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Original Research Article

Prospective Observational Assessment of the Clinic-Demographic and Outcome Profile of Diabetic Ketoacidosis in Children with Type 1 Diabetes Mellitus

Satish Kumar[1], Rakesh Kumar[2], Mithilesh Kumar[3]

[1]Assistant Professor, Department of Paediatrics, Jawaharlal Nehru Medical College and Hospital, Bhagalpur, Bihar, India

[2]Assistant Professor, Department of Paediatrics, Jawaharlal Nehru Medical College and Hospital, Bhagalpur, Bihar, India

[3]Senior Resident, Department of Paediatrics, Jawaharlal Nehru Medical College and Hospital, Bhagalpur, Bihar, India

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Corresponding author: Dr. Rakesh Kumar
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Abstract

Aim: A clinical, demographic, biochemical and outcome profile of diabetic ketoacidosis in children with type 1 diabetes mellitus.

Material and methods: This Prospective observational study was carried out in the Department of Paediatrics, Jawaharlal Nehru Medical College and Hospital, Bhagalpur, Bihar, India for 15 months, 50 DKA patients admitted during the study period. All those patients aged from 6 months to 14 years with Type 1 D.M. with DKA.

Results: In the present study incidence of DKA in children with type 1 Diabetes Mellitus was 2.4%. The mean age of presentation was 10.76 ±3.88 years; the preadolescent age group was most affected, constituting approximately 50% of the total cases. Significant presenting signs were dehydration in 41 (82%), Kussmaul's Breathing in 35 (70%), altered sensorium in 28 (56%), tachy penia in 9 (18%), shock in 7 (14%), while abdominal distension and guarding was present in 6 (12%) and 3 (6%) cases were comatose. In the present study, infection in 28 cases (56%) was the most common precipitating factor of DKA, URTI being the commonest in 16 (32%), followed by acute gastroenteritis in 8(16%), pneumonia in 5 (10%), U.T.I. in 4 (8%) and severe sepsis in 3 (6%). Mean R.B.S. was 395.72±91.2 mg/dl, and mean HbA1c on admission was 9.8 ±1.81%. The mean duration of insulin infusion required for resolution of ketoacidosis and changing over subcutaneous insulin was 39.98±17.61hrs. The mean duration of hospital stay was 9.19 ±2.65 days. The most common complication observed was shocking in 7 (14%) followed by hyponatremia and hypokalaemia in 4 (8%), A.K.I. in 5 (10%), cerebral edema in 6 (12%) and 2 (4%) cases had hypernatremia. The mortality rate was 6.4%. 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).

Conclusion: Diabetic ketoacidosis is a life-threatening complication of Type 1 Diabetes Mellitus in children and adolescents. Preadolescent and adolescent age groups are facing more risk of developing DKA with female predominance.

Keywords: Diabetic Ketoacidosis, Diabetes Mellitus, Children.

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 clinicaly 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]. Cerebraloedema is a rare complication, with an incidence of 0.5% to 0.9%[4].

It can result in medium- and long-term morbidity such as neurological dysfunction.[5] addition, the mortality rate of children in cerebral oedema with DKA is 40%[6]. The severity of diabetic ketoacidosis can be defined by blood gas results, as follows

- Mild diabetic ketoacidosis - pH level of less than 7.3, bicarbonate level of less than 15 mmol/L,
- Moderate diabetic ketoacidosis - pH level of less than 7.2, bicarbonate level of less than 10 mmol/L
- Severe diabetic ketoacidosis - pH level of less than 7.1, bicarbonate level of less than 5 mmol/L[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

Considering the above facts, a cross-sectional study was planned to evaluate the clinical, demographic, biochemical and outcome profile of diabetic ketoacidosis in children with type 1 diabetes mellitus.

Material and methods

This Prospective observational study was carried out in the Department of Paediatrics, Jawaharlal Nehru Medical College and Hospital, Bhagalpur, Bihar, India for 15 months. 50 DKA patients admitted during the study period. All those patients aged from 6 months to 14 years with Type 1 D.M. with DKA.

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 were 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.

Results

In the present study incidence of DKA in children with type 1 Diabetes Mellitus was 2.4%. The mean age of presentation was 10.76 ±3.88 years; the preadolescent age group was most affected, constituting approximately 50% of the total cases. The majority of the patients in this study were females 37 (74%). Mean B.M.I. was 13.31 ±3.5 kg/m2. Most of the children, 30 (60%), were from upper lower class IV socioeconomic status families as per the Modified Kuppuswamy scale. DKA patients from rural areas were approximately three times higher than DKA patients from urban areas, i.e., 31 (62%) of rural regions vs 19 (38%) from urban areas. Family history of Type 2 D.M. was found in only 3 (6%) patients. 12 (24%) cases presented with DKA as 1st episode of disease, and 32 (59.25%) cases of the DKA were already diagnosed case of Type 1 D.M. We found that out of 50 cases, 20 (40%) cases presented with severe DKA, 20 (40%) were of DKA with moderate severity and 10 (20%) cases with mild DKA The most common presenting symptoms were nausea/vomiting in 38 (76%), pain abdomen in 32 (64%), followed by fever in 31 (62%), Weakness in 23 (46%), polyuria in 14 (28%), polydipsia in 12 (24%) and headache in 11 (22%).

