Original Research Article

Infections in type 2 diabetic patients and its correlations with glycosylated haemoglobin in a tertiary care teaching hospital

Namita Mohapatra[1], Pratima Soreng[2], Dibya Prasanna Mohanty[3], Gurukrushna Mohapatra[4]*

[1]Department of Medicine, Bhima Bhoi Medical College, Balangir, Odisha, India
[2]Department of Medicine, [3]Department of Microbiology, SCB Medical College, Cuttack, Odisha, India
[4]Department of Community Medicine, Bhima Bhoi Medical College Balangir, Odisha, India

*Correspondence:
Dr. Gurukrushna Mohapatra,
E-mail: gurukrushna@gmail.com

ABSTRACT

Background: Diabetes mellitus increases the risk of infections and results in adverse outcomes, but the effect of better glycaemic control has not been thoroughly investigated. Therefore, it was intended to study the various types of infections in Type 2 diabetic patients and its correlation with HbA1c.
Methods: It was a prospective observational study for one year, conducted on Type 2 diabetic patients hospitalized for various causes. Patients with HIV infection or immunocompromised state were excluded. Routine investigations, radiological and culture studies were conducted as required to identify the various infections present. The prevalence of infections was then corelated with blood glucose and HbA1c levels.
Results: Total 105 hospitalized diabetic cases were studied, out of which infections were detected in 72 (68.6%) patients, which was found to be statistically significant. The most common infection detected was UTI (45.8%). Among the UTI patients, *E. coli* was the most common organism isolated (52.3%) followed by *Enterococcus* (19%), *Pseudomonas* (19%) and *Citrobacter* (9.5%). Infections occurred in 61 (82.4%) patients with HbA1C >6.5% and in 11 (35.5%) patients with HbA1C <6.5%, which was found to be statistically significant.
Conclusions: Diabetes increases the risk of infections. Urinary tract infection is the most common infection, affecting the females predominantly. An association between current hyperglycaemia, glycosylated haemoglobin and infection risk in type 2 diabetes patients was found.

Keywords: Blood glucose, Diabetes mellitus, Infections, Glycosylated haemoglobin

INTRODUCTION

Diabetes mellitus (DM) is a clinical syndrome associated with deficiency of insulin secretion or action. It is one of the leading causes of morbidity and mortality worldwide. The global burden of diabetes is rising due to the increasing obesity and population ageing. According to the latest 2016 data from the World Health Organization (WHO), an estimated 422 million adults are living with diabetes globally.[1] Besides the classical complications of the disease, which include the macrovascular and microvascular complications, DM has been associated with greater susceptibility to infections. In general, infectious diseases are more frequent and more serious in patients with diabetes, which potentially increase their morbidity and mortality. Diabetic patients have 4.4 times greater risk of systemic infections than non-diabetics.[2]

The greater susceptibility to infections in diabetic patients is due to the hyperglycemic environment that favors

immune dysfunction (damage to the neutrophil function, humoral immunity, reduced response of T cells, depression of the antioxidant system), micro- and macro-angiopathies, decrease in the antibacterial activity of urine, gastrointestinal and urinary dysmotility, neuropathy, and the greater number of medical interventions required in these patients.[3,4]

All organs and systems can be infected. Some infections almost always affect only people with DM, such as rhino cerebral mucormycosis, malignant external otitis, and gangrenous cholecystitis.[5] Moreover, infections may be the first manifestation of diabetes mellitus or may trigger diabetic complications like ketoacidosis and hypoglycemia.

Though there is evidence suggesting greater susceptibility to infections and adverse outcome in diabetic patients, the effect of better glycemic control has not been thoroughly investigated.[6]

HbA1c reflects glycemia over 2-3 months and is the standard measure used to monitor glycemia in diabetic patients, but few studies have shown an association of HbA1c with occurrence of infections. Therefore, it was intended to study the various types of infections in Type 2 diabetic patients and its correlation with HbA1c in a tertiary care teaching hospital, so that it would help us to develop clinically relevant guidelines and targets to reduce mortality, morbidity and improve the quality of life of diabetic patients.

Objectives of this particular study was to determine the prevalence of different types of infections in hospitalized diabetic patients, identify the etiology of the infections in hospitalized diabetic patients and to correlate the blood glucose levels and HbA1c level with the prevalence of infections.

METHODS

Study design

A prospective observational study was conducted on Type 2 diabetic patients admitted to the indoor of PG Department of Medicine, S.C.B Medical College, Cuttack during period of one year from September 2017 to August 2018, after approval from the Institutional Ethics Committee.

