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Antibiotic Susceptibility and MDR (Multi Drug Resistance) Pattern of Common Bacteria Isolated from Wound Infection in a Tertiary Care Hospital, Gazipur, Bangladesh

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ABSTRACT ***Background:*** Wound infections pose a greater concern in developing countries than in wealthy nations. Antimicrobial resistance (AMR) increasingly threatens clinical treatment and public health globally. ***Objective:*** To evaluate the antibiotic susceptibility and MDR (multidrug resistance) pattern of common bacteria isolated from wound infections. ***Materials and Methods:*** From January to June 2024, a cross-sectional study was conducted at the Microbiology and Virology Department of KPJ Specialized Hospital and Nursing College, Gazipur, following approval by the Institutional Ethics Committee. The study cultured 219 wound-infected samples, identifying 142 as culture-positive and 77 as culture-negative. This research aimed to determine the prevalence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) Gram-positive and Gram-negative bacteria isolated from wound specimens submitted for routine culture and sensitivity testing. ***Results:*** The majority of Gram-positive organisms were Staphylococcus aureus (46.48%). Among the Gram-negative bacteria, the most frequently isolated bacteria were Klebsiella spp. (21.83%), Pseudomonas spp. (16.20%), and E. coli (11.27%). Overall, 94 isolates (52%) were found to exhibit multiple antimicrobial resistance. High rates of resistance were observed against Penicillin G (89.55%), Cefixime (75%), Cephalexin (75%), Azithromycin (68.85%), Amoxicillin (67.61%), Tobramycin (64.71%), Oxacillin (63.27%), and Cefuroxime (63.04%). ***Conclusion:*** In our investigation, the most prevalent isolates were Staphylococcus aureus, a Gram-positive pathogen. Among the Gram-negative bacteria, Klebsiella spp., Pseudomonas spp., and E. coli were the most frequently isolated species.

Keywords: Wound infection, Antibiotic Susceptibility, MDR.

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INTRODUCTION

Wound infection remains the most important cause of postoperative mortality and morbidity and generates considerable additional social and healthcare costs [1]. Various coliforms, Enterococcus faecalis, Proteus

spp., and multidrug-resistant Staphylococcus aureus cause most wound infections. Wound infections are a leading cause of illness in underdeveloped and developing countries compared to developed nations. Antimicrobial resistance (AMR) is a serious hazard to clinical treatment and public health, and its worldwide impact is increasing at an alarming rate [2] The rise and dissemination of Gram-negative bacilli (GNB) that are extensively drug-resistant (XDR) and multidrug-resistant (MDR) is especially worrisome because it has severely reduced the efficacy of widely used antibiotics in clinical settings.2 Antimicrobial resistance has become one of the most severe public health problems in both developed and developing countries like Bangladesh [3]. Managing this issue effectively has proven challenging, especially in developing nations like Bangladesh, owing to the lack of relevant scientific findings, the lack of data sharing, the low health standards, and the low quality of drugs [4, 5]. Moreover, self-medication by patients, unnecessary antibiotic prescriptions made by physicians without doing proper susceptibility testing on the bacteria, and the rapid and uncontrolled use of antimicrobials in agriculture and farming have all exacerbated the problem [6, 7]. Wounds typically form when the skin epithelium and skin integrity deteriorate. Thus, exposure to the subcutaneous tissues of wounds allows easy access to polymicrobes like bacteria, viruses, and fungi, and offers a nourishing and sustaining environment for the growth and multiplication of these organisms [8, 9]. The rise of multidrug resistant Gram-negative bacterial pathogens is of important concern since it poses a severe mortality risk of various infections, including nosocomial infections caused by multidrug resistant bacteria than non-multidrug resistant bacteria [10]. Surveillance results about antimicrobial resistance and etiology are an important way to overcome the risk associated with treatment failure and drug resistance. Hence, the present investigation aimed to analyze the antibiotic sensitivity pattern of bacteria in wound infections and the antibiotic resistance of frequently determined clinical bacterial strains.

