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Clinical presentation and Outcomes of Diabetic ketoacidosis in Children: A Retrospective study at a Tertiary Care Hospital

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Abstract

Objective: To assess the clinical presentation and outcomes of Diabetic Ketoacidosis in Pakistani children with type 1 diabetes.

Study design: A Retrospective study.

Duration of place of study. Department of Pediatric Saidu teaching hospital swat from Jan, 2020 to 31st Dec 2023

Methods: This retrospective analysis was carried out in previous 3 years from 1st Jan, 2020 to 31st Dec 2023 on 79 cases. Record of patients fulfilling the inclusion criteria which according to the international society of pediatrics and adolescent diabetes, DKA is defined by the presence of all of the following, RBS >200, PH <7.3, and HCO3 <15 meq/L. Clinical features of all included patients were recorded on predesigned proforma. Complications and mortality were compared across DKA severities using statistical tests with a significance level set at $p < 0.05$.

Results: The mean age was 9.27 ± 2.95, and 51 (64.56%) were females. The most common clinical feature observed in the study participants was abdominal pain, reported by 51 (64.56%) individuals. Following closely, vomiting was observed in 43 (54.43%), respiratory distress in 45 (56.96%), and polyuria in 41 (51.90%). Other features, such as fever (n=12, 15.19%), shock (n=11, 13.92%), and enuresis (n=17, 21.52%), were reported with lower frequency. Mortality was found to be 10.13% and limited to severe DKA cases.

Conclusion: The most common features of children with DKA are abdominal pain, respiratory distress, and polyuria-polydipsia. Severe DKA cases have a high rate of mortality.

Keywords: Children, Diabetic Ketoacidosis, Type 1 Diabetes, mortality.

INTRODUCTION

Children with type 1 diabetes (T1D) face a significant threat from diabetic ketoacidosis (DKA), a leading cause of morbidity and mortality.[1] DKA is characterized by high blood sugar (>200 mg/dl), low venous pH (<7.3), serum bicarbonate (<18 mmol/L), and elevated beta-hydroxybutyrate or moderate-large urine ketones.[2] DKA severity is classified as mild, moderate, or severe based on specific pH and serum bicarbonate levels.[3] DKA may occur in instances of diabetes that remains undiagnosed or is attributable to

factors like skipped insulin doses, malfunctions in insulin pumps, or inadequate management of infections.[4] The prevalence of DKA at the onset of T1D is substantial, ranging from 30 to 40% in high-income countries.[5] Insulin deficiency triggers DKA, leading to the production of ketones and metabolic imbalances.[6] Prompt recognition and intervention, involving fluid and insulin administration, are critical for DKA management and preventing serious complications.[7]

The mortality rate among children with Diabetic Ketoacidosis (DKA) ranges from 3.4% to 13.4% in developing nations.[8, 9] The variability in mortality rates underscores the impact of diverse factors, such as healthcare infrastructure, access to medical resources, and the effectiveness of clinical management practices, which contribute to different outcomes in developing countries.[8]

The increasing incidence of diabetes mellitus in Pakistan contrasts with the insufficient attention given to its complications, particularly Diabetic Ketoacidosis (DKA). Limited literature, especially in the pediatric age group, exists on the clinical profile and outcomes of DKA in the Pakistani population.[10] To improve DKA management protocols in children, understanding the clinical profile and current outcome trends is crucial.

The objective of this study was to determine clinical presentation, complications and mortality in children with DKA

METHODOLOGY

This retrospective study was conducted on participants aged equal to or less than 13 years old who presented with Diabetic Ketoacidosis (DKA) at Saidu Group of Teaching Hospital in Swat over the past decade. Ethical approval for the study was obtained from the relevant institutional review board, and informed consent was obtained from their parents. The calculated sample size was 79 cases with a 4% margin of error and a 95% confidence level, using the frequency of mortality (3.4%) in children with DKA from a previous study[8].

