Original Research Article

Antibiotic sensitivity pattern of bacterial isolates recovered from clinical samples at tertiary care hospital in western UP, India

Krati R Varshney[1], Sanjeev Dimri[2*]

[1]Associate Professor, Department of Microbiology, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India

[2]Professor and Head, Department of Microbiology, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India

Received: 05-02-2021 / Revised: 19-03-2021 / Accepted: 17-04-2021

Abstract

Aim: The aim of this study was 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.**Material and Methods:** A total of 232 bacterial isolates were recovered in samples from urine, blood, pus & fluids and respiratory tract. The isolates were first identified by standard biochemical techniquesand then subjected to antibiotic susceptibility testing by Kirby Bauer disc diffusion method on Mueller Hinton agar plate as per CLSI guidelines.**Result:** Majority of bacterial isolates were recovered in clinical samples collected from IPD (66.38%). E. coli (34.05%) was the predominant isolate in the study. E. coli (59.01%) was the predominant bacteria in urine samples and was highly sensitive to colistin (100.00%) 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 & fluids samples and was maximally sensitive to linezolid while half the isolates were methicillin-resistant staphylococcus aureus (MRSA). Acinetobacterbaumannii (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 E. coli was the major bacterial isolate from all clinical samples and was the predominant bacteria in urine samples. The most effective antibiotics in our study was colistin and carbapenems for gram-negative bacterial isolates and nitrofurantoin for urinary isolates of E. coli while linezolid &glycopeptide antibiotics were the most effective antibiotics for gram-positive cocci.

Keywords: E. coli, Carbapenenems, CLSI, Colistin, Nosocomial.

Introduction

Infectious diseases have a devastating effect on the well-being of human beings[1].Antibiotics came to the aid of alleviating 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[4]. 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[6].The unregulated sales of cheap antibiotics have amplified the crisis of antimicrobial resistance in Indiabesides 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[1]. 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[16].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[4].Infection control practices and new antimicrobial development have primarily targeted control and treatment of infections caused by gram-positive organisms[18-21]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[4,9].Infections caused by MDR

**Correspondence*
Dr. Sanjeev Dimri
Professor and Head, Department of Microbiology, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India.
E-mail: sdimri1966@yahoo.co.in

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.

Material and Methods

The study was conducted in the Department of Microbiology, Saraswathi Institute of Medical Sciences, Hapur, UP. A total of 232 bacterial isolates were recovered in samples from urine, blood, pus & 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), amoxycillin/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 E. coli and enterococcal isolates only.

Results

A total of 232 bacterial isolates were recovered in samples from urine, blood, pus & 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 & fluids (n=39) (16.81%) and respiratory tract (n=28) (12.07%) (table 1).

Table 1: Sample-wise distribution of bacterial isolates

S. N.	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 & Fluids	23(14.94%)	16(20.51%)	39(16.81%)
4	Respiratory	27(17.54%)	01(01.28%)	28(12.07%)

E. coli (n=79) (34.05%) was the predominant isolate followed by Klebsiella pneumoniae (n=45) (19.40%), Coagulase negative staphylococci (n=26) (11.20%), Acinetobacterbaumannii (n=20) (08.62%),Pseudomonas aeruginosa (n=19) (08.19%), Staphylococcus aureus (n=14) (06.03%), Enterococcus fecium(n=10) (04.31%), Enterobacter species (n=07) (03.02%), Proteus mirabilis (n=03) (01.30%), Salmonella typhi (n=03) (01.30%), Salmonella paratyphi-A (n=02) (00.86%), Citrobacter species (n=02) (00.86%), Enterococcus fecalis (n=01) (00.43%) and Morganellamorganii (n=01) (00.43%). (Table 2).

