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Research Article

Clinical Profile and Outcome of Pediatric Patients with Diabetic Ketoacidosis: A Retrospective Study at a Developing Country

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Abstract

Introduction: Diabetic Ketoacidosis (DKA) is a life-threatening complication of type 1 diabetes mellitus in children. It is characterized by a biochemical triad of hyperglycemia, ketonuria, and acidemia. DKA is an important complication of undiagnosed or poorly controlled diabetes mellitus. If DKA is properly managed, the morbidity and mortality attributable to diabetes mellitus can be easily prevented. The objective of this retrospective descriptive study is to analyze the clinical profile, precipitating factors, and outcome of pediatric patients with Diabetic Ketoacidosis.

Material and Method: A descriptive retrospective study was conducted in a tertiary hospital in Olongapo, Zambales, Philippines from January 1, 2012 to December 31, 2017. The charts of 14 pediatric patients (below 18 years old), who were admitted to the pediatric ward were retrieved from the medical records section and analyzed. The severity of DKA was graded as mild (pH 7.25-7.35, pCO2 16-20 mEq/L), moderate (pH 7.15-7.25, pCO2 10-15 mEq/L), and severe (pH <7.15, pCO2 <10 mEq/L).

Results: The mean age of the patients was 12.7 years. Out of the 14 patients that were included in the study, 12 (85.7%) patients were females and two (14.3%) were males. The most common signs and symptoms of DKA were dehydration, polyuria, polydipsia, respiratory distress, weakness, and abdominal pain. At the time of presentation, five patients had mild DKA, three patients had moderate DKA and six patients had severe DKA. Eight (57.14%) were known cases of diabetes mellitus while six (42.8%) patients were newly diagnosed cases of diabetes mellitus, which presented as DKA on presentation. There was successful resolution in 12 (85.7%) patients whereas two (14.3%) patients died. The presence of infection, the need for a mechanical ventilator, low serum sodium and potassium levels, and low arterial pH were factors that impacted the outcome of the patient.

Conclusion: History of omission of insulin, infection, and poor compliance were associated with the severity of diabetic ketoacidosis. Family history of diabetes in a newly diagnosed diabetic patient was seen as an important risk factor for DKA according to this study. We advise that patients should have regular follow up with a pediatric endocrinologist. Parents and caregivers should be educated about the importance of the need for regular insulin injection, regular monitoring of blood glucose, and early management and treatment of infection which can be also considered as an important long-term management strategy.

Keywords: Diabetic Ketoacidosis; DKA; Type 1 Diabetes Mellitus

Introduction

DKA is potentially a life-threatening acute complication of type-1 Diabetes Mellitus (DM), characterized by a biochemical triad of hyperglycemia, ketonuria, and acidemia [1]. DKA is reported in 20–40% of newly diagnosed diabetic patients, and when unrecognized, it may lead to impairment of consciousness and even death [2]. It may occur in association with infection, other stress, or non-compliance with treatment. DKA occurs in 20%-40% of children with known DM who omit insulin doses or who are not managed appropriately during intercurrent illness [3].

The likelihood of DKA occurring at the onset of DM varies considerably between 11% - 67% from one country to another [4]. The mortality of DKA in children in developed countries has declined to 0.15%-0.31% with a higher rate (13%) being reported from developing countries [5]. Mortality and morbidity in DKA include - hypoglycemia, infection, pulmonary edema, central nervous system hemorrhage or thrombosis, large vessel thrombosis, cardiac arrhythmia caused by electrolyte imbalances, pancreatitis, renal failure, and intestinal necrosis [6].

Management requires careful replacement of fluids and electrolyte deficits, intravenous administration of insulin, and close monitoring of clinical and biochemical parameters, directed towards timely detection of complications, including hypokalemia, hypoglycemia, and cerebral edema. In order to minimize complications, DKA should be diagnosed early and appropriate management should be done.

The objective of this retrospective descriptive study is to analyze the clinical profile, precipitating factors, and outcome of pediatric patients below 18 years with Diabetic Ketoacidosis at James L. Gordon Memorial Hospital, Olongapo, Zambales, Philippines.

Methodology

This is a descriptive retrospective study conducted at James L Gordon Memorial Hospital, a tertiary hospital in Olongapo City, Zambales. This study was conducted following the ethical standards of the responsible committee on human experimentation of this institution. In this study, a 59-month chart review from January 1, 2012 to December 31, 2017 was done. The charts of 14 pediatric patients less than 18 years old, who were admitted to the pediatric ward of James L Gordon Memorial Hospital due to DKA were retrieved from the medical record section. DKA was diagnosed when the blood sugar was >250mg/dl with acidosis (pH <7.3, pCO2 <20 mEq/L) and positive urinary ketones. Patients were diagnosed to have newly diagnosed diabetes if they were previously undiagnosed and had presented with DKA. The severity of DKA was graded as mild (pH 7.25-7.35, pCO2 16-20 mEq/L), moderate (pH 7.15-7.25, pCO2 10-15 mEq/L), and severe (pH <7.15, pCO2 <10 mEq/L) [7]. All patients were monitored every hour for heart rate, respiratory rate, blood pressure, urine output, oxygen saturation, sensorium, and clinical progress. All patients included the measurement of at least the following parameters: random blood sugar, urine ketones, serum electrolytes, arterial blood gas, and complete blood count. Intravenous hydration and insulin infusion were initially given. Potassium replacement and restriction were done as required. Once the patient's condition stabilized and their DKA resolved (no emesis, pCO2 >15mEq/L, normal electrolytes, and pH >=7.3), they were shifted to subcutaneous insulin and started with oral feeding. All children were given prophylactic antibiotics until they improved clinically or blood/urine cultures were reported to be sterile. The presence of infection was indicated by radiologic imaging or culture. This was supported by elevated white blood cell count and clinical examination. The measure of compliance with insulin was based on the history given by the attendants of the patients. Poor compliance was defined as missing insulin injections on multiple days, especially before or during the period of illness. Omission of insulin is defined as not taking insulin.

Results

Of the hospital admissions from January 2012 to December 2017, a total of fourteen children presented with DKA. The mean age of presentation was 12.7 years. Two were boys (14.3%) and 12 patients were girls (85.7%) with male to female ratio being 1:6. The mean duration of symptoms before hospitalization was 9.5 days. Six (42.8%) patients were newly diagnosed with type 1 DM which presented as DKA on presentation. Seven (50%) had a family history of DM. Among the 14 patients, all presented with signs of dehydration and polyuria. Other signs and symptoms were respiratory distress (50%), weakness (35.7%), abdominal pain (28.5%), fever (28.5%), weight loss (14.2%) and loss of appetite (14.2%), polydipsia (7.1%), impaired consciousness (7.1%), smell of ketones (7.1%) and polyphagia (7.1%). The frequency of signs and symptoms among the patients with DKA in our research is shown in Table 1.

Out of the total 14 patients, five (35.7%) patients had mild DKA, three (21.4%) patients had moderate DKA, and six (42.8%) patients had severe DKA. The presence of infection (most commonly viral fever, pneumonia, and urinary tract Infection), history of omission of insulin, and poor compliance were factors that were associated significantly with the severity of Diabetic Ketoacidosis at presentation. The baseline features of patients with DKA in our research are given in Table 2.

The mean value of various important serum parameters in the patients include random blood sugar - 421.4 mg/dl; Sodium - 134.2 mEq/L; Potassium - 3.9 mEq/L; pH - 7.2. The mean duration of hospital stay was 9.9 days.

Table 1: Frequency of signs and symptoms among 14 patients with DKA.

S.N.	Clinical Presentation	Numbers	Percentage (%)
1.	Dehydration	14	100
2.	Polyuria	14	100
3.	Respiratory Distress	7	50
4.	Weakness	5	35.7
5.	Abdominal Pain	4	28.5
6.	Fever	4	28.5
7.	Weight loss	2	14.2
8.	Loss of appetite	2	14.2
9.	Polydipsia	1	7.1
10.	Impaired Consciousness	1	7.1
11.	Smell of Ketones	1	7.1
12.	Polyphagia	1	7.1

Table 2: Baseline disease feature of patients with DKA.

Baseline variables	Mild DKA	Moderate DKA	Severe DKA
AGE			
1-5 years			
5-10 years	1	1	1
>10years	4	2	5
GENDER			
Male			2
Female	5	3	4
BMI (kg/m^2)			
<18.5	5	2	5
18.5-24.9	2		
Family History of Diabetes	4	1	2
History of Omission of Insulin	3	1	
Poor Compliance		1	3
First Time Diagnosis	3		3
Duration of Symptoms in Days			
<=1 day		1	
2-4 days	1		1
5-10 days	2		2
>10 days	3	1	3
Presence of Infection	4	2	5

(BMI = Body Mass Index; kg/m^2 = Kilogram per square metre).