The diagnosis of DKA was based on identifying characteristic ketonuria, hyperglycemia (> 200 mg/dl or 11.1 mmol/l), and metabolic acidosis. Severity levels were classified as mild, moderate, or severe. The inclusion criteria were children with DKA, Pakistani nationals (on basis of parents NIC) and both genders. Exclusion criteria were the individuals not meeting the laboratory parameters of DKA or having an alternative diagnosis explaining signs and symptoms as well as those with incomplete or missing data.

The measurement of HbA1c, or glycated hemoglobin, was conducted using a technique known as high-performance liquid chromatography (HPLC). This method involves separating and analyzing the different components of a mixture, in this case, the various forms of hemoglobin in the blood. HPLC is a highly precise and reliable technique commonly employed for the quantification of HbA1c levels. The Body Mass Index (BMI) was calculated by determining the person's weight in kilograms, measured using a calibrated scale, and dividing this value by the square of their height in meters. Height was measured using a stadiometer, a device designed for precisely measuring a person's height. This involved the individual standing upright against the stadiometer, ensuring accurate measurement from the base to the highest point of the head.

The clinical features like fever, vomiting, abdominal pain, respiratory distress, shock, polyuria and polydipsia, and enuresis were recorded. The comprehensive recording process involved a thorough assessment of each patient, combining information gathered from both medical history and clinical examinations. For fever, the presence or absence of elevated body temperature was noted, relying on historical accounts or direct temperature measurements. Vomiting frequency and severity were documented based on patient reports or clinical observations. Abdominal pain was evaluated through patient history and physical examination, capturing details such as location, intensity, and duration to provide a comprehensive understanding of this symptom. Respiratory distress was assessed through clinical examinations, including observations of respiratory rate, chest movements, and the use of accessory muscles. Shock was evaluated by monitoring signs of systemic hypoperfusion, such as blood pressure, heart rate, and peripheral perfusion. Polyuria and polydipsia were recorded based on patient history and clinical observation of increased urine output and excessive thirst. Enuresis was documented through historical information regarding involuntary

urination. Outcomes of DKA like complications and mortality were also recorded.

Data were computed using R software (Vienna, Austria). Categorical data, such as gender, clinical features, and outcomes, were calculated in the form of frequencies and percentages, while age was computed as the mean and standard deviation (SD). Complications and mortality were compared among different severities of DKA using the chi-square/Fisher exact test. The level of significance was set at $p < 0.05$.

