

## Original Research Article

## Different bacterial isolates showing antibiotic sensitivity pattern retrieved from different clinical samples.

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- Escherichia coli,
- Carbapenems,
- CLSI,
- Colistin,
- Nosocomial.

## ABSTRACT

**Background:** The aim of this study was to demonstrate various bacteria can be retrieved from clinical samples that can be collected from IPD and OPD patients of the hospital with their antibiotic sensitivity pattern.

**Materials and Methods:** A total of 232 samples were retrieved in different samples from urine, blood, pus and fluids and respiratory tract. The samples were first identified by a standard biochemical method and then by antibiotic susceptibility testing.

**Results:** Majority of bacterial isolates were recovered in clinical samples collected from IPD (66.38%). Escherichia coli (34.05%) were mainly isolated in our study. Escherichia coli (59.01%) was the prevalent bacteria in urine samples and was highly sensitive to colistin (100%) and least sensitive to ampicillin (08.33%). Coagulase negative staphylococci (45.24%), were the predominant bacteria in blood samples and maximally sensitive to linezolid (89.47%) while all isolates were resistant to penicillin. Staphylococcus aureus (25.64%) was the predominant bacteria in pus and fluids samples and was maximally sensitive to linezolid while half the isolates were methicillin-resistant staphylococcus aureus (MRSA). Acinetobacter baumannii (44.83%) was the predominant bacteria in respiratory samples and was maximally sensitive to colistin (100.00%) while all isolates were resistant to carbapenems.

**Conclusion:** Our study shows that Escherichia coli was a predominant type of bacterial isolate in clinical samples and was the majorly bacteria identified in urine samples. The most effective antibiotics in our study found was colistin and carbapenems for gram-negative bacteria and nitrofurantoin for different urine samples of Escherichia coli while linezolid and glycopeptide antibiotics were the most effective antibiotics in gram-positive cocci.

## INTRODUCTION

Infectious diseases have an overwhelming effect on human beings [1]. Antibiotics came to the aid to assuage human bacterial infections ever since penicillin was discovered by Alexander Fleming in 1928 and its use marked the genesis and proliferation of conventional antibiotic agents in medicine [2] but their widespread usage in preventing and treating human infections led to the emergence and spread of antibiotic resistance due to selective pressure on susceptible strains causing the survival of resistance strains [2,3]. The emergence of antibiotic resistance is a worldwide

public health problem<sup>4</sup> and a threat to mankind [5]. The burden of infectious disease in India is highest among the world and recent reports showed that the inappropriate and irrational use of antimicrobial agents against the diseases led to an increase in the development of antimicrobial resistance<sup>6</sup>. The unregulated sales of cheap antibiotics have amplified the crisis of antimicrobial resistance in India besides being a poor financial conditions, inadequate infrastructure and high burden of disease [7,8]. Incorrect diagnosis, irrational use of antibiotics, and irregular antibiotic consumption are

the other factors that contribute to antibiotic resistance [9] and improving on these aspects can prevent the spread of antibiotic resistance. Bacterial infections are a frequent cause of hospitalization [4] and nosocomial infections (hospital acquired infections) pose a great challenge towards patient management [10,11] which ultimately increases the length of stay for in-patients and impacts negatively on hospital costs [1]. Immunocompromised patients such as the elderly and children, patients with underlying diseases, patients undergoing medical or surgical treatments, antibiotic use and long-term care in hospitals contribute to the rapid emergence of nosocomial pathogens [12]. Nosocomial pathogens are resistant to at least one of the commonly used antibiotics in clinic settings and continued exposure of these pathogens to antibiotics increases antibiotic resistance [13,14]. Also, the route of antibiotic administration influences the level of antibiotic resistance in gut microbiota and commensal bacteria facilitate the spread of antibiotic resistance [14,15]. The increasing levels of hospital and community acquired infections caused by antibiotic resistant bacteria have reduced the choices of choosing an effective antibiotic therapy. Broad spectrum antibiotics become the ultimate choice as the number of resistant strains increase in clinical settings, but the manifestation of resistance to these antibiotics in multidrug-resistant bacterial strains reduces the chances of choosing an effective empirical therapy [17]. The emergence of antibiotic resistance and limited availability of treatment options present an increasing challenge for the management of bacterial infections worldwide. Infection control practices and new antimicrobial development have primarily targeted control and treatment of infections caused by gram-positive organisms [18,19,20,21] but recently the incidence of infections caused by gram-negative bacteria in intensive care units (ICU) has increased and the lack of available treatment options against some multi-drug-resistant (MDR) strains is alarming. Infections caused by MDR gram-negative bacteria are associated with high morbidity and mortality [22] and hence, careful adherence to infection control and infection treatment guidelines and programs helps to improve patient outcome and reduce hospital cost [4]. Therefore, analysis of efficacy of various antibiotics used in a hospital setup is important and which can be achieved through infection control practices that may provide insights on how clean a surface is by sampling

various surfaces such as taps, sinks, toilets, beds, and floors for epidemiological investigations to assess the spread of nosocomial pathogens and their associated antibiotic susceptibility patterns [23]. This study was conducted to demonstrate various bacteria recovered in clinical samples collected from in-patient department (IPD) and out-patient department (OPD) of the hospital and their antibiotic sensitivity pattern.

## **MATERIALS AND METHODS**

The study was conducted in the Department of Microbiology, Santosh Hospital, Ghaziabad, Uttar Pradesh, India. A total of 232 bacterial isolates were recovered in samples from urine, blood, pus and fluids and respiratory tract collected from in-patient department (IPD) and out-patient department (OPD) of the hospital.