Significant presenting signs were dehydration in 41 (82%), Kussmaul's Breathing in 35 (70%), altered sensorium in 28 (56%), tachy penia 9 (18%), shock in 7 (14%), while abdominal distension and guarding was present in 6 (12%) and 3 (6%) cases were comatose. In the present study, infection in 28 cases (56%) was the most common precipitating factor of DKA, URTI being the commonest in 16 (32%), followed by acute gastroenteritis in 8(16%), pneumonia in 5 (10%), U.T.I. in 4 (8%) and severe sepsis in 3 (6%). Mean R.B.S. was 395.72±91.2 mg/dl, and mean HbA1c on admission was 9.8 ±1.81%. The mean duration of insulin infusion required for resolution of ketoacidosis and changing over subcutaneous insulin was 39.98±17.61hrs. The mean duration of

hospital stay was 9.19 ±2.65 days. The most common complication observed was shocking in 7 (14%) followed By hyponatremia and hypokalaemia in 4 (8%), A.K.I. in 5 (10%), cerebral edema in 6 (12%) and 2 (4%) cases had hypernatremia. The mortality rate was 6.4% 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 diarrhoea, 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 (OR=6.09, p=0.015), poor GCS on admission (<8) (OR=34.5, p=0.05), cerebral edema (OR=11.5, p=0.03), hyponatremia (serum sodium <130meq/L) (OR=4.14, p=0.048) and requirement of insulin infusion >72hrs (OR=4.04, p=0.01.

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

Variables	N	Mild (N=10)	Moderate (N=20)	Severe (N=20)	p-value
Age group					
1 – 5 years	10	0	4	4	0.13
5 – 10 years	10	5	5	6	
> 10 years	30	5	11	10	
Gender					
Male	13	2	4	3	0.28*
Female	37	8	16	17	
Body Mass Index (kg/m2)					
<12	16	0	4	12	0.02*
12.1 -15	20	6	10	4	
15.1 – 18	10	3	6	2	
18.1 – 21	4	1	0	2	
Socioeconomic status					
High	15	0	0	2	0.05*
Middle	5	3	2	9	
Low	30	7	18	9	
Area of residence					
Rural	31	10	15	14	0.02*
Urban	19	0	5	6	
Family history of diabetes					
Yes	47	10	19	18	0.67
No	3	0	1	2	
Precipitating factor					
DKA 1st episode	12	4	8	7	0.04*
Insulin omission	10	4	8	6	0.02*
Infection	28	2	4	7	0.01*

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

Variables	N	Mild	Moderate	Severe	p-value
Symptoms					
Nausea/Vomiting	38	4	12	22	0.52
Pain Abdomen	32	2	13	17	0.13
Cold / Cough	21	3	10	8	0.32
Fever	31	3	12	16	0.49
Weakness	23	2	9	12	0.30
Polyuria	14	1	6	7	0.84
Polydipsia	12	2	6	4	0.55
Polyphagia	7	1	2	4	0.43
Diarrhoea	14	0	4	10	0.012*
Weight Loss	4	1	1	2	0.31
Headache	11	1	3	7	0.81
Seizure	2	0	0	2	0.30
Signs					
Dehydration	41	10	9	21	0.65
Shock	7	0	2	5	0.017*
Kussmaul Breathing	35	5	15	15	0.05
Tachypnea	9	2	4	3	0.07
Altered Sensorium/ drowsy	28	1	4	23	0.16
GCS					
<8	3	0	1	2	0.018*
8-12	16	1	5	10	
13-15	23	6	11	6	

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	Odds ratio	Confidence Interval		p-value
		Lower	Upper	
GCS level (< 8)	34.50	2.88	413.25	0.05*
Presence of cerebral oedema	11.50	1.26	104.86	0.30*
Need for mechanical ventilation	0.03	0.00	1.49	0.99
Presence of shock requiring ionotropic support	0.06	0.00	1.45	0.99
Length of hospital stay in days (> 7 days)	0.10	0.01	1.10	0.06
Age of patient (< 5 years)	6.09	0.53	69.21	0.15*
Gender of patient (male)	0.35	0.04	2.75	0.31
Socioeconomic Status (low)	2.33	0.30	18.14	0.41
Serum sodium level (<130 mEq/l)	4.14	0.37	46.23	0.48*
Serum potassium level (< 2.5 mEq/l)	1.92	0.13	361.41	0.38
pH value (<7.0)	1.19	0.37	3.82	0.76
Serum bicarbonate level (<5.0)	0.13	0.01	1.76	0.12
Serum osmolarity (>320)	0.38	0.04	3.32	0.38
Anion gap (>12)	0.85	0.03	0.20	1.00

