Original Article

Microbiological profile of community acquired pneumonia in diabetic patients and their antibiotic sensitivity pattern in a tertiary care hospital of Bangladesh

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ABSTRACT

Background: *Diabetes mellitus is an immunosuppressive state leading to increased susceptibility to various infections. Pneumonia, urinary tract infection, skin and soft tissue infection are more common in diabetic population. Pneumonia in diabetic patient is often atypical, caused by more virulent organisms and associated with increased antibiotic resistance. The predisposition for infection may also be based on conditions that interfere with normal clearance mechanisms and on disturbance of pulmonary immune cell function. Several aspects of immunity such as polymorphonuclear leukocyte function (i.e. leukocyte adherence, chemotaxis and phagocytosis) and bactericidal activity of serum are depressed in patients with diabetes. This study was designed to evaluate the microorganisms most commonly causing community acquired pneumonia in diabetic patients.*

Methods*: This descriptive type of cross-sectional study was conducted in Department of Medicine, BIRDEM General Hospital from 25th March 2018 to 24th September 2018. Total 50 diabetic patients with community acquired pneumonia were included. Detail demographic data were collected and recorded in structured case report form. Clinical examination and relevant investigation were done. Antibioctic sensitivity pattern of isolated organisms were studied.*

Results*: Mean age of the patient was 53.4 ± 11.5 years. Male and female ratio was 1.6:1. In this study* Klebsiella pneumoniae *was found to be the most prevalent 14 (30.4%), followed by* Streptococcus pneumoniae *11 (23.9%). Among the Gram-positive cocci,* Streptococcus pneumonia *11 (23.9%) was the predominant, followed by* Staphylococcus aureus *in 6 (13.0%) patients. Bacterial antibiotic sensitivity pattern to ceftriaxone, ceftazidime, cefixime and amoxycillin were as follows:* Klebsiella pneumonia *(57.1%, 14.2%, 28.5%, 21.4% respectively),* Streptococcus pneumonia *(45.5%, 54.5%, 36.3%, 0% respectively). Present study shows that maximum patients (72.0%) were having uncontrolled glycemic status. In this study, most of the growth of all the bacteria (*Klebsiella *64.2%,* Staphylococcus *72.8%,* Pseudomonas *60.0%,* Acinetobacter *100%,* E. coli *100%) occurred in patients with poor glycemic control (HbA1c ≥7.0%).*

Conclusions: *This study results concluded that CAP in diabetic patients are more frequently due to Gram negative bacilli like* Klebsiella pneumoniae*,* Pseudomonas *and also* Staphylococcus aureus *and they are resistant to commonly used antibiotics. So, effective treatment of community acquired pneumonia in diabetic patients should be guided by sputum culture results.*

Key words: *community acquired pneumonia, diabetes mellitus, antibiotic sensitivity.*

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INTRODUCTION

Diabetes is the leading cause of morbidity and mortality in both developed and developing countries. The global prevalence (age-standardized) of diabetes has nearly doubled since 1980, rising from 4.7% to 8.5% in the adult population.[1] The global costs of diabetes and its consequences are large and will substantially increase by 2030.[2] Prevalence of diabetes in adults worldwide was estimated to be 4.0% in 1995 and to rise to 5.4% by the year 2025. It is higher in developed than in developing countries. The number of adults with diabetes in the

world will rise from 135 million in 1995 to 300 million in the year 2025.[3] High incidence of diabetes in Bangladesh is due to sedentary life style, lack of physical activity, obesity, stress and consumption of diet rich in fat, sugar and calories. Increasing economic growth will raise diabetes prevalence in Bangladesh even more than what is estimated.

Pneumonia, urinary tract infection, skin and soft tissue infections are all more common in diabetic population.[4, 5] In general, the organisms that cause pulmonary infection are similar to those found in the non-diabetic population; however, Gram negative organisms, *Staphylococcus aureus* and *Mycobacterium tuberculosis* are more frequent organisms.[6] For patients with community acquired pneumonia, diabetes mellitus is one of the most common predisposing risk factor. The magnitude and duration of hyperglycemia with glycaemic status is strongly associated with the severity of micro vascular and neurologic complication.[7] The presence of these complications add to risk of infection. The predisposition for infection may also be based on conditions that interfere with normal clearance mechanisms and on disturbance of pulmonary immune cell function.[5]