Inclusion criteria

Type 2 Diabetic patients above 15 years of age admitted for various causes, with or without infections, and willing to participate in the study.

Exclusion criteria

Patients without diabetes, patients with HIV infection or immunocompromised state.

All patients either with a known diabetic history or newly diagnosed cases of diabetes, that were admitted to the Medicine department for various causes were taken up for study. After written consent, detailed history was taken, and clinical examination was done and recorded in a proforma. Fasting blood glucose, 2 hr Postprandial blood glucose and HbA1C level were measured at admission. Routine investigations like Complete blood count, Comment on peripheral smear, Erythrocyte sedimentation rate, Quantitative C-Reactive Protein, Liver function test, Renal function test were done. Blood, urine and stool cultures were sent for bacterial and fungal growth. Patients with pleural effusion, ascites or meningitis were subjected to thoracentesis, ascitic tap and lumbar puncture respectively, and individual fluid samples were sent for cytological, biochemical, Cartridge Based Nucleic Acid Amplification Test (CB-NAAT), culture and sensitivity study. In patients with cough, sputum AFB stain, Gram stain, CB-NAAT and culture and sensitivity were performed. Chest X-Ray, ultrasound, CT Scan were done wherever required. X-Ray of joint with synovial fluid AFB stain, Gram stain, CB-NAAT and culture and sensitivity were done for septic arthritis. Skin lesion swab for AFB stain and Gram stain, CB-NAAT and culture and sensitivity, and microscopic studies on scrapings were conducted.

Statistical evaluation

Statistical analysis was done by MS Excel and SPSS version 21.0. Categorical data were presented in the form of frequency and percentage and represented by pie charts, frequency diagrams and line diagrams. For analysis of continuous data mean and standard deviations were used. Test of significance was determined with the help of chi square, p value <0.05 was considered as statistically significant. Pearson correlation test was done to find the correlation between two continuous variables. The difference between mean of two continuous variables was estimated using independent t test.

RESULTS

This study consisted of 105 hospitalised diabetic cases, out of which 70 (66.7%) were male and 35 (33.3%) were female. The male to female ratio was 2:1. Most of the patients (80%) were above 50 years of age. The mean age of the subjects was 57.6 years.

The presence of infection among the 105 diabetic patients was detected in 72 (68.6%) persons, and 33 (31.4%) of them had no infection (Table- 1). The prevalence of infection in hospitalized diabetic patients was found to be statistically significant (Table 1).

Among the various types of infections, urinary tract infection (UTI) was the most common infection coexisting with diabetes, accounting for 45.8%, followed by respiratory tract infection (RTI) accounting for 22.2% of the patients. UTI was found in 63.2% of the female

patients, and 39.6% of male patients (Table 2). Fifteen patients had more than one type of infection.

Urine culture was found to be positive in 21 (63.6%) out of the 33 UTI patients. E. coli was the most common organism found in 11 (52.3%) cases followed by Enterococcus and Pseudomonas found in 4 (19%) cases each and Citrobacter found in 2 (9.5%) cases (Table 3).

Out of 16 patients with RTI, sputum culture was positive in 10 cases, and the most common causative organism detected was Streptococcus pneumoniae isolated from 6 (60%) cases followed by Chlamydia species 2 (20%) cases, Mycoplasma pneumoniae and Mycobacterium tuberculosis, seen in 1 (10%) patient each (Table 4).

Table 1: Prevalence of infection in hospitalised diabetic patients.

Gender	Diabetes mellitus with infection n (%)	Diabetes mellitus without infection n (%)	Total n (%)
Male	53(73.6%)	17(51.5%)	70(66.7%)
Female	19(26.4%)	16(48.5%)	35(33.3%)
Total	72(68.6%)	33(31.4%)	105(100%)
Chi square statistics = 4.9716 p value =0.03			

Table 2: Different infections in hospitalized diabetic patients.

Gender	U.T.I	R.T.I	Skin and soft tissue infections	Systemic viral, bacterial and Parasitic infections	G.I. and Liver infections	C.N.S. infections	Bones & Joint infections	Eye infections
Male n=53	21(39.6%)	13(24.5%)	8(15.1%)	8(15.1%)	6(11.3%)	4(7.5%)	2(3.8%)	1(1.9%)
Female n=19	12(63.2%)	3(15.8%)	3(15.8%)	2(10.5%)	3(15.8%)	1(5.3%)	0(0%)	0(0%)
Total n=72	33(45.8%)	16(22.2%)	11(15.3%)	10(13.9%)	9(12.5%)	5(6.9%)	2(2.8%)	1(1.4%)

Table 3: Different organisms causing urinary tract infection in hospitalized diabetic patients.

