DOI: https://doi.org/10.54393/pjhs.v5i09.2206

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (P): 2790-9352, (E): 2790-9344
Volume 5, Issue 9 (September 2024)

Original Article

OPEN ACCESS

Prevalence of Hypokalemia in Diabetic Ketoacidosis Patients Presenting to the Emergency Department

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ARTICLE INFO

Keywords:
Diabetic Ketoacidosis, Hypokalemia, Insulin Therapy, Hyperglycemia, Serum Potassium

How to Cite:
Siddiqui, N. us S., Ahmed, M., Sikhandar, S., Memon, S. Z., Fatima, F., & Aakash, A. (2024). Prevalence of Hypokalemia in Diabetic Ketoacidosis Patients Presenting to the Emergency Department: Hypokalemia in Diabetic Ketoacidosis Patients. Pakistan Journal of Health Sciences, 5(09). https://doi.org/10.54393/pjhs.v5i09.2206

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Received Date: 3rd August, 2024
Acceptance Date: 24th September, 2024
Published Date: 30th September, 2024

ABSTRACT

Diabetic Ketoacidosis (DKA) is a potentially life-threatening hyperglycemic emergency that leads to severe metabolic derangements which may cause low potassium concentrations, resulting from insulin and hence a poorer outcome among patients admitted in emergency departments. **Objective:** To determine the prevalence and severity of hypokalemia in patients with Diabetic Ketoacidosis (DKA) presenting to the emergency department. **Methods:** A cross-sectional study was conducted at the Department of Emergency Medicine of Jinnah Postgraduate Medical Centre, Karachi from November 2022 to April 2023. 97 patients with a blood glucose level of 250 mg/dL or higher at the time of arrival and aged between 18 and 65 years were included in the study, using consecutive sampling, meeting the diagnostic criteria for DKA. **Results:** The prevalence of hypokalemia was 53.61% (n=52). Within this group, 39.18% had mild hypokalemia, 11.34% had moderate hypokalemia, and 3.09% had severe hypokalemia. Conversely, 45.36% of patients maintained normal potassium levels, while only 1.03% presented with hyperkalemia. Furthermore, among those with hypokalemia, 53.16% were using insulin, with a p-value of 0.082 indicating no significant association with insulin use. In terms of gender, 30 males (53.57%) and 22 females (42.31%) experienced hypokalemia, but this was also found to be statistically insignificant (p=0.42). **Conclusions:** This research revealed that significant prevalence of hypokalemia in diabetic ketoacidosis (DKA), with 53.61% of participants affected (3.1% of cases exhibited severe hypokalemia), highlighting the importance of adhering to the American Diabetes Association's recommendation to assess serum potassium levels before initiating DKA treatment.

INTRODUCTION

Diabetic Ketoacidosis (DKA) is a potentially life-threatening hyperglycemic emergency that leads to severe metabolic derangements, including ketone production, metabolic acidosis, and electrolyte disturbances [1]. Approximately thirty-three percent of children who are newly diagnosed with type 1 diabetes exhibit Diabetic Ketoacidosis (DKA) at the time of diagnosis [2]. Abnormally low potassium concentrations have been observed in DKA patients admitted to the ED [3]. Usually, the patients are predicted to exhibit a significant decrease in total body potassium levels, ranging from 300 to 600 mEq. This reduction is attributed to several factors, including kaliuresis resulting from osmotic diuresis, limited oral intake, and gastrointestinal losses due to diarrhea and vomiting [4]. Insulin, part of the DKA treatment regimen, shifts potassium back into the intracellular space, which can result in profound hypokalemia, even with aggressive replacement. Consequently, monitoring potassium levels closely during the initial hours of treatment is essential. Continuous cardiac monitoring is strongly recommended