The isolates were first identified by standard biochemical techniques [24] and then subjected to antibiotic susceptibility testing by Kirby Bauer disc diffusion method on Mueller Hinton agar plate as per CLSI guidelines [25] using penicillin (PEN) (10U), cefoxitin (CX) (30µg), erythromycin (ERM) (5µg), clindamycin (CLD) (2µg), ciprofloxacin (CIP) (5µg), levofloxacin (LE) (5µg), tetracycline (TE) (30µg), rifampicin (RIF) (5µg), vancomycin (VAN) (30µg), teicoplanin (TEI) (30µg), linezolid (LZ) (30µg), co-trimoxazole (COT) (1.25+23.75µg), ampicillin (AMP) (10µg), amoxicillin/clavulanic acid (AMC) (20+10µg), ticarcillin/clavulanic acid (TCC) (75+10µg), piperacillin/tazobactam (PIT) (100+10µg), cefuroxime (CXM) (30µg), ceftriaxone (CTR) (30µg), ceftazidime (CAZ) (30µg), cefepime (CPM) (30µg), ertapenem (ETP) (10µg), imipenem (IPM) (10µg), meropenem (MRP) (10µg), doripenem (DOR) (10µg), gentamicin (GEN) (10µg), high level gentamicin (HLG) (120µg), amikacin (AK) (30µg), minocycline (MIN) (30µg), aztreonam (AT) (30µg), and colistin (CL) (10µg) antibiotic discs. Nitrofurantoin (300µg) antibiotic discs were tested for urinary *Escherichia coli* and enterococcal isolates only.

## **RESULTS**

A total of 232 bacterial isolates were recovered in samples from urine, blood, pus and fluids and respiratory tract collected from in-patient department (IPD) (n=154) (66.38%) and out-patient

department (OPD) of the hospital (n=78) (33.62%) (table 1). IPD was the major source of isolates (n=154) (66.38%). Majority of bacteria were isolated from urine (n=123) (53.02%) followed by blood (n=42) (18.10%), pus and fluids (n=39) (16.81%) and respiratory tract (n=28) (12.07%) [Table 1].

*Escherichia coli* (n=79) (34.05%) was the predominant isolate followed by *Klebsiella pneumoniae* (n=45) (19.40%), Coagulase negative staphylococci (n=26) (11.20%), *Acinetobacter baumannii* (n=20) (8.62%), *Pseudomonas aeruginosa* (n=19) (8.19%), *Staphylococcus aureus* (n=14) (6.03%), *Enterococcus fecium* (n=10) (4.31%), *Enterobacter species* (n=07) (3.02%), *Proteus mirabilis* (n=03) (1.30%), *Salmonella typhi* (n=03) (1.30%), *Salmonella paratyphi-A* (n=02) (0.86%), *Citrobacter species* (n=02) (0.86%), *Enterococcus fecalis* (n=01) (0.43%) and *Morganella morganii* (n=01) (0.43%). [Table 2]

In Urine samples, *Escherichia coli* (n=72) (58.54%) was the predominant bacteria followed by *Klebsiella pneumoniae* (n=24) (19.51%), *Pseudomonas aeruginosa* (n=10) (8.13%), *Enterococcus fecium* (n=07) (5.69%), *Citrobacter species* (n=02) (1.63%), *Proteus mirabilis* (n=03) (2.44%), Coagulase negative staphylococci (n=02) (1.63%), *Acinetobacter baumannii* (n=01) (0.81%), *Enterobacter species* (n=01) (0.81%) and *Enterococcus fecalis* (n=01) (0.81%). [Table 3]

In Blood samples, Coagulase negative staphylococci (n=19) (45.24%), was the predominant bacteria followed by *Klebsiella pneumoniae* (n=06) (14.28%), *Enterobacter species* (n=04) (9.52%), *Salmonella typhi* (n=03) (7.14%), *Acinetobacter baumannii* (n=03) (7.14%), *Salmonella paratyphi-A* (n=02) (4.76%), *Staphylococcus aureus* (n=02) (4.76%) and *Enterococcus fecium* (n=02) (4.76%). [Table 3]

In Pus and fluids samples, *Staphylococcus aureus* (n=10) (25.64%) was the predominant bacteria followed by *Klebsiella pneumoniae* (n=07) (17.95%), *Pseudomonas aeruginosa* (n=06) (15.38%), *Escherichia coli* (n=05) (12.83%), *Acinetobacter baumannii* (n=04) (10.26%), Coagulase negative staphylococci (n=04) (10.26%),

*Enterococcus fecium* (n=01) (02.56%), *Enterobacter species* (n=01) (02.56%), and *Morganella morganii* (n=01) (02.56%) [Table 3].

In Respiratory samples, *Acinetobacter baumannii* (n=13) (42.86%) was the predominant bacteria followed by *Klebsiella pneumoniae* (n=08) (28.58%), *Pseudomonas aeruginosa* (n=02) (07.14%), *Escherichia coli* (n=02) (07.14%), *Staphylococcus aureus* (n=02) (07.14%), Coagulase negative staphylococci (n=01) (03.57%) and *Enterobacter species* (n=01) (03.57%). [Table 3]

In urine samples, *Escherichia coli* was found to be maximally sensitive to colistin (100.00%) followed by amikacin (86.11%), ertapenem (81.94%), imipenem (81.94%), meropenem (81.94%), nitrofurantoin (75.00%), piperacillin/tazobactam (63.88%), gentamicin (56.94%), co-trimoxazole (43.05%), amoxicillin/clavulanic acid (40.27%), ciprofloxacin (23.61%), cefepime (13.88%), ceftriaxone (13.88%) and cefuroxime (12.50%). Ampicillin was found to be least sensitive (08.33%). [Table 4]

*Klebsiella pneumoniae* isolates were found to be maximally sensitive to colistin (95.83%) followed by gentamicin (41.66%), amikacin (37.50%), ertapenem (33.33%), imipenem (33.33%), meropenem (33.33%), co-trimoxazole (29.16%), piperacillin/tazobactam (25.00%), amoxicillin/clavulanic acid (25.00%), ciprofloxacin (20.83%), ceftriaxone (12.50%), cefepime (08.33%) and cefuroxime (08.33%). No isolate was found to be sensitive to ampicillin. [Table 4]

