Original Article

Outcome Of Diabetic Ketoacidosis And The Factors Affecting It - Experience From Pediatric Intensive Care Unit

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Abstract

Objective: To study the outcome of patients admitted with DKA in the Pediatric Intensive Care Unit (PICU) and the factors affecting it.

Methods: It was a prospective study, conducted in the Pediatric Intensive Care Unit of the University of Child Health Sciences & The Children's Hospital, Lahore, from June 2019 to July 2022. Data was collected on a well-designed form. Patients who were admitted to the PICU with DKA were enrolled in the study. Data was analyzed using SPSS version 25. Chi-square test was used to find out the p-value.

Results: In this study, 165 patients were enrolled, from June 2019 to July 2022, with a mean age of 7.88±3.97yrs years. Forty-four patients (26.7%) presented in moderate DKA, while 73.3%(n=121) presented in severe DKA. Ninety-five patients (57.6%) had new-onset diabetes. Among already known cases, 50.3%(n=83) had poor glycemic control. Mean hospital stay was 5.0 ±2.4 days. Moderate cases recovered within 24-36 hours of hospital stay, while severe cases took 5-7 days to recover completely. Mortality was seen in 23.6%(n=39) while 76.3%(n=126) recovered. Conscious level, pH at admission, hypernatremia, pulmonary edema, cerebral edema, refractory shock, need for mechanical ventilation, and dialysis were the factors that were strongly associated with the outcome of DKA patients (p <0.001).

Conclusion: The more severe the presentation of DKA, the greater the chances of complications and worse outcomes. Altered conscious level, pH<7 at admission, hypernatremia, pulmonary edema, cerebral edema, refractory shock, need for mechanical ventilation, and peritoneal dialysis were the factors associated with poor outcome.

Keywords: Diabetic Ketoacidosis, Treatment outcome, Risk factors, Pediatric ICU

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AA, MA - Acquisition, Analysis, Interpretation
AA, MA, SA, AR - Drafting
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Introduction

Diabetic ketoacidosis (DKA) is a common reason for hospitalization in patients with type 1 diabetes mellitus.[1] While DKA occasionally occurs in children with type 2 diabetes, it is particularly prevalent in those with type 1 diabetes, with approximately 30% of affected children in the United States and Canada presenting with DKA as their initial sign of the disease.[2,3] Early recognition and treatment are crucial to prevent this lethal complication and reduce the risk of severe outcomes, including death.[4] Common complications of DKA include cerebral edema, acute renal failure, and secondary infections.[5]

Several factors raise the plausibility of DKA as the primary manifestation of type 1 diabetes in children, such as young age (particularly below 2 years of age), ethnic minority status, poor socioeconomic background, and delayed diagnosis.[6,7] For those with established type 1 diabetes, DKA occurs at a rate of 6 to 8% annually. Contributing factors include peri-pubertal and pubertal growth, gastroenteritis, infection, poor metabolic control, poor adherence to diet and follow-up, limited access to healthcare, and missing doses of insulin.[8,9]

Mortality in diabetes is largely due to DKA and its complications, with DKA accounting for 73% of deaths in the first decade after the disease diagnosis. Cerebral edema, occurring in 0.3-1% of patients, is the leading cause of death in DKA, with other causes being less common.[10] In developed countries, DKA mortality has decreased to 0.15%-0.31%. However, in resource-limited countries, mortality is as high as 3.4% to 13.4%, often due to delayed or inadequate treatment.[11-14] In these regions, higher rates of complications such as cerebral edema, sepsis, shock, and renal failure contribute to mortality, with delayed diagnosis identified as a major risk factor, particularly in children.[12]

The rationale of this study is that we want to find out the outcome of diabetic ketoacidosis and its risk factors in the pediatric population of a developing country. Our center caters large population of diabetic ketoacidosis from the province. We want to find out what we are lacking in terms of treatment and outcome of our diseased population. It will help identify the responsible factors to address them effectively.

The objective was to study the outcome of patients admitted with DKA in the Pediatric Intensive Care Unit and the factors affecting it.

Original Article

Materials And Methods

A prospective study was conducted in the PICU of the University of Child Health Sciences & The Children's Hospital, Lahore, from June 2019 to July 2022. Non-probability consecutive sampling was done. Data was collected on a well-designed proforma. All patients with DKA who were admitted to the PICU were enrolled in the study. Patients with developmental delay or renal disease were excluded from the study. Demographics, DKA severity, complications, outcome, and factors affecting it were collected.

