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Antibiotic Susceptibility Patterns of Bacterial Isolates from Infected Wounds in a Tertiary Health Care Center, India

N. Krithik Jain[1*] and Rufus Ranjithsingh Edwin[1]

[1]Saveetha Medical College & Hospital, Saveetha Institute of Medical & Technical Sciences, Chennai, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Background: An infected wound prolongs the period of stay in hospital which results in further chances of getting affected by nosocomial infection leading to increased number of comorbidities. Hence adequate and appropriate treatment of the infective organism is of prime importance.
Objectives: To find out the most common antibiotics susceptible to the bacterial isolates from the pus samples.
Materials and Methods: A cross sectional study was conducted of the bacterial isolates from pus samples in a hospital setup of Saveetha medical college and hospital, Chennai for 100 patients. Pus samples were collected from patients who came to the surgery OPD with complaints of ulcer and discharge were subjected to culture and sensitivity after obtaining proper consent and the bacterial growths were noted. Antibiotic susceptibilities of the isolates were determined according to disk diffusion method recommended by the Clinical and Laboratory Standard institute [1].
Results: Out of the total samples collected (n=200) 90% of the samples showed bacterial growth and the remaining 10% of the samples showed no growth. The most predominant bacteria in our study was found to be *E. coli* (33%) being most susceptible to Amikacin followed by S. *aureus* (19%) which was highly susceptible to Linezolid and Vancomycin.

Conclusion: There is a peak in the incidence of antimicrobial resistant cases which is a great threat for human mankind. Hence emphasis should be laid on rational use of antibiotics and proper sterile techniques to be followed.

Keywords: Amikacin; antimicrobial resistance; E. coli, linezolid; wound; S. aureus.

1. INTRODUCTION

A wound is defined as "a breakdown in the protective function of the skin, the loss of continuity of epithelium, with or without loss of underlying connective tissue"[2]. These wounds range from minor cuts and burns to major surgical wounds and body ulcers[2]. Infected wounds are analogous with increasing rates of morbidity and mortality. The second most common cause of wound infections is surgical infections [3,4]. The understanding of the causative organism of the infection its pathophysiology and its pharmacokinetic interaction with administered antibiotics are very crucial for the proper treatment of the disease. Infections are broadly classified as Pyogenic and non pyogenic infections. If the bacterial organism which infects the wound is pus forming then it results in a pyogenic infection which has symptoms of inflammation. The latter one is usually caused by fungi, viruses and atypical mycobacterium where the leukocytes invade to kill the organism due to local inflammation. These dead leukocytes form pus which is white to yellow in color [5,6]. In the modern era due to irrational use of antibiotics and availability of the antibiotics as over-the-counter drugs has led to a spike in the number of cases of antimicrobial resistance. Bacteria have the ability to acquire resistance to therapeutic drugs and can transfer the resistance from one bacterium to another [4]. This has lead to a decrease in the rate of effectiveness of the antibiotics against the bacterial organisms which poses a major threat by narrowing the choice of antibiotics available for a particular organism.

Hence this study is conducted to find out the most common bacteria found in pus samples and the antibiotics to which these organisms are sensitive to, so that the hospital can frame its own guidelines and policies for appropriate empirical therapy.

2. MATERIALS AND METHODS

A cross sectional study was conducted from February 2021 to July 2021 in a tertiary care hospital in Chennai, Tamilnadu. A total of 200 wound swabs were collected from patients who came to the surgery OPD (Out Patient Department) with the complaints of ulcer and discharge and were subjected to culture and sensitivity and their bacterial growths were noted. These patients were randomly booked in the Surgery OPD to avoid the bias by following a proper blinding method. The collected swabs were inoculated into Blood agar (5% of sheep blood) and MacConkey agar which was incubated for 48 hours at 35°C-37°C. The bacteria was identified and differentiated from other bacteria by Gram staining, colony characters, microscopic features and biochemical tests using standard microbiological methods [7]. Antibiotic susceptibilities of the isolates were determined according to disk diffusion method recommended by the Clinical and Laboratory Standard institute [7]. The isolates were spread on Muller-Hinton agar plates and corresponding antibiotic discs were placed in the agar plate for 18 hours at 35°C. The susceptibility patterns were measured and were classified as sensitive, intermediate, resistant according to the CLSI guidelines [7].

3. RESULTS

Out of the 200 wound swabs collected 180 samples (90%) showed bacterial growth and the remaining 20 samples were negative for any growth after 2 days of incubation. The organisms were characterized into different species based on their morphology and gram staining. Broadly it was identified into Gram Positive (42 organisms) and Gram negative (138 organisms) each contributing 21% and 69% respectively of the total sample size (n=200).