In patients with pneumonia, diabetes mellitus is associated with polymicrobial etiology, multilobe involvement, increased intensive care unit (ICU) admissions, increased severity in the form of high pneumonia severity index score and mortality.[8] Glycemic status has impact on severity of complication and infection. Specific defects in innate and adaptive immune function have been identified in diabetic patients. Several aspects of immunity such as polymorphonuclear leukocyte function (i.e. leukocyte adherence, chemotaxis and phagocytosis) and bactericidal activity of serum are depressed in patients with diabetes.[9, 10] Alteration in T-lymphocyte subsets, including relative reduction in T-helper lymphocyte, could interfere with immune defence against infection. As a response to infection and cytokine release, insulin resistance in peripheral tissue occurs, resulting in the elevation at blood sugar.[7] Hyperglycemia impairs a wide range of functions in neutrophils and monocytes (macrophages) this is particularly important in limiting invasion by pyogenic and other bacteria.[7, 10]

The presence of healthy microcirculation is essential to certain infectious insults. Alteration in the function of capillary endothelium, the rigidity of red blood corpuscles and changes in the oxygen dissociation curve that occur as a result of chronic hyperglycemia are factors which affect the host ability to combat infection. It is therefore no surprise that patient with long standing diabetes with micro vascular complications are at a much greater risk of infections than non-diabetic or diabetics without complications. The reduced oxygen supply to tissue as a result of micro vascular changes predisposes them to infections by anaerobic organisms which grow best under such conditions.[11]

Community-acquired pneumonia (CAP) is one of the most common infectious disease requiring hospitalization. Study in Bangladesh reported that, majority of the patients had growth of *Klebsiella pneumoniae* in sputum, followed by *Staphylococcus aureus* and then other Gram negative bacteria. All (100%) of the *Pseudomonas* and *Acinetobacter* were sensitive to colistin and all (100%) of the *Staphylococcus aureus* were sensitive to vancomycin. Regarding glycemic status, most of the bacterial growth was isolated in patients with uncontrolled diabetes as evidenced by HbA1c e”7.0%.[12] Another study reported that *Streptococcus pneumoniae* is the most frequently isolated micro-organism in CAP, followed by the Gram-negative bacterium *Haemophilus influenzae.*[13] Another study shows that Gram negative organisms were isolated more (56%) than Gram-positive organisms. Most common bacteria isolated were *K. pneumoniae.*[14] Pneumonia in diabetes major cause of morbidity and mortality. Aim of this study was to see the microorganisms most commonly causing community acquired pneumonia in diabetic patients.

METHODS

This cross-sectional observational study was conducted in Department of Medicine, Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) General Hospital, Dhaka, from 25th March 2018 to 24th September 2018. Total 50 diabetic patient with CAP were enrolled for study. Patients with nosocomial

pneumonia, ventilator associated pneumonia, patient on immunosuppressive agent and patient with end-stage renal disease were excluded. The diagnosis of dibetes and CAP was confirmed by clinical history, physical examination and available medical records evidence. Informed written consent was obtained accordingly. Plan of treatment and outcome of modalities of treatment, antibiotic sensitivity pattern, common organism of CAP was evaluated. Patients were monitored and followed-up after initial treatment and outcome was measured accordingly. All the information recorded in data collection sheet. Data was processed and analysed with the help of computer program SPSS and Microsoft excel. Quantitative data expressed as mean and standard deviation and qualitative data as frequency and percentage. Result was presented by tabulation and graphical presentation in the form of tables, pie chart, graphs, bar diagrams, histogram and charts etc.

RESULTS

Total patients were 50 with a mean age of 53.4 ± 11.5 years. Male and female ratio was 1.6:1. Large numbers of respondents came from urban area (Table I).

Table I. Demographic characteristics of the patients (N=50)

Variables	Male (n=31)	Female (n=19)
Age (years)		
30-40	1(3.2%)	0
41-50	9(29.0%)	6(31.5%0
51-60	16(51.6%)	11(57.8%)
>60	5(16.1%)	2(10.5%)
Mean ± SD	53.4 ± 11.5	
Residence		
Rural	10(32.2%)	6(31.5%)
Urban	21(67.7%)	13(68.4%)

Imaging findings shows that, patchy consolidation (48%), followed by interstitial infiltrates (18.0%). Lobar consolidation was present in 30.0% and patchy ground-glass opacity with peribronchial nodules in lung field was detected in 4.0% patients (Table II).