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because of the potential for a rapid shift in potassium levels and the associated risk of cardiac arrhythmia [5]. While potassium replacement is a key component of DKA management, its depletion and subsequent treatment are not fully explained. Potassium is often depleted before the patient's potassium levels are even documented, and treatment with fluids and insulin can exacerbate this imbalance. Proper correction of hypokalemia before initiating insulin therapy is critical, as untreated hypokalemia can result in life-threatening complications such as paralysis or severe cardiac arrhythmias the recognition of the significance of potassium replacement in the management of Diabetic Ketoacidosis (DKA) has substantially reduced the mortality rate [6]. Previously, the mortality rate was as high as 30 to 50%, even after the introduction of specific management strategies [7]. Hypokalemia has historically been reported in 4% of patients, with associated complications such as paralysis and abnormal heart rhythms. However, it is noteworthy that these findings are based on studies with varied sample sizes and certain limitations, indicating a need for further conclusive evidence [8]. At the national level, there is a lack of published data on the prevalence and severity of hypokalemia among patients with Diabetic Ketoacidosis (DKA) at the time of their initial presentation to the emergency department. This research gap highlights the need for a focused investigation into the potassium levels of DKA patients before fluid resuscitation and insulin therapy.

Therefore, it conducted an observational study to address this gap and determine the prevalence and severity of hypokalemia in adult patients with DKA presenting to the emergency department.

METHODS

A cross-sectional study was conducted at the Department of Emergency Medicine of Jinnah Postgraduate Medical Centre, Karachi from November 2022 to April 2023. Approval for the study was obtained from the institutional review board (No. F.2-81/2022-GENL/206/JPMC). Informed written consent was taken from participants/their attendants. A sample size of 97 patients was calculated via WHO open epi sample size calculator keeping incidence of DKA in newly diagnosed patients as 6.7% with 5% margin of error and 95% confidence interval [9]. Patients diagnosed with DKA having a blood glucose level of 250 mg/dL or higher at the time of arrival and aged between 18 and 65 years were included in the study, using consecutive sampling. Exclusion criteria included patients aged 65 and above, those on potassium-sparing diuretics, individuals who had taken insulin within 12 hours before arriving at the emergency department, patients with pre-existing heart conditions, those diagnosed with septic shock, and pregnant individuals. Prevalence and severity of hypokalemia was the main outcomes of the study. Patients who fulfilled the inclusion criteria underwent an assessment that included a Venous Blood Gas (VBG) and a serum chemistry panel to diagnose DKA. The diagnosis of DKA was confirmed if patients met all the criteria established by the American Diabetes Association (ADA), which included a serum glucose level of 250 mg/dL or higher, a serum anion gap greater than 10 mmol/L, carbon dioxide levels of 18 mmol/L or greater, and a pH of 7.30 or lower. The VBG was used solely to determine the serum pH, acknowledging that there may be some potential inaccuracies in pH measurement compared to Arterial Blood Gas (ABG) analysis; however, VBG was a practical choice for rapid assessment in the emergency department setting. The serum chemistry panel provided the electrolyte levels. Additionally, to verify insulin use within the 12 hours prior to presentation, patient interviews were conducted, and medical records were reviewed to ensure accuracy. Hypokalemia was classified based on the following ranges: mild hypokalemia was defined as a potassium level between 3.1 and 3.5 mmol/L, moderate hypokalemia as 2.5 to 3.0 mmol/L, and severe hypokalemia as less than 2.5 mmol/L [10]. The data analysis was conducted using IBM SPSS version 21.0 and Microsoft Excel 365. Descriptive statistics, including mean ± standard deviation, were used for continuous variables such as age, duration of diabetes, glucose levels, and potassium levels. Frequency and percentages were employed to calculate the categorical variables such as gender, prevalence and severity of hypokalemia, history of diabetes, insulin usage, and type of treatment. Chi-square was used to determine the association between severity of presence of hypokalemia with gender and insulin usage.

RESULTS

The mean age was 40.6 years (SD, 13.6 years; range, 18-65 years). The cohort was 57.27% male and 42.31% female. Among them, 79 (81.40%) patients, were using insulin, and 18 (81.60%) were on oral hypoglycemic agents, as detailed in table 1.

Table 1: Description of the Study Parameters (n=97)

Variables	N (%) / Mean ± SD
Age (Year)	40.6 (13.6%)
Male	56 (57.7%)
Female	41 (42.3%)
Insulin Use	79 (81.4%)
Oral Hypoglycemic Agents	18 (18.6%)
Mean Serum Potassium (mmol/L)	5.2 ± 1.4 (2.2-6.9)

The prevalence of hypokalemia was observed in 52 patients (53.61%). Among these, 38 patients (39.18%) had mild hypokalemia, 11 patients (11.34%) had moderate hypokalemia, and 3 patients (3.09%) had severe hypokalemia. Additionally, 44 patients (45.36%) had normal potassium levels, while only 1 patient (1.03%) exhibited hyperkalemia.