All the organisms were further identified into 11 different bacterial species out if which E. *coli* was the recurrent bacteria with growth on 66 different cultures (33%) followed by S. *aureus* with growth on 38 cultures comprising of 19% (Table 1).

Following E. *coli* and S. *aureus* the most common organism was found to be K. *pneumoniae* and *P.aeruginosa* with a count of 24 each corresponding to 12% each (Table 1). The other organisms which were found were P.

mirabilis (4%) followed by A. *baumannii*, P. *stuartii*, M. *morganii* each corresponding to 2%. One percent was contributed each by *Citrobacterspp* and *Burkholderia spp*.

All the Staphylococcal isolates were sensitive to Cloxacillin (100%), Linezolid (100%), and Vancomycin (100%) whereas it was least sensitive to Amoxicillin-clavulanic acid, Ampicillin, Ciprofloxacin (Table 2).

In Gram negative bacteria, the majority of the bacteria were susceptible to Amikacin and imipenem. In specific, E. *coli*, K*. pneumoniae* and *P.aeruginosa* were most susceptible to Amikacin and imipenem being the most effective antibiotics against these organisms. *P.mirabilis* was highly susceptible to Amikacin, Cefoperazone /Sulbactam, Ciprofloxacin, Ofloxacin and Piperacillin-tazobactam whereas it was totally resistant to Cefuroxime (Table 3).

Other organisms like *Acinetobacterbaumanii* and *Providenciastuartii* were resistant to all the antibiotics tested. In *Citrobacterspp* and *Burkholderiaspp* carbapenem and fluoroquinolones class of antibiotics were highly effective (Table 3).

Table 1. Growth count of different organisms grown from the samples collected

S.no	Type of organism	Organism species	No. Of organisms		% of organisms	
1	Gram positive	Staphylococcus *aureus*	38	42	19%	21%
2		*Streptococcus spp*	4		2%	
3	Gram	*Escherichiacoli*	66	138	33%	69%
4	negative	*Klebsiellapneumoniae*	24		12%	
5		*Pseudomonasaeruginosa*	24		12%	
6		*Proteusmirabilis*	8		4%	
7		*Acinetobacterbaumanii*	4		2%	
8		*Providenciastuartii*	4		2%	
9		*Morganellamorganii*	4		2%	
10		*Citrobacterspp*	2		1%	
11		*Burkholderiaspp*	2		1%	

Table 2. Antibiotic susceptibilities of gram-positive bacteria in percentages isolated from a tertiary care centre, Chennai

S.No	ANTIBIOTIC	Staphylococcus *aureus* (n = 38) % of susceptibility	*Streptococcus spp* (n = 2)
1	Amoxicillin-clavulanic acid	11	50
2	Ampicillin	11	50
3	Azithromycin	23	100
4	Cefepime	34	50
5	Ceftriaxone	67	100
6	Cefotaxime	45	100
7	Cefuroxime	78	100
8	Cephalexin	67	100
9	Ciprofloxacin	11	100
10	Clindamycin	73	100
11	Cloxacillin	100	100
12	Trimethoprim/sulfamethoxazole	34	50
13	Erythromycin	28	100
14	Imipenem	89	100
15	Levofloxacin	28	100
16	Linezolid	100	100
17	Meropenem	84	100
18	Piperacillin-tazobactam	28	100
19	Teicoplanin	78	100
20	Tetracycline	50	50
21	Vancomycin	100	100

Table 3. Antibiotic susceptibilities of Gram-negative bacteria in percentages isolated from a tertiary care centre, Chennai

S. No	Antibiotic	Escherichia *coli*	Klebsiella*pneumoniae*	Pseudomonas *aeruginosa*	Proteus *mirabilis*	Acinetobacter*baumanii*	Providencia*stuartii*	Morganella*morganii*	*Citrobacter sp*	*Burkholderia sp*
		(n=66)	(n=24)	(n=24)	(n=8)	(n=4)	(n=4)	(n=4)	(n=2)	(n2)
		% of susceptibility								
1	Amikacin	76	50	79	100	0	0	50	0	0
2	Amoxicillin-clavulanic acid	6	0	0	50	0	0	0	0	0
3	Aztreonam	19	11	42	50	0	0	0	0	0
4	Cefepime	16	11	21	50	0	0	0	50	0
5	Cefoperazone/Sulbactam	34	11	21	100	0	0	50	50	0
6	Ceftriaxone	30	11	21	50	0	0	0	50	0
7	Cefotaxime	21	0	0	50	0	0	0	0	0
8	Cefuroxime	5	0	0	0	0	0	0	0	0
9	Ciprofloxacin	21	42	62	100	0	0	0	100	100
10	Trimethoprim/sulfamethoxazole	32	21	21	50	0	0	0	0	0
11	Ertapenem	26	29	nt	50	0	0	0	50	0
12	Gatifloxacin	21	42	42	50	0	0	0	100	0
13	Gentamicin	46	42	58	50	0	0	50	0	100
14	Imipenem	76	50	79	50	0	0	0	100	0
15	Levofloxacin	26	29	62	50	0	0	0	100	0
16	Meropenem	68	42	79	50	0	0	0	100	0
17	Netilmicin	57	29	79	50	0	0	0	50	0
18	Norfloxacin	14	21	21	50	0	0	0	100	0
19	Ofloxacin	16	29	42	100	0	0	0	100	0
20	Piperacillin-tazobactam	36	42	79	100	0	0	50	50	0