Only one isolate of *Enterobacter species* was recovered and was found to be sensitive to colistin, gentamicin, amikacin, ertapenem, imipenem, meropenem, co-trimoxazole, piperacillin/tazobactam, ciprofloxacin, ceftriaxone and cefepime. The isolate was resistant to cefuroxime, amoxicillin/clavulanic acid and ampicillin. [Table 4]

Both isolates of *Citrobacter species* were sensitive to colistin while only one isolate was sensitive to gentamicin, amikacin, ertapenem, imipenem, meropenem, co-trimoxazole, piperacillin/tazobactam, amoxicillin/clavulanic acid, ciprofloxacin, ceftriaxone, cefepime and

cefuroxime. No isolate was found to be sensitive to ampicillin. [Table 4]

*Proteus mirabilis* isolates were found to be maximally sensitive to ertapenem (100.00%), meropenem (100.00%), piperacillin/tazobactam (100.00%), amoxicillin/clavulanic acid (100.00%), followed by imipenem (66.66%), amikacin (66.66%) and gentamicin (33.33%). All isolates were resistant to co-trimoxazole ciprofloxacin, ceftriaxone, cefepime, cefuroxime and ampicillin. [Table 4]

*Pseudomonas aeruginosa* isolates were found to be maximally sensitive to colistin (100.00%) followed by gentamicin (70.00%), amikacin (70.00%), imipenem (70.00%), meropenem (70.00%), doripnem (70.00%), piperacillin/tazobactam (70.00%), ceftazidime (70.00%), cefepime (70.00%), ciprofloxacin (60.00%), levofloxacin (60.00%), aztreonam (30.00%) and ticarcillin/clavulanic acid (10.00%. [Table 4]

Only one isolate of *Acinetobacter baumannii* was recovered and was found to be sensitive to colistin, gentamicin, amikacin, imipenem, meropenem, doripenem, piperacillin/tazobactam, ciprofloxacin, levofloxacin, ceftazidime. Cefepime, minocycline, co-trimoxazole. The isolate was resistant to ticarcillin/clavulanic acid [Table 4]

Coagulase negative staphylococcal isolates were found to be maximally sensitive to linezolid (100.00%), vancomycin (100.00%), teicoplanin (100.00%), clindamycin (100.00%), ciprofloxacin (100.00%), levofloxacin (100.00%), gentamicin (100.00%), co-trimoxazole (100.00%) followed by rifampicin (50.00%), tetracycline (50.00%). Both the isolates were found to be methicillin-resistant [Table 4]

Only one isolate of *Enterococcus fecalis* was recovered and was sensitive to linezolid, vancomycin, teicoplanin high level gentamicin, ciprofloxacin, levofloxacin and nitrofurantoin. The isolate was resistant to penicillin, erythromycin and tetracycline (table 4). *Enterococcus fecium* isolates were found to be maximally sensitive to linezolid (100.00%) followed by vancomycin (71.42%), teicoplanin (71.42%), nitrofurantoin (28.57%) and tetracycline (28.57%). All isolates were resistant to high level gentamicin, ciprofloxacin, levofloxacin, penicillin and erythromycin. [Table 4]

In blood samples, *Klebsiella pneumoniae* isolates were found to be maximally sensitive to colistin (100.00%), gentamicin ciprofloxacin (100.00%), co-trimoxazole (100.00%), gentamicin (100.00%), amikacin (100.00%) followed by ertapenem (25.00%), imipenem (25.00%), meropenem (25.00%), piperacillin/tazobactam (25.00%), amoxicillin/clavulanic acid (25.00%), ceftriaxone (25.00%), cefepime (25.00%), and cefuroxime (25.00%). No isolate was found to be sensitive to ampicillin. [Table 5]

*Enterobacter* species isolates were found to be maximally sensitive to colistin (100.00%), gentamicin (100.00%), amikacin (100.00%), ciprofloxacin (100.00%), co-trimoxazole (100.00%) followed by ertapenem (25.00%), imipenem (25.00%), meropenem (25.00%), piperacillin/ tazobactam (25.00%), amoxicillin/ clavulanic acid (25.00%), cefuroxime (25.00%), ceftriaxone (25.00%), and cefepime (25.00%). All isolates were resistant to ampicillin [Table 5]

*Salmonella typhi* isolates were found to be maximally sensitive to colistin (100.00%), ertapenem (100.00%), imipenem (100.00%) meropenem (100.00%), piperacillin/tazobactam (100.00%), amoxicillin/clavulanic acid (100.00%), ceftriaxone (100.00%), cefepime (100.00%) and co-trimoxazole (100.00%) followed by ampicillin (66.66%) and ciprofloxacin (33.33%). All isolates were resistant to cefuroxime, gentamicin and amikacin [Table 5]

Both *Salmonella paratyphi-A* isolates were sensitive to colistin, ertapnenem, imipenem, meropenem, piperacillin/ tazobactam, amoxicillin/ clavulanic acid, ceftriaxone, cefepime and co-trimoxazole. Both isolates were resistant to ciprofloxacin, gentamicin and amikacin [Table 5]

Only one isolate of *Pseudomonas aeruginosa* was recovered and was found to be sensitive to colistin, gentamicin, amikacin, imipenem, meropenem, doripenem, piperacillin/tazobactam, ciprofloxacin, levofloxacin, ceftazidime, cefepime. The isolate was resistant to aztreonam, piperacillin/tazobactam and ticarcillin/clavulanic acid [Table 5]