DKA was diagnosed as hyperglycemia (blood glucose >200 mg/dL), venous pH <7.3 or serum bicarbonate <15 mmol/L, and ketonemia (blood ß-hydroxybutyrate ≥3mmol/L) or moderate/large ketonuria. ISPAD GUIDELINES.[15] Its severity was classified as: Mild (pH 7.2-7.3), moderate (pH 7.1-7.2), or severe (pH <7.1).[15] Headache, sudden deterioration in conscious level, bradycardia, hypertension, cranial nerve involvement, respiratory pattern abnormalities, decerebrate/decorticate posturing, and consistent MRI DWI findings were labeled as cerebral edema. Tachycardia, along with poor perfusion (capillary refill time>3 sec) in the presence or absence of hypotension, was labeled as shock as per PALS guidelines.[16]

Outcome was seen as expired or recovered. Data was analyzed statistically by using SPSS version 25. Quantitative variables were presented as mean and standard deviation. Qualitative variables were presented as frequency and percentage. Chi-square test was used to find out the p-value.

Results

In this study, 165 patients were enrolled, with a 51% female and 49% male population. Mean age was 7.88±3.97yrs. Mean weight was 20.08±8.57kg. Forty-four patients (26.7%) presented in moderate DKA, while 73.3%(n=121) presented in severe DKA.

At admission, abdominal pain (70%, n=133) was the most common symptom, followed by polydipsia (60%, n=100), altered sensorium (43%, n=71), polyuria (54.4%, n=90), vomiting (29.7%, n=49), nausea (23.6%, n=39), and fever (21.2%, n=35). Forty-three percent of patients (n=71) were unconscious, with a mean GCS of 10.46± 3.48, 25.5% (n=42) had papilledema, and 40.7% (n=67) had irregular breathing.

BSR was more than 500 in 72.1%(n=119), pH was less than 7 in 49.1%(n=81) and had bicarbonate less than 5 in 76.4%(n=126). The rate of fall of glucose was >100 in 55.8%(n=92). An initial fluid bolus (10-20 ml/kg) was given in 76.4%(n=126). New onset type 1 DM was seen in 57.6%(n=95), and 42.4%(n=70) were known cases of type 1 DM. Initial treatment at the periphery was given in 37%(n=61), and 80%(n=132) were transported by self-transport. Among known cases of 1 DM, 50.3% had poor glycemic control, 40.6% had noncompliance with insulin, 46.1% had noncompliance with diet and follow-up, and 58.8% had a preceding history of infection. The majority, 86.7%(n=143), had low socioeconomic status, while 67.3%(n=111) parents had less than primary. Mean hospital stay was 3.5±1.5 days. Moderate cases recovered within 01±1.0 days of hospital stay, while severe cases took 06±2.0 days in recovery. Mortality was observed in 23.6%(n=39) cases while 76.3%(n=126) recovered. Increased mortality was seen in patients presenting with severe DKA (25.60%).

