 isolates were community acquired and 10 were hospital acquired. There were 11 isolates of *Staphylococcus aureus* among which 5 were community acquired. Antibiotic sensitivity of Gram positive organisms in our study is detailed in table-3.

**Table 3:** Antibiotic susceptibility of Gram-Positive bacteria

| ANTIBIOTICS             |   | STAPH. AUREUS (n=11) |          | ENTEROCOCCUS FAECIUM (n=14) |          |
|-------------------------|---|----------------------|----------|-----------------------------|----------|
|                         |   | CA (n=5)             | HA (n=6) | CA(n=4)                     | HA(n=10) |
| Linezolid               | S | 100%                 | 100%     | 100%                        | 100%     |
|                         | R | 0%                   | 0%       | 0%                          | 0%       |
| Vancomycin              | S | 100%                 | 100%     | 100%                        | 60%      |
|                         | R | 0%                   | 0%       | 0%                          | 40%      |
| Teicoplanin             | S | 100%                 | 100%     | 100%                        | 55.5%    |
|                         | R | 0%                   | 0%       | 0%                          | 44.5%    |
| Tetracycline            | S | 100%                 | 100%     | 50%                         | 44.5%    |
|                         | R | 0%                   | 0%       | 50%                         | 55.5%    |
| Piperacillin-tazobactam | S | 0%                   | 0%       | 100%                        | 75%      |
|                         | R | 100%                 | 100%     | 0%                          | 25%      |
| Gentamycin              | S | 60%                  | 66.7%    | 50%                         | 25%      |
|                         | R | 40%                  | 33.3%    | 50%                         | 75%      |
| Erythromycin            | S | 40%                  | 0%       | -                           | -        |
|                         | R | 60%                  | 100%     | -                           | -        |
| Clindamycin             | S | 25%                  | 0%       | -                           | -        |
|                         | R | 75%                  | 100%     | -                           | -        |
| Levofloxacin            | S | 0%                   | 0%       | 0%                          | 0%       |
|                         | R | 100%                 | 100%     | 100%                        | 100%     |
| Ciprofloxacin           | S | 0%                   | 0%       | 0%                          | 0%       |
|                         | R | 100%                 | 100%     | 100%                        | 100%     |
| Cefepime                | S | 0%                   | 0%       | -                           | -        |
|                         | R | 100%                 | 100%     | -                           | -        |
| Cefoperazone-sulbactam  | S | 0%                   | 0%       | -                           | -        |
|                         | R | 100%                 | 100%     | -                           | -        |
| Ceftriaxone             | S | 0%                   | 0%       | -                           | -        |
|                         | R | 100%                 | 100%     | -                           | -        |

**Abbreviations:** CA: community acquired, HA: hospital acquired, S: sensitive, R: resistant.

#### Antibiotic susceptibility of Gram-Negative bacteria

As evident from table-4 the sensitivity testing for Gram negative bacteria revealed a high level of resistance to ampicillin (100%) and ceftriaxone (>90%), and intermediate level of resistance to piperacillin-tazobactam (70%) and fluoroquinolones (62%).

Table-4: Antibiotic susceptibility of Gram-Negative bacteria.