*Acinetobacter baumannii* isolates were found to be maximally sensitive to colistin (100.00%) followed by piperacillin/ tazobactam (66.66%), co-



trimoxazole (66.66%), cefepime (66.66%), gentamicin (33.33%), amikacin (33.33%), imipenem (33.33%), meropenem (33.33%), doripenem (33.33%), ciprofloxacin (33.33%), levofloxacin (33.33%), minocycline (33.33%) and ceftazidime (33.33%). The isolates were resistant to aztreonam and ticarcillin/clavulanic acid [Table 5]

Both *Staphylococcus aureus* isolates were found to be sensitive to linezolid, vancomycin, teicoplanin, clindamycin, erythromycin, co-trimoxazole, rifampicin and tetracycline. Both the isolates were resistant to gentamicin, ciprofloxacin and levofloxacin. Both isolates were methicillin-resistant *Staphylococcus aureus* (MRSA) [Table 5]

Coagulase negative staphylococcal isolates were found to be maximally sensitive to linezolid (89.47%), vancomycin (89.47%), teicoplanin (89.47%), followed by rifampicin (78.94%), tetracycline (73.68%), gentamicin (52.63%), co-trimoxazole (52.63%), clindamycin (42.10%), ciprofloxacin (36.84%), levofloxacin (36.84%), ceftazidime (15.78%) and erythromycin (05.26%). All isolates were resistant to penicillin. Sixteen isolates (84.24%) were methicillin-resistant coagulase negative staphylococci (MR-CNS) [Table 5]

*Enterococcus faecium* isolates were found to be maximally sensitive to linezolid (100.00%), vancomycin (100.00%), teicoplanin (100.00%) followed by tetracycline (50.00%). All isolates were resistant to nitrofurantoin, high level gentamicin, ciprofloxacin, levofloxacin, penicillin and erythromycin. [Table 5]

In pus and fluids samples, *Escherichia coli* was found to be maximally sensitive to colistin (80.00%), gentamicin (80.00%) followed by meropenem (60.00%), imipenem (60.00%), co-trimoxazole (60.00%), amikacin (60.00%), ertapenem (40.00%), piperacillin/ tazobactam (40.00%), amoxicillin/ clavulanic acid (40.00%), ciprofloxacin (23.61%), cefepime (20.00%), ceftazidime (20.00%), and cefuroxime (20.00%). All isolates were resistant to ampicillin and ciprofloxacin [Table 6]

*Klebsiella pneumoniae* isolates were found to be maximally sensitive to colistin (100.00%) followed by gentamicin (57.14%), amikacin (57.14%), ertapenem (28.57%), imipenem (28.57%),

meropenem (28.57%), co-trimoxazole (28.57%), piperacillin/tazobactam (28.57%), ciprofloxacin (28.57%). All isolates were resistant to amoxicillin/ clavulanic acid, ceftazidime, cefepime, cefuroxime (08.33%) and ampicillin [Table 6]

Only one isolate of *Enterobacter* species was recovered and was found to be sensitive to colistin, gentamicin, amikacin, ertapenem, imipenem, meropenem, co-trimoxazole, piperacillin/ tazobactam, ciprofloxacin, ceftazidime and cefepime. The isolate was resistant to cefuroxime, amoxicillin/clavulanic acid and ampicillin [Table 6]

Only one isolate of *Morganella morganii* was recovered and was found to be sensitive to amikacin, ertapenem, imipenem, meropenem, piperacillin/tazobactam, amoxicillin/clavulanic acid, ceftazidime, cefepime. The isolate was resistant to ampicillin, cefuroxime, gentamicin, ciprofloxacin, co-trimoxazole and colistin [Table 6]

*Pseudomonas aeruginosa* isolates were found to be maximally sensitive to colistin (100.00%) followed by gentamicin (50.00%), amikacin (50.00%), imipenem (50.00%), meropenem (50.00%), doripenem (50.00%), piperacillin/ tazobactam (50.00%), ceftazidime (50.00%), cefepime (50.00%), ciprofloxacin (50.00%), levofloxacin (50.00%), aztreonam (33.33%) and ticarcillin/ clavulanic acid (33.33%) [Table 6]

*Acinetobacter baumannii* isolates were maximally sensitive to colistin (100.00%) followed by minocycline (75.00%), gentamicin (25.00%), amikacin (25.00%), imipenem (25.00%), meropenem (25.00%), doripenem (25.00%), piperacillin/ tazobactam (25.00%), ciprofloxacin (25.00%), levofloxacin (25.00%), ceftazidime (25.00%), cefepime (25.00%), co-trimoxazole (25.00%), ticarcillin/ clavulanic acid (25.00%) and aztreonam (25.00%) [Table 6]

*Staphylococcus aureus* isolates were maximally sensitive to linezolid (100.00%) followed by vancomycin (90.00%), teicoplanin (90.00%), rifampicin (90.00%), gentamicin (70.00%), tetracycline (70.00%), clindamycin (60.00%), ceftazidime (50.00%), co-trimoxazole (40.00%) erythromycin (30.00%), levofloxacin (20.00%), penicillin (20.00%) and ciprofloxacin (10.00%).