MATERIALS AND METHODS

This hospital-based, cross-sectional study was conducted in the Microbiology and Virology Department, KPJ Specialized Hospital and Nursing College, Gazipur, over a period of six months from January 2024 to June 2024, following approval from the Institutional Ethics Committee. A total of 219 wound infected samples were cultured, among them 142 were found culture positive and 77 were found culture negative. The study aimed to determine the prevalence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) Gram-positive and Gram-negative bacterial isolates from a variety of wound infected specimens submitted for routine culture and sensitivity testing. All microbiological tests, result collection, and report maintenance were done by a trained microbiologist of the Microbiology and Virology Department, KPJ Dhaka Specialized Hospital and Nursing College, Gazipur. The antibiotic susceptibility examination was done using the disc diffusion method according to the National Committee for Clinical Laboratory Standards. Samples with colony counts $<10^5$ cfu/mL were omitted. Quality assurance has been strictly controlled by following the Clinical and Laboratory Standards Protocols according to the "Performance Standards for Antimicrobial Susceptibility Testing". We used the definition of MDR as resistance against three or more classes of antibiotics, both for Gram-positive and Gram-negative bacteria. Seven frequently used classes of antibiotics were used to analyze MDR.

RESULTS

Table 1: Age Distribution of the Study Subjects (N=219)

Age in years	Number	Percentage
1 year	15	6.8
1-5 years	5	2.3
6-20 years	14	6.4
21-30 years	37	16.9
31-40 years	57	26.0
41-50 years	40	18.3

51-60 years	30	13.7
>60 years	21	9.6
Mean ±SD	37.43 (±18.14)	Range 1-80 years
Gender		
Male	123	56.2
Female	96	43.8

The mean age was 37.43 (±18.14) years, minimum age was 1 year and maximum age was 80 years. Male were predominant 123(56.2%) and 96(43.8%) were female. Out of 219 cultures, 142 (65%) were culture positive and 77(35%) were culture negative.

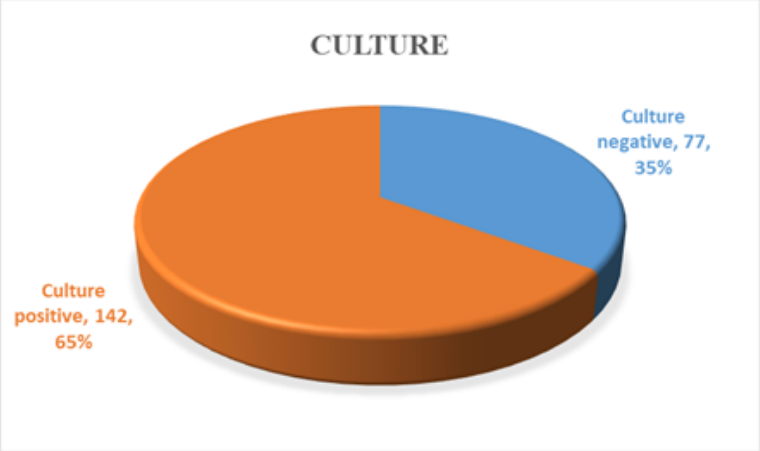

Figure 1: Growth Distribution of Culture-Positive and Culture-Negative Isolates

Table 2: Isolated Organisms from Culture (N=142)

Isolated organism	Number	Percentage
Gram-positive (n=66)		
Staphylococcus Aureus	66	46.48
Gram-negative (n=76)		
Klebsiella spp.	31	21.83
Pseudomonas spp.	23	16.20
E. coli	16	11.27
Enterococcus spp.	4	2.82
Acinetobacter	2	1.41
Total	142	100.00

The majority of Gram-positive organisms were Staphylococcus aureus (46.48%). Klebsiella spp. 31 (21.83%), Pseudomonas spp. (16.20%). and E. coli 16 (11.27%) were the most frequently isolated Gram-negative bacteria.

