

Spectrum of Complications in Children with Moderate to Severe DKA Admitted in Pediatric Intensive Care Unit of a Tertiary Care Hospital

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Author's Contribution

¹ Conception of study

^{2,4} Experimentation/Study conduction

¹ Analysis/Interpretation/Discussion

¹ Manuscript Writing

^{3,5} Critical Review

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Abstract

Objective: To find out the complications of moderate to severe DKA in pediatric patients admitted to Pediatric Intensive Care Unit (PICU).

Materials & Methods: Cross-sectional study was conducted in the PICU of the University of Child Health Sciences & The Children's Hospital, Lahore from Jan 2015 to Dec 2018. Data was collected from retrospective records of patients admitted to PICU. All patients with moderate/severe DKA were included. Data were analyzed using SPSS version 25. The Chi-square test was used to find out the p-value.

Results: A total of 152 patients with moderate/severe DKA were included in the study, having a mean age of 7.86 ± 4.06 years. Most patients 42% (n=64) were more than 10 years of age. The mean weight of the children was 19.89 ± 8.70 kg. Majority 59% (n= 89) were of new-onset diabetes. Severe DKA was seen in 74% (n=112) while moderate DKA in 26% (n=40) patients. The complications seen were: hypokalemia 33% (n=50), cerebral edema 28% (n=42), hypernatremia 18% (n=27), hyponatremia 8% (n=12) and acute kidney injury (AKI) in 7% (n=11). The survival rate was 85% while the mortality rate was 15%.

Conclusion: Hypokalemia and cerebral edema were the most common complications observed. Complications were more common in those patients who presented with DKA in the first presentation.

Keywords: Complications, DKA severity, children, PICU.

Introduction

Type I diabetes mellitus (DM) is the most common endocrine disorder in children and adolescents. Diabetic ketoacidosis (DKA) is the major source of mortality and morbidity in type 1 DM, with case fatality rates ranging from 0.15% to 0.31% in the United States.¹ Among newly diagnosed type 1 DM patients, 30-40% present with DKA in the first presentation.² DKA occurs due to relative or absolute insulin deficiency, and excess of counter-regulatory hormones. It manifests as hyperglycemia, ketosis, and acidosis.³

Cautious fluid resuscitation, insulin, and electrolyte replacement along with observation for complications are the mainstay of treatment. DKA is associated with complications like electrolyte imbalance, intracranial hemorrhage, cerebral edema, cerebral infarction, deep vein thrombosis, dural sinus thrombosis, acute kidney injury, and death.⁵ The most dreadful complication is cerebral edema. Cerebral edema occurs in 0.5% to 0.9% of patients with DKA, with a mortality rate of 40%. It manifests as headache, irritability, drowsiness, altered state of consciousness, cranial nerve palsy, bradycardia, hypertension, and coma.⁶

In a study conducted in Karachi, 37 children were admitted with DKA. Following complications were observed i.e., hyperchloremia (35.94%), hypokalemia (30.81%), hyponatremia (26.70%), cerebral edema (16.43%), shock (13.35%), AKI (10.27%), arrhythmias (3.8%), and thrombotic thrombocytopenic purpura (TTP) (5.4%), myocarditis and ARDS in 1 patient. The mortality rate was 5.4%.⁷

As preliminary identification of complications leads to better management and outcome. It is, therefore, important that moderate/severe DKA patients are closely monitored for complications. As previous studies have been done with small sample size, this study is being conducted with large patient size, so that burden can be assessed accurately and more emphasis should be given to educational programs on the prevention of recurrent attacks of DKA.

Materials and Methods

A cross-sectional study was conducted in the PICU of the University of Child Health Sciences & The Children's Hospital, Lahore from Jan 2015 to Dec 2018. Non-probability consecutive sampling was done. Data was collected from retrospective records. All patients with moderate/severe DKA who got admitted to

PICU were enrolled in the study. Patients who left against medical advice were excluded from the study. Demographic details, diagnosis, DKA severity, and complications were collected from retrospective records.

DKA was diagnosed as hyperglycemia (blood glucose >200 mg/dL), Venous pH <7.3 or serum bicarbonate <15 mmol/L and Ketonemia (blood β -hydroxybutyrate \geq 3mmol/L) or moderate/large ketonuria. Its severity was classified as Mild (pH 7.2-7.3), moderate (pH 7.1-7.2), or severe (pH <7.1).³ Headache, sudden deterioration in conscious level, bradycardia, hypertension, cranial nerve involvement, respiratory pattern abnormalities, decelerate/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/absence of hypotension was labeled as a shock as per PALS Guidelines.¹³

The collected data was entered and analyzed statistically by using SPSS version 25. Quantitative variables like age, duration of stay, and duration of mechanical ventilation were presented in the form of mean and standard deviation. Qualitative variables like gender, complications & outcome were presented in the form of frequency and percentage.