Table 2: Over-all distribution of bacterial isolates

S. N.	Isolate	IPD n=154	OPD n=78	Total n=232
1	E. coli (EC)	41(26.62%)	38(48.72%)	79(34.05%)
2	Klebsiellapneumoniae (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	Morganellamorganii (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	Acinetobacterbaumannii (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 fecalis (EFL)	01(00.65%)	00(00.00%)	01(00.43%)
14	Enterococcus fecium (EFM)	07(04.54%)	03(03.85%)	10(04.31%)

In Urine samples, E. coli (n=72) (58.54%) was the predominant bacteria followed by Klebsiella pneumoniae (n=24) (19.51%), Pseudomonas aeruginosa (n=10) (08.13%), Enterococcus fecium (n=07) (05.69%), Citrobacter species (n=02) (01.63%), Proteus mirabilis (n=03) (02.44%), Coagulase negative staphylococci (n=02) (01.63%), Acinetobacter baumannii (n=01) (00.81%), Enterobacter species (n=01) (00.81%) and Enterococcus fecalis (n=01) (00.81%) (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) (09.52%), Salmonella typhi (n=03) (07.14%), Acinetobacter baumannii (n=03) (07.14%), Salmonella paratyphi-A (n=02) (04.76%), Staphylococcus aureus (n=02) (04.76%) and Enterococcus fecium (n=02) (04.76%) (table 3).

In Pus & 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%), E. 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%), E. 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).

Table 3: Sample-wise distribution of bacterial isolates

S. N.	Isolate	Urine n=123	Blood n=42	PUS &Fluids n=39	Respiratory N=28
1	*E. coli*	72 (58.54%)	00(00.00%)	05(12.83%)	02(07.14%)
2	*Klebsiellapneumoniae*	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%)	00(00.00%)	00(00.00%)	00(00.00%)
5	*Proteus mirabilis*	03(02.44%)	00(00.00%)	00(00.00%)	00(00.00%)
6	*Morganellamorganii*	00(00.00%)	00(00.00%)	01(02.56%)	00(00.00%)
7	*Salmonella typhi*	00(00.00%)	03(07.14%)	00(00.00%)	00(00.00%)
8	*Salmonella paratyphi-A*	00(00.00%)	02(04.76%)	00(00.00%)	00(00.00%)
9	*Pseudomonas aeruginosa*	10(08.13%)	01(02.38%)	06(15.38%)	02(07.14%)
10	*Acinetobacterbaumannii*	01(00.81%)	03(07.14%)	04(10.26%)	12(42.86%)
11	*Staphylococcus aureus*	00(00.00%)	02(04.76%)	10(25.64%)	02(07.14%)
12	CNS	02(01.63%)	19(45.24%)	04(10.26%)	01(03.57%)
13	*Enterococcus fecalis*	01(00.81%)	00(00.00%)	00(00.00%)	00(00.00%)
14	*Enterococcus fecium*	07(05.69%)	02(04.76%)	01(02.56%)	00(00.00%)

In urine samples, E. 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%), amoxycillin/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%), amoxycillin/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, amoxycillin/ 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%), amoxycillin/clavulanic acid (100.00%), followed by imipenem (66.66%), amikacin (66.66%) and gentamicin (33.33%). All isolates were resistant to co-trimoxazoleciprofloxacin, 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 Acinetobacterbaumannii 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, erythomycin 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).

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

S. N.	ATB		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	00.00%	00.00%	00.00%	00.00%	--	--	--	--	--
2	AMC	40.27%	25.00%	00.00%	50.00%	100.00%	--	--	--	--	--
3	TCC	--	--	--	50.00%	--	10.00%	00.00%	--	--	--
4	PIT	63.88%	25.00%	100.00%	50.00%	100.00%	70.00%	100.00%	--	--	--
5	CXM	12.50%	08.33%	00.00%	50.00%	00.00%	--	--	--	--	--
6	CTR	13.88%	12.50%	100.00%	50.00%	00.00%	--	--	--	--	--
7	CAZ	--	--	--	--	--	70.00%	100.00%	--	--	--
8	CPM	13.88%	08.33%	100.00%	50.00%	00.00%	70.00%	100.00%	--	--	--