Lactate level (>5)	0.07	0.13	0.53	0.99
Random Blood Glucose (>500 mg/dl)	1.08	0.07	16.67	0.95
Hb1Ac level (>12)	0.09	0.05	1.90	0.12
Duration of insulin infusion (>72hrs)	4.04	0.03	0.56	0.17*
Presence of Infection/sepsis	0.01	0210	0.77	0.99

Discussion

DKA represents a decompensated phase of diabetes mellitus, which may require PICU admission, especially in the presence of cardiovascular instability, inability to protect the airway, altered state of consciousness, the presence of acute abdominal signs or symptoms.

In our study majority of the 37 patients (74%) were females. These findings were similar to Ameyaw E et al. (2017) in Ghana, where 71.1% of subjects were female[8]. The mean B.M.I. of subjects in our study was 13.31±3.51kg/m2. These findings concordance to a survey by Syed M et al. (2011), who found that mean B.M.I. was 14.4 ± 2.9 kg/m2[9]. However, Al-Shaikh A et al. (2019) reported that patients who were diagnosed with DKA had higher B.M.I. (20.87 ± 5.21kg/m2)[10].

Our study shows that most of the children, 30(60%), were from upper lower-class IV families, similar to the study by Basavanthapa et al. (2015) and Padma B.K. et al (2019)[11,12].

We reported most DKA patients were from rural areas, 31 (62%) DKA and only 19 (38%) from the urban areas. Basavanthapa et al. (2015) also reported that most of the patients, i.e., 31 (62%), were from rural areas[13]. In contrast to our study, Rashid I et al. (2019) found that 70% of patients belonged to urban areas, and only 30% lived in rural areas[14].

We observed that only 3 (6%) patients had a family history of Type 2 D.M. Similar findings were also noticed by Ababulgu RZ et al. (2020), who found a family history of D.M. in only 7(11.1%) patients[15]. However, Satti AS et al. (2013) reported a family history of diabetes (either type 1 or 2) in 59 (74%) cases which is significantly higher than in our study[16]. In our study, 32 (64%) of the DKA cases were already diagnosed with type 1 D.M., whiles 12 (24%) patients were newly diagnosed as type 1 D.M. on admission. Similarly, Bhardwaj P et al. (2017) found that 48.2% were newly diagnosed and 51.8% were previously diagnosed cases of diabetes[17]. Dehydration was the primary presenting sign in 82% cases, followed by Kussmaul breathing in 70% cases, altered sensorium in 56%, tachycardia was found in 56% cases, shock in 18% and 5.55% cases were comatose. This was comparable to the study by Neu A et al. (2003), where almost 53% had altered levels of consciousness, with 10.9% of them being unconscious[23]. Islam R et al. (2014) also found that Kussmaul's breathing, and dehydration were the commonest clinical feature of DKA[18].

We found that 28 (56%) patients had intercurrent illness/infection as a major precipitating factor of DKA. 12 (24%) cases presented with DKA as 1st episode, 10 (20%) patients omitted insulin in more than two instances leading to precipitation of DKA, among 15 (27.7%) cases infection with insulin omission were precipitating factor, new-onset diabetes with sepsis was noted in 10 (18.5%). These findings were supported by Jayashree M et al. (2004), which shows that precipitating events identified by them were new-onset diabetes with sepsis (37%), new-onset diabetes alone (31%), insulin omission (15%), and infection with insulin omission (7%)[19].

In our study among intercurrent illness, URTI was most common and was found in 16 (32%) cases, followed by acute

gastroenteritis in 8 (16%), pneumonia in 5 (10%) cases, urosepsis (U.T.I.) was present in 4 (8%) cases, 3 (6%) subjects had severe sepsis in the form of intercurrent illness, 3 (5.55%) cases presented with a skin infection and 1 (1.85%) patient presented with malaria. Mbugua PK et al. (2005) also reported respiratory, genito- urinary, and septicemia[20].

In our study, the mean duration of insulin infusion required for resolution of ketoacidosis was 39.98±18.61 hrs, and the mean duration of hospital stay was 9.19 ±2.85 days; this was similar to study by Varshney GA et al. (2015) they reported the median time for the arterial blood gases to become normal was 26 hrs. The average length of the hospital was7.8 days[21].

Conclusion

Diabetic ketoacidosis is a life-threatening complication of Type 1 Diabetes Mellitus in children and adolescents. Preadolescent and adolescent age groups are facing more risk of developing DKA with female predominance.

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