| Antibiotics   |   | Burkh. cepecia (n=41) |         | E.coli (n=16) |         | Acineto. baumannii (n=14) |         | Kleb. pneu. (n=12) | Salmonella typhi/para (n=11) | Pseudo. aerugino. (n=7) |        | Acinet lwoffii (n=4) | Ente cloac (n=2) |
|---------------|---|-----------------------|---------|---------------|---------|---------------------------|---------|--------------------|------------------------------|-------------------------|--------|----------------------|------------------|
|               |   | CA (2)                | HA (39) | CA (6)        | HA (10) | CA (1)                    | HA (13) | HA (12)            | CA (11)                      | CA (1)                  | HA (6) | HA (4)               | HA (2)           |
| Tnp/Smx       | S | 100                   | 97.4    | 33.3          | 25      | 100                       | 60      | 57.1               | 100                          |                         |        | 50                   | 50               |
|               | R | 0                     | 2.6     | 66.7          | 75      | 0                         | 40      | 42.9               | 0                            |                         |        | 50                   | 50               |
| Meropenem     | S | 100                   | 97.4    | 83.3          | 60      | 100                       | 50      | 20                 | -                            | 100                     | 50     | 100                  | 100              |
|               | R | 0                     | 2.6     | 16.7          | 40      | 0                         | 50      | 80                 | -                            | 0                       | 50     | 0                    | 0                |
| Imipenem      | S | -                     | -       | 83.3          | 90      | 100                       | 50      | 20                 | -                            | 100                     | 40     | 75                   | 100              |
|               | R | -                     | -       | 16.7          | 10      | 0                         | 50      | 80                 | -                            | 0                       | 60     | 25                   | 0                |
| Ceftazidime   | S | 100                   | 94.9    | 20            | 0       | 0                         | 57      | 0                  | -                            | 100                     | 66.7   | 100                  | 0                |
|               | R | 0                     | 5.1     | 80            | 100     | 100                       | 43      | 100                | -                            | 0                       | 33.3   | 0                    | 100              |
| Tigecycline   | S | 100                   | 94.9    | 100           | 100     | 100                       | 80      | 50                 | -                            | -                       | -      | -                    | -                |
|               | R | 0                     | 5.1     | 0             | 0       | 0                         | 20      | 50                 | -                            | -                       | -      | -                    | -                |
| Minocycline   | S | 100                   | 91.7    | -             | -       | -                         | -       | -                  | -                            | -                       | -      | -                    | -                |
|               | R | 0                     | 8.3     | -             | -       | -                         | -       | -                  | -                            | -                       | -      | -                    | -                |
| Levofloxacin  | S | 50                    | 80      | 40            | 0       | 0                         | 30.8    | 11.1               | 0                            | 100                     | 50     | 100                  | 50               |
|               | R | 50                    | 20      | 60            | 100     | 100                       | 69.2    | 88.9               | 100                          | 0                       | 50     | 0                    | 50               |
| Ciprofloxacin | S | -                     | -       | 20            | 30      | 0                         | 20      | 9.1                | 0                            | 100                     | 66.7   | 66.7                 | 50               |
|               | R | -                     | -       | 80            | 70      | 100                       | 80      | 90.9               | 100                          | 0                       | 33.3   | 33.3                 | 50               |
| Amikacin      | S | -                     | -       | 100           | 70      | 100                       | 46.2    | 54.5               | -                            | 100                     | 66.7   | 100                  | 100              |
|               | R | -                     | -       | 0             | 30      | 0                         | 53.8    | 45.5               | -                            | 0                       | 33.3   | 0                    | 0                |
| Gentamycin    | S | -                     | -       | 100           | 60      | 100                       | 25      | 44.4               | -                            | 100                     | 50     | 33.3                 | 100              |
|               | R | -                     | -       | 0             | 40      | 0                         | 75      | 55.6               | -                            | 0                       | 50     | 66.7                 | 0                |
| Cefo-Sul      | S | -                     | -       | 83.3          | 50      | 100                       | 46.2    | 18.2               | -                            | 100                     | 40     | 100                  | 0                |
|               | R | -                     | -       | 16.7          | 50      | 0                         | 53.8    | 81.8               | -                            | 0                       | 60     | 0                    | 100              |
| Pip-taz       | S | -                     | -       | 66.7          | 60      | 0                         | 30      | 18.2               | -                            | -                       | -      | 66.7                 | 50               |
|               | R | -                     | -       | 33.3          | 40      | 100                       | 70      | 81.8               | -                            | -                       | -      | 33.3                 | 50               |
| Cefepime      | S | -                     | -       | 66.7          | 40      | 0                         | 30      | 22.2               | -                            | 100                     | 50     | 66.7                 | 100              |
|               | R | -                     | -       | 33.3          | 60      | 100                       | 70      | 77.8               | -                            | 0                       | 50     | 33.3                 | 0                |
| Ceftriaxone   | S | -                     | -       | 16.7          | 0       | -                         | -       | 33.3               | 100                          | 0                       | 0      | -                    | 0                |
|               | R | -                     | -       | 83.3          | 100     | -                         | -       | 66.7               | 0                            | 100                     | 100    | -                    | 100              |
| Ampicillin    | S | -                     | -       | 0             | 0       | -                         | -       |                    | 90.9                         | -                       | -      | -                    | -                |
|               | R | -                     | -       | 100           | 100     | -                         | -       |                    | 9.1                          | -                       | -      | -                    | -                |
| Colistin      | S | -                     | -       | -             | 100     | -                         | 100     | 100                | -                            | -                       | 100    | -                    | 100              |
|               | R | -                     | -       | -             | 0       | -                         | 0       | 0                  | -                            | -                       | 0      | -                    | 0                |