Table 3: Antibiotic Sensitivity Pattern of the Isolated Bacteria (N=142)

Antibiotics	Sensitive		Resistant		Used disc
	n	%	n	%	

Penicillin G	7	10.45	60	89.55	67
Cefixime	10	25.00	30	75.00	40
Cephalexin	13	25.00	39	75.00	52
Azithromycin	19	31.15	42	68.85	61
Amoxicillin	23	32.39	48	67.61	71
Tobramycin	6	35.29	11	64.71	17
Oxacillin	18	36.73	31	63.27	49
Cefuroxime	17	36.96	29	63.04	46
Cefotaxime	25	52.08	23	47.92	48
Co-Trimoxazole	68	52.31	62	47.69	130
Cefepime	40	55.56	32	44.44	72
Netilmicin	9	56.25	7	43.75	16
Piperacillin	11	57.89	8	42.11	19
Ceftriaxone	41	58.57	29	41.43	70
Ceftazidime	13	59.09	9	40.91	22
Levofloxacin	94	69.63	41	30.37	135
Ciprofloxacin	52	70.27	22	29.73	74
Meropenem	62	72.09	24	27.91	86
Imipenem	50	73.53	18	26.47	68
Gentamycin	101	74.81	34	25.19	135
Clindamycin	49	75.38	16	24.62	65
Polymyxin	13	76.47	4	23.53	17
Cefoxitin	20	76.92	6	23.08	26
Amikacin	90	77.59	26	22.41	116
Tigecycline	14	82.35	3	17.65	17
Vancomycin	55	85.94	9	14.06	64
Linezolid	61	88.41	8	11.59	69
Chloramphenicol	62	95.38	3	4.62	65
Moxifloxacin	56	96.55	2	3.45	58

Regarding resistant pattern, the common resistant anti-microbial agents were Penicillin G (89.55%), Cefixime (75%), Cephalexin (75%), Azithromycin (68.85%), Amoxicillin (67.61%), Tobramycin (64.71%), Oxacillin (63.27%), Cefuroxime (63.04%), Cefotaxime (47.79%), Co-Trimoxazole (47.69%), Cefepime (44.44%), Netilmicin (43.75%), Piperacillin (42.11%), Ceftriaxone (41.43%) and Ceftazidime (40.91%).