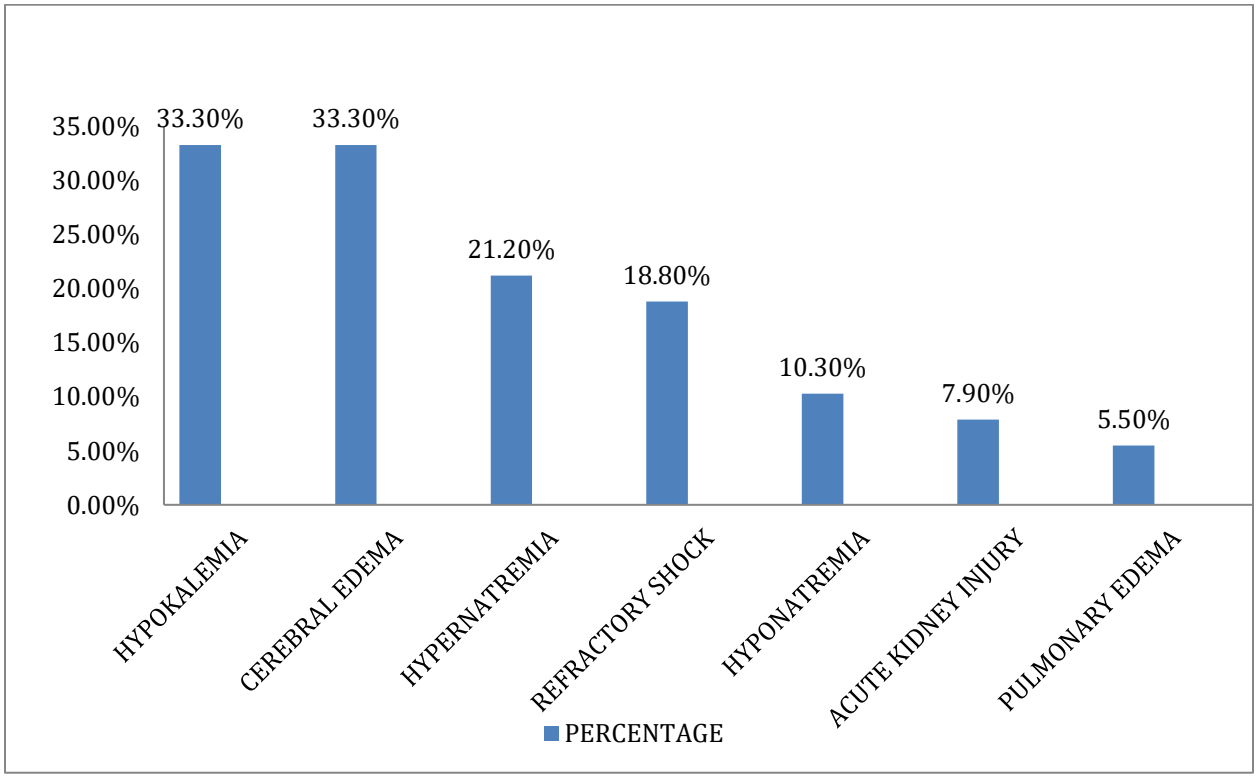

Figure 1: Showing complications of DKA

Figure 2 shows the association between the severity of DKA and outcome. Hypokalemia (33.3%) and cerebral edema (33.3%) were the most common complications seen in DKA patients (Figure 1). Thirty-six patients (21.8%) required mechanical ventilation, and Peritoneal dialysis was done in 17.6%(n=29). Patients who presented in severe DKA had a higher mortality rate, as shown in the figure below.