9	AT	--	--	--	--	--	30.00%	00.00%	--	--	--
10	ETP	81.94%	33.33%	100.00%	50.00%	100.00%	--	--	--	--	--
11	IPM	81.94%	33.33%	100.00%	50.00%	66.66%	70.00%	100.00%	--	--	--
12	MRP	81.94%	33.33%	100.00%	50.00%	100.00%	70.00%	100.00%	--	--	--
13	DOR	--	--	--	--	--	70.00%	100.00%	--	--	--
14	AK	86.11%	37.50%	100.00%	50.00%	66.66%	70.00%	100.00%	--	--	--
15	GEN	56.94%	41.66%	100.00%	50.00%	33.33%	70.00%	100.00%	100.00%	100.00%	00.00%
16	CIP	23.61%	20.83%	100.00%	50.00%	00.00%	60.00%	100.00%	100.00%	100.00%	00.00%
17	LE	--	--	--	--	--	60.00%	100.00%	100.00%	100.00%	00.00%
18	CL	100.00%	95.83%	100.00%	100.00%	--	100.00%	100.00%	--	--	--
19	COT	43.05%	29.16%	100.00%	50.00%	00.00%	--	100.00%	100.00%	--	--
20	MIN	--	--	--	--	--	--	100.00%	--		
21	PEN	--	--	--	--	--	--	--	00.00%	00.00%	00.00%
22	CX	--	--	--	--	--	--	--	00.00%	--	--
23	ERM	--	--	--	--	--	--	--	00.00%	00.00%	00.00%
24	CLD	--	--	--	--	--	--	--	100.00%	--	--
25	LZ	--	--	--	--	--	--	--	100.00%	100.00%	100.00%
26	VA	--	--	--	--	--	--	--	100.00%	100.00%	71.42%
27	TEI	--	--	--	--	--	--	--	100.00%	100.00%	71.42%
28	TE	--	--	--	--	--	--	--	50.00%	00.00%	28.57%
29	RIF	--	--	--	--	--	--	--	50.00%	--	--
30	NIT	75.00%	--	--	--	--	--	--	--	100.00%	28.57%

In blood samples, Klebsiellapneumoniae 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%), amoxycillin/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%),amoxycillin/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%), amoxycillin/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, amoxycillin/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 Staphylococcal aureus isolates were found to be sensitive to linezolid, vancomycin, teicoplanin, clindamycin, erythromcycin, 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%), cefoxitin (15.78%) and erythromcycin (0526%). All isolates were resistant to penicillin. Sixteen isolates (84.24%) were methicillin-resistant coagulase negative staphylococci (MR-CNS) (table 5). Enterococcus fecium 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).

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

S. N.	ABT	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	00.00%	00.00%	66.66%	100.00%	--	--	--	--	--
2	AMC	25.00%	25.00%	100.00%	100.00%	--	--	--	--	--
3	TCC	--	--	--	--	00.00%	00.00%	--	--	--
4	PIT	25.00%	25.00%	100.00%	100.00%	00.00%	66.66%	--	--	--
5	CXM	25.00%	25.00%	00.00%	00.00%	--	--	--	--	--
6	CTR	25.00%	25.00%	100.00%	100.00%	--	--	--	--	--
7	CAZ	--	--	--		100.00%	33.33%	--	--	--
8	CPM	25.00%	25.00%	100.00%	100.00%	100.00%	66.66%	--	--	--
9	AT	--	--	--	--	00.00%	00.00%	--	--	--
10	ETP	25.00%	25.00%	100.00%	100.00%	--	--	--	--	--

