Journal of Cardiovascular Disease Research

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE04, 2022

Prospective hospital based assessment of the outcome profile of diabetic ketoacidosis in children with type 1 diabetes mellitus

Dr. Kaushik Barot

Assistant Professor, Department of Paediatrics, Shantabaa Medical College and General Hospital, Amreli in Gujarat, India

Corresponding author:

Kaushik Barot

E mail ID: ksbarot@gmail.com

Assistant Professor, Department of Paediatric, Shantabaa Medical College and General Hospital, Amreli

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, Shantabaa Medical College and General Hospital, Amreli in Gujaratfor the period of 9 months, after taking the approval of the protocol review committee and institutional ethics committee. 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: DKA was seen in 2.4% of children with type 1 Diabetes Mellitus in this research. The mean age of presentation was 10.76 3.88 years, with the preadolescent age group accounting for over half of all cases. Tachypnea (9%) and shock (7%) were evident, whereas abdominal distension and guarding (6%) and comatose (6%). In this research, infection caused DKA in 28 instances (56%) with URTI being the most prevalent (32%) followed by acute gastroenteritis (16%), pneumonia (10%), UTI (4%) and severe sepsis (3%). The mean RBS was 395.72 mg/dl and the mean HbA1c was 9.8 1.81 percent. The mean insulin infusion time needed to reverse ketoacidosis and switch to subcutaneous insulin was 39.98±17.61hrs. The mean hospital stay was 9.19 days. The most prevalent consequence was shocking (7%) followed by hyponatremia and hypokalaemia (8%), A.K.I. (5%), cerebral edema (6%), and hypernatremia (4%). The severity of DKA was linked with gender, BMI, socioeconomic position, residential region, and precipitating variables (p-value 0.05).

Conclusion: Among children and adolescents with Type 1 Diabetes Mellitus, diabetic ketoacidosis is lethal. Adolescents and preadolescents are more susceptible to DKA, with a female preponderance.

Keywords: Diabetic ketoacidosis, Diabetes Mellitus, children

Introduction

Diabetes ketoacidosis (DKA) is an extremely prevalent emergency for children with type 1 and type 2 diabetes. In children with type I diabetes, it's a leading cause of death and serious health problems. DKA is a frequent clinical manifestation of newly diagnosed type I diabetes mellitus.[1]

Diabetic ketoacidosis (DKA) is frequent in children and teenagers at the time of diagnosis of the disease. The prevalence ranges from 13 to 80 percent globally.[2]Acid-base status, glycemia, and serum electrolytes are routinely evaluated throughout DKA therapy to keep tabs on treatment effectiveness, identify problems from DKA and its treatment, and establish whether or not DKA has resolved. As far as treatment regimens are concerned, there is a fair amount of variety.[3]

In addition to being an acutely life-threatening condition, DKA may be linked with both acute and long-term consequences. Hypokalaemia, deep vein thrombosis (DVT), cerebral edema, and mortality are all possible acute consequences of the condition. Cerebraledema is an uncommon condition that occurs in around 0.5 percent to 0.9 percent of patients.[4]

Neurological dysfunction and other long- and medium-term consequences are possible.[5]A further concern is that children with cerebral edema associated with DKA have a death rate of 40%.[6] The severity of diabetic ketoacidosis may be determined by the findings of blood gas analysis.[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.

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE04, 2022

Material and methods

This Prospective observational study was carried out in the Department of Paediatrics, Shantabaa Medical College and General Hospital, Amreli in Gujarat for the period of 9 months, after taking the approval of the protocol review committee and institutional ethics committee. 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

This hospital's paediatric critical care unit conducted a complete examination of all children after getting written informed permission from their parents. Gender, age, location, family socioeconomic situation (Kuppuswamy modified scale), BMI, degree of consciousness, time of admission, length of symptoms, diabetes family history (family history), consanguinity, important presenting signs and symptoms were all included on the proforma. All children were tested for precipitating events. A positive radiological imaging scan or blood culture indicates infection/current disease. A high white blood cell count and a physician's clinical examination confirmed this. The patients' attendants were asked about their insulin compliance.

Many days of insulin injections were skipped, either before or during illness. Examination of vitals, anthropometry and systems was part of the comprehensive physical examination. There were a number of tests that were done on admission that were critical to the patient's well-being. These included a urine ketone test, an arterial/venous blood gas reading and an ECG of the patient's heart. The urine was tested for ketone bodies as well as for regular analysis. Patients with signs and symptoms of sepsis were given blood cultures, urine cultures, and sensitivity tests for C- reactive protein. All youngsters were tested for HbA1c to determine their long-term glycaemic state. Infection, renal failure, hypoglycemia, hypokalemia, hypoglycemia, and other complications have all been reported. 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 DM. 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%), tachypnea 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 severity of DKA was significantly associated with gender, BMI of the patient, socioeconomic status, area of residence and precipitating factors (p-value < 0.05 for each).

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE04, 2022

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 (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*

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE04, 2022

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
Diarrhea	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	Confidence Interval			p- value
	Odds ratio	Lower	Upper	
GCS level (< 8)	34.50	2.88	413.25	0.05*
Presence of cerebral edema	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

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE04, 2022

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	0.210	0.77	0.99

Discussion

DKA represents a decompensate 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/m^2. 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/m^2.[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 DM 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., while 12 (24%) patients were newly diagnosed as type 1 DM 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, genitourinary, 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)

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE04, 2022

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

According to the findings of the current research, diabetic ketoacidosis is a potentially life-threatening consequence of Type 1 Diabetes Mellitus in children and teenagers. Pre-adolescent and teenage age groups are at greater risk of having DKA, and female preponderance contributes to this risk.