RESULTS

summarizes the characteristics of the study participants (n=79), presenting mean values along with standard deviations for various parameters. The average age of the participants was 9.27 ± 2.95 years. The mean weight was 22.58 ± 8.25 kg. Glycated hemoglobin (HbA1C) levels were measured, yielding a mean value of 12.57%, with a standard deviation of 2.24. The length of stay at the hospital was also assessed, revealing an average duration of 3.89 ± 1.95 days. Additionally, the gender distribution of the participants is presented, with 51 individuals (64.56%) identified as female and 28 individuals (35.44%) as male. outlines the clinical features observed in patients diagnosed with Diabetic Ketoacidosis (DKA), presenting various variables and their corresponding characteristics. Among the total of 79 participants, 33 individuals (41.77%) were identified as newly diagnosed cases, while 46 individuals (58.23%) were categorized as old cases. Regarding fever, 12 participants (15.19%) reported this symptom, while the majority of 67 participants (84.81%) did not exhibit fever. Abdominal pain was prevalent in 51 participants (64.56%), whereas 28 participants (35.44%) did not report abdominal pain. Shock was observed in 11 participants (13.92%), contrasting with the majority of 68 participants (86.08%) who did not present with shock. Vomiting was reported by 43 participants (54.43%), while 36 participants (45.57%) did not exhibit this symptom. Respiratory distress was noted in 45 participants (56.96%), and 34 participants (43.04%) showed no signs of respiratory distress. Polyuria polydipsia, common in diabetes, was reported by 41 participants (51.90%), and 38 participants (48.10%) did not exhibit this symptom. Enuresis, or involuntary urination, was identified in 17 participants (21.52%), while 62 participants (78.48%) did not report this symptom. These detailed findings offer insights into the prevalence of clinical features among DKA patients, providing a nuanced understanding of the condition based on the number of participants in each percentage category. In this study involving a total of 79 participants, the severity of the condition was categorized into mild, moderate, and severe. Among the participants, 29 individuals (36.71%) experienced mild symptoms, 9 individuals (11.39%) had moderate symptoms, and the majority, comprising 41 individuals (51.90%), exhibited severe symptoms. Regarding mortality outcomes, 8 individuals (10.13%) unfortunately succumbed to the condition, while a significant majority of 71 individuals (89.87%) showed improvement in their health status. In terms of complications observed among the study participants, a variety of conditions were reported. Acute Renal Failure (ARF) was noted in 3 individuals (3.80%), while an additional 3 individuals (3.80%) experienced a combination of ARF and Cerebral Edema. Cerebral Edema occurred independently in 2 individuals (2.53%), and 4 individuals (5.06%) presented with Hypoglycemia. Furthermore, 3 individuals (3.80%) exhibited both Hypoglycemia and Cerebral Edema. Notably, the majority of participants, comprising 64 individuals (81.01%), did not report any complications during the course of the study.provides a comprehensive comparative analysis of complications and mortality in children diagnosed with Diabetic Ketoacidosis (DKA), stratified by the severity of the condition—Moderate (N = 9), Severe (N = 41), and Mild (N = 29). The assessment of complications across these severity groups revealed diverse frequencies, with the number of participants in each category providing a detailed perspective. Acute Renal Failure (ARF) was identified in 1 participant (11.11%) among Moderate cases, 1 participant (2.44%) among Severe cases, and 1 participant (3.45%) among Mild cases. ARF & Cerebral Edema (CE) were observed in 3 participants (7.32%) among Severe cases. Cerebral Edema (CE) occurred in 2 participants (4.88%) among Severe cases. Hypoglycemia was reported in 4 participants (9.76%) among Severe cases. Hypoglycemia, CE, ARF were present in 3 participants (7.32%) among Severe cases. A majority of cases did not exhibit any complications, with 8 participants (88.89%) among Moderate cases, 28 participants (68.29%) among Severe cases, and 28 participants (96.55%) among Mild cases. Furthermore, in terms of mortality, death was not reported among Moderate or Mild cases, but it was

observed in all 8 participants (100%) among Severe cases. Improvement was noted in 9 participants (12.67%) among Moderate cases, 33 participants (46.47%) among Severe cases, and 29 participants (40.84%) among Mild cases. Significant association was found between severity of DKA and mortality (p=0.016).

Table 1: Mean of age, weight, gylcated hemoglobin and length of stay at hospital

Characteristic	**n=79**
Age (years) , Mean ± SD	9.27 ± 2.95
weight (kg), Mean ± SD	22.58 ± 8.25
HbA1C (%),Mean ± SD	12.57 ± 2.24
Stay at hospital (days), Mean ± SD	3.89 ±1.95
Gender, n(%)	
female	51 (64.56)
male	28 (35.44)

Table 2: Frequency of clinical features of DKA patients

Variable	**Characteristic**	**n(%)**
Type of case	Newly diagnosed	33 (41.77)
	Old	46 (58.23)
Fever	No	67 (84.81)
	Yes	12 (15.19)
Abdominal pain	No	28 (35.44)
	yes	51 (64.56)
Shock	No	68 (86.08)
	yes	11 (13.92)
Vomiting	No	36 (45.57)

	yes	43 (54.43)
Respiratory distress	No	34 (43.04)
	yes	45 (56.96)
Polyuria polydipsia	No	38 (48.10)
	yes	41 (51.90)
Enuresis	No	62 (78.48)
	yes	17 (21.52)

