Clinical profile and outcome of Diabetic ketoacidosis in children

Harish G V[1] , Panduranga G[2]

[1]Assistant Professor, [2]Post Graduate Student, Department of Paediatrics, Prathima Institute of Medical Sciences, Karimnagar, Telangana, India.

Address for correspondence: Dr.Harish G V, Assistant Professor, Department of Paediatrics,

Prathima Institute of Medical Sciences, Karimnagar, Telangana,,India

E mail id : drharish82@gmail.com Phone:8179753111.

ABSTRACT

Introduction:

Diabetic ketoacidosis is a potentially life threatening acute complication of type 1 diabetes mellitus,characterised by triad of hyperglycemia,ketosis and acidemia,accounting for a majority of deaths related to diabetes in children. Diabetic ketoacidosis is a fatal acute metabolic complication of diabetes mellitus with heterogeneous clinical presentation . Poor compliance was associated with severity of Diabetic Ketoacidosis and infection precipitate the Diabetic Ketoacidosis easily.

Aims and objectives:

The present study helps to determine clinical profile and outcome of diabetic ketoacidosis in children.

Materials & Methods:

It is a retrospective clinical study of children under 15years of age admitted in PICU at tertiary care center, for a period of one year 2016 January to 2017 January.Children are evaluated through detailed clinical history and laboratory investigations.Among all children admitted 10 children have diabetic ketoacidosis.We selected all children admitted in pediatric intensive care unit of 565 admissions out of 10 cases were diabetic ketoacidosis,in which 9 out of 10 cases were newly diagnosed.90% cases were newly diagnosed and 10% due to omission of insulin resulting in diabetic keto acidosis.

We describe the clinical profile and outcome of diabetic ketoacidosis in children seen in tertiary care centre over a 1-year period. All subjects admitted in pediatric intensive care were reviewed for type 1 diabetes.Data retrieved include age, sex, family history, clinical features, and anthropometry studied about presenting complaints,precipitating factors,course of illness in the hospital, management,outcome of diabetic ketoacidosis cases by using standard protocols for treatment of diabetic ketoacidosis.

Diagnosis was made by the presence of hyperglycemia (Blood sugar >250 mg), acidosis (Arterial pH=7.3) serum carbonate (=15 mEq) and ketonemia. All relevant investigations were performed and patients were treated with the aim to achieve ketone free condition and euglycemia.

Results :

Out of 565 pediatric intensive care unit admissions from January 2016 to January 2017, a total of 10 children presented with DKA (a prevalence of 1 in 56 hospital admissions). The median age at presentation was 7.6years (range: 9 months to 14 years) with a male:female ratio of 1:4; the mean duration of symptoms before hospitