Section: Medicine

Original Research Article

AN OBSERVATIONAL STUDY OF INFECTIONS IN PATIENTS WITH DIABETES MELLITUS WITH SPECIAL ATTENTION TO GLYCEMIC CONTROL AND HOSPITAL OUTCOMES

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ABSTRACT

Background: Historically, infections have been acknowledged as a significant contributor to mortality in diabetes and continue to be a crucial factor in morbidity and mortality. This is especially accurate in underdeveloped nations and regions, where infections frequently serve as the initial indication of previously undiagnosed diabetes. The study aimed to assess the pattern and clinical profile of infections occurring among patients with diabetes mellitus, determine the correlation between glycaemic control and the occurrence of infections, and evaluate the outcomes of various infections in the diabetic population.

Materials and Methods: This hospital-based observational cross-sectional study was conducted in the Department of Medicine, North Bengal Medical College, Darjeeling, from May 2018 to April 2019, among a total of 200 patients with diabetes mellitus.

Results: Among 200 participants, most were aged 50–60 years, male, urban residents, and had type 2 diabetes mellitus. Fever was the predominant clinical feature, while LRTI and SSTI were common infections. Sepsis showed the highest mean TLC, with a statistically significant difference across infection types ($p<0.001$). Most radiological findings were normal, while consolidation was the commonest chest X-ray abnormality.

Conclusion: We concluded that infections in patients with diabetes mellitus showed a diverse clinical spectrum, predominantly involving fever, respiratory and skin infections. Type 2 diabetes and diabetic complications were common. TLC varied significantly across infection syndromes, with highest values in sepsis. Early diagnosis, appropriate investigation, and timely management are essential for improving outcomes.

Keywords: Diabetes mellitus, Infections, Glycemic control, Diabetic complications.

INTRODUCTION

Historically, infections have been acknowledged as a significant contributor to mortality in diabetes and continue to be a crucial factor in morbidity and mortality. This is especially accurate in underdeveloped nations and regions, where infections frequently serve as the initial indication of previously undiagnosed diabetes. The infected diabetic foot exemplifies this phenomenon prominently.

The correlation between diabetes and infections is widely acknowledged, however the dynamics are intricate, frequently ambiguous, and often contentious.

Information regarding the actual occurrences of specific infections is insufficient, and several

elements hinder the evaluation of infection risks and consequences. Research is frequently retrospective and lacks control. Certain infections that primarily affect individuals with diabetes are rare and hence possess restricted information. Instances encompass malignant otitis externa, mucormycosis, the emphysematous variant of cholecystitis, cystitis and pyelonephritis, as well as Fournier gangrene. In instances of additional infections that, although not exclusive to individuals with diabetes, consider diabetes as a complicating element, numerous factors contribute to significant variability in the clinical trajectory, encompassing disease duration, existence of diabetic complications, glycemic management (both recent and historical), availability and delivery of healthcare services, and the presence or absence of other concurrent ailments.[1]

A research study conducted in Utrecht has established that individuals with type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM) are generally more susceptible to lower respiratory tract infections, urinary tract infections, and infections of the skin and mucous membranes.[2] Elevated hospitalization rates attributed to bacterial infections have been documented in adults (>14 years, n=4748; RR 2.3) with T1DM, and this correlates with the severity of any concurrent nephropathy. It was shown that every percentage increase in HbA1c corresponded to a 6-10% rise in yearly antibiotic acquisitions.[3]

Both host-related and organism-specific elements seem to contribute to heightened vulnerability and risk.

From the viewpoint of the host, deficiencies in innate immunity are especially significant, particularly the diminished capabilities (chemotaxis, phagocytosis, and cytotoxicity) of neutrophils, monocytes, and macrophages.

Additional elements encompass the ramifications of diabetic problems, inadequate wound healing, the existence of chronic renal insufficiency, and recurrent hospital admissions, along with the associated threat of hospital-acquired infections.

Infections can also trigger metabolic disturbances, creating a reciprocal link between hyperglycemia and infection.

Certain infections may also be directly involved in the causation of diabetes. Medical practitioners in primary care must possess a keen understanding of the connections between diabetes and infections, as well as the significant infections that may be implicated.