Fifty percent (50.00%) isolates were MRSA [Table 6]

Coagulase negative staphylococcal isolates were found to be maximally sensitive to linezolid (100.00%), vancomycin (100.00%), teicoplanin (100.00%), clindamycin (100.00%), rifampicin (100.00%) followed by gentamicin (50.00%), tetracycline (50.00%), erythromycin (25.00%). All isolates were resistant to ciprofloxacin, levofloxacin, co-trimoxazole, ceftazidime and penicillin. All isolates were methicillin-resistant (MR-CNS) [Table 6]

Only one isolate of *Enterococcus fecium* was recovered which was sensitive to linezolid, vancomycin, teicoplanin, high level gentamicin, penicillin, erythromycin and tetracycline. The isolate was resistant to ciprofloxacin, levofloxacin. [Table 6]

In respiratory tract samples, *Escherichia coli* was found to be maximally sensitive to colistin (100.00%) followed by gentamicin (50.00%), amikacin (50.00%), ertapenem (50.00%), meropenem (50.00%), imipenem (50.00%), co-trimoxazole (50.00%), piperacillin / tazobactam (50.00%), amoxicillin/clavulanic acid (50.00%) and ciprofloxacin (50.00%). No isolate was found to be sensitive to cefepime, ceftriaxone, cefuroxime and ampicillin [Table 7]

*Klebsiella pneumoniae* isolates were found to be maximally sensitive to colistin (75.00%) followed by gentamicin (62.50%), amikacin (62.50%), co-trimoxazole (37.50%), ertapenem (25.00%), imipenem (25.00%), meropenem (25.00%), piperacillin/ tazobactam (25.00%), amoxicillin/ clavulanic acid (25.00%), ciprofloxacin (25.00%), ceftriaxone (12.50%) cefepime, (12.50%) cefuroxime (12.50%) All isolates were resistant to and ampicillin [Table 7]

Only one isolate of *Enterobacter* species was recovered and was found to be sensitive to colistin, gentamicin, amikacin, ertapenem, imipenem, meropenem, co-trimoxazole, piperacillin/ tazobactam, ciprofloxacin, ceftriaxone and cefepime. The isolate was resistant to cefuroxime, amoxicillin/clavulanic acid and ampicillin. [Table 7]

Both isolates of *Pseudomonas aeruginosa* were sensitive to colistin, gentamicin, amikacin, imipenem, meropenem, doripenem, piperacillin/tazobactam, ceftazidime, cefepime, ciprofloxacin, levofloxacin, aztreonam while only one isolate was sensitive to ticarcillin/clavulanic acid [Table 7]

*Acinetobacter baumannii* isolates were maximally sensitive to colistin (100.00%) followed by amikacin (16.66%), gentamicin (08.33%), cefepime (08.33%), ciprofloxacin (08.33%), levofloxacin (08.33%), co-trimoxazole (08.33%). All isolates were resistant to imipenem, meropenem, doripenem, piperacillin/tazobactam, ceftazidime, minocycline, ticarcillin/clavulanic acid and aztreonam [Table 7]

Both *Staphylococcus aureus* isolates were sensitive to linezolid, vancomycin, teicoplanin, rifampicin, and tetracycline while only one isolate was sensitive to gentamicin and co-trimoxazole. Both isolates were MRSA and resistant to clindamycin, erythromycin, ciprofloxacin, levofloxacin, ceftazidime and penicillin. [Table 7]

Only one Coagulase negative staphylococcal isolate was recovered which was sensitive to linezolid, vancomycin, teicoplanin, erythromycin, clindamycin, rifampicin, gentamicin, ciprofloxacin, levofloxacin, co-trimoxazole and resistant to tetracycline, ceftazidime and penicillin. The isolate was methicillin-resistant (MR-CNS). [Table 7]

In urine samples, *Escherichia coli* (n=72) (58.54%) and *Klebsiella pneumoniae* (n=24) (19.51%) were the major isolates. *Escherichia coli* isolates (n=37) (51.39%) and *Klebsiella pneumoniae* isolates (n=13) (54.17%) were predominantly recovered from OPD (table 8). In blood samples, Coagulase negative staphylococci (n=19) (45.24%) and *Klebsiella pneumoniae* (n=06) (14.28%) were the major isolates. All *Klebsiella pneumoniae* (n=06) (100.00%) and majority of Coagulase negative staphylococcal isolates (n=18) (94.74%) were recovered from IPD [Table 8]

In pus and fluids samples, *Staphylococcus aureus* (n=10) (25.64%), *Klebsiella pneumoniae* (n=05) (71.43%) and *Pseudomonas aeruginosa* (n=06) (15.38%) were the major isolates. All the *Staphylococcus aureus* (n=08) (80.00%), *Klebsiella pneumoniae* (n=07) (17.95%) and *Pseudomonas*

aeruginosa (n=05) (83.33%) isolates were predominantly recovered from IPD [Table 8]

In respiratory samples, *Acinetobacter baumannii* (n=12) 42.86%) and *Klebsiella pneumoniae* (n=08) (28.58%) were the major isolates. All the *Acinetobacter baumannii* (n=12) (100.00%) and *Klebsiella pneumoniae* (n=08) (100.00%) isolates were recovered from IPD [Table 8]

## **DISCUSSION**

Urine samples (53.02%) comprised the majority of samples in our study which correlated with study from Chanda W et al. [1] and IPD (66.38%) was the major source of isolates. Urinary tract infections (UTI) are the most frequently reported bacterial infections in long-term care facilities which leads to increased antibiotic usage [1].

The most common bacteria in our study from all clinical samples were *Escherichia coli* (34.05%)1 followed by *Klebsiella pneumoniae* (19.40%), Coagulase negative staphylococci (11.20%), *Acinetobacter baumannii* (08.62%) and *Pseudomonas aeruginosa* (08.19%), which correlated with study from Savanur SS [4].

*Escherichia coli* (58.54%) and *Klebsiella pneumoniae* (19.51%) were the commonest bacteria isolated from urine samples which was in agreement with other studies [1,26,27,28,29]. *Escherichia coli* isolates were highly sensitive to colistin (100.00%), amikacin (86.11%), carbapenems (81.94%), nitrofurantoin (75.00%) and least sensitive to ampicillin (08.33%) in our study which shows that nitrofurantoin is still effective against *Escherichia coli*1. *Klebsiella pneumoniae* isolates were found to be maximally sensitive to colistin (95.83%) followed by gentamicin (41.66%), amikacin (37.50%), carbapenems (33.33%) while all isolates were resistant to ampicillin.

