



## Original Article

# Antimicrobial Susceptibility Pattern of the Causative Bacterial Agents Among the Patients with Diabetic Foot Infection and Pneumonia in the Rajshahi Region

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### Abstract

**Background:** Infection and Diabetes often coexist, making each other the worse for it. Patients with diabetes have a greater frequency and severity of many common infections such as urinary, pulmonary, soft tissue infections. This study aims to describe the bacterial agents and determine the antimicrobial susceptibility of diabetic foot infections (DFI) and pneumonia in the Rajshahi region.

**Materials and Methods:** A descriptive study was performed over a period of one year in a tertiary care hospital that involved 120 patients. The aerobic bacterial agents were isolated, their antimicrobial susceptibility patterns were determined from wound swab and sputum samples.

**Results:** A total of 106 microorganisms were isolated among 95 culture-positive cases. The microorganism isolated were 50.94% (n = 54) GN (Gram-negative) and 49.06% (n = 52) GP (Gram-positive). GN microorganisms include *Pseudomonas* spp. (25.47%), *E. coli* (14.15%), *Klebsiella* spp. (9.43%), and *Proteus* spp. (1.89%). *S. aureus* (38.68%) were predominant among GP, followed by *S. pyogenes* (3.77%) and *Enterococcus* spp. (1.89%). About 4.72% were Coagulase Negative *Staphylococcus* (CoNS). *S. aureus* showed 95.12% sensitivity to Vancomycin and 90.24% to Imipenem. On the other hand, *Pseudomonas* spp. showed highest 85.19% sensitivity to Meropenem.

**Conclusion:** Gram-negative (GN) microorganisms were predominantly isolated from DFIs and pneumonia, but *S. aureus* was the most frequently isolated organism. They showed a wide range of susceptibility towards different antimicrobials.

**Keywords:** Diabetic foot infection, pneumonia, antimicrobial susceptibility.

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### Introduction

Diabetic Foot Infection (DFI) is a major complication of diabetes, eventually leading to the development of gangrene and lower-extremity amputation, and constitutes the most frequent

diabetes-related cause of hospitalization.<sup>1,2</sup> The magnitude and duration of hyperglycemia are strongly associated with the severity of microvascular and neurologic complications.<sup>3</sup> Chronic foot infections in patients with diabetes

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mellitus usually complicate initially uninfected ulcerations that follow minor trauma in patients with peripheral neuropathy, chronic neuropathic ulcers or arterial vascular insufficiency and take the form of cellulitis, soft tissue necrosis or osteomyelitis.<sup>4</sup>

The global diabetic foot infection prevalence was 6.3% and in Europe 5.1%<sup>5</sup>. In the Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorder (BIRDEM), they found 4% of diabetic patients were suffered from DFI<sup>6</sup> (Islam *et al.*, 2010).

Diabetes mellitus is often regarded as an independent risk factor for the development of lower respiratory tract infection, specially pneumonia.<sup>7</sup> Pneumonia in itself is a serious illness associated with considerable morbidity and mortality, and any associated condition decreased body's immunity may lead to severe disease and worse outcomes. Infections due to *S. aureus*, Gram-negative bacteria, and Mycobacteria occur with increased frequency in diabetic patients. DM increases the risk of community-acquired pneumonia (CAP) besides increasing the morbidity and mortality in CAP.<sup>7</sup>

These infections are difficult to treat because these patients have impaired microvascular circulation, which limits the access of phagocytic cells and poor concentration of antibiotics in the infected tissue.<sup>8</sup>

In Bangladesh, the most frequently isolated pathogens are Gram-positive and Gram-negative aerobic organisms, including *Klebsiella pneumoniae* (22.1%), *Pseudomonas aeruginosa* (18.2%), *Staphylococcus aureus* (14.3%), *E. coli* (13%), CoNS (7.8%) (Mohammuddunnobi *et al.*, 2018). *Bacteroides fragilis*, *Enterococcus faecalis*, *Peptostreptococcus* species, *Proteus vulgaris*, *Acinetobacter baumannii* were also found.<sup>9</sup>

Many of these microorganisms develop resistance to commonly used antibiotics largely due to their indiscriminate use<sup>10</sup> The proper management of these infections requires appropriate antibiotic selection based on culture and antimicrobial susceptibility testing, which may also help to

reduce the development of multidrug resistance to avoid further complications of these already worse infections. Therefore, this study is aimed with the objective to determine the bacterial profile and antimicrobial susceptibility pattern of these infections in Rajshahi.