Infections affecting the foot, soft tissues, skin, and nails, along with the urinary tract, hold significant relevance as they frequently occur in individuals with diabetes, may be evident at the time of diagnosis, and might serve as the initial symptom necessitating the diagnosis of diabetes.

MATERIALS AND METHODS

Type of Study: Observational cross sectional, hospital based

Place of Study: Department of Medicine, North Bengal Medical College, Darjeeling

Study Duration: From May 2018 to April 2019

Sample Size: 200 patients

Inclusion Criteria:

- Patients diagnosed as Diabetes Mellitus under treatment at Department of Medicine, North Bengal Medical College, Darjeeling
- Clinical features suggestive of infection and / or
- Lab features documenting ongoing infection

Exclusion Criteria:

- Patients refusing to consent to participate in the study
- Patients less than 12 years age
- Patients with comorbidities likely to contribute to immune compromise status like HIV, malignancy, long term steroids, cancer chemotherapy, or other immunosuppressive therapies

Study Variables:

- Sociodemographic variables: Age, gender, and place of residence.
- Diabetes-related variables: Type of diabetes mellitus (Type 1/Type 2), duration of diabetes, and diabetic complications.
- Glycaemic control variables: Fasting blood glucose, postprandial blood glucose, HbA1c, and other relevant glycaemic parameters.
- Infection-related variables: Type and site of infection, clinical syndrome, presenting symptoms, signs, severity of infection, and microbiological findings.
- Clinical variables: Fever pattern, respiratory symptoms, genitourinary symptoms, diabetic foot manifestations, nephropathy, neuropathy, and other relevant clinical findings.
- Laboratory variables: Total leucocyte count, differential leucocyte count, renal function parameters, and other infection-related investigations.
- Radiological variables: Ultrasonography abdomen and chest X-ray findings.

Statistical Analysis

Data were entered into Excel and subsequently analyzed using SPSS and GraphPad Prism. Continuous variables were summarized as means with standard deviations, while categorical variables were presented as counts and percentages. Comparisons between independent groups were performed using two-sample t-tests, and paired t-tests were applied for correlated (paired) data. Categorical data were compared using chi-square tests, with Fisher's exact test applied when expected cell counts were small. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

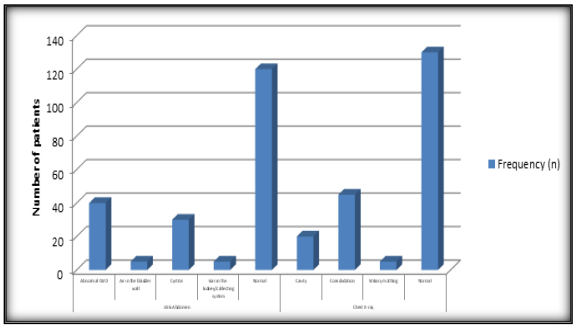


Figure 1: Radiological Findings on Ultrasonography (USG) Abdomen and Chest X-ray among the Study Population

Among the 200 participants, the majority were aged 50–60 years, accounting for 105 (52.5%) participants, followed by 40–50 years and >60 years with 30 (15%) participants each. Participants aged <30 years constituted 20 (10%), while 15 (7.5%) participants were aged 30–40 years. Regarding gender, males predominated with 126 (63%) participants, whereas females accounted for 74 (37%). In terms of place of residence, 122 (61%) participants were from urban areas and 78 (39%) were from rural areas. [Table 1]

Fever was the most frequently reported clinical feature, observed in 195 (97.5%) participants. Clinically diagnosed lower respiratory tract infection (LRTI) and skin and soft tissue infection (SSTI) were each present in 90 (45%) participants. Clinically diagnosed genitourinary (GU) infection was observed in 50 (25%) participants, including 40 (20%) with dysuria and 10 (5%) with dysuria associated with loin pain. Diabetic foot was reported in 65 (32.5%) participants, while nephropathy and neuropathy were present in 80 (40%) and 55 (27.5%) participants, respectively. Regarding fever severity, 105 (52.5%) participants had low-grade fever and 90 (45%) had high-grade fever. Decreased urinary output was reported in 25 (12.5%) participants. [Table 2]

The distribution of SSTI showed that ulcers were the most common presentation, occurring in 40 (20%) participants, followed by abscesses in 15 (7.5%), cellulitis in 10 (5%), and carbuncles in 5 (2.5%) participants. No SSTI was reported in 130 (65%) participants.