11	IPM	25.00%	25.00%	100.00%	100.00%	100.00%	33.33%	--	--	--
12	MRP	25.00%	25.00%	100.00%	100.00%	100.00%	33.33%	--	--	--
13	DOR	--	--	--		100.00%	33.33%	--	--	--
14	AK	100.00%	100.00%	00.00%	00.00%	100.00%	33.33%	--	--	--
15	GEN	100.00%	100.00%	00.00%	00.00%	100.00%	33.33%	00.00%	52.63%	00.00%
16	CIP	100.00%	100.00%	33.33%	00.00%	100.00%	33.33%	00.00%	36.84%	00.00%
17	LE	--	--	--		100.00%	33.33%	00.00%	36.84%	00.00%
18	CL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	--	--	--
19	COT	100.00%	100.00%	100.00%	100.00%	--	66.66%	100.00%	52.63%	--
20	MIN	--	--	--		--	33.33%	--	--	
21	PEN	--	--	--		--	--	00.00%	00.00%	00.00%
22	CX	--	--	--		--	--	00.00%	15.78%	--
23	ERM	--	--	--		--	--	100.00%	05.26%	00.00%
24	CLD	--	--	--		--	--	100.00%	42.10%	--
25	LZ	--	--	--		--	--	100.00%	89.47%	100.00%
26	VA	--	--	--		--	--	100.00%	89.47%	100.00%
27	TEI	--	--	--		--	--	100.00%	89.47%	100.00%
28	TE	--	--	--		--	--	100.00%	73.68%	50.00%
29	RIF	--	--	--		--	--	100.00%	78.94%	--

In pus & fluids samples, E. 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%), amoxycillin/clavulanic acid (40.00%), ciprofloxacin (23.61%), cefepime (20.00%), ceftriaxone (20.00%), and cefuroxime (20.00%). All isolates were resistant to ampicillin and ciprofloxacin (table 6). Klebsiellapneumoniae 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 amoxycillin/ clavulanic acid, ceftriaxone, 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, ceftriaxone and cefepime. The isolate was resistant to cefuroxime, amoxycillin/clavulanic acid and ampicillin (table 6). Only one isolate of Morganellamorganii was recovered and was found to be sensitive to amikacin, ertapenem, imipenem, meropenem, piperacillin/ tazobactam, amoxycillin/ clavulanic acid, ceftriaxone, 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). Acinetobacterbaumannii 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%), cefoxitin (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, cefoxitin 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, erythromcycin and tetracycline. The isolate was resistant to ciprofloxacin, levofloxacin (table 6).

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

S. N.	ABT	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	00.00%	00.00%	00.00%	00.00%	--	--	--	--	--
2	AMC	40.00%	00.00%	00.00%	100.00%	--	--	--	--	--
3	TCC	--	--	--	--	33.33%	25.00%	--	--	--
4	PIT	40.00%	28.57%	100.00%	100.00%	50.00%	25.00%	--	--	--
5	CXM	20.00%	00.00%	00.00%	00.00%	--	--	--	--	--
6	CTR	20.00%	00.00%	100.00%	100.00%	--	--	--	--	--
7	CAZ	--	--	--	--	50.00%	25.00%	--	--	--
8	CPM	20.00%	00.00%	100.00%	100.00%	50.00%	25.00%	--	--	--
9	AT	--	--	--	--	33.33%	25.00%	--	--	--
10	ETP	40.00%	28.57%	100.00%	100.00%	--	--	--	--	--
11	IPM	60.00%	28.57%	100.00%	100.00%	50.00%	25.00%	--	--	--
12	MRP	60.00%	28.57%	100.00%	100.00%	50.00%	25.00%	--	--	--
13	DOR	--	--	--	--	50.00%	25.00%	--	--	--
14	AK	60.00%	57.14%	100.00%	100.00%	50.00%	25.00%	--	--	--