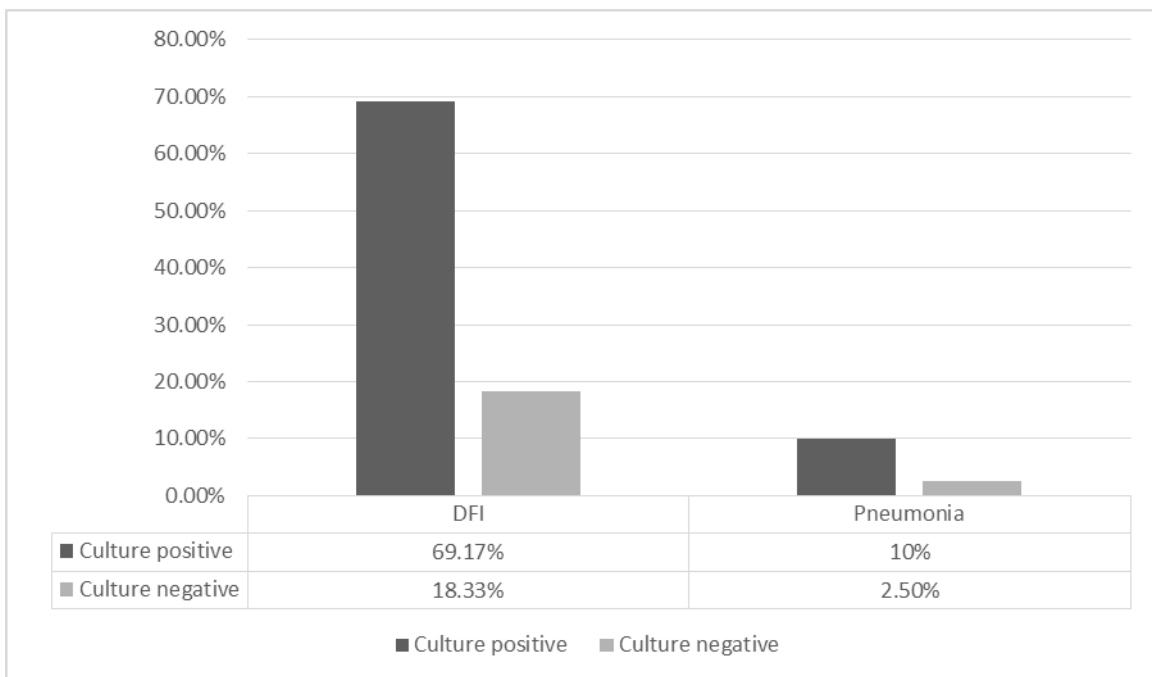
**Methods:** A cross-sectional descriptive study was conducted during the period from July 2018 till June 2019. Adult 120 diabetic patients irrespective of age and sex having DFI and pneumonia attending RMCH and Diabetic Association General Hospital, Rajshahi, were included in the study. Microbiological works were done in the laboratory of The Department of Microbiology, Rajshahi Medical College (RMC). Wound swabs and sputum have been collected as specimens, and data were compiled in a partially structured pre-tested datasheet. Culture and identification of the organisms of the specimens and antimicrobial susceptibility testing were done according to the Clinical and Laboratory Standards Institute (CLSI) guideline 2017 and World Health Organization (WHO).<sup>11,12</sup>

**Results:** A total of 120 specimens were collected from Diabetic Foot Infection (DFI) and pneumonia cases and cultured in different aerobic bacteriological culture media. Most of the patients were in the 41-60 years (75; 62.5%) age group, with the mean age of the study population was 56.23 years (Table 1). Overall male predominance was observed with a male-female ratio of 1.6:1. Among them, 105(87.5%) were DFI cases, and 15(12.5%) were pneumonia cases. Total 95(79.17%) were culture positive, and 25(20.83%) were negative culture cases (Figure 1). The microorganism isolated were 50.94% (n = 54) GN (gram-negative) and 49.06% (n = 52) GP (gram-positive) (Figure 2). GN microorganisms include *Pseudomonas* spp. (25.47%), *E. coli* (14.15%), *Klebsiella* spp. (9.43%), and *Proteus* spp. (1.89%). *S. aureus* (38.68%) were predominant among GP, followed by *S. pyogenes* (3.77%) and *Enterococcus* spp. (1.89%). About 4.72% were CoNS (Table 2). *S. aureus* showed 95.12% sensitivity to Vancomycin and 90.24% to Imipenem. On the other hand, *Pseudomonas* spp. showed the highest 85.19% sensitivity to Meropenem (Table 2).