The severity of DKA was found to be inversely proportional to the level of consciousness. The severity of hyponatremia increased significantly with the severity of DKA. Hypokalemia is seen in 28.5% of patients. Among the 14 patients with DKA, 85.7% had complete resolution and 14.3% of patients died. Out of fourteen cases, eight cases were known cases of diabetes mellitus and six were newly diagnosed cases. The mean duration of insulin infusion was 33.5 hours. The presence of infection, the need for a mechanical ventilator, low serum sodium level, and low arterial pH were factors that impacted the outcome of the patient. The relation between the biochemical and clinical parameters with the severity of DKA is presented in Table 3.

Table 3: Relation between different biochemical and clinical parameters and grade of severity of DKA.

Parameters in DKA	Mild DKA	Moderate DKA	Severe DKA
Glasgow Coma Scale at presentation			
<=8			1
8-11			5
>=12	6	2	
Random Blood Sugar at admission (mg/dl)			
250 - 350	2		3
350.1 - 450	2		
450.1 - 550	1	2	3
>550.1	1		
Serum Sodium (mEq/L)			
<135	3	1	2
135 - 145	2	1	2
>145	1		2
Serum Potassium (mEq/L)			
<3.5	2	2	
3.6 – 5.5	4	1	4
>5.5			1
Blood Urea Nitrogen (mg/dl)			
<12	2	1	
12.1 - 20	2		4
>20	1		4
Hospital stay in days			
2-5	1		
6 - 10	3	1	1
>10	3	1	4
Final Outcome			
Complete resolution of DKA	6	1	5
Death		1	1

(mg/dl= milligram per deciliter; mEq/l= milliequivalents per liter; mmol/l= millimoles per liter).

The mean GCS of my research was 12.14 ± 2.80. The mean RBS was 421.86 ± 99.49. The mean sodium was 134.07 ± 6.60. The mean potassium was 3.85 ± 0.77. The mean BUN was 16.13 ± 4.40. The mean age was 12.86 ± 3.15 years. The mean BMI was 15.07 ± 2.90.

Discussion

DKA is a life-threatening condition caused by an imbalance between effective circulating insulin and counter-regulatory hormones (glucagon, catecholamines, cortisol, and growth hormones) leading to hyperglycemia, hyperosmolarity, increased lipolysis, ketonemia, and metabolic acidosis [8].

DKA in newly diagnosed cases of diabetes mellitus in our study was 42.8%, which was close to a study done in Italy (41.9%), France (43.9%), and Brazil (42.3%); but it is somewhat higher as compared to Austria (30.0%), Germany (21.1%) and US (31.1%) [9].

In our study, 50% of the patients with DKA presented with a positive family history of DM. A family history of diabetes is a preventive factor for patients for DKA, due to increased awareness within families with previous experience with diabetes and to the increased alertness of the investigating physician. We may therefore conclude that awareness of the disease at both family and public levels can have a positive effect in terms of correct and early diagnosis. The major precipitating factor for DKA in our study was infection (most commonly viral fever, pneumonia, and urinary tract infection), omission of insulin, and poor compliance. In a study done in Egypt, infection was found to precede the diagnosis of DKA in 21.9% of cases [10]. A study from Smith CP et.al which was based on a 6-year retrospective review of 135 diabetic children found that abnormal insulin treatment behavior was an important factor in the development of DKA episodes in established DM children [11].

Severe DKA was seen in 42.8%. The increasing frequency of severe DKA could be explained in part by the significantly increased incidence of type 1 DM in children <18 years. In our study, the severity of acidosis as a reflection of the severity of DKA, appeared to have a clinically significant relation with the Glasgow coma scale at the time of presentation. Acidosis has been reported as an independent predictor of the level of consciousness in DKA as it reflects the Glasgow coma scale even without the development of cerebral edema. The most common signs and symptoms of DKA were dehydration, polyuria, polydipsia, respiratory distress, weakness, and abdominal pain which is consistent with other literature [12].

In our study, the frequency of DKA is higher among girls similar to a study done by Alphonsus., *et al.* [12].

Our study had two mortality, both of which had infection and were also malnourished.

Conclusion

DKA is a life-threatening complication of DM in children. Most of the cases were newly diagnosed, which was aggravated by infection and presented as severe DKA. Poor compliance with insulin is an important modifiable precipitating factor for DKA in children with established type 1 DM. Early identification, and careful monitoring of fluid, electrolytes, and renal function are the cornerstone for successful DKA management. Education to the public, family members, and caregivers, regarding the importance of regular blood sugar monitoring and insulin dosing, should be considered an important long-term management strategy.

Recommendations for Researchers

The larger sample size is more representative of the population, hence larger sample size is recommended for future research. Multicenter retrospective research is recommended to include both public and private institutions.

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