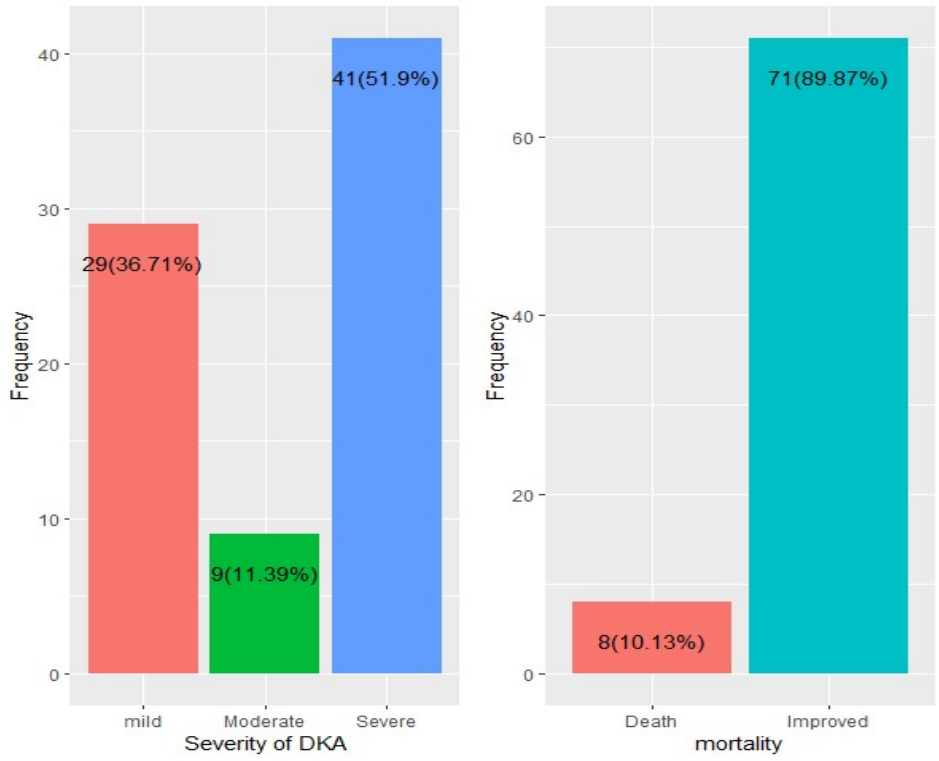

Fig 1: Severity and mortality among DKA children

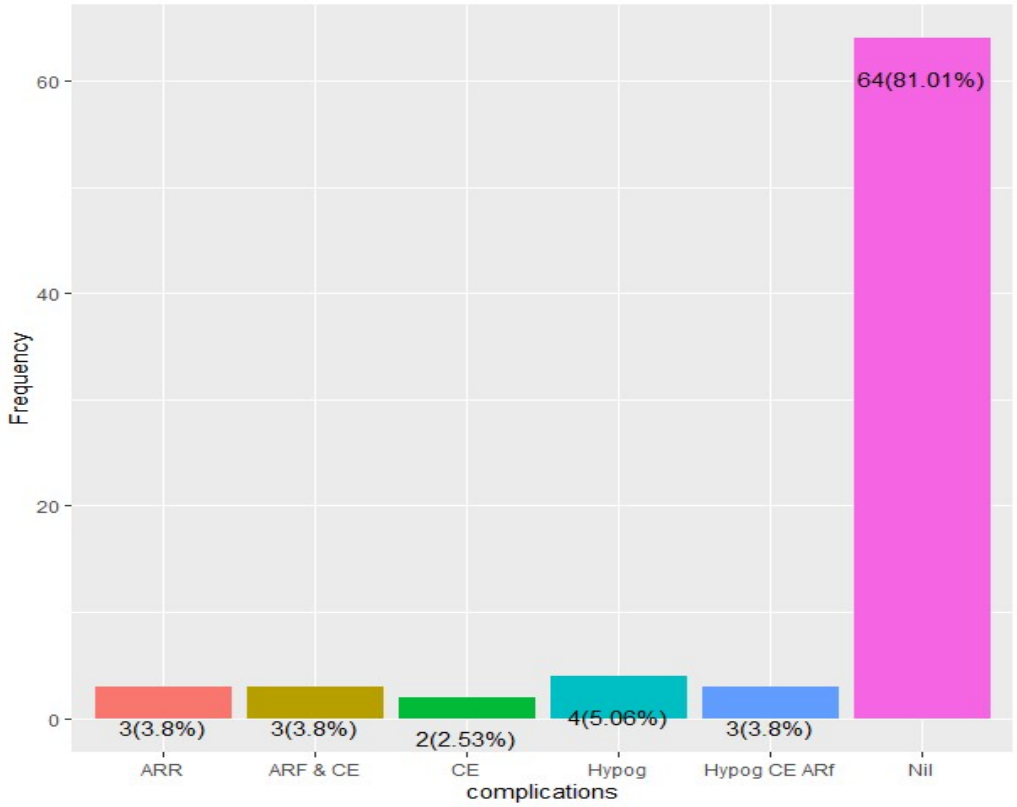

Fig 2: Complications of DKA in children

Table 3: Comparison of complications and mortality by severity of DKA among DKA children

Characteristic	**Moderate**, N = 9	**Severe**, N = 41	**mild**, N = 29	**p-value** *
Complications, n(%)				0.16
ARF	1 (11.11)	1 (2.44)	1 (3.45)	
ARF & CE	0 (0.00)	3 (7.32)	0 (0.00)	
CE	0 (0.00	2 (4.88	0 (0.0	

Characteristic	Moderate, N = 9	Severe, N = 41	mild, N = 29	p-value *
	)	)	0)	
Hypoglycemia	0 (0.00)	4 (9.76)	0 (0.0 0)	
Hypoglycemia, CE, ARF	0 (0.00)	3 (7.32)	0 (0.0 0)	
Nil	8 (88.8 9)	28 (68.2 9)	28 (96. 55)	
Mortality, n(%)				0.016
Death	0 (0.00)	8 (100)	0 (0.0 0)	
Improved	9 (12.6 7)	33 (46.4 7)	29 (40. 84)	

*Fisher exact test

DISCUSSION

In our study, abdominal pain emerged as the most prevalent feature, identified in 64.56% of cases. Following closely, vomiting was reported in 54.43%, while respiratory distress was observed in 56.96%. Fever was found in 15.19% of cases, shock in 13.92%, polyuria in 51.90%, and enuresis in 21.52%. Previous research work shows variable presentations of patients with DKA. Study conducted by Rahak k and Ibrahim MN eteal that vomiting was the most frequently reported symptom, present in 58.8% of cases. Fever followed closely, reported in 51.1% of cases, while abdominal pain and respiratory distress were noted in 32.1% and 26.0% of cases, respectively.[11]

In our study cerebral edema was found in children with severe DKA in 4.8%. Cerebral edema

emerges as a paramount complication in children affected by DKA, manifesting in 1% of DKA episodes.[12] The gravity of this condition is underscored by a substantial mortality rate, ranging from 21% to 24%, and a noteworthy incidence of neurological sequelae in survivors, reported between 21% and 26% in various studies.