Table II. Imaging findings of the patients (N=50)

Imaging findings	Frequency	Percentage
Patchy consolidation in lung field	24	48.0
Lobar consolidation	15	30.0
Interstitial infiltrates	9	18.0
Patchy ground-glass opacity with peribronchial nodules in lung field	2	4.0

Sputum containing more than 25 polymorphonuclear cells and less than 10 epithelial cells per low power field was subjected to Gram staining and culture. Of the 50 sputum samples, 46 (92.0%) yielded growth. Among the 46 growths, 17 (34.0%) were Gram-positive cocci, 22 (44.0%) were Gram negative bacilli and 7 (14.0%) were Gram negative coccobacilli.

Klebsiella pneumoniae was found to be the most prevalent 14 (30.4%), followed by *Streptococcus pneumoniae* 11(23.9%). Among the Gram-positive cocci, *Streptococcus pneumonia* 11 (23.9%) was the predominant, followed by *Staphylococcus aureus* in 6 (13.0%) of patients. *Klebsiella pneumonia* was the predominant Gram-negative bacilli, followed by *Pseudomonas aeruginosa* in 5 (10.8%) of patients and *Escherichia coli* in 3 (6.5%) of patients. Gram negative coccobacilli was *Haemophilus influenza* in 4 (8.6%) and *Acinetobacter* in 3 (6.5%) of sputum samples (Table III). Bacterial antibiotic sensitivity pattern was given in Table IV.

Table III. Isolated micoorganism from Sputum culture with frequency (n=46)

Bacterial growth in sputum culture	Frequency	Percentage
Streptococcus pneumoniae	11	23.9
Staphylococcus aureus	6	13.0
Klebsiella pneumoniae	14	30.4
Pseudomonas aeruginosa	5	10.8
Escherichia coli	3	6.5
Haemophilus influenzae	4	8.6
Acinetobacter	3	6.5

Table IV. Sensitivity of common bacterial growth in sputum to different antibiotics (n=46)

Bacterial growth in sputum culture		Sensitivity of antibiotics*						
		CTR	CFT	CXM	AMC	AMK	CIP	CHL IMI
Streptococcus pneumonia (n=11)	5(45.5%)	6(54.5%)	4(36.3%)	0	2(18.1%)	2(18.1%)	5(45.5%)	9(81.8%)
Staphylococcus aureus (n=6)	2(33.3%)	3(50.0%)	3(50.0%)	1(16.7%)	0	0	4(66.7%)	6(100.0%)
Klebsiella pneumonia (n=14)	8(57.1%)	2(14.2%)	4(28.5%)	3(21.4%)	5(35.7%)	2(14.2%)	4(28.5%)	12(85.7%)
Pseudomonas aeruginosa (n=5)	1(20.0%)	0	1(20.0%)	0	4(80.0%)	1(20.0%)	0	4(80.0%)
Escherichia coli (n=3)	1(33.3%)	0	0	0	2(66.7%)	0	1(33.3%)	3(100.0%)
Haemophilus influenza (n=4)	1(25.0%)	0	1(25.0%)	0	3(75.0%)	0	1(25.0%)	3(75.0%)
Acinetobacter (n=3)	0	0	0	1(33.3%)	3(100.0%)	1(33.3%)	0	3(100.0%)

**Sensitivity pattern shown in the table is the percentage of isolates. AMC: amoxicillin; AMK: amikacin; CFT: ceftazidime; CIP: ciprofloxacin; CTR: ceftriaxone; CXM: cefixime; CHL: Cephalexin; IMI: Imipenem.*

Figure 1 and 2 shows the spectrum of bacterial growth in relation to glycemic status of diabetes patients. Regarding glycemic status, most of the bacterial growth was isolated in patients with uncontrolled diabetes (HbA1c ≥7.0%).