Coagulase negative staphylococci (CNS) (45.24%) were the predominant bacteria in blood samples in our study which was consistent with Ghadiri et al30 where CNS was the predominant cause of blood stream infection. Coagulase negative staphylococcal isolates were found to be maximally sensitive to linezolid (89.47%), vancomycin (89.47%), teicoplanin (89.47%) and sixteen isolates

(84.22%) were methicillin-resistant coagulase negative staphylococci (MR-CNS).

*Staphylococcus aureus* (25.64%) was the predominant bacteria in pus and fluids samples which correlated with study by Chanda W et al. [1]. *Staphylococcus aureus* isolates were predominantly sensitive to linezolid (100.00%), vancomycin (90.00%), teicoplanin (90.00%), rifampicin (90.00%). MRSA constituted 50% of staphylococcus aureus isolates in our study.

In our study, *Acinetobacter baumannii* (42.86%) was the predominant bacteria in respiratory samples and all isolates were sensitive to colistin (100.00%) while being resistant to carbapenem antibiotics.

The most effective antibiotics in our study was colistin and carbapenems for gram-negative bacterial isolates and nitrofurantoin for urinary isolates of *Escherichia coli* while linezolid and glycopeptide antibiotics were most effective antibiotics for gram-positive cocci. Older medications like colistin have been revived for treatment of gram-negative bacterial infections due to emergence of multi-drug resistant bacteria. Emergence of such multi-drug resistant bacteria is a serious issue and a threat to mankind. There is a need to establish an antibiogram for local purposes so as to make a decision for initiating an empirical antibiotic therapy until the results of culture and antibiotic sensitivity are available.

Antibiotic resistance has garnered attention in worldwide clinical practices due to its effects on increasing health-care costs, morbidity and mortality of patients from bacterial diseases and this situation is even worse in developing countries as information related to antibiotic sensitivity patterns are sporadic [31]. Some important factors that encourage the dissemination of antibiotic resistance are overuse or misuse of antibiotics, incorrect diagnosis and the irrational use of antibiotics [9,31]. There is a lack of evidence-based practice in developing countries, antibiotics are prescribed without laboratory analysis and many antibiotics are easily accessible over the counter which further increases the risk of emerging antibiotic resistance [1].

The hospitals should lay emphasis on use of sterile techniques during procedures, proper hand-hygiene

and use of gowns and gloves specially in critical care settings to prevent nosocomial infections.

## CONCLUSION

The most common bacteria in our study shows that *Escherichia coli* was the major bacterial isolate from all clinical samples. The most effective antibiotics in our study was colistin and carbapenems for gram-negative bacterial isolates and nitrofurantoin for urinary isolates of *Escherichia coli* while linezolid and glycopeptide antibiotics were most effective antibiotics for gram-positive cocci. Emergence of such multi-drug resistant bacteria is a serious issue and there is a need to establish anantibiogram for local purposes so as to make a decision for initiating an empirical antibiotic therapy. There is a lack of evidence-based practice in developing countries. The hospitals should lay emphasis on use of sterile techniques during procedures, proper hand-hygiene and use of gowns and gloves specially in critical care settings to prevent nosocomial infections.

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Table 1: Sample-wise distribution of bacterial isolates

Sr.No.	SITE	IPD n=154 (66.38%)	OPD n=78 (33.62%)	TOTAL n=232 (%)
1	Urine	63(40.90%)	60(76.93%)	123(53.02%)
2	Blood	41(26.62%)	01(01.28%)	42(18.10%)
3	Pus and Fluids	23(14.94%)	16(20.51%)	39(16.81%)
4	Respiratory	27(17.54%)	01(01.28%)	28(12.07%)

Table 2: Over-all distribution of bacterial isolates

Sr.No.	ISOLATE	IPD n=154	OPD n=78	TOTAL n=232
1	E. coli (EC)	41(26.62%)	38(48.72%)	79(34.05%)
2	Klebsiella pneumoniae (KP)	30(19.48%)	15(19.23%)	45(19.40%)
3	Enterobacter species (EB)	06(03.90%)	01(01.28%)	07(03.02%)
4	Citrobacter species (CB)	01(00.65%)	01(01.28%)	02(00.86%)
5	Proteus mirabilis (PM)	01(00.65%)	02(02.56%)	03(01.30%)
6	Morganella morganii (MM)	00 (00.00%)	01(01.28%)	01(00.43%)
7	Salmonella typhi (ST)	03(01.95%)	00(00.00%)	03(01.30%)
8	Salmonella paratyphi-A (SPA)	02(01.30%)	00(00.00%)	02(00.86%)
9	Pseudomonas aeruginosa (PA)	10(06.49%)	09(11.54%)	19(08.19%)
10	Acinetobacter baumannii (ACB)	17(11.04%)	03(03.85%)	20(08.62%)
11	Staphylococcus aureus (SA)	12(07.80%)	02(02.56%)	14(06.03%)
12	Coagulase negative staphylococci (CNS)	23(14.93%)	03(03.85%)	26(11.20%)
13	Enterococcus faecalis (EFL)	01(00.65%)	00(00.00%)	01(00.43%)
14	Enterococcus fecium (EFM)	07(04.54%)	03(03.85%)	10(04.31%)

