e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2022; 14(3); 299-305

Original Research Article

A Prospective, Cross-Sectional, Hospital-Based Assessment of the Clinico-Demographic, Biochemical and Outcome Profile of Diabetic ketoacidosis in Children with Type 1 Diabetes Mellitus

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Received: 07-01-2022 / Revised: 15-02-2022 / Accepted: 28-03-2022
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Conflict of interest: Nil

Abstract

Aim: To study the clinical, demographic, biochemical and outcome profile of the children admitted with Diabetic ketoacidosis (DKA).

Material & Methods: This was a prospective, cross-sectional, hospital-based and observational study. This study was conducted over a period of one year in the Department of Pediatrics, Darbhanga Medical College and Hospital, Darbhanga, Bihar, India.

Results: The majority of the patients in this study were females (43), with a female to male ratio of2.2:1. Mean B.M.I. was 13.66 ±3.281 kg/m^2. Most of the children, 60%, were from upper lower class IV socioeconomic status families as per the Modified Kuppuswamy scale. The most common presenting symptoms were nausea/vomiting in 40, pain abdomen in 31, followed by fever in 37.

Conclusion: In our study, the most common precipitating factor observed for DKA was an infection. For the long-term management strategy, education of the patients and their parents regarding infection control, regular blood sugar monitoring and proper Insulin dosing appear to be promising tools.

Keywords: Diabetic ketoacidosis, Type 1 Diabetes mellitus, cerebral edema

Introduction

Diabetic ketoacidosis (DKA) is a relatively common pediatric emergency. It's a major cause of morbidity and mortality in children with type I diabetes mellitus. DKA is commonly encountered clinically as the first presentation of newly diagnosed cases of type I diabetes mellitus. [1]

DKA at diagnosis of diabetes is common in children and adolescents. The worldwide incidence varies from approximately 13 to 80%. [2] During the management of DKA, acid-base status, glycemia, and serum electrolytes are measured frequently to monitor the efficacy of treatment, detect complications of DKA and its treatment, and to determine resolution of DKA. Although there is some variation in the specific details of treatment protocols. [3]

DKA is an acute life-threatening disease, which may be associated with acute and chronic complications. Acute complications can include hypokalaemia,

deep vein thrombosis (DVT), cerebral oedema and death. [1]Cerebral oedema is a rare complication, with an incidence of 0.5% to 0.9%. [4] DKA most often can be found in patients diagnosed with T1DM, however, patients with type 2 diabetes are also susceptible to DKA under stress-inducing situations, such as trauma, surgery, or infections. [5-6]

Most patients with DKA recover when treated correctly. If left untreated, the patient may develop complications like cerebral edema, thromboembolism, acute respiratory distress syndrome (ARDS), disseminated intravascular coagulation (D.I.C.), electrolyte abnormalities, infections, and shock [7]. Early identification of ketoacidosis and aggressive management with insulin, intravenous fluids, and electrolytes replacement and identification and treatment of precipitating cause may change the natural course of the disease. Excessively rapid fluid resuscitation should be avoided to prevent cerebral edema, a rare but debilitating and potentially fatal complication of DKA [8].

Thus, this study aims to; study the clinical, demographic, biochemical and outcome profile of the children admitted with Diabetic ketoacidosis (DKA).

Material & Methods:

This was a prospective, cross-sectional, hospital-based and observational study carried out among 60 DKA patients admitted during the study period of 1 year in the Department of Pediatrics, Darbhanga Medical College and Hospital, Darbhanga, Bihar, India.

Inclusion Criteria:

- All those patients aged from 6 months to 12 years fulfilling the diagnostic criteria of Type 1 Diabetes
- Diabetes Mellitus presenting to PICU with Diabetic ketoacidosis (DKA).

Exclusion Criteria:

- Neonatal Diabetes mellitus (0-6 months)
- MODY/Juvenile Diabetes mellitus
- Type 2 Diabetes Mellitus
- Non-diabetic Hyperglycemia.

Methodology

After preliminary evaluation and management in the pediatric intensive care unit of this hospital, the detailed assessment of all patients was done and recorded in a pre-designed proforma after obtaining written informed consent from their parents. The proforma contained information on patient's gender, age, area of residence, socioeconomic status of the family according to modified Kuppuswamy scale, Body Mass Index (B.M.I.), level of consciousness, time of admission, duration of symptoms, family history of diabetes, consanguinity, significant presenting signs, symptoms. An attempt to detect the precipitating events was made in all children. The presence of infection/ intercurrent illness as indicated by a positive radiological imaging study or blood culture. This was supported by an elevated white blood cell count and clinical examination by the physician. The measure of compliance regarding insulin was based on the history given by the attendants of the patients. Insulin omission was defined as missing insulin injections on multiple days, especially immediately before or during the period of illness.