E.coli	Enterococcus	Pseudomonas	Citrobacter	Total
11(52.3%)	4 (19%)	4 (19%)	2 (9.5%)	21 (100%)

Table 4: Different organisms causing respiratory tract infection in hospitalised diabetic patients.

Streptococcus pneumoniae	Chlamydia species	Mycoplasma pneumoniae	Mycobacterium tuberculosis	Total
6 (60%)	2 (20%)	1 (10%)	1 (10%)	10

Table 5: Mean of the Blood Glucose parameters among the hospitalized diabetic patients with and without infection.

Parameter	Diabetes mellitus with infection (n=72)	Diabetes mellitus without infection (n=33)	t statistic	p value
	Mean(SD)	Mean (SD)		
FBS	236.5(14.66)	158.4(11.82)	26.84	0.0001
PPBS (2hour)	346.1(14.76)	238.4(12.54)	36.31	0.0001

The mean FBS and 2hrPPBS in patients of diabetes with infection was found to be 236.5±14.66 mg/dl and 346.1±14.76 mg/dl respectively, while those patients without infection showed a mean FBS of 158.4±11.82 mg/dl and 2hrPPBS of 238.4±12.54 mg/dl. The difference in the mean FBS levels and PPBS (2hour) levels in both the groups was found to be statistically significant (Table 5).

Out of 105 diabetic cases, 74 (70.5%) had HbA1C >6.5% and 31 (29.5%) had HbA1C <6.5% at the time of

admission. Infections occurred in 61 (82.4%) patients with HbA1C >6.5% and in 11 (35.5%) patients with HbA1C <6.5%, which was found to be statistically significant (Table 6).

Table 6 : Distribution of infections in hospitalized diabetic patients according to the level of HbA1C.

Cases	HbA1C <6.5%	HbA1C >6.5%	Total
With infection	11(35.5%)	61(82.4%)	72(68.6%)
Without infection	20(64.5%)	13(17.6%)	33(31.4%)
Total	31(29.5%)	74(70.5%)	105(100%)
Chi-square statistics = 22.345 p value is <0.00001			

DISCUSSION

This was a prospective, observational, hospital-based study carried out on 105 hospitalized adult Type 2 diabetic patients over a period of one year in a tertiary care teaching hospital. The different types of infections, their etiology and a correlation with their HbA1C level was studied.

Most of the hospitalized diabetic patients (80%) were above 50 years of age. Various infections in 68.6% patients (Table 1) was found, showing that infections occurs very commonly in diabetic patients, which is in accordance to earlier studies by Iain M et al, and Mor A et al.[6,7]

The most common infection detected among the diabetic patients was UTI found in 45.8% patients, affecting 63.2% of females. Next common were RTI found in 22.2%, followed by skin and soft tissue infection in 15.3% cases (Table 2). Findings were similar to that of Azra et al, where the most frequent infection was UTI (70%), followed by RTI (11.8%) and soft tissue infections (10.3%).[8]

Urinary tract infection was detected in 39.6% of males and 63.1% of females showing that they are more common in women (Table 2). Azra et al, and Mehvish et al, had also found that urinary tract infection was more common in diabetic women.[8,9]

Different factors are thought to predispose diabetic patients to UTIs. Autonomic neuropathy leading to reduced sensitivity and altered distensibility of the urinary bladder can result in stagnation of urine and higher rates of instrumentation. Moreover, glycosuria can enhance bacterial growth and impair phagocytosis. Women tend to get UTI more often than men because bacteria can reach the bladder more easily in women. The urethra is shorter in women than in men and located near the rectum, so bacteria have a shorter distance to travel.

Out of 33 diabetic patients with UTI, 21(63.6%) were culture positive. *E. coli* was the most common organism isolated from 52.3% cases, followed by Enterococcus in 19%, *Pseudomonas* in 19%, *Citrobacter* in 9.5% (Table 3). Results were similar to those of Azra et al, Mehvish et al, Ifodiora et al, who found *E. coli* as the most common causative organism for urinary tract infection in diabetic patients.[8-10]

According to Ifediora et al, about 70% diabetic patients were positive for urine culture, which is slightly higher than this study where culture positivity was found in 63.6%.[10] According to Shankar EM et al, 68% of patients with diabetic foot ulcer were found to be culture positive.[11] The low rate of culture positivity in patients could be due to the various antibiotics treatment given to diabetic patients before getting admitted to tertiary care teaching hospital.

The second most common infection found in diabetics in study was RTI, with bacterial pneumonia contributing to nearly 90%. Sputum culture revealed Streptococcus pneumoniae as the most common organism (Table 4).