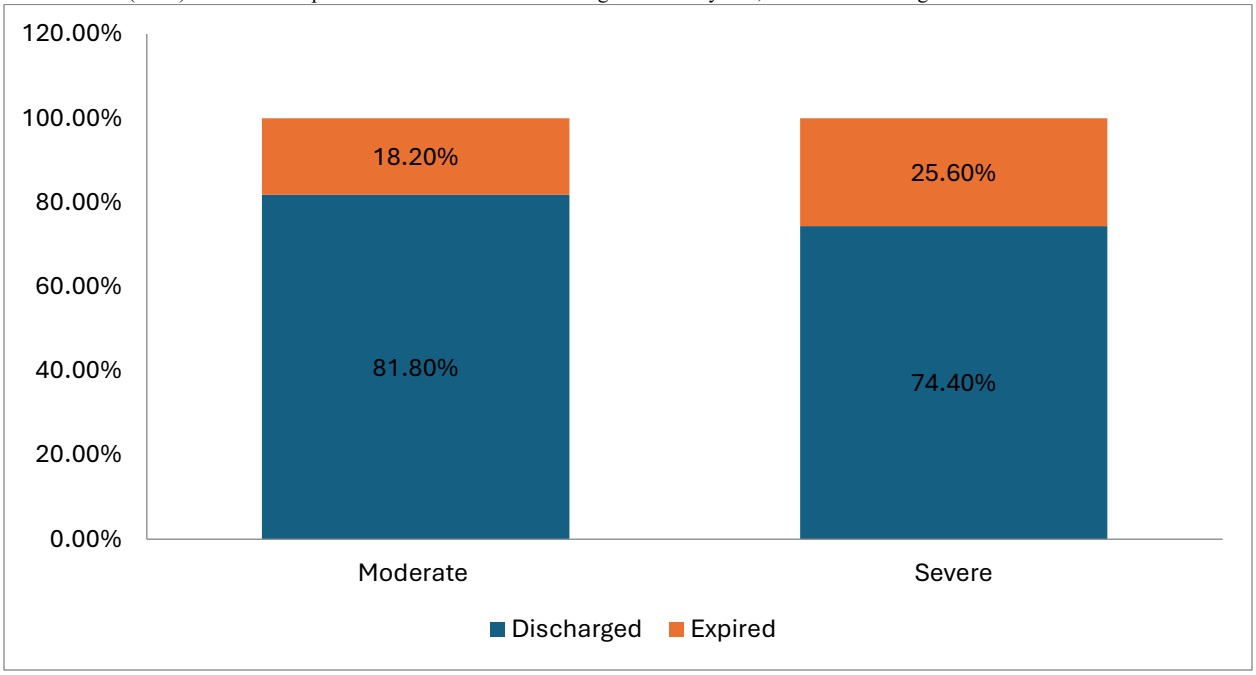

Figure 2: Showing the severity of DKA and the outcome

Patients who presented with DKA as the first presentation of type 1 DM had a high mortality rate of 22.10% as shown in the figure below.

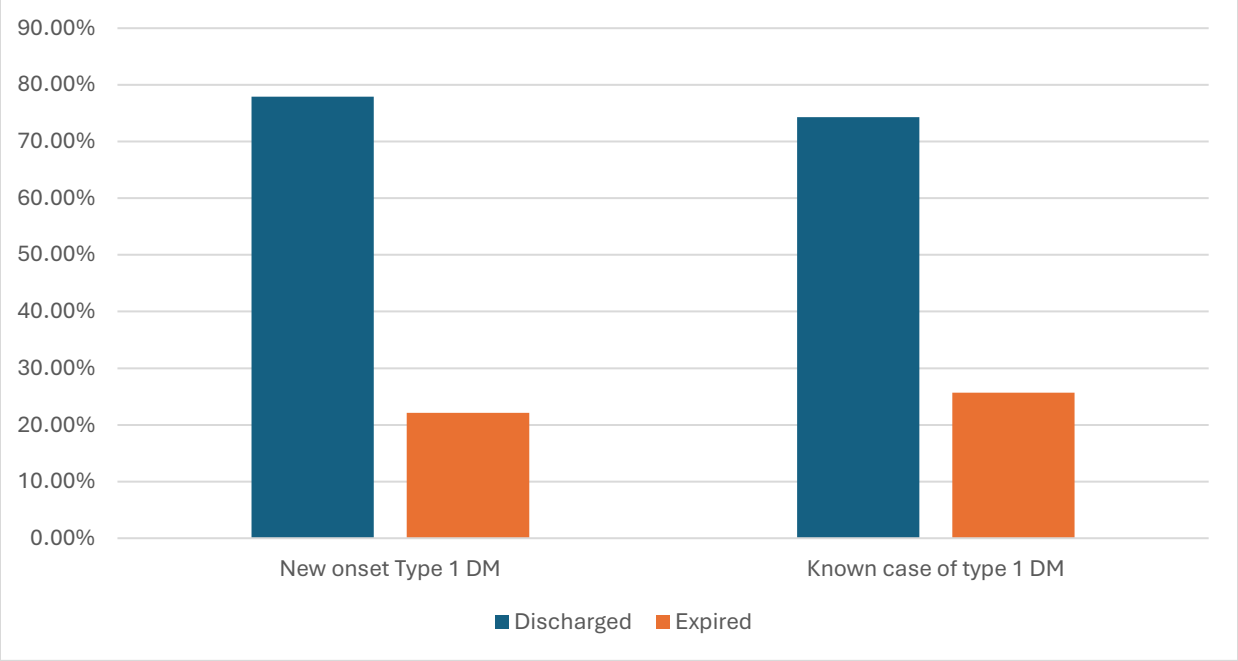

Figure 3: Showing duration of type 1 diabetes and outcome

Conscious level, pH at admission, hypernatremia, pulmonary edema, cerebral edema, refractory shock, need for mechanical ventilation, and peritoneal dialysis were the factors which have a statistically significant association with the outcome of DKA($p < 0.001$), as shown in the table below.