Signs of respiratory infection were observed in 80 (40%) participants and signs of GU tract infection were present in 55 (27.5%). Foot ulcer was also observed in 55 (27.5%) participants, while a weak pulse over the foot was documented in 30 (15%) participants. Regarding the type of diabetes, the majority of participants had type 2 diabetes mellitus, accounting for 175 (87.5%) participants, whereas 25 (12.5%) had type 1 diabetes mellitus. [Table 3]

Table 4 shows the relationship between total leucocyte count (TLC) and different types of infection. The highest mean TLC was observed among participants with sepsis, with a mean of 24,172.00 ± 3,826.87 cells/µL, followed by respiratory tract infection (RTI) with a mean TLC of 21,314.29 ± 4,198.54 cells/µL. Participants with SSTI had a mean TLC of 19,446.92 ± 4,358.72 cells/µL, while those with UTI had a mean of 19,371.60 ± 4,941.92 cells/µL. The lowest mean TLC was observed among participants with tuberculosis (TB), at 13,160.00 ± 800 cells/µL. The difference in mean TLC across the different clinical syndromes was statistically significant ($p<0.001$). [Table 4]

Table 5 presents the radiological findings obtained through ultrasonography (USG) of the abdomen and chest X-ray. On USG abdomen, 120 (60%) participants had normal findings, whereas 40 (20%) showed abnormal CMD. Cystitis was observed in 30 (15%) participants, while air in the bladder wall and gas in the kidney/collecting system were each identified in 5 (2.5%) participants.

On chest X-ray, normal findings were observed in 130 (65%) participants. Consolidation was the most common abnormal finding, present in 45 (22.5%) participants, followed by cavity in 20 (10%) participants and miliary mottling in 5 (2.5%) participants. [Table 5]

Table 1: Sociodemographic Characteristics of the Study Participants

	Variable	Frequency (n)	Percent (%)
Age (years)	<30	20	10
	30–40	15	7.5
	40–50	30	15
	50–60	105	52.5
	>60	30	15
Gender	Female	74	37
	Male	126	63
Place of residence	Rural	78	39
	Urban	122	61

Table 2: Clinical Syndrome and Clinical Profile of Infections among the Study Population

	Clinical syndrome of infection	**Frequency (n)**	**Percent (%)**
Clinical profile	Fever	195	97.5
	Clinically LRTI	90	45
	Clinically GIT infection	15	7.5
	Clinically GU infection	50	25
	Dysuria	40	20

	Dysuria + loin pain	10	5
	SSTI	90	45
	Diabetic foot	65	32.5
	Nephropathy	80	40
	Neuropathy	55	27.5
	High-grade fever	90	45
	Low-grade fever	105	52.5
	Decreased output	25	12.5
Distribution of SSTI	Abscess	15	7.5
	Carbuncle	5	2.5
	Cellulitis	10	5
	Ulcer	40	20
	No SSTI	130	65

Table 3: Clinical Signs and Type of Diabetes among the Study Population

		Frequency (n)	Percent (%)
Clinical signs	Signs of respiratory infection	80	40
	Signs of GU tract infection	55	27.5
	Foot ulcer	55	27.5
	Weak pulse over foot	30	15
Type of diabetes	DM Type 1	25	12.5
	DM Type 2	175	87.5

Table 4: Relation of Total Leucocyte Count with type of infection (n = 200)

Clinical syndrome	Number (n)	Mean TLC	SD	Minimum	Maximum	Median	p-value
RTI	35	21,314.29	4,198.54	16,500	27,500	19,500	<0.001
Sepsis	25	24,172.00	3,826.87	19,700	28,600	23,000	
SSTI	65	19,446.92	4,358.72	12,400	28,500	19,500	
TB	25	13,160.00	800	12,000	14,000	13,200	
UTI	50	19,371.60	4,941.92	14,500	28,900	17,175	

Table 5: Radiological Findings on Ultrasonography (USG) Abdomen and Chest X-ray among the Study Population

	Finding	Frequency (n)	Percent (%)
USG Abdomen	Abnormal CMD	40	20
	Air in the bladder wall	5	2.5
	Cystitis	30	15
	Gas in the kidney/collecting system	5	2.5
	Normal	120	60
Chest X-ray	Cavity	20	10
	Consolidation	45	22.5
	Miliary mottling	5	2.5
	Normal	130	65