**Abbreviations:** CA: community acquired, HA: hospital acquired, S: sensitive%, R: resistant%, Tmp/Smx: Trimethoprim-sulfamethoxazole, Cefo-sul:cefoperazone-sulbactam, Pip-taz: piperillin-tazobactam,

## DISCUSSION

In our study males (n= 84, 62%) outnumbered females (n=52, 38%) with a male: female ratio of 1.6:1. This is consistent with the study by Kaur and Singh who reported a higher proportion of males (65.22%) with positive cultures.<sup>10</sup> Similar gender distribution was reported in other studies as well.<sup>10,11,12</sup> However, females outnumbered culture positivity in a study by Zenebe et al.<sup>13</sup>

In our study, 41.2% of patients were more than 60 years of

age. Nazir et al found the highest prevalence of BSI in neonates (25.6%) followed by the age group of 60 years and above (22.1%).<sup>12</sup> This can be because extremes of age are relatively immuno-compromised and hence more susceptible to infections.

Fever (87%) followed by breathlessness and hypotension was the most common clinical presentation in this study. Fever was also reported to be the most common presentation by Rode A et al in patients with central line-associated BSI.<sup>14</sup>

HA-BSI contributed to 76.5% of cases in our study while we had 23.5% of patients with CA-BSI. Anderson et al reported healthcare exposure in three of every four patients of BSI.<sup>24</sup>

Kollef M H et al in a multi-centre study also reported healthcare-associated BSI was twice more common than CA-BSI. Similarly, data from 59 hospitals in a review revealed 62% of BSI followed some sort of healthcare exposure.<sup>15</sup>

Gram-negative organisms were the predominant isolates in our study than Gram-positive bacteria (78.7% vs 18.4%). Is by studies by Mehta et al, Barati et al, Mehdinejad et al, and Ayobola et al.<sup>12</sup>, In contrast, Karlowsky et al<sup>16</sup>, Anbumani et al, Kamga et al, China et al and Nazir et al reported a higher rate of BSI due to Gram-positive organisms.<sup>12</sup>

The most common pathogen in this study was *Burkholderia cepacia* followed by *E. coli* and *Acinetobacter baumannii*. *B. cepacia* was also the most common pathogen in hospital-acquired BSI in this study. In contrast, *S. aureus* was the predominant pathogen isolated in BSI in studies by Prasad et al and Anderson et al<sup>15</sup>. A study by Hoenigl M et al reported that *E. coli* followed *S. aureus* and CoNS as the commonest pathogens in BSI.<sup>17</sup> *E. coli* was the most common cause of BSI in community hospitals before 2000.<sup>18,19</sup> Fayaz et al, Karlowsky et al, Karunakaran et al, and Aiken et al found *E. coli* as the commonest Gram-negative isolate.<sup>20,16,21</sup> Nazir et al reported *Acinetobacter* as the predominant gram-negative organism in BSI.<sup>12</sup> Thus, the observed emergence of *Burkholderia cepacia* as the commonest pathogen for BSI in our geographic area highlights the importance of this study in deciding the antimicrobial therapy in patients with sepsis before the culture results are available.

Among Gram-positive bacteria, *Enterococcus* sp followed by *Staphylococcus aureus* were the commonest isolates in this study. In our study, we considered CoNS as the causative organism for BSI if it was isolated from two or more blood cultures drawn on separate occasions within 48 hours. Mehta et al and Kaistha et al reported a higher incidence of *S. aureus* among Gram-positive bacteria causing BSI.<sup>12</sup>

*Salmonella* (34.4%) was the most common pathogen in CA-BSI in this study. This suggests enteric fever is still a major problem in our region<sup>12,22,23</sup> This is consistent with previous studies from India, Pakistan, Nepal, and Africa.<sup>22,24-27</sup> *E. coli*, *S. aureus*, *E. faecium*, *Pseudomonas* and *Acinetobacter* spp. were other community-acquired isolates in this study which is similar to the findings of a previous study from this

region<sup>12</sup>. Notably we had two cases of *Brucella* CABSI (6.2%) which highlights the importance of high suspicion for the same in our community.