Table 1: Factors associated with the outcome of DKA patients

Factors	Discharged	Expired	p-value
ge	38(80.8%)		0.893
<5	88(74.5%)	09(19.1%)	
>5		30(25.4%)	
Conscious level at presentation			<0.001
Unconscious	40(56.3%)	31(43.7%)	
Conscious	86(91.5%)	08(8.5%)	
Cerebral Edema			<0.001
Present	19(97.3%)	36(65.5%)	
Absent	107(97.3%)	03(2.7%)	
Onset of Diabetes			0.590
New Onset	74(77.9%)	21(22.1%)	
Diagnosed	52(74.3%)	18(25.7%)	
BSR at admission			0.444
>500 mg/dl	89(74.8%)	30(25.2%)	
<500 mg/dl	37(80.4%)	09(19.6%)	
pH at admission			<0.001
pH <7.0	51(63.0%)	30(37.0%)	
pH >7.0	75(89.3%)	09(10.7%)	
Serum Sodium			<0.001
Hypernatremia	15(42.9%)	20(57.1%)	
Normal Sodium	111(85.4%)	19(14.6%)	
Mechanical ventilation			<0.001
Ventilated	06(16.7%)	30(83.3%)	
Not Ventilated	120(93.0%)	09(7.0%)	
Pulmonary edema			<0.001
Present	00(0%)	09(100%)	
Absent	126(80.8%)	30(19.2%)	
Refractory shock			<0.001
Yes	04(12.9%)	27(87.1%)	
No	122(91.0%)	12(9.0%)	
Peritoneal dialysis done			<0.001
Yes	08(27.6%)	21(72.4%)	
No	118(86.8%)	18(13.2%)	

Discussion

DKA is the primary reason for hospitalization in patients with type 1 diabetes mellitus. Severe cases may necessitate admission to the pediatric intensive care unit (PICU), while milder cases can be treated in a ward. In this study, only moderate to severe DKA patients were managed in the PICU, while mild cases were managed in the ward. In other studies, mild cases of DKA as well as those managed in the ward were included. But in our study, we included only those patients who were managed in the PICU, and these patients were having moderate to severe DKA. Most of the studies have included a smaller patient population than the index study.[14, 17 -20] As far as the patient population is considered, this is the only study from the PICU that includes the largest patient population over a period of three years. Of 165 patients, Forty-four patients (26.7%) presented in moderate DKA, while 73.3% (n=121) presented in severe DKA. Our study had a larger population with severe DKA than in other studies. Mean age (7.88±3.97yrs) in our study is comparable to a study conducted in Pakistan,[14] while it is less than in other studies.[17-20]

Diagnosis of DKA is difficult to make as it presents with vague symptoms like vomiting, abdominal pain abdomen and rapid breathing, frequently mistaken as acute abdomen, gastroenteritis, or pneumonia. The challenge is greater in newly diagnosed type-1 diabetes patients, where a lack of information among the health care providers can delay diagnosis, resulting in DKA complications. In the index study, 57.6% (n=95) presented with new onset diabetes, which is comparable to other studies done in Kenya and Ethiopia.[17-20]

In our study, among diagnosed cases of type 1 DM, 58.8% had a preceding history of infection, 50.3% had poor glycemic control, 40.6% had non-compliance with insulin, and 46.1% had non-compliance with diet & follow-up. This can be due to poor access to health care facilities, a low literacy rate of 67.3%(n=111), and low socioeconomic status, 86.7%(n=143).

Mortality was seen in 23.6%(n=39). It is higher than studies done in Pakistan, Kenya, Ethiopia, and North India, with mortality rates of 3.4%, 6.9%, 0%, and 3.4% respectively.[14,17,19,20] This can be due to increased patient load and increased complications in our study population. The most common complications seen in this study were hypokalemia (33.30%) and cerebral edema (33.30%), as mentioned in Figure # 01. The percentage of these complications was higher than in other studies. [14,17,20]

According to Syed et al.'s study, the presence of cerebral edema, need for mechanical ventilation, and low socioeconomic status were the factors that impacted the outcome of the patients which correlates with our study. As per a study done in Kenya, high serum creatinine, low urine output, and altered consciousness were all associated with a higher risk of mortality.[17]

Measures should be taken to reduce complications and mortality of DKA. Preventing DKA at the time of diagnosis is crucial and should focus on rigorously educating the community and primary care physicians to increase understanding of the disease. Moreover, strategies must be implemented to prevent DKA episodes in patients with established type 1 diabetes mellitus. Educating patients and ensuring access to specialized diabetes programs can significantly improve the management and outcomes for these patients.

Conclusions

The more severe the presentation of DKA, the higher the chances of complications and worse outcomes. Altered conscious level, pH<7 at admission, hypernatremia, pulmonary edema, cerebral edema, refractory shock, need for mechanical ventilation, and peritoneal dialysis were the factors associated with poor outcome.
Strength of the study is that it is a prospective study, conducted in a pediatric intensive care unit, over a year's period, and enrolled a large patient population. A limitation of the study is that it is a single-center study.

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