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Table 2: Potassium Profile of Dka Patients

Potassium Level	Range (mmol/L)	N (%)
Hyperkalemia	>5.5 mmol/L	1 (1.03%)
Normokalemia	3.6 - 5.5 mmol/L	44 (45.36%)
Prevalence of Hypokalemia	<3.5 mmol/L	52 (53.61%)
Mild Hypokalemia	3.1 - 3.5 mmol/L	38 (39.18%)
Moderate Hypokalemia	2.5 - 3.0 mmol/L	11 (11.34%)
Severe Hypokalemia	<2.5 mmol/L	3 (3.09%)

Table 3 shows that 53.61% of patients had hypokalemia, while 46.39% did not. Among those with hypokalemia, 42 patients were using insulin, with a p-value of 0.082, indicating no significant association. For gender, 30 males (53.57%) and 22 females (42.31%) had hypokalemia, with a p-value of 0.42, suggesting no significant relationship.

Table 3 : Presence of Hypokalemia Vs Insulin Use and Gender

Variables	N (%)		p-Value
	Present	Absent	
Hyperkalemia	52 (53.61%)	45 (46.39%)	-
Insulin Use Present	42 (53.16%)	37 (46.84%)	0.082
Insulin Use Absent	10 (55.56%)	8 (44.44%)	
Male	30 (53.57%)	26 (57.78%)	0.42
Female	22 (42.31%)	19 (42.22%)	

DISCUSSION

This research analyzed serum potassium levels in a cohort of 97 patients with DKA and found that 3.1% had severe hypokalemia, 39.18% had mild hypokalemia, and 1.03% presented with hyperkalemia. These findings were consistent with other studies. For instance, Makinouchi R, *et al.*, reported a 5.6% prevalence of hypokalemia among 54 DKA patients, where severe cases correlated with higher mortality [11]. Qassabi SS *et al.*, found hypokalemia in 9% of their sample [12]. In contrast, a 2024 study involving 537 DKA patients reported only 1.3% with mild hypokalemia and no cases below 3.3 mmol/L [13]. Collectively, these studies indicate that while hypokalemia is relatively rare in DKA, it can lead to severe complications if not promptly addressed. Recent research has indicated that routine potassium replacement in patients with mild hypokalemia may not always be warranted and could potentially result in adverse events, particularly hyperkalemia, especially in patients with coexisting medical conditions [14, 15]. This suggests that potassium management should be tailored based on individual patient profiles and the severity of their hypokalemia. Moreover, studies recommend conducting serum potassium measurements 2 hours after initiating insulin therapy and then at 4-hour intervals until DKA resolution for most DKA patients, administering 20–30 mmol of potassium per liter of intravenous fluid is generally sufficient to maintain serum potassium within the target range [16-18]. The 3.1% prevalence of severe hypokalemia in this study highlights the importance of proactive potassium monitoring and replacement to prevent potentially fatal outcomes. This aligns with the recommendations from Coregliano-Ring L *et al.*, and Lee MH *et al.*, who advocate for initiating potassium replacement when levels drop below 5.0 mmol/L and delaying insulin therapy until potassium exceeds 3.5 mmol/L to prevent life-threatening complications [19, 20]. This study benefits from a well-defined inclusion and exclusion criteria and clear diagnostic criteria for DKA, ensuring the accuracy of these findings. Additionally, using both venous blood gas and serum chemistry panels for measurements enhances the reliability of the data. However, limitations include the small sample size and single-center setting, which may limit the generalizability of these findings.

CONCLUSIONS

This study reveals a significant prevalence of hypokalemia among patients with Diabetic Ketoacidosis (DKA), with 53.61% of participants exhibiting varying degrees of potassium deficiency. Notably, the majority of hypokalemic patients presented with mild hypokalemia, highlighting the need for vigilant potassium monitoring in this population. Despite the observed prevalence, no significant associations were found between hypokalemia and insulin use or gender, suggesting that other factors may contribute to potassium imbalances in DKA.

Authors Contribution

Conceptualization: NUSS
Methodology: NUSS, FF, AA
Formal analysis: NUSS
Writing, review and editing: MA, SS1, SS2, SZM, FF, AA

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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