Bacterial antibiotic sensitivity pattern to ceftriaxone, ceftazidime, cefixime and amoxycillin were as follows: *Klebsiella pneumonia* (57.1%, 14.2%, 28.5%, 21.4% respectively), *Streptococcus pneumonia* (45.5%, 54.5%, 36.3%, 0% respectively), *Staphylococcus aureus* (33.3%, 50.0%, 50.0%, 16.7% respectively), *Pseudomonas species* (20.0%, 0%, 20.0%, 0% respectively), *Escherichia coli* (33.3%, 0%, 0%, 0% respectively), *Haemophilus influenza* (25.0%, 0%, 25.0%, 0% respectively), *Acinetobacter* (0%, 0%, 0%, 33.3% respectively). Bacterial antibiotic sensitivity pattern to amikacin, ciprofloxacin, cephalexin and imipenem were as follows: *Klebsiella pneumonia* (35.7%, 14.2%, 28.5%, 85.7% respectively), *Streptococcus pneumonia* (18.1%, 18.1%, 45.5%, 100% respectively), *Staphylococcus aureus* (0%, 0%, 66.7%, 100% respectively), *Pseudomonas species* (80.0%, 20.0%, 0%, 80.0% respectively), *Escherichia coli* (66.7%, 0%, 33.3%, 100.0% respectively), *Haemophilus influenza* (75.0%, 0%, 25.0%, 75.0% respectively), *Acinetobacter* (100%, 33.3%, 0%, 100% respectively). Present study shows that maximum patients (72.0%) were uncontrolled glycemic status.

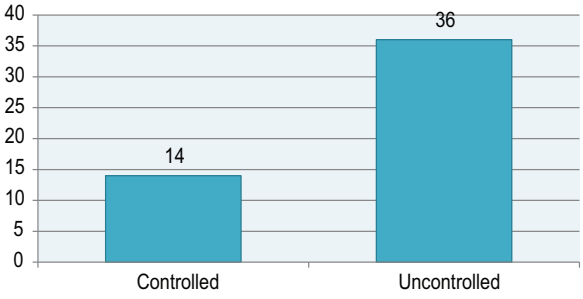

Figure 1. Glycemic status of the respondents (N=50)

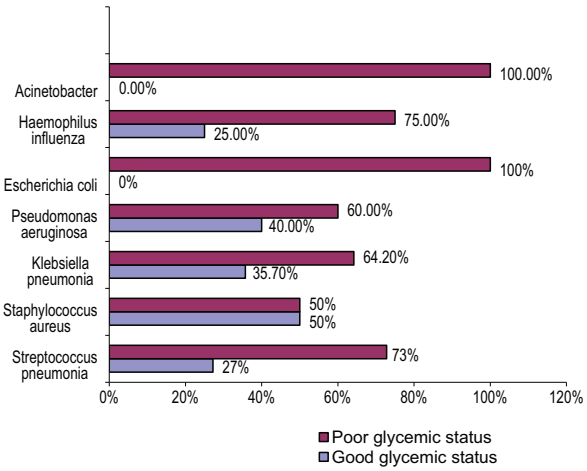

Figure 2. Spectrum of bacterial growth in relation to glycemic status of diabetes patients (N=50)

Figure shows the spectrum of bacterial growth in relation to glycemic status of diabetes patients. Regarding glycemic status, most of the bacterial growth was isolated in patients with uncontrolled DM as evidenced by HbA1c ≥7.0%.

DISCUSSION

More than half of our patients were in 5th decade of life and mean age of the patient was over 53 years and there was male predominance. One study reported that mean age (±SD) of the patients was 57.93±9.71 years.[8] Other studies also noted male predominance.[12,15]

In this study *Klebsiella pneumoniae* was the most prevalent organism followed by *Streptococcus pneumoniae*. *Staphylococcus aureus* was in 13.0% of patients. This finding is similar to other studies conducted in Bangladesh[12, 16, 17] but somehow different from another study in India where the majority of growth was *Pseudomonas* followed by *Staphylococcus* aureus.[18] It has been suggested that patients with DM have increased rate of colonization and adherence of Gram-negative bacteria to the upper respiratory epithelium. From there aspiration of these bacteria to the lung may be facilitated by the use of anti-ulcer drugs and diabetic gastroparesis. Diabetic patients are also at increased risk of Staphylococcal pneumonia as because the rate of nasal carriage of *Staphylococcus* in diabetic patients is 30% compared to 11% in non-diabetic individuals.[19] Similar study in Bangladesh reported, *Klebsiella pneumonia* was the most commonly isolated organism from sputum sample. It is followed by *Streptococcus pneumoniae*, *Staphylococcus aureus*, *E. coli* and *Pseudomonas* aeruginosa.[17]