A positive co-relation between both fasting and postprandial blood glucose to the occurrence of infection in hospitalized diabetic patients was found. The occurrence of infections in type 2 diabetes patients with HbA1c >6.5% was significantly higher than those with lower values (Table 6).

Similar results were reported by Aswani SM et al, where majority of diabetics with UTI (87.1%) had HbA1c >6.5% with p <0.001 showing that elevated HbA1c correlates with occurrence of UTI.[12] They concluded that achieving HbA1C <6.5% protects diabetics from UTI if they don't have any other underlying predisposing factors, and HbA1C >8% increases the chance of UTI. According to Zubair et al, diabetic patients with HbA1c >6.5% showed a high risk of ulcer development in their foot.[13] Julia et al, also concluded that poor glycemic control is powerfully associated with serious infections in diabetic patients.[14]

CONCLUSION

This study showed that diabetic patients are at high risk of infections. The most frequent infection is urinary tract infection, affecting predominantly the females, the most common causative organism being *E.coli*.

Respiratory tract infection was the next common infection, Streptococcus pneumonia being the most common organism. An association between current hyperglycemia, glycosylated hemoglobin values and infection risk in diabetes patients was found. Therefore, good glycemic levels should always be aimed at in order to prevent serious infections and reduce mortality and morbidity thereby improving the quality of life in diabetic patients.

REFERENCES

1. World Health Organization, Global Report on Diabetes. Geneva, 2016. Available at: https://apps.who.int/iris/bitstream/handle/10665/204 871/9789241565257_eng. Assessed 04 November 2019.
2. Stoeckle M, Kaech C, Trampuz A, Zimmerli W. The role of diabetes mellitus in patients with bloodstream infections. Swiss Medical Weekly. 2008 Sep 6;138(35):512-9.
3. Casqueiro J, Casqueiro J, Alves C. Infections in patients with diabetes mellitus: A review of pathogenesis. Indian J Endocrinol Metab. 2012 Mar;16(Suppl1):S27-S36.
4. Muller LM, Gorter KJ, Hak E, Goudzwaard WL, Schellevis FG, Hoepelman AI, et al. Increased risk of common infections in patients with type 1 and type 2 diabetes mellitus. Clini Infect Dis. 2005 Aug 1;41(3):281-8.
5. Peleg AY, Weerarathna T, McCarthy JS, Davis TM. Common infections in diabetes: pathogenesis, management and relationship to glycaemic control. Diabetes/Metab Res Reviews. 2007 Jan;23(1):3-13.
6. Carey IM, Critchley JA, DeWilde S, Harris T, Hosking FJ, Cook DG. Risk of infection in type 1 and type 2 diabetes compared with the general population: a matched cohort study. Diabetes Care. 2018 Mar 1;41(3):513-21.
7. Mor A, Dekkers OM, Nielsen JS, Beck-Nielsen H, Sørensen HT, Thomsen RW. Impact of glycemic control on risk of infections in patients with type 2 diabetes: a population-based cohort study. Am J Epidemiol. 2017 Jun 9;186(2):227-36.
8. Burekovic A, Dizdarevic-Bostandzic A, Godinjak A. Poorly regulated blood glucose in diabetic patients-Predictor of acute infections. Medical Archives. 2014 Jun;68(3):163-6.
9. Saleem M, Daniel B. Prevalence of urinary tract infection among patients with diabetes in Bangalore city. Inter J Emerging Sci. 2011 Jun 1;1(2):133-42.
10. Chinwe IA, Obeagu EI, Chukwudi A, Priscilla EU. Prevalence of Urinary Tract Infection in Diabetic patients attending Umuahia Health care facilities J Bio Innov. 2016;5(1):68-82.
11. Shankar EM, Mohan V, Premalatha G, Srinivasan RS, Usha AR. Bacterial etiology of diabetic foot infections in South India. Europ J Internal Med. 2005 Dec 1;16(8):567-70.
12. Aswani SM, Chandrashekar UK, Shivashankara KN, Pruthvi BC. Clinical profile of urinary tract infections in diabetics and non-diabetics. Australasian Medica J. 2014;7(1):29-34.
13. Zubair M, Malik A, Ahmad J. Glycosylated hemoglobin in diabetic foot and its correlation with clinical variables in a north Indian tertiary care hospital. J Diabetes Metab. 2015 Jul 1;6(571):2.
14. Critchley JA, Carey IM, Harris T, DeWilde S, Hosking FJ, Cook DG. Glycemic control and risk of infections among people with type 1 or type 2 diabetes in a large primary care cohort study. Diabetes Care. 2018 Oct 1;41(10):2127-35.