Figure 2 shows majority 94(66%) were found multiple anti-microbial resistant

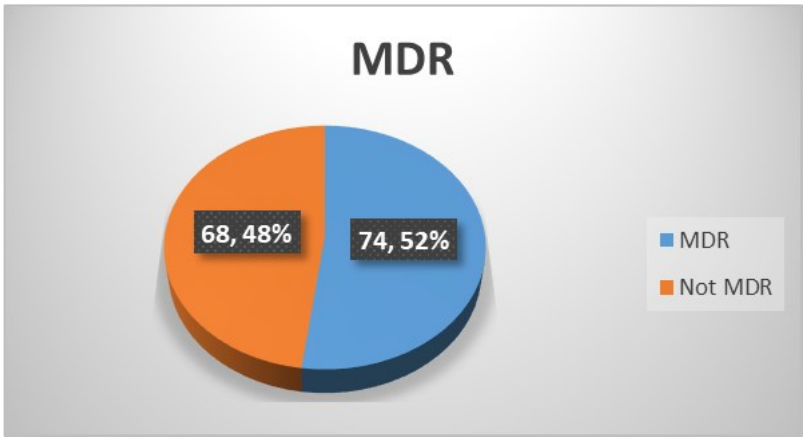

Figure 2: Multidrug Resistance

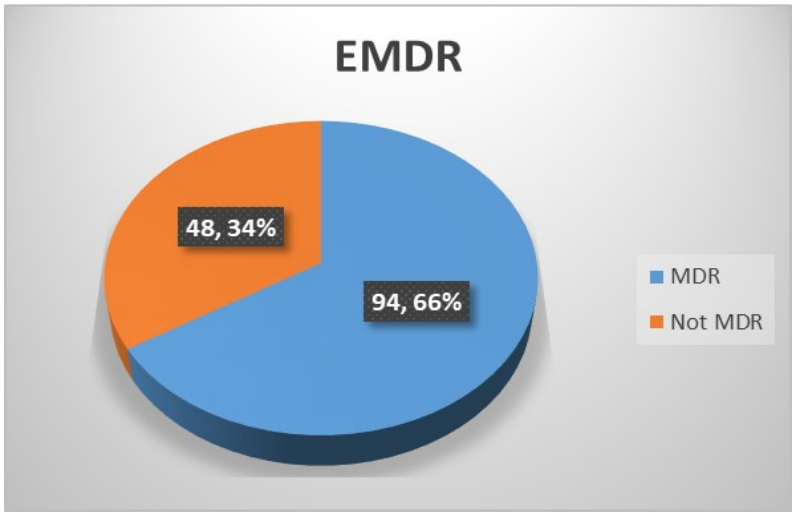

Figure 3: Extreme Multidrug Resistance

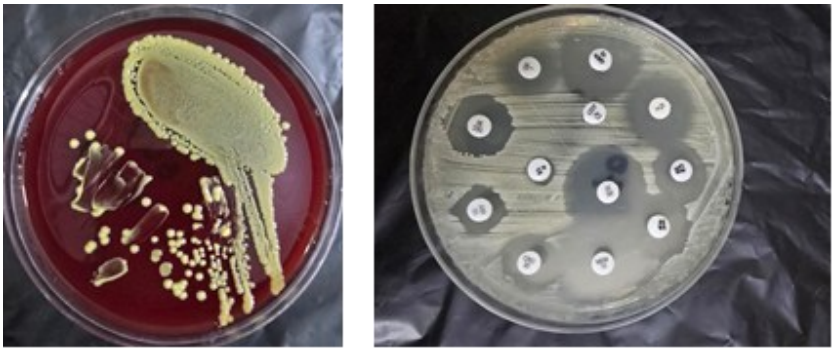

Figure 4: Staphylococcus aureus colony and antimicrobial sensitivity

DISCUSSION

This study assessed the prevalence of multidrug-resistant (MDR) bacteria in wound infections and identified the commonly associated microorganisms at the Microbiology and Virology Department of KPJ Dhaka Specialized Hospital and Nursing College, Gazipur. Gram staining, age, and sex were considered as independent variables.

In this study, we observed that the mean age was 37.43 (±18.14) years, the minimum age was 1 year, and the maximum age was 80 years. Male were predominant

123(56.2%) and 96(43.8%) were female. Kumar *et al*, study revealed that the patient age range was broad, spanning 18 to 85 years, with a nearly balanced gender representation (53.57% male, 46.43% female) [2]. Alam *et al*, study revealed that bacteria isolated from children and older aged patients with wound infections are more prone to become MDR than bacteria from other age groups [11]. Isolates from patients aged >60 years had 1.77 times more chance of becoming MDR in comparison to bacteria isolated from young-adult patients (20-39 years). Moreover, wound samples isolated from children also showed a relatively higher percentage (72.8%) of MDR.

The current study observed that the majority of Gram-positive organisms were Staphylococcus aureus (46.48%). Klebsiella spp. 31 (21.83%), Pseudomonas spp. (16.20%). and E. coli 16 (11.27%) were the most frequently isolated Gram-negative bacteria. Nobel *et al*, reported that the most prevalent Gram-positive and Gram-negative bacteria present in wound infections were Staphylococcus spp [3]. (81.5%) and Pseudomonas spp. (89%), respectively. The distribution of pathogens revealed that E. coli was the most frequently isolated organism, accounting for 52 isolates (37.14%), and followed by Klebsiella pneumoniae with 36 isolates (25.71%). These two Enterobacteriaceae are common etiological agents in both community- and hospital-acquired infections, particularly urinary and lower respiratory tract infections. Pseudomonas aeruginosa (17.14%) and Acinetobacter baumannii (11.43%) were also significant contributors, primarily isolated from respiratory and wound samples, as reported similarly by Agyepong *et al* and Kindu *et al*. Less frequently isolated were Proteus mirabilis (5.71%) and Enterobacter cloacae (2.86%) [12, 13]. This distribution reflects a typical Gram-negative profile found in tertiary care settings, with Enterobacteriaceae predominating, but with a notable presence of non-fermenters in high-dependency units [12, 13]. According to several studies, the most common bacteria that cause wound infections are Staphylococcus aureus, Pseudomonas aeruginosa, E. coli, Acinetobacter spp. and Klebsiella spp [14-16]. They have found that Staphylococcus aureus followed by Pseudomonas spp. and E. coli were the most prevalent organisms associated with wound infections, which is supported by several studies conducted previously [17, 18].