15	GEN	80.00%	57.14%	100.00%	00.00%	50.00%	25.00%	70.00%	50.00%	100.00%
16	CIP	00.00%	28.57%	100.00%	00.00%	50.00%	25.00%	10.00%	00.00%	00.00%
17	LE	--	--	--	--	50.00%	25.00%	20.00%	00.00%	00.00%
18	CL	80.00%	100.00%	100.00%	00.00%	100.00%	100.00%	--	--	--
19	COT	60.00%	28.57%	100.00%	00.00%	--	25.00%	40.00%	00.00%	--
20	MIN	--	--	--	--	--	75.00%	--	--	--
21	PEN	--	--	--	--	--	--	20.00%	00.00%	100.00%
22	CX	--	--	--	--	--	--	50.00%	00.00%	--
23	ERM	--	--	--	--	--	--	30.00%	25.00%	100.00%
24	CLD	--	--	--	--	--	--	60.00%	100.00%	--
25	LZ	--	--	--	--	--	--	100.00%	100.00%	100.00%
26	VA	--	--	--	--	--	--	90.00%	100.00%	100.00%
27	TEI	--	--	--	--	--	--	90.00%	100.00%	100.00%
28	TE	--	--	--	--	--	--	70.00%	50.00%	100.00%
29	RIF	--	--	--	--	--	--	90.00%	100.00%	--

In respiratory tract samples, E. 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%), amoxycillin/clavulanic acid (50.00%) and ciprofloxacin (50.00%). No isolate was found to be sensitive to cefepime, ceftriaxone, cefuroxime and ampicillin (table 7). Klebsiellapneumoniae 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%), amoxycillin/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, amoxycillin/ 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 6). Acinetobacterbaumannii 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, cefoxitin 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, cefoxitin and penicillin. The isolate was methicillin-resistant (MR-CNS) (table 7).

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

S. N.	ABT	Isolates						
		EC n=02	KP n=08	EB n=01	PA n=02	ACB n=12	SA n=02	CNS n=01
1	AMP	00.00%	00.00%	00.00%	--	--	--	--
2	AMC	50.00%	25.00%	00.00%	--	--	--	--
3	TCC	--	--	--	50.00%	00.00%	--	--
4	PIT	50.00%	25.00%	100.00%	100.00%	00.00%	--	--
5	CXM	00.00%	12.50%	00.00%	--	--	--	--
6	CTR	00.00%	12.50%	100.00%	--	--	--	--
7	CAZ	--	--	--	100.00%	00.00%	--	--
8	CPM	00.00%	12.50%	100.00%	100.00%	08.33%	--	--
9	AT	--	--	--	100.00%	00.00%	--	--
10	ETP	50.00%	25.00%	100.00%	--	--	--	--
11	IPM	50.00%	25.00%	100.00%	100.00%	00.00%	--	--
12	MRP	50.00%	25.00%	100.00%	100.00%	00.00%	--	--
13	DOR	--	--	--	100.00%	00.00%	--	--
14	AK	50.00%	62.50%	100.00%	100.00%	16.66%	--	--
15	GEN	50.00%	62.50%	100.00%	100.00%	08.33%	50.00%	100.00%
16	CIP	50.00%	25.00%	100.00%	100.00%	08.33%	00.00%	100.00%
17	LE	--	--	--	100.00%	08.33%	00.00%	100.00%
18	CL	100.00%	75.00%	100.00%	100.00%	100.00%	--	--
19	COT	50.00%	37.50%	100.00%	--	08.33%	50.00%	100.00%
20	MIN	--	--	--	--	00.00%	--	--
21	PEN	--	--	--	--	--	00.00%	00.00%
22	CX	--	--	--	--	--	00.00%	00.00%
23	ERM	--	--	--	--	--	00.00%	100.00%
24	CLD	--	--	--	--	--	00.00%	100.00%
25	LZ	--	--	--	--	--	100.00%	100.00%

26	VA	--	--	--	--	--	100.00%	100.00%
27	TEI	--	--	--	--	--	100.00%	100.00%
28	TE	--	--	--	--	--	100.00%	00.00%
29	RIF	--	--	--	--	--	100.00%	100.00%

In urine samples, E. coli (n=72) (58.54%) and Klebsiella pneumoniae (n=24) (19.51%) were the major isolates. E. 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 & fluids samples, Staphylococcus aureus (n=10) (25.64%), Klebsiellapneumoniae (n=05) (71.43%) and Pseudomonas aeruginosa (n=06) (15.38%) were the major isolates. All the Staphylococcus aureus (n=08) (80.00%), Klebsiellapneumoniae (n=07) (17.95%) and Pseudomonas aeruginosa (n=05) (83.33%) isolates were predominantly recovered from IPD (table 8). In respiratory samples, Acinetobacterbaumannii (n=12) 42.86%) and Klebsiellapneumoniae (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).