Table 3: Sample-wise distribution of bacterial isolates

Sr.No.	Isolates	Urine n=123	Blood n=42	Pus and fluids n=39	Respiratory n=28
1	E. coli	72 (58.54%)	0 (0%)	05(12.83%)	02(07.14%)
2	Klebsiella pneumoniae	24(19.51%)	06(14.28%)	07(17.95%)	08(28.58%)
3	Enterobacter species	01(00.81%)	04(09.52%)	01(02.56%)	01(03.57%)
4	Citrobacter species	02(01.63%)	0 (0%)	0 (0%)	0 (0%)
5	Proteus mirabilis	03(02.44%)	0 (0%)	0 (0%)	0 (0%)
6	Morganella morganii	0 (0%)	0 (0%)	01(02.56%)	0 (0%)
7	Salmonella typhi	0 (0%)	03(07.14%)	0 (0%)	0 (0%)
8	Salmonella paratyphi-A	0 (0%)	02(04.76%)	0 (0%)	0 (0%)
9	Pseudomonas aeruginosa	10(08.13%)	01(02.38%)	06(15.38%)	02(07.14%)
10	Acinetobacter baumannii	01(00.81%)	03(07.14%)	04(10.26%)	12(42.86%)
11	Staphylococcus aureus	0 (0%)	02(04.76%)	10(25.64%)	02(07.14%)
12	CoNS	02(01.63%)	19(45.24%)	04(10.26%)	01(03.57%)
13	Enterococcus faecalis	01(00.81%)	0 (0%)	0 (0%)	0 (0%)
14	Enterococcus fecium	07(05.69%)	02(04.76%)	01(02.56%)	0 (0%)

Table 4: Antibiotic sensitivity percentages of urine isolates (n=123)

Sr.No	ATB	Bacterial Isolates									
		EC n=72	KP n=24	EB n=01	CB n=02	PM n=03	PA n=10	ACB n=01	CNS n=02	EFL n=01	EFM n=07
1	AMP	08.33	0%	0%	0%	0%	--	--	--	--	--
2	AMC	40.27%	25%	0%	50%	100%	--	--	--	--	--
3	TCC	--	--	--	50%	--	10%	0%	--	--	--
4	PIT	63.88%	25%	100%	50%	100%	70%	100 %	--	--	--
5	CXM	12.50%	08.33%	0%	50%	0%	--	--	--	--	--
6	CTR	13.88%	12.50%	100%	50%	0%	--	--	--	--	--
7	CAZ	--	--	--	--	--	70%	100%	--	--	--
8	CPM	13.88%	08.33%	100%	50%	0%	70%	100%	--	--	--
9	AT	--	--	--	--	--	30%	0%	--	--	--
10	ETP	81.94%	33.33%	100%	50%	100%	--	--	--	--	--
11	IPM	81.94%	33.33%	100%	50%	66.66%	70%	100%	--	--	--
12	MRP	81.94%	33.33%	100%	50%	100%	70%	100%	--	--	--
13	DOR	--	--	--	--	--	70%	100%	--	--	--
14	AK	86.11%	37.50%	100%	50%	66.66%	70%	100%	--	--	--
15	GEN	56.94%	41.66%	100%	50%	33.33%	70%	100%	100%	100%	0%
16	CIP	23.61%	20.83%	100%	50%	0%	60%	100%	100%	100%	0%
17	LE	--	--	--	--	--	60%	100%	100%	100%	0%
18	CL	100%	95.83%	100%	100%	--	100%	100%	--	--	--
19	COT	43.05%	29.16%	100%	50%	0%	--	100%	100%	--	--
20	MIN	--	--	--	--	--	--	100%	--	--	--
21	PEN	--	--	--	--	--	--	--	0%	0%	0%
22	CX	--	--	--	--	--	--	--	0%	--	--
23	ERM	--	--	--	--	--	--	--	0%	0%	0%
24	CLD	--	--	--	--	--	--	--	100%	--	--
25	LZ	--	--	--	--	--	--	--	100%	100%	100%
26	VA	--	--	--	--	--	--	--	100%	100%	71.42%
27	TEI	--	--	--	--	--	--	--	100%	100%	71.42%
28	TE	--	--	--	--	--	--	--	50%	0%	28.57%
29	RIF	--	--	--	--	--	--	--	50%	--	--
30	NIT	75%	--	--	--	--	--	--	--	100%	28.57%

Table 5: Antibiotic sensitivity percentages of blood isolates (n=42)

Sr.No	ABT	Bacterial Isolates								
		KP n=06	EB n=04	ST n=03	SPA n=02	PA n=01	ACB n=03	SA n=02	CNS n=19	EFM n=02
1	AMP	0%	0%	66.66%	100%	--	--	--	--	--
2	AMC	25%	25%	100%	100%	--	--	--	--	--
3	TCC	--	--	--	--	0%	0%	--	--	--
4	PIT	25%	25%	100%	100%	0%	66.66%	--	--	--
5	CXM	25%	25%	0%	0%	--	--	--	--	--
6	CTR	25%	25%	100%	100%	--	--	--	--	--
7	CAZ	--	--	--	--	100%	33.33%	--	--	--
8	CPM	25%	25%	100%	100%	100%	66.66%	--	--	--
9	AT	--	--	--	--	0%	0%	--	--	--
10	ETP	25%	25%	100%	100%	--	--	--	--	--
11	IPM	25%	25%	100%	100%	100%	33.33%	--	--	--
12	MRP	25%	25%	100%	100%	100%	33.33%	--	--	--
13	DOR	--	--	--	--	100%	33.33%	--	--	--
14	AK	100%	100%	0%	0%	100%	33.33%	--	--	--
15	GEN	100%	100%	0%	0%	100%	33.33%	0%	52.63%	0%
16	CIP	100%	100%	33.33%	0%	100%	33.33%	0%	36.84%	0%
17	LE	--	--	--	--	100%	33.33%	0%	36.84%	0%
18	CL	100%	100%	100%	100%	100%	100%	--	--	--
19	COT	100%	100%	100%	100%	--	66.66%	100%	52.63%	--
20	MIN	--	--	--	--	--	33.33%	--	--	--
21	PEN	--	--	--	--	--	--	0%	0%	0%
22	CX	--	--	--	--	--	--	0%	15.78%	--
23	ERM	--	--	--	--	--	--	100%	05.26%	0%
24	CLD	--	--	--	--	--	--	100%	42.10%	--
25	LZ	--	--	--	--	--	--	100%	89.47%	100%
26	VA	--	--	--	--	--	--	100%	89.47%	100%
27	TEI	--	--	--	--	--	--	100%	89.47%	100%
28	TE	--	--	--	--	--	--	100%	73.68%	50.00%
29	RIF	--	--	--	--	--	--	100%	78.94%	--