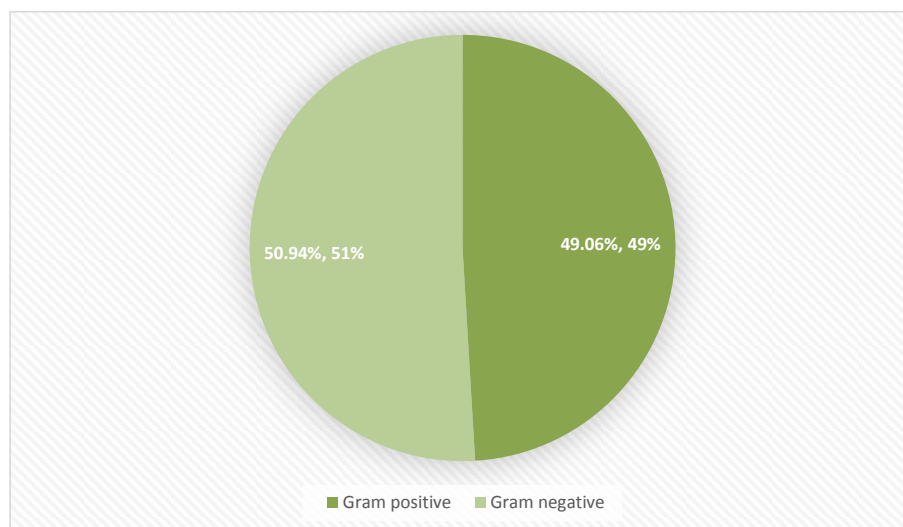


**Table 1: Demographic data of DFI and pneumonia cases. (N =120)**

Variables	(n %)
Age (years)	(41-60, highest age group)
Mean age	56.23 years
Gender	
Male	73(60.83%)
Female	47(39.17%)
Presentation (Sample)	
DFI (wound swab)	105(87.5%)
Pneumonia(sputum)	15(12.5%)

**Figure 1: Culture characteristics of isolated organisms (DFI=105, pneumonia=15).**

**Figure 2: Distribution of isolated Gram-positive and Gram-negative bacteria from DFI and Pneumonia cases. (N=106)**



**Table 2: Distribution of isolated aerobic bacteria from DFI and Pneumonia cases with their susceptibility (N=106)**

Isolated bacteria	<i>S.aureus</i> (41, 38.68%)	<i>S. pyogenes</i> (4, 3.77%)	CoNS (5, 4.72%)	<i>Enterococcus faecalis</i> (2, 1.89%)	<i>Pseudomonas aeruginosa</i> (27, 25.47%)	<i>E.coli</i> (5, 14.15%)	<i>Klebsiella pneumoniae</i> (10, 9.43%)	<i>Proteus vulgaris</i> (2, 1.89%)
Ceftazidime	21.95%	25.00%	40.00%	0.00%	33.33%	66.67%	30.00%	0.00%
Azithromycin	14.63%	25.00%		0.00%	18.52%	26.67%	30.00%	0.00%
Oxacillin	24.39%	25.00%	20.00%	0.00%	-	-	-	-
Vancomycin	95.12%	100.00%	80.00%	100.00%	-	-	-	-
Imipenem	90.24%	100.00%	60.00%	100.00%	81.48%	86.66%	80.00%	100.00%
Amoxiclav	51.22%	50.00%	40.00%	50.00%	51.85%	60.00%	60.00%	50.00%
Cefuroxime	29.26%	25.00%		0.00%	-	60.00%	40.00%	0.00%
Ceftriaxone	21.95%	25.00%	20.00%	0.00%	14.81%	46.67%	30.00%	0.00%
Ciprofloxacin	53.66%	-	40.00%	50.00%	33.33%	53.33%	70.00%	50.00%
Gentamycin	78.05%	75.00%	60.00%	50.00%	51.85%	80.00%	40.00%	50.00%
Amikacin	43.90%	50.00%	40.00%	100.00%	-	53.33%	60.00%	100.00%
Piperacillin/Tazobactam	-	-		-	77.78%	-	-	-
Meropenem	-	-	60.00%	-	85.19%	80.00%	80.00%	100.00%
Polymyxin	-	-		-	92.59%	-	-	-
Colistin	-	-		-	92.59%	-	-	-

## Discussion

This study included 120 patients with Diabetes mellitus presenting with wound infection and pneumonia (105+15=120) (Table 1). The highest age group was (41-60) years (62.50%) with a mean age of 56.23 years (Table 1), which was similar to an Indian study.<sup>13</sup> As age increases, the chance of getting foot infections and pneumonia also increases.