Table 8: Distribution of major isolates from clinical samples

S. N.	Isolate	Samples	
		Urine	
		IPD	OPD
1	E. coli (n=72)	n=35 (48.61%)	n=37 (51.39%)
2	Klebsiellapneumoniae (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%)
	Klebsiellapneumoniae (n=06)	n=06 (100.00%)	n=00 (00.00%)
		PUS &Fluids	
1	Staphylococcus aureus (n=10)	n=08 (80.00%)	n=02 (20.00%)
2	Klebsiellapneumoniae (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	Acinetobacterbaumannii (n=12)	n=12 (100.00%)	n=00 (00.00%)
2	Klebsiellapneumoniae (n=08)	n=08 (100.00%)	n=00 (00.00%)

Discussion

Urine samples (53.02%) comprised the majority of samples in our study which correlated with study from Chanda W et al 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 E. 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].E. coli (58.54%) and Klebsiella pneumoniae (19.51%) were the commonest bacteria isolated from urine samples which was in agreement with other studies [26-29]. E. 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 E. 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 al[30] 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 & 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 E. coli while linezolid &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 & 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. 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 & gloves specially in critical care settings to prevent nosocomial infections.

Conclusion

The most common bacteria in our study shows that E. 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 E. coli while linezolid &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 an antibiogram 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 & gloves specially in critical care settings to prevent nosocomial infections.

References

1. Chanda W et al. Evaluation of antibiotic susceptibility patterns of pathogens isolated from routine laboratory specimens at Ndola Teaching Hospital: A retrospective study. PLOS ONE. 2019; 14(12):e0226676.
2. CDC. Antimicrobial Resistance, 2015.
3. Bell BG et al. A systematic review and meta-analysis of the effects of antibiotic consumption on antibiotic resistance. BMC infectious diseases. 2014; 14:(13):1-25.
4. SavanurSS, Gururaj H. Study of Antibiotic Sensitivity and Resistance Pattern of Bacterial Isolates in Intensive Care Unit Setup of a Tertiary Care Hospital. Indian J Crit Care Med. 2019; 23(12):547–555.
5. World Health Organization (WHO), WAAW: World Antibiotic Awareness Week, 2018.
6. Travasso C. India draws a red line under antibiotic misuse. BMJ. 2016; 352:i1202.
7. World Health Organization (WHO). Antimicrobial resistance: draft global action plan on antimicrobial resistance, 2015.
8. Ganguly NK et al. Rationalizing antibiotic use to limit antibiotic resistance in India. Indian J Med Res. 2011; 134:281-294.
9. Chamoun K et al. Surveillance of antimicrobial resistance in Lebanese hospitals: retrospective nationwide compiled data. International journal of infectious diseases. 2016; 46:64–70.
10. Kouchak F, Askarian M. Nosocomial infections: the definition criteria. Iranian journal of medical sciences. 2012; 37(2):72-73.
11. Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care 2013; associated infection and criteria for specific types of infections in the acute care setting. American journal of infection control. 2008; 36(5):309-332.
12. Weinstein RA. Nosocomial infection update. Emerging infectious diseases.1998; 4(3):416–420.
13. Hui C, Lin MC, Jao MS, Liu TC, Wu RG. Previous antibiotic exposure and evolution of antibiotic resistance in mechanically ventilated patients with nosocomial infections. Journal of critical care. 2013;28(5):728-734.
14. Zhang L, Kinkelaar D, Huang Y, Li Y, Li X, Wang HH. Acquired antibiotic resistance: Are we born with it? Applied and environmental microbiology. 2011; 77(20):7134-7141.
15. Zhang L, Huang Y, Zhou Y, Buckley T, Wang HH. Antibiotic administration routes significantly influence the levels of antibiotic resistance in gut microbiota. Antimicrobial agents and chemotherapy. 2013; 57(8):3659-3666.
16. Cassir N, Rolain JM, Brouqui P. A new strategy to fight antimicrobial resistance: the revival of old antibiotics. Frontiers in microbiology. 2014; 5:551.
17. Hirsch EB, Tam VH. Impact of multidrug-resistant Pseudomonas aeruginosa infection on patient outcomes. Expert review of pharmacoeconomics& outcomes research. 2010; 10(4):441-451.
18. Prabaker K, Weinstein RA. Trends in antimicrobial resistance in intensive care units in the United States. Curr Opin Crit Care. 2011;17(5):472-479.
19. deKraker ME et al. Mortality and hospital stay associated with resistant Staphylococcus aureus and Escherichia coli bacteremia: estimating the burden of antibiotic resistance in Europe. PLoS Med. 2011;8(10):e1001104.
20. Sader HS, Flamm RK, Jones RN. Tigecycline activity tested against antimicrobial resistant surveillance subsets of clinical bacteria collected worldwide (2011). DiagnMicrobiol Infect Dis. 2013;76(2):217–221.
21. Bouchillon SK, Badal RE, Hoban DJ, Hawser SP. Antimicrobial susceptibility of inpatient urinary tract isolates of gram-negative bacilli in the United States: results from the study for monitoring antimicrobial resistance trends (SMART) program: 2009-2011. ClinTher. 2013;35(6):872-877.
22. Paterson DL et al. Antibiotic therapy for Klebsiella pneumoniae bacteremia: implications of production of extended- spectrum beta-lactamases. Clin Infect Dis. 2004; 39(1):31-37.
23. Rohr U et al. Colonization of patients and contamination of the patients' environment by MRSA under conditions of single-room isolation. International journal of hygiene and environmental health. 2009;212(2):209-215.
24. Becker K, von Eiff C. Staphylococcus, micrococcus, and other catalase-positive cocci. Manual of clinical microbiology, tenth edition, Washington press, DC, ASM press. 2011;1:308-330.
25. Clinical and laboratory standards institute (CLSI). Performance standards for antimicrobial susceptibility testing; 2016;26 edition (January) M100-S22,36(1).
26. Beyene G, Tsegaye W. Bacterial uropathogens in urinary tract infection and antibiotic susceptibility pattern in jimma university specialized hospital, southwest Ethiopia. Ethiop J Health Sci. 2011; 21(2):141-146.
27. Hameed T, Al Nafeesah A, Chishti S, AlShaalan M, Al Fakeeh K. Community-acquired urinary tract infections in children: resistance patterns of uropathogens in a tertiary care center in Saudi Arabia. International journal of pediatrics and adolescent medicine. 2019; 6(2):51-54.
28. Shill MC, Huda NH, Moain FB, Karmakar UK. Prevalence of uropathogens in diabetic patients and their corresponding resistance pattern: results of a survey conducted at diagnostic centers in Dhaka, Bangladesh. Oman Med J. 2010; 25(4):282-285.
29. Olorunmola FO, Kolawole DO, Lamikanra A. Antibiotic resistance and virulence properties in Escherichia coli strains from cases of urinary tract infections. African journal of infectious diseases. 2013;7(1):1-7.
30. Ghadiri H et al. The antibiotic resistance profiles of bacterial strains isolated from patients with hospital-acquired bloodstream and urinary tract infections. Critical care research and practice. 2012; 2012:890797.
31. Hart CA, Kariuki S. Antimicrobial resistance in developing countries.BMJ (Clinical research ed). 1998; 317(7159):647-650.

Conflict of Interest: Nil
Source of support:Nil