In this study bacterial antibiotic sensitivity pattern to ceftriaxone, ceftazidime, cefixime and amoxycillin were as follows: *Klebsiella pneumonia* (57.1%, 14.2%, 28.5%, 21.4% respectively), *Streptococcus pneumonia* (45.5%, 54.5%, 36.3%, 0% respectively), *Staphylococcus aureus* (33.3%, 50.0%, 50.0%, 16.7% respectively), *Pseudomonas species* (20.0%, 0%, 20.0%, 0% respectively), *Escherichia coli* (33.3%, 0%, 0%, 0% respectively), *Haemophilus influenza* (25.0%, 0%, 25.0%, 0% respectively), *Acinetobacter* (0%, 0%, 0%, 33.3% respectively). Findings accordance with result of other studies in Bangladesh, e.g., bacterial antibiotic sensitivity pattern to ceftriaxone, ciprofloxacin, amikacin and imipenem were as follows: *Klebsiella pneumoniae* (19%, 47%, 74%, 96% respectively), *Staphylococcus aureus* (1 1%, 33%, 78%, 67% respectively), *Pseudomonas species* (19%, 75%, 81%, 88% respectively), *Acinetobacter* (0%, 0%, 20%, 50% respectively), *Escherichia coli* (22%, 22%, 100%, 100% respectively).[12] Most of these patients had uncomtrolled diabetes (HbA1c e"7.0%).[12] It is worthy to note that growth of relatively uncommon organisms like *Acinetobacter* was quite high in diabetic patients. Moreover, growth of *Streptococcus pneumoniae* is negligible compared to conventional finding in nondiabetic patients.[20] Antibiotic sensitivity pattern showed that most of the bacteria including almost 80% of *Klebsiella* were resistant to ceftriaxone. This is similar to other studies in Bangladesh[16] and India.[20] Similar study in Bangladesh reported regarding antimicrobial sensitivity pattern of isolated organism, all the isolates (100%) of *Klebsiella pneumoniae* from diabetic patients were resistant to co-amoxiclav, 66.7% to levofloxacin, 55.6% to clarithromycin and 11.1% to ceftriaxone and ceftazidime. All isolates of *Staphylococcus aureus* from diabetic patients were sensitive to ceftriaxone, imipenem and meropenem and 50% sensitive to ceftazidime, clarithromycin and levofloxacin and all were resistant to co-amoxiclav. *E. coli* isolates were sensitive to ceftazidime, imipenem and meropenem, 50% to ceftriaxone and levofloxacin and all were resistant to co-amoxiclav. All the *Pseudomonas aeruginosa* isolates were from diabetic patients with CAP, which were sensitive to ceftazidime, imipenem and meropenem and were resistant to co-amoxiclav, ceftriaxone, clarithromycin and levofloxacin.[17]

Bacterial infections were significantly associated with glycemic status. Present study showed that maximum patients (72.0%) had uncontrolled glycemic status. In this study, most of the growth of all the bacteria (*Klebsiella* 64.2%, *Staphylococcus* 72.8%, *Pseudomonas* 60.0%, *Acinetobacter* 100%, *E. coli* 100%) occurred in patients with poor glycemic control (HbA1c ≥7.0%). Previous study reported, most of the bacterial growth was isolated in patients with uncontrolled diabetes. This is because uncontrolled diabetes causes immunosuppression leading to increased chance of any infection including pneumonia.[12]

Diabetes is a global epidemic and growing concern for health care providers due to wide range of complications. Pneumonia, a frequent infection in diabetics, is an

important cause of morbidity and mortality in diabetes. This study results suggest that CAP in diabetic patients are more frequently due to Gram negative bacilli like *Klebsiella pneumoniae*, *Pseudomonas species* and also *Staphylococcus aureus* and mostly they are resistant to commonly used antibiotics. So, effective treatment of CAP in diabetic patients should be guided by sputum culture results. According to the results, this study emphasizes the need for strict glycemic control to prevent any infection in diabetic patients.

Authors' contribution: TA, MAR, AKMM planned the study. TA collected data, analyzed data, drafted manuscript. All authors read and approved final manuscript for submission.

Conflicts of interest: Nothing to declare.

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