Regarding resistant patterns, common antimicrobial-resistant antibiotics included Penicillin G (89.55%), Cefixime (75%), Cephalexin (75%), Azithromycin (68.85%), Amoxicillin (67.61%), Tobramycin (64.71%), Oxacillin (63.27%), Cefuroxime (63.04%), Cefotaxime (47.79%), Co-Trimoxazole (47.69%), Cefepime (44.44%), Netilmicin (43.75%), Piperacillin (42.11%), Ceftriaxone (41.43%), and Ceftazidime (40.91%). Kim *et al*, reported that the isolated strains showed high resistance to Ampicillin (89%), Ciprofloxacin (90.8%), Cefepime (90.5%), Piperacillin (91.8%), and Oxacillin (92.5%) [1]. According to Morehead and Scarbrough's analysis, the most effective antimicrobials against Gram positive bacteria were Meropenem, Gentamicin, and Amikacin. They did not find Meropenem-resistant Staphylococcus aureus. Cefixime, Ceftazidime, Amoxicillin, and Penicillin G were identified as the most resistant antimicrobials to Gram positive isolates, with over 70% resistance. More than 90% of Staphylococcus aureus were reported to be resistant to Amoxicillin and Ceftazidime, and 81.8% of Staphylococcus aureus were found to be resistant to Azithromycin and Cefuroxime [19]. More than 50% of all Staphylococcus spp. were resistant to Levofloxacin (50.6%), Cefixime (71.9%), Colistin (53.9%), Penicillin G (68.5%), Cefradine (51.6%), Amoxicillin (68.5%), Ceftazidime (70.8%), and Trimethoprim/Sulfamethoxazole (59.5%). Kumar *et al*, reported that among the MDR group (n = 78), resistance was highest to Ceftriaxone (84.62%), Ciprofloxacin (79.49%), and Cefepime (76.92%), reflecting compromised efficacy of commonly used third- and fourth-generation cephalosporins and fluoroquinolones [2]. Even Piperacillin-Tazobactam, a frequently used empirical therapy, showed 61.54% resistance. Carbapenem resistance, our last-line defense, was lower in MDR isolates but significantly higher in XDR isolates.

The present study revealed that a significant majority, 94 individuals (66%), exhibited multiple antimicrobial resistance. In a study by Kumar *et al*, multidrug-resistant (MDR) organisms accounted for 78 isolates (55.71%), demonstrating resistance to at least one agent across three or more antimicrobial categories [2]. Similarly, in the research conducted by Alam *et al*., out of a total of 1,266 bacterial isolates, 850 (67.1%) were identified as multidrug-resistant (MDR) based on the definition of MDR used in our study.

CONCLUSION

In our investigation, the most prevalent isolates were Staphylococcus aureus, a Gram-positive pathogen. Among the Gram-negative bacteria, Klebsiella spp., Pseudomonas spp., and E. coli were the most frequently isolated. Polymyxin, Clindamycin, Gentamicin, Imipenem, Meropenem, and Ciprofloxacin were identified as the most effective antibiotics against both Gram-positive and Gram-negative microorganisms. However, most commercially available antibiotics used in Bangladesh showed high levels of resistance among the isolates. A significant rate of multidrug resistance (MDR) was observed among the commonly isolated microorganisms. The ongoing rise of MDR organisms presents a serious and growing public health concern. Early detection of drug-resistant bacteria and evidence-based treatment strategies are vital for the effective prevention and management of wound infections.

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