Reference

1. Wolfsdorf JI, Allgrove J, Craig ME et al. ISPAD clinical practice consensus guidelines 2014. Diabetic ketoacidosis and hyperglycemic hyperosmolar state. Pediatr Diabetes.2014; 15(20):154-179.
2. Usher-SmithJ A,Thompson M,Ercole A. Variation between countries in the frequency of diabetic ketoacidosis at first presentation of type 1 diabetes in children: a systematic review.Diabetologia.2012;55:2878–2894.
3. 3-Barrios EK, Hageman J, Lyons E.Current variability of clinical practice management of pediatric diabetic ketoacidosis in Illinois pediatric emergency departments.PediatrEmerg Care.2012; 28 (12): 1307-1313.
4. Wolfsdorf J, Craig ME, Daneman D. Diabetic ketoacidosis in children and adolescents with diabetes. Pediatr Diabetes.2009;10(12):118-133.
5. Cameron FJ, Scratch SE, Nadebaum C. Neurological consequences of diabetic ketoacidosis at initial presentation of type 1 diabetes in a prospective cohort study of children. Diabetes Care.2014;37(6):1554-1562.
6. Patel A, Singh D, Bhatt P. Incidence, trends, and outcomes of cerebral edema among children with diabetic ketoacidosis in the United States. ClinPediatr (Phila).2016;55(10):943-951.
7. Noyes J, Crofton P, Bath L. Hydroxybutyrate near-patient testing to evaluate a new end-point for intravenous insulin therapy in the treatment of diabetic ketoacidosis in children.Pediatr Diabetes.2007; 8: 150-15.
8. Ameyaw E, Asafo-Agyei SB, Thavapalan S, Middlehurst AC, Ogle GD. Clinical profile of diabetes at diagnosis among children and adolescents at an endocrine clinic in Ghana. World J Diabetes. 2017;8(9):429-435.
9. Al Shaikh A, Farahat F, Saeedi M, Bakar A, Al Gahtani A, Al-Zahrani N, et al. incidence of diabetic ketoacidosis in newly diagnosed type 1 diabetes children in western Saudi Arabia: 11-year experience. J Pediatr Endocrinol Metab. 2019;32(8):857-862.
10. Varshney GA, Varshney D, Mehr V, Kela G, Kharia, R, Agrawal G, Gupta R. Clinical profile and outcome of diabetic ketoacidosis in children at tertiary care hospital. Journal of Evolution of Medical and Dental Sciences. 2015;4 (31):5329-33.
11. Padma B, Deepa K. Clinico-laboratory characteristics and immediate outcome in children with diabetes mellitus. Journal of Evolution of Medical and Dental Sciences. 2019;8:1998-2001.
12. Rashid I, Amin A, Mushtaq HF, Sa'd Masood M. Diabetic Ketoacidosis and Its Outcome in Children. Asian Journal of Multidisciplinary Studies. 2020;8(1):221-24.
13. Ababulgu RZ, Tesfaye BT. Characteristics and Outcomes of Children with Type-I Diabetes Mellitus Hospitalized for Ketoacidosis. Curr Diabetes Rev. 2020;16(7):779-786.
14. Satti SA, Saadeldin IY, Dammas AS. Diabetic Ketoacidosis in children admitted to Pediatric Intensive Care Unit of King Fahad Hospital, Al-Baha, Saudi Arabia: Precipitating factors, epidemiological parameters and clinical presentation. Sudan J Paediatr. 2013;13(2):24-30.
15. Bhardwaj P, Yadav V, Sharma M. "Clinical profile and outcome of the children with diabetic ketoacidosis (DKA) in hilly Himalayan state of north India." Int J Res Med Sci 5.12 (2017): 5402-5
16. Kumar, Madhava Vijaya, and Kalappurayil Manjusha. Precipitating factors, clinical profile and metabolic abnormalities of diabetic ketoacidosis in children with type-1 diabetes and their role in predicting the outcome. htsteologiese studies/theological studies 2017;4:393-400.
17. Neu A, Ehehalt S, Willasch A, Kehrer M, Hub R, Ranke MB. Varying clinical presentations at onset of type 1 diabetes mellitus in children--epidemiological evidence for different subtypes of the disease? Pediatr Diabetes. 2001;2(4):147-53.
18. Islam, R. , Akhter, S. , Shelim, R. , Mohsin, F. , Begum, T., & Akhter, G. Precipitating factors, clinical features and outcome of diabetic ketoacidosis in children and adolescents admitted in a tertiary care hospital in Dhaka. Bangladesh Journal of Medical Science 2014;13: 53-57

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE04, 2022

19. Jayashree M, Singhi S. Diabetic ketoacidosis: predictors of outcome in a pediatric intensive care unit of a developing country. Pediatr Crit Care Med. 2004;5(5):427-33.
20. Mbugua PK, Otieno CF, Kayima JK, Amayo AA, McLigeyo SO. Diabetic ketoacidosis: clinical presentation and precipitating factors at Kenyatta National Hospital, Nairobi. East Afr Med J. 2005 Dec;82(12 Suppl):S191-6.
21. Varshney GA, Varshney D, Mehr V, Kela G, Kharia R, Agrawal G, Gupta R. Clinical profile and outcome of diabetic ketoacidosis In children at tertiary care hospital. Journal of Evolution of Medical and Dental Sciences, 4.31 (2015): 5329-5334