[13,14] Consequently, an urgent imperative is recognized for proactive measures geared toward both preventing and promptly recognizing warning signs associated with cerebral edema. These indicators encompass diminished arousal, lethargy following initial improvement, headache, vomiting, relative bradycardia, and relative hypertension. This underscores the critical importance of addressing this life-threatening complication in the management of DKA among pediatric patients, emphasizing the need for heightened clinical awareness and timely interventions to enhance patient well-being and outcomes.[10]

In the current study the mortality was 10.13%. The overall mortality rates vary in children with Diabetic Ketoacidosis (DKA) in different regions. In Western countries such as the UK, Canada, and the USA, the mortality rate for children with DKA is relatively low, ranging from 0.15% to 0.35%.[15, 16] This suggests that in these high-income countries, medical care, resources, and management strategies may contribute to better outcomes for children with DKA. On the other hand, in low-middle income countries, the overall mortality rates for children with DKA are considerably higher, ranging from 3.4% to 13.4%.[17] This substantial increase in mortality rates in less economically developed regions could be attributed to factors such as limited access to healthcare, resources, and potentially delayed or inadequate medical interventions.

CONCLUSION

On the basis of our analysis we found that the most common presentation of children with DKA is abdominal pain, respiratory distress, and polyuria-polydipsia , while the severity of DKA is directly related with poor outcomes and complications .

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Authors Contribution

Concept & Design of Study: Ashfaq Ahmad1,Arshad Karim2
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Final Approval of version: All Above

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