Detailed physical examination, including the vitals, anthropometry, and systems examination, was carried out. Essential laboratory parameters done on admission included blood glucose, urine ketone level by dipstick method, arterial/venous blood gas, sodium, potassium, calcium, complete blood counts, blood urea, serum creatinine, chest radiograph and an electrocardiogram. Urine examination was done for routine analysis and for detecting ketone body. C-reactive protein (C.R.P.), blood culture and sensitivity, urine culture, and sensitivity were sent to patients with suspected sepsis. HbA1c was done in all children to look for

long-term glycaemic status. Complications including cerebral edema, cardiac arrhythmia, hypoglycemia, hypokalaemia, hypernatremia, infection and renal failure were recorded.

Time duration required for resolution of DKA and insulin infusion duration were recorded. The outcome in the form of survival and death were noted. Resolution of DKA was considered when the consciousness was normal, no vomiting, pH more than 7.3 and serum bicarbonate level more than 15.

DKA is defined as the presence of hyperglycemia (blood glucose >200mg/dL) with a venous pH <7.3 and bicarbonate <15mmol/L with associated Glycosuria, ketonuria and ketonemia in established cases of diabetes mellitus. DKA is categorized as mild (venous Ph < 7.3 and/or bicarbonate <15mmol/L), moderate (pH <7.2 and/or bicarbonate <10mmol/L), and severe (pH <7.1 and/or bicarbonate <5mmol/L). After categorization, various clinical, demographic and biochemical parameters were analyzed using appropriate statistical tools for association with severity of DKA and outcome.

Statistical Analysis:

All relevant data was entered into pre-designed proforma and was analyzed using Microsoft SPSS software for windows TM version 22.0, I.B.M. TM Corp NY, and Microsoft excelM.,

Microsoft Inc. U.S.A. Data are expressed as a percentage and mean ± D. wherever possible, Chi-square test/ Fisher exact test and logistic regression test were used to analyze the significance of the difference between distributions of qualitative values. P-value <0.05 is considered statistically significant.

Results:

The majority of the patients in this study were females (43), with a female to male ratio of

2.2:1. Mean B.M.I. was 13.66 ±3.281 kg/m^2. Most of the children, 60%, were from upper lower class IV socioeconomic status families as per the Modified Kuppuswamy scale.

Family history of Type 2 D.M. was found in only 4 patients. 14 cases presented with DKA as 1st episode of disease. We found that out of 60 cases, 14 cases presented with severe DKA, 12 were of DKA with moderate severity and 34 cases with mild DKA. [Table 1]

The most common presenting symptoms were nausea/vomiting in 40, pain abdomen in 31, followed by fever in 37, Weakness in 32, polyuria in 22, polydipsia in 13 and headache in 14. Significant presenting signs were dehydration in 48, Kussmaul's Breathing in 38, altered sensorium in 36, tachycardia in 16, shock in 14. [Table 2]

The severity of DKA was significantly associated with gender, B.M.I. of the patient, socioeconomic status, area of residence and precipitating factors (p-value < 0.05 for each). The presence of diarrhea, presence of shock and poor G.C.S. on admission were significantly associated with the severity of DKA. (p-value <0.05 for each). Present study suggest that likelihood of death was significantly higher among the patients who had age <5years (p=0.011), poor GCS on admission (p=0.05), cerebral edema (p=0.05), hyponatremia (serum sodium <130meq/L) (, p=0.005) and requirement of insulin infusion >72hrs (p=0.015) [Table 3]

Table 1: Association between severities of DKA with the demographic profile of pediatric patients with DKA

Variables	N	Mild [N=10]	Moderate [N=15]	Severe [N=35]	P value
Age group					
1 – 5 years	10	0	4	6	1.271
5 – 10 years	20	4	6	10	
> 10 years	30	5	10	15	
Gender					
Male	17	0	6	11	0.023*
Female	43	5	13	25	
Body Mass Index (kg/m2)					
<12	16	0	7	9	0.005*
12.1 -15	25	4	17	4	
15.1 – 18	14	3	9	2	
18.1 – 21	5	2	2	1	
Socioeconomic status					
High	4	0	0	4	0.005*
Middle	16	2	2	12	
Low	40	5	23	12	
Family history of diabetes					
Yes	56	6	20	31	0.468
No	4	0	1	3	
Precipitating factor					
DKA 1stepisode	14	4	3	7	0.002*
Insulin omission	12	2	4	6	0.005*
Infection	34	5	10	19	0.005*

Table 2: Association between severity of DKA and symptoms/signs in pediatric patients of diabetic ketoacidosis

Variables	N	Mild [N=10]	Moderate [N=15]	Severe [N=35]	P value
Symptoms					
Nausea/Vomiting	40	6	15	19	0.281
Pain Abdomen	31	2	11	18	0.722
Cold / Cough	20	5	10	5	0.662
Fever	37	4	13	20	0.121
Weakness	32	1	12	19	0.211
Polyuria	22	3	6	13	0.391
Polydipsia	13	2	7	4	0.222
Polyphagia	15	1	4	10	0.712
Diarrhea	20	0	7	13	0.011*
Weight Loss	10	2	6	2	0.722
Headache	14	2	6	6	0.281
Seizure	3	0	0	3	0.172
Signs					
Dehydration	48	7	17	24	0.192
Shock	14	0	4	10	0.010*

Kussmaul Breathing	38	2	14	22	0.102
Tachypnea	16	3	5	8	0.211
Altered Sensorium/ drowsy	36	3	11	22	0.113
GCS					
<12	8	0	2	6	0.227
8-12	22	1	6	15	0.015*
13-15	30	8	12	10	0.831

Table 3: Correlation between different clinical, biochemical and socio-demographic parameters in survivor's vs. deaths (multivariate logistic regression analysis)

Clinical, biochemical or socio-demographic parameters in survivors vs. deaths	Confidence Interval			P value
	Odds ratio	Lower	Upper	
GCS level (< 8)	33.410	3.41	112.9	0.010*
Presence of cerebral oedema	2	1.25	1.561	0.012*
Need for mechanical ventilation	0.36	0.00	1.432	0.721
Presence of shock requiring ionotropic support	0.72	0.00	1.209	0.221
Length of hospital stay in days (> 7 days)	0.115	0.001	1.348	0.261
Age of patient (< 5 years)	7.32	0.632	1.326	0.011*
Gender of patient (male)	0.311	0.07	3.15	0.172
Socioeconomic Status (low)	2.41	0.317	20.19	0.726
Serum sodium level (<130 mEq/l)	5.143	0.134	51.21	0.012*
Serum potassium level (< 2.5 mEq/l)	2.11	0.410.	328.2	0.221
0.738pH value (<7.0)	1.78	0.393	4.311	0.626
Serum bicarbonate level (<5.0)	1.43	0.001	1.827	0.251
Serum osmolarity (>320)	2.183	0.281	1.762	0.111
Anion gap (>12)	2.191	0.729	2.172	0.261
Hb1Ac level (>12)	1.028	0.881	321.23	0.282
Duration of insulin infusion (>72hrs)	0.271	0.417	0.649	0.015*
Presence of Infection/sepsis	0.629	0.627	0.802	0.721

Discussion:

Diabetic ketoacidosis (DKA) is defined by the American Diabetes Association as hyperglycemia (plasma glucose > 200 mg/dL or approximately 11 mmol/L and venous pH < 7.3 and or bicarbonate (HCO3)< 15 mmol/L. DKA is the most common cause of death in children with T1DM.The most common rare and primary fatal complication of DKA is cerebral edema. [9]

DKA is an acute complication of DM that was incurable before discovery of insulin and a leading cause for admission to the pediatric intensive care unit (PICU). [10]

In addition, DKA is related to impaired cognitive functions, such as short-term memory and long-term intelligence. [11]

In a study as regards those who found in their study that 50 (42.7%) cases had established T1DM and 67 (57.2 %) children were newly diagnosed T1DM, [12] the explanation may be related to a lower awareness of symptoms of diabetes among parents or may be referred to a missed T1DM diagnosis at the first medical counseling visit for symptoms such as polyurea, polydipsia, and weight loss. As mentioned earlier, some patients were misdiagnosed with gastroenteritis or

respiratory infection and diagnosed with T1DM later, In disagreement with our work, the study that reported48.2% were newly diagnosed and 51.8% were previously diagnosed cases of diabetes. [13]

Results of Butalia et al. [14], hospitalization due to ketoacidosis was higher in December and September than in other months. So, healthcare professionals 'alertness may need to be increased, particularly during certain months of the year. Polyuria, polydipsia, abdominal pain, vomiting, and altered level of consciousness were the commonest presenting complaints of DKA consistent with findings in previous studies [15-16].

A study in 2010 [17], severe DKA was observed in 47.2% of patients which differs from other studies as they found a lower number of severe DKA compared with mild and moderate type. For instance, Schober et al. [18] reported that of 1,238 Austrian children with DKA, 383 (11.5%) had severe DKA. In the study of Oyarzabal et al. [19] severe DKA was diagnosed in 17.8% DKA episodes. The DKA episodes were severe in 49.4%, consistent with the results of Guisado-Vasco et al study [20]. The possible reason may be due to a lack of access to healthcare professionals for the study population or delayed diagnosis by primary care physician. Recognition of DKA can be improved by increasing health care provision and facilities as well as healthcare professionals' alertness.

Among clinical and biochemical parameters, presence of infection, insulin omission, DKA 1st episode, presence of diarrhea, presence of shock, poor G.C.S. on admission, fever on admission, and time required for resolution of Diabetic ketoacidosis was significantly associated with severity of DKA. (P-value <0.05 for each). This was supported by Syed M et al. (2011), they observed that severity of diabetic ketoacidosis was significantly associated with the presence of infection, history of omission of insulin, poor compliance, presence of shock at the time of presentation, length of stay in the hospital, outcome ($p < 0.01$ for each of these associations) and Glasgow Coma Scale score ($p=0.02$) [21, 22].

Conclusion:

In our study, the most common precipitating factor observed for DKA was an infection. For the long-term management strategy, education of the patients and their parents regarding infection control, regular blood sugar monitoring and proper Insulin dosing appear to be promising tools.

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