In this study, two *Candida albicans* isolated were HA-BSI. This is in contrast with studies by Karunakaran et al who reported 3.8% positivity of *Candida* spp. Nazir et al reported 20.9% isolates of *Candida* spp. with predominance of non-alcoholic *albicans* species; however, all these cases were neonates.<sup>12</sup> Kohli-Kochhar et al reported 3% yeast isolates.<sup>28</sup> This could probably be due to the increased use of invasive devices and broad-spectrum antibiotics in present-day intensive care units. Our study included only adult patients with BSI and multiple previous studies reported a high prevalence of non-*albicans* *Candida* in the pediatric population. So, adults could probably be more prone to *Candida albicans* candidemia. Another study from Spain involving 15 hospitals reported all fungal bloodstream infections were acquired in hospitals which was also evident in our study.<sup>29</sup>

#### Antimicrobial susceptibility of Gram-positive bacteria

Antimicrobial susceptibility of bacteria differs significantly between community and hospital-acquired BSI. Gram-positive organisms in this study showed high sensitivity to vancomycin, linezolid and teicoplanin which was consistent with studies by Fayaz et al, Marshall et al and Kaur et al.<sup>20,30,28</sup>

In this study, Community-acquired *Enterococcus* was 100% sensitive to vancomycin, linezolid, teicoplanin and piperacillin/tazobactam and 50% sensitive to tetracycline. However, sensitivity to vancomycin, teicoplanin, piperacillin/tazobactam and tetracycline dropped to 60%, 55%, 75% and 44% respectively among hospital-acquired strains of *Enterococcus*. Decreased sensitivity to vancomycin (57.2%) was also reported by Kaur et al.<sup>10</sup> Both CA and HA *Enterococcus* were 100% resistant to fluoroquinolones which was consistent with a study by Fayaz et al.<sup>20</sup> Furthermore, most *Enterococcus* isolates in this study were MDR as was reported by Gupta et al.<sup>24</sup>

In this study, both CA and HA strains of *S. aureus* were 100% sensitive to vancomycin, linezolid, teicoplanin and tetracycline. CA *S. aureus* was 60% sensitive to gentamycin and trimethoprim/sulphamethoxazole, 40% sensitive to erythromycin, 25% sensitive to clindamycin and 20% sensitive to beta-lactams. HA *S. aureus* was 66% sensitive

to gentamycin, 50% sensitive to cotrimoxazole and 100% resistant to beta-lactams. Both hospital and community-acquired *S. aureus* were 100% resistant to fluoroquinolones. MRSA was found in significant frequency (91%), consistent with previous studies.<sup>12,24</sup>

#### Antimicrobial susceptibility of Gram-negative bacteria

Community-acquired *B. cepacia* was 100% sensitive to cotrimoxazole, meropenem, ceftazidime, tigecycline and minocycline, and 50% sensitive to levofloxacin. Hospital-acquired strains of *B. cepacia* was 97.4% sensitive to cotrimoxazole and meropenem, 95% sensitive to Ceftazidime and Tigecycline, 91.7% to minocycline, and 80% sensitive to levofloxacin.

Community-acquired *E. coli* was 100% sensitive to tigecycline, amikacin and gentamycin, 83.3% sensitive to carbapenems and cefoperazone-sulbactam, 66.6% sensitive to piperacillin/tazobactam and cefepime, 40% to levofloxacin, 33.3% to cotrimoxazole and 20% sensitive to ceftazidime and ciprofloxacin. Hospital-acquired *E. coli* showed 100% sensitivity to colistin and tigecycline. Sensitivity to imipenem was 90% which was nearly consistent with the study by Jyoti et al and Vasudeva et al.<sup>31,32</sup>

About two third (70%) sensitivity to amikacin is consistent with the study by Fayaz et al and Vasudeva et al.<sup>20,32</sup> Both CA and HA isolates of *E. coli* were 100% to resistant ampicillin which was also reported by Jyoti et al and Vasudeva et al.<sup>31,32</sup>

Community and hospital-acquired *E. coli* in our study had 20 and 30% sensitivity respectively to ciprofloxacin which nearly coincides the results of an Indian study by Vasudeva et al.<sup>32</sup> 100% resistance to levofloxacin among hospital-acquired strains of *E. coli* seen was also reported by Fayaz et al.<sup>20</sup>

Hospital-acquired isolates of *A. baumannii* were 100% sensitive to colistin, 80% sensitive to tigecycline, 60% sensitive to cotrimoxazole, 50% to meropenem and imipenem, 46% to amikacin and cefoperazone-sulbactam, 30% to levofloxacin, cefepime and piperacillin, 25% to gentamycin and 20% sensitivity to ciprofloxacin. Sensitivity to colistin and tigecycline was consistent with what was observed by Nazir et al.<sup>12</sup> However sensitivity of more than 80% was reported for carbapenems by Nazir et al which was more than in our study.

