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The Clinical Importance of Glycemic Status in the Course and Outcomes of Acute Pyelonephritis in Patients with Diabetes Mellitus

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Abstract: Acute pyelonephritis represents a severe and potentially life-threatening infectious complication in patients with diabetes mellitus. The presence of chronic hyperglycemia alters immune function, disrupts microcirculation, and creates favorable conditions for rapid bacterial proliferation within the urinary tract. As a result, diabetic patients frequently experience a more aggressive disease course, higher rates of complications, and prolonged hospitalization.

The present study aimed to comprehensively evaluate the impact of blood glucose levels on the clinical course, complication profile, and treatment outcomes of acute pyelonephritis in hospitalized patients with diabetes mellitus. A retrospective observational analysis was conducted involving 76 adult patients with diabetes mellitus who were treated for acute pyelonephritis at a tertiary care hospital between January and December 2024. Clinical data, laboratory findings, imaging results, and therapeutic interventions were analyzed with particular emphasis on glycemic status and insulin dependence.

The results demonstrated that poor glycemic control was strongly associated with increased disease severity, higher incidence of renal abscess formation, and the need for invasive interventions. Insulin-dependent patients exhibited significantly higher blood glucose levels and a greater frequency of complications compared to non–insulin-dependent patients. Optimization of glycemic control during hospitalization was associated with improved clinical outcomes and reduced length of hospital stay.

These findings underscore the critical importance of maintaining optimal blood glucose levels in diabetic patients with acute pyelonephritis and highlight glycemic control as a key modifiable factor in reducing complications and improving prognosis.

Keywords: Diabetes mellitus, acute pyelonephritis, hyperglycemia, glycemic control, insulin therapy, renal abscess.

Introduction

Diabetes mellitus is one of the most prevalent chronic metabolic disorders worldwide and is associated with a wide range of infectious complications. Among these, urinary tract infections, particularly acute pyelonephritis, occur more frequently and tend to follow a more severe clinical course in diabetic patients compared to the general population. The increased susceptibility to infection in diabetes is multifactorial and involves impaired immune responses, vascular abnormalities, autonomic dysfunction, and persistent hyperglycemia.

Acute pyelonephritis is an inflammatory condition of the renal parenchyma and collecting system, most commonly caused by ascending bacterial infection. In individuals with diabetes mellitus, the disease often presents atypically, progresses rapidly, and is associated with a higher risk of complications such as renal abscesses, emphysematous changes, and sepsis. These complications significantly increase morbidity, mortality, and healthcare costs.

Hyperglycemia plays a central role in the pathogenesis and progression of infections in diabetic patients. Elevated blood glucose levels impair neutrophil chemotaxis, phagocytosis, and intracellular killing, thereby weakening host defense mechanisms. Additionally, glucose-rich environments promote bacterial growth and biofilm formation, further complicating infection control. Despite these well-recognized mechanisms, the direct relationship between glycemic control and the clinical course of acute pyelonephritis remains insufficiently explored in clinical settings.

Understanding the influence of blood glucose levels on disease severity and outcomes is crucial for optimizing management strategies in diabetic patients with acute pyelonephritis. Identifying optimal glycemic targets during hospitalization may help reduce complications, minimize invasive procedures, and shorten hospital stays.

Aim of the Study

The primary aim of this study was to assess the significance of blood glucose levels in determining the clinical course and outcomes of acute pyelonephritis in patients with diabetes mellitus treated in a hospital setting.

The secondary objectives included:

- Evaluating the association between insulin dependence and disease severity
- Determining the frequency of renal complications in relation to glycemic status
- Assessing the need for intensification of antidiabetic therapy during hospitalization
- Analyzing the impact of glycemic control on the duration of inpatient treatment

Materials and Methods

This retrospective observational study was conducted at Tashkent City Clinical Hospital No.1, a tertiary referral center providing specialized care for patients with infectious and metabolic disorders. Medical records of patients treated between January and December 2024 were reviewed.

The study included 76 adult patients aged 18 years and older who met the following inclusion criteria:

- Confirmed diagnosis of diabetes mellitus
- Clinical and radiological diagnosis of acute pyelonephritis
- Inpatient treatment during the study period

Patients with chronic kidney disease stage IV–V, pregnancy, malignancy, or incomplete medical records were excluded from the analysis.