Results

DKA constitutes 20.24% of total PICU admissions. A total of 152 patients with DKA admitted to PICU were included in the study. There was male predominance (52%). The mean age was 7.86 ± 4.06 years. Forty-two percent of patients were more than 10 years of age. The mean weight was 19.89 ± 8.70 kg. The majority 134 (88%) belonged to a poor social class. Most of the patients 89 (59%) were of new-onset diabetes. Severe DKA was seen in 74% (n=112) while 26% (n=40) had moderate DKA. The mean pH was 7.03 ± 0.16 . Mean bicarbonate at admission was 4.13 ± 2.50 . Mean GCS on presentation was 10.5 ± 3.61 (p=0.023).

The complications observed were hypokalemia 50(33%), cerebral edema 42(28%), hypernatremia 27(18%), hyponatremia 12(8%), and AKI in 11(7%). Mechanical ventilation was required in 30(20%). Inotropes were given in 25(16%). Peritoneal dialysis was done in 20(13%). Complications were more common in those who presented with DKA in the first presentation, although only hypernatremia is statistically significant as shown in Table 2. The mean length of ICU stay was 5 ± 1.5 days. The survival rate was 85% while the mortality rate was 15%.

Table 1: Association of complications with the duration of Type 1 Diabetes Mellitus

Complications	New onset DM	Established DM	P value
Hypokalemia	34	16	0.098
Cerebral edema	28	14	0.210
Hypernatremia	21	6	0.025
Hyponatremia	7	5	0.987
AKI	8	3	0.317
Shock requiring inotropes	16	9	0.545
Pulmonary edema	6	3	0.610

Discussion

Incidence of DKA has increased in our setup, with 20.17% PICU admissions in 2015 and 23.34% in 2018. Local studies showed only 1.9% of DKA patients of total PICU admission, with 3.4% in 2015. This is because we cater major burden of patients from all over the province.⁷

In our study, male predominance (52%) was seen as compared to local and international studies which had female predominance (70%, 53.1% respectively).^{7,11} Mean age of patients was 7.86 ± 4.06 years which is similar to other studies.^{7,10,11} Among newly diagnosed Type 1 DM, 59% presented with DKA in the first presentation, this percentage is less than in local and international studies (75%, 66% respectively).^{7,10} Main reason behind this can be poor access to health care facilities or parental ignorance of symptoms as 88% of our patients belonged to a poor socioeconomic class. Mallare et al also showed a high incidence of DKA in patients with low socioeconomic status.¹⁴

Despite comprehensive knowledge regarding T1DM, DKA occurs quite frequently. Complications are less common with immediate and appropriate management of DKA. However, when complications develop; they have a significant contribution to morbidity and mortality. Cerebral edema is the most common complication of DKA.^{8,9} In our study, cerebral edema was seen in 27.6%, while Qalb et al study and Jayshree et al study showed 43%, and 13.2% respectively.^{7,10}

Regarding electrolyte imbalance, hypokalemia 50(32.9%), hypernatremia 27(17.8%), and hyponatremia 12(7.9%) were seen in our study. These complications are much higher than those observed in local and international studies.^{7,10,11} The root cause is large patient load, initially missed diagnosis, and delayed referrals from the periphery.

Complications were more common in those who presented with DKA in the first presentation than those with already established DM. Similar results were observed in a local study.⁷ Reason being late diagnosis of DM due to subtle symptoms, poor access to health care, and poor socioeconomic status. Among new-onset diabetes patients, mechanical ventilation was required in 18, inotropes in 16, and peritoneal dialysis in 13 patients. They are higher than those with already established diabetes mellitus patients. These results are clinically significant. Although, only hypernatremia is statistically significant ($p=0.025$).

In local study, arrhythmias (8%), myocarditis (2.7%), stroke (2.7%), hyperchloremia (94%), ARDS (2.7%), TTP (5.4%) and sepsis (13.5%) were seen in addition to other complications. These complications were not seen in our study.⁷

As the incidence of DKA is increasing, more and more complications are seen. It can be due to missed diagnosis initially, followed by inappropriate management leading to complications. A study from Korea showed that 46.6% study population had missed diagnosis of diabetes leading to an increased risk of DKA ($p=0.002$).¹²

The mean length of ICU stay in our study was 5 ± 1.5 days while in the local study, it was 2 ± 2.8 days.^{7,10} It is higher than in other studies. It is attributable to more complications seen in our study contributing to a prolonged hospital stay.

Mortality in our study was 15%, while it was 5% in local studies and 13.2% in international studies. It is ascribable to a missed diagnosis of DKA initially, late presentation, delayed referral, and increased frequency of complications contributing to increased mortality.^{7,10}

Strengths & Limitations:

Our study included a large study population than in other local and international studies. Our study has the limitations of being a single-centered study, from retrospective data.

Conclusion

Hypokalemia and cerebral edema were the most common complications seen. Complications were more frequent in those patients who presented with DKA in the first presentation. Awareness should be created regarding type I diabetes mellitus so that patients can be treated earlier, and complications can be avoided.

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