DISCUSSION

The present observational study included 200 patients with diabetes mellitus presenting with infections. The majority of participants were aged 50–60 years (52.5%), followed by those aged 40–50 years and >60 years (15% each). Males constituted 63% of the study population, while 61% were urban residents. The predominance of middle-aged and older adults is consistent with the recognized increase in infectious morbidity with increasing age and the accumulation of diabetes-related complications. Abu-Ashour W et al. reported a significantly increased risk of several bacterial infections among individuals with diabetes, emphasizing the substantial infectious burden in this population.[4] Critchley et al. also demonstrated an association between poor glycaemic control and increased risk of infection among patients with diabetes.[5] Fever was the predominant clinical manifestation in the present study, occurring in 97.5% of participants. LRTI and SSTI were each observed in 45% of participants, while GU infection occurred in 25%. Diabetic foot, nephropathy and neuropathy were present in 32.5%, 40% and 27.5%, respectively. These findings indicate that both acute infections and chronic diabetes-related complications were common in the study population. Abu-Ashour W et al. reported increased risks of respiratory, urinary and skin infections among individuals with diabetes.[4] Similarly, Pannu AK et al. demonstrated a higher incidence of respiratory, urinary and skin infections in patients with diabetes compared with individuals without diabetes.[6] The high frequency of LRTI in the present study may be related to diabetes-associated impairment of innate immune responses and other metabolic abnormalities. SSTI represented another major infectious syndrome, with ulcers being the most frequent presentation (20%), followed by abscesses (7.5%), cellulitis (5%) and carbuncles (2.5%). The predominance of ulcerative lesions is clinically relevant because diabetic neuropathy, vascular insufficiency and impaired wound healing can facilitate the development and persistence of skin and foot infections. Pannu AK et al. reported a substantially increased risk of skin infections among patients with diabetes.[6] The occurrence of diabetic foot and neuropathy in the present study further

supports the clinical importance of peripheral complications in infected diabetic patients. Type 2 diabetes predominated in the present study, accounting for 87.5% of participants. Respiratory signs were observed in 40%, GU signs in 27.5%, and foot ulcers in 27.5%. Umpierrez and Korytkowski described impaired leukocyte function, vascular abnormalities and neuropathy as important mechanisms contributing to increased susceptibility to infection in diabetes. Thus, the clinical pattern observed in the present study is consistent with the established pathophysiological relationship between diabetes and infection. A statistically significant difference was observed in mean TLC across the different infectious syndromes ($p<0.001$). The highest mean TLC was recorded among participants with sepsis (24,172.00 ± 3,826.87 cells/µL), followed by RTI, SSTI and UTI, whereas the lowest value was observed among those with TB. Liu Q et al. reported a considerable burden of severe infectious emergencies, including sepsis, among hospitalized diabetic patients.[7] The marked leukocytosis in sepsis in the present study may therefore reflect a greater systemic inflammatory response. However, TLC should be interpreted alongside clinical and other laboratory parameters. Radiological evaluation showed that consolidation was the most common abnormal chest X-ray finding (22.5%), followed by cavity (10%) and miliary mottling (2.5%). On abdominal ultrasonography, cystitis was observed in 15%, while air in the bladder wall and gas within the kidney/collecting system were each observed in 2.5%. These findings are clinically relevant given the increased susceptibility of diabetic patients to respiratory and complicated urinary infections. The presence of cavity and miliary mottling also emphasizes the importance of considering tuberculosis in appropriate clinical settings, as diabetes has been associated with increased tuberculosis risk.[8,9]

CONCLUSION

We concluded that infections among patients with diabetes mellitus showed a diverse clinical spectrum, with fever, lower respiratory tract infections, and skin and soft tissue infections being commonly observed. Type 2 diabetes predominated, and diabetic complications such as nephropathy, neuropathy, and diabetic foot were frequently encountered. Significant variation in total leucocyte count was observed across different infection syndromes, with the highest mean TLC noted in sepsis. Radiological abnormalities were identified in both abdominal ultrasonography and chest X-ray, with consolidation being the most common chest X-ray finding. These findings emphasize the importance of early identification of infections, careful assessment of diabetic complications, appropriate investigation, and timely management to reduce infection-related complications and improve hospital outcomes.

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