All *Klebsiella* isolates were hospital-acquired. *K. pneumonia* was 100% sensitive to colistin, 57% to

cotrimoxazole, 54.5% to amikacin, 50% to tigecycline, 44.4% to gentamycin, 33.3% to ceftriaxone, 22% to cefepime, 20% to carbapenems, 18.2% to piperacillin-tazobactam and cefoperazone-sulbactam, 11% to levofloxacin and ciprofloxacin and was 100% resistant to Ceftazidime. Nazir et al reported 100% sensitivity to colistin which is similar to our study, however in contrast to our results nearly half of isolates were sensitive to carbapenems.<sup>23</sup> Fayaz et al, Nikita et al and Jyoti et al reported sensitivities of 59.2%, 100% and 96% to imipenem in their studies.<sup>20,32,31</sup> Nazir et al had shown 90% sensitivity to tigecycline in contrast to 50% in isolates of *Klebsiella* in the present study.<sup>12</sup> Sensitivity to ampicillin, cefepime and gentamycin observed in our study was consistent with what was observed by Vasudeva et al.<sup>32</sup> However, results for amikacin sensitivity in our study were significantly lesser when compared to 85% and 83% reported by Fayaz et al and Nikita et al.<sup>20, 32</sup> This reflects the growing concern of increasing antibiotic resistance in the present era and the necessity for more and more rational steps to overcome the same.

All isolates of salmonella were community-acquired. *Salmonella* showed 100% sensitivity to ceftriaxone and cotrimoxazole, 90% sensitivity to ampicillin, and 100% resistance to fluoroquinolones. Increased resistance of salmonella to ampicillin (10%) and fluoroquinolones (100%) has compromised our therapeutic choices. Our results are consistent with the study by Khanal B, et al, who reported 14.2% and 87.5% resistance to ampicillin and fluoroquinolones respectively.<sup>33</sup>

A single isolate of community-acquired *P. aeruginosa* in this study was sensitive to tested antipseudomonal drugs. HA isolates of *P. aeruginosa* were 100% sensitive to colistin, 66.7% sensitive to amikacin, ciprofloxacin and ceftazidime and 50% to meropenem, gentamycin, levofloxacin and cefepime. Both CA and HA *P. aeruginosa* were 100% resistant to ceftriaxone. Vasudeva et al in their study also reported high sensitivity to carbapenems and colistin.<sup>32</sup> Also Hafsa et al and Fayaz et al reported a comparable sensitivity to ciprofloxacin and amikacin.<sup>34,20</sup> However, HA *Pseudomonas* showed high resistance to imipenem (60%). Fayaz et al reported a comparable sensitivity to ceftazidime and Rabirad et al reported a sensitivity of 65.8% to Ceftazidime.<sup>20,35</sup>

Significant variation in the antibiogram was observed among various organisms isolated in this study when compared to literature from different parts of the world. This is because the drug sensitivity of bacteria is determined by multiple factors like the type of prevalent strain, previous antibiotic use and resistance pattern in a particular area. Antibiogram of Gram-negative bacteria showed a higher rate of resistance as compared with Gram-positive bacteria as has also been reported by another study from Kashmir.<sup>12</sup>

## CONCLUSION

Gram-negative bacteria are the major contributors to BSI in our population. A higher rate of antimicrobial resistance among Gram-negative and Gram-positive organisms is an alarming issue in our community, especially in patients with hospital-acquired infections. Also, the availability of updated epidemiological data on antimicrobial resistance in frequently encountered bacterial pathogens will be useful not only for deciding the empirical treatment strategies but also for devising an effective antimicrobial policy in our hospital. Finally, being a single-centre study its external validity stays limited and necessitates a multicenter study for adequately understanding the microbial ecology in this part of the globe.

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