Table 6: Antibiotic sensitivity percentages of pus and fluids isolates (n=39)

Sr.No.	ABT	Bacterial Isolates								
		EC n=05	KP n=07	EB n=01	MM n=01	PA n=06	ACB n=04	SA n=10	CNS n=04	EFM n=01
1	AMP	0%	0%	0%	0%	--	--	--	--	--
2	AMC	40%	0%	0%	100%	--	--	--	--	--
3	TCC	--	--	--	--	33.33%	25%	--	--	--
4	PIT	40%	28.57%	100%	100%	50%	25%	--	--	--
5	CXM	20%	0%	00%	0%	--	--	--	--	--
6	CTR	20%	0%	100%	100%	--	--	--	--	--
7	CAZ	--	--	--	--	50%	25%	--	--	--
8	CPM	20%	0%	100%	100%	50%	25%	--	--	--
9	AT	--	--	--	--	33.33%	25%	--	--	--
10	ETP	40%	28.57%	100%	100%	--	--	--	--	--
11	IPM	60%	28.57%	100%	100%	50%	25%	--	--	--
12	MRP	60%	28.57%	100%	100%	50%	25%	--	--	--
13	DOR	--	--	--	--	50%	25%	--	--	--
14	AK	60%	57.14%	100%	100%	50%	25%	--	--	--
15	GEN	80%	57.14%	100%	0%	50%	25%	70%	50%	100%
16	CIP	0%	28.57%	100%	0%	50%	25%	10%	0%	0%
17	LE	--	--	--	--	50%	25%	20%	0%	0%
18	CL	80%	100%	100%	0%	100%	100%	--	--	--
19	COT	60%	28.57%	100%	0%	--	25%	40%	0%	--
20	MIN	--	--	--	--	--	75%	--	--	--
21	PEN	--	--	--	--	--	--	20%	0%	100%
22	CX	--	--	--	--	--	--	50%	0%	--
23	ERM	--	--	--	--	--	--	30%	25%	100%
24	CLD	--	--	--	--	--	--	60%	100%	--
25	LZ	--	--	--	--	--	--	100%	100%	100%
26	VA	--	--	--	--	--	--	90%	100%	100%
27	TEI	--	--	--	--	--	--	90%	100%	100%
28	TE	--	--	--	--	--	--	70%	50%	100%
29	RIF	--	--	--	--	--	--	90%	100%	--

Table 7: Antibiotic sensitivity percentages of respiratory tract isolates (n=28)

Sr.No.	ABT	Bacterial Isolates						
		EC n=02	KP n=08	EB n=01	PA n=02	ACB n=12	SA n=02	CNS n=01
1	AMP	0%	0%	0%	--	--	--	--
2	AMC	50%	25%	0%	--	--	--	--
3	TCC	--	--	--	50%	0%	--	--
4	PIT	50%	25%	100%	100%	0%	--	--
5	CXM	0%	12.50%	0%	--	--	--	--
6	CTR	0%	12.50%	100%	--	--	--	--
7	CAZ	--	--	--	100%	0%	--	--
8	CPM	0%	12.50%	100%	100%	08.33%	--	--
9	AT	--	--	--	100%	0%	--	--
10	ETP	50%	25%	100%	--	--	--	--
11	IPM	50%	25%	100%	100%	0%	--	--
12	MRP	50%	25%	100%	100%	0%	--	--
13	DOR	--	--	--	100%	0%	--	--
14	AK	50%	62.50%	100%	100%	16.66%	--	--
15	GEN	50%	62.50%	100%	100%	08.33%	50%	100%
16	CIP	50%	25.00%	100%	100%	08.33%	0%	100%
17	LE	--	--	--	100%	08.33%	0%	100%
18	CL	100%	75.00%	100%	100%	100%	--	--
19	COT	50%	37.50%	100%	--	08.33%	50.00%	100%
20	MIN	--	--	--	--	0%	--	--
21	PEN	--	--	--	--	--	0%	0%
22	CX	--	--	--	--	--	0%	0%
23	ERM	--	--	--	--	--	0%	100%
24	CLD	--	--	--	--	--	0%	100%
25	LZ	--	--	--	--	--	100%	100%
26	VA	--	--	--	--	--	100%	100%
27	TEI	--	--	--	--	--	100%	100%
28	TE	--	--	--	--	--	100%	0%
29	RIF	--	--	--	--	--	100%	100%

Table 8: Distribution of major isolates from clinical samples

SNo.	ISOLATE	SAMPLES	
		URINE	
		IPD	OPD
1	E. coli (n=72)	n=35 (48.61%)	n=37 (51.39%)
2	Klebsiella pneumoniae (n=24)	n=11 (45.83%)	n=13 (54.17%)
		BLOOD	
1	Coagulase negative staphylococci (n=19)	n=18 (94.74%)	n=01 (05.26%)
	Klebsiella pneumoniae (n=06)	n=06 (100%)	n=0 (0%)
		PUS AN FLUIDS	
1	Staphylococcus aureus (n=10)	n=08 (80%)	n=02 (20.00%)
2	Klebsiella pneumoniae (n=07)	n=05 (71.43%)	n=02 (28.57%)
3	Pseudomonas aeruginosa (n=06)	n=05 (83.33%)	n=01 (16.67%)
		RESPIRATORY	
1	Acinetobacter baumannii (n=12)	n=12 (100%)	n=0 (0%)
2	Klebsiella pneumoniae (n=08)	n=08 (100%)	n=0 (0%)

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