Male (60.83%) were predominant subjects in both DFI and Pneumonia cases (Table 1). India and Bangladesh also reported alike with present study.<sup>14,15</sup>

In this study, most of the specimens from DFI (69.17%, n=83) and pneumonia (10%, n=12) cases were culture-positive (Figure 1). Out of 105 DFI cases, 83(79.05%) were culture positive. It is similar to the studies from Indonesia.<sup>16</sup> On the other hand, some studies showed more than 90% culture-positive cases of DFI, which were dissimilar with this study.<sup>17</sup>

In the present study, among 15 pneumonia cases, 12 (80%) were culture positive (Figure 1). In Bangladesh, 76% culture-positive pneumonia cases were found, which was similar to the present study.<sup>18</sup> The culture-negative cases might be due to patients already receiving antibiotics prior to sample collection or due to infection caused by anaerobic organisms or fungus.

In DFI cases, the isolates were predominantly gram-negative (51.06%), and in pneumonia cases, the isolates were 50% gram-positive and 50% gram-negative (Figure 2).

Overall, 106 isolates were found from 95 culture-positive cases; among them, 54(50.94%) were gram-negative, and 52(49.06%) were gram-positive. Similar findings were found in Korea.<sup>17</sup> In their study, they found near equal distribution of gram-positive and gram-negative growth, like the present study. There are some other studies that showed the opposite picture of the present study. They found the majority of growth as gram-negative.<sup>16</sup> This might be due to the variation of organisms from region to region.

In this study several aerobic organisms were isolated (Table 2) from DFI and pneumonia cases such as *S. aureus* (41, 38.38%), *Pseudomonas aeruginosa* (27, 25.47%), *E.coli* (15, 14.15%), *Klebsiella pneumoniae* (10, 9.43%), CoNS (5, 4.72%), *Streptococcus pyogenes* (4, 3.77%), *Enterococcus faecalis* (2, 1.89%) and *Proteus vulgaris* (2, 1.89%). This study was in agreement with other studies conducted in Korea, India, and Bangladesh.<sup>17,14,9</sup>

The variation in organisms might be multifactorial, such as geographical location, personal hygiene, presence of other systemic diseases, and prolonged stay in hospital.

The pattern of antimicrobial resistance is important for epidemiological and clinical purposes. For the rational use of antibiotics, it is important to choose appropriate antibiotics in this era of multidrug-resistant (MDR) organisms.

The present study shows antimicrobial susceptibility pattern of *S. aureus* (Table 2) that were the predominant organism, showed the highest sensitivity to Vancomycin (95.12%) followed by Imipenem (90.24%) and Gentamycin (78.05%). This study was in conformity with the reports of some Pakistani and Bangladeshi studies.<sup>19,20</sup>

*Pseudomonas aeruginosa* in the study showed (Table 2) the highest sensitivity to Meropenem 85.19%, followed by Imipenem 81.48% and Piperacillin/Tazobactam 77.78%. These findings were nearly comparable with other studies.<sup>21</sup> In the present study, we found 92.59 % sensitivity for Colistin and Polymyxin B. Some studies found 100% sensitivity towards these drugs, which were near similar to this study.<sup>22</sup>

In our study, we found *E.coli*, which showed 86.66 %, 80.00%, and 80% sensitivity to Imipenem, Meropenem, and Gentamycin, respectively (Table 2). Near similar report was found in the study conducted in India and Pakistan.<sup>21,19</sup>

Increased resistance to Ceftazidime (60%) was noted among the *Klebsiella pneumoniae* isolated in the study group. In India, 50% resistance to Ceftazidime was found.<sup>23</sup> Overall, Imipenem,

Meropenem, and Vancomycin were found to be the most effective drugs for these patients so far.

### Conclusion:

DFI and pneumonia s are common among diabetic patients in this region. Most of the patients are above 40 years of age with male predominance. The majority of the specimen were culture positive. Though gram-negative bacteria are the dominating bacteria, *S. aureus* is the most prevalent one. Vancomycin and Imipenem are the drugs of choice for most gram-positive bacteria, and Meropenem and Imipenem are found to be effective against gram-negative bacteria.

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