All patients underwent comprehensive clinical assessment upon admission, including evaluation of symptoms, vital signs, and comorbid conditions. Laboratory investigations included:

- Complete blood count
- Serum biochemical profile
- Coagulation parameters
- Fasting and postprandial blood glucose measurements

- General urinalysis
- Quantitative urine analysis per 1 ml

Glycemic status was monitored regularly throughout hospitalization to guide therapeutic adjustments.

Renal ultrasonography was performed in all patients to assess kidney size, parenchymal structure, and urinary tract obstruction. MSCT of the urinary system was used when complications were suspected or when clinical improvement was insufficient. MSCT findings were particularly valuable in identifying renal abscesses requiring interventional management.

All patients received standard antimicrobial therapy according to institutional protocols, adjusted based on clinical response and laboratory findings. Antidiabetic treatment was individualized, with insulin therapy intensified or initiated as necessary to achieve acceptable glycemic control.

Descriptive statistical methods were used to analyze demographic characteristics, clinical features, laboratory values, and outcomes. Continuous variables were expressed as mean values, while categorical variables were presented as frequencies and percentages.

Results

Among the 76 patients included in the study, the largest proportion belonged to the 31–40-year age group (36.84%). Patients aged 21–30 years and 41–50 years each accounted for 21.05% of cases. Individuals older than 50 years comprised 18.42% of the study population. Female patients predominated, accounting for 57.89% of cases, while male patients represented 42.10%.

Insulin-dependent diabetes mellitus was present in 63.15% of patients, whereas 36.84% had non–insulin-dependent diabetes. Among insulin-dependent patients, women slightly outnumbered men. A similar gender distribution was observed in the non–insulin-dependent group.

Left-sided acute pyelonephritis was observed in 53.94% of patients, while right-sided involvement occurred in 46.05%. Both insulin-dependent and non–insulin-dependent patients were affected, although insulin-dependent patients demonstrated a higher frequency of severe presentations regardless of laterality.

Insulin-dependent patients exhibited significantly elevated blood glucose levels. The highest recorded value was 29.7 mmol/L, while the lowest was 12.8 mmol/L, with a mean level of 17.8 mmol/L.

In contrast, non–insulin-dependent patients demonstrated lower glucose values, ranging from 9.7 to 17.7 mmol/L, with a mean level of 10.5 mmol/L.

Renal abscess formation was identified in 32.89% of patients based on MSCT findings. This complication was more frequent among insulin-dependent patients compared to non–insulin-dependent patients. Percutaneous drainage of renal abscesses was performed in all affected cases.

During hospitalization, insulin doses were increased in insulin-dependent patients to achieve better glycemic control. Notably, 25% of patients who were initially non–insulin-dependent required temporary insulin therapy due to poor glycemic control during the acute infectious process.

The average duration of inpatient treatment was 7 days. Patients with better glycemic control demonstrated faster clinical improvement and shorter hospital stays, whereas those with persistent hyperglycemia required prolonged treatment and closer monitoring.

Discussion

The findings of this study highlight the pivotal role of glycemic control in determining the clinical course of acute pyelonephritis in patients with diabetes mellitus. Persistent

hyperglycemia was associated with increased disease severity, higher complication rates, and greater need for invasive interventions.

Insulin-dependent patients were particularly vulnerable to adverse outcomes, likely due to longer disease duration, greater metabolic instability, and more pronounced immune dysfunction. The high incidence of renal abscess formation in this group underscores the importance of early recognition and aggressive management.

The requirement for intensification of insulin therapy during hospitalization reflects the dynamic nature of glucose metabolism during acute infection. Stress-induced hyperglycemia, combined with inflammatory mediators, necessitates close monitoring and flexible treatment strategies.

Importantly, patients whose blood glucose levels were maintained within a target range of approximately 9–10 mmol/L demonstrated improved outcomes. This finding suggests that moderate glycemic control, rather than overly strict targets, may be both effective and safe in the acute care setting.

Conclusion

Blood glucose levels play a decisive role in shaping the clinical course and outcomes of acute pyelonephritis in patients with diabetes mellitus. Poor glycemic control significantly increases the risk of complications such as renal abscess formation and prolongs hospitalization.

Maintaining blood glucose levels within an optimal range of 9–10 mmol/L during inpatient treatment appears to reduce complication rates, limit the need for invasive procedures, and shorten hospital stay. These findings emphasize the importance of integrated metabolic and infectious disease management in this high-risk patient population.

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