4. DISCUSSION

This study had a predominance of Gram negative bacteria with 138 organisms being isolated comprising of 69% which was comparable with that of the study done by Rugira Trojan et Al [8] who had agram negative bacteria prevalence of 77%. E. col*i* was the most predominant organism which was found in our study with a prevalence of 33% which was comparable with that of the study of Rugira Trojan et al[8] and Zhang et al[9]. This was followed by Staphylococcus *aureus* with a predominance rate of 19% again being comparable with that of the study done by Rugira Trojan et al[8] and Zhang et al[9]. But in the study done by Bessa et al [10] there was a predominance of *S. aureus* followed by *P. aeruginosa*, *P. mirabilis*, *E. coli*, and *Corynebacterium*spp which is not in concordance with our findings.

The antibiogram results from our data analysis showed that *E. coli* were most resistant to Amoxicillin-clavulanic acid and Cefuroxime (2nd generation cephalosporin) and Amikacin (76%) being the most sensitive to *E. coli*. In the Antibiogram Acinetobacter*baumanii* and Providencia*stuartii* showed multidrug resistance being resistant to all the available antibiotics. These findings were in concordance with that of Rugira Trojan et al[8]. In the study done by Radhi et al[11] there was a resistance of 73.3% of Acinetobacter*baumanii* to Carbapenems which was not in concordance with our study results where there was a 100% resistance to it.

Proteus *mirabilis* was highly susceptible to Fluroquinolones and Amikacin whereas being moderately susceptible to other antibiotics. When comparing Antibiotic susceptibility pattern of *Klebsiella pneumonia*e and *Pseudomonas aeruginosa* the latter was more susceptible to the antibiotics tested. Both these organisms were resistant to Cephalosporins which was conflicting with the results of study done by Bubonja-Sonje et al[12] and Labarca et al [13] where there was resistance towards Carbapenems and Aminoglycosides but not towards Cephalosporins. In the study done by Al-Charrakh et al [14] 37.5% of *Pseudomonas aeruginosa* isolates were resistant to carbapenems where as in our study only 21% of the *Pseudomonas aeruginosa* isolates were resistant to carbapenems indicating a greater susceptibility pattern and a more effective reserve drug.

Staphylococcus aureus showed high sensitivity towards Linezolid (100%), Vancomycin (100%) which was in concordance to that of the study done by Krati et al[15]showing Linezolid (100%), Vancomycin (90%) sensitivity. *Streptococcus* spp was most susceptible to most of the antibiotics tested.

5. CONCLUSION

E. coli was the most common pathogen in the tertiary care centre followed by S. *aureus*, K. *pneumoniae,* P. *aeruginosa* and then P. *mirabilis*. According to our study analysis Linezolid, Vancomycin and Cloxacillin were highly effective against gram positive bacteria. Antibiotics like Carbapenems, Fluroquinolones and gentamycin were highly effective against gram negative bacteria.But antibiotics like Carbapenems, Vancomycin and Linezolid being very high-end antibiotics should not be used as a drug for first line therapy and instead drugs like broad-spectrum penicillins with or without β-lactamase inhibitors, Cephalosporins are to be used for first line therapy for less severe infections. Drugs like Carbapenems should be used as a reserve drug for serious infections and as a last resort drug for highly resistant organisms to other drugs. The rising rate of antimicrobial resistance is a serious threat to our society and hence rational use of antibiotics is must. Irrational use of antibiotics and availability of the drug over the counter should be prohibited. This data can be used to set up an empirical therapy policy for the health centre and also the hospital should encourage the health care workers to follow proper sterile techniques during procedures, proper hand-hygiene and use of PPE's to prevent hospital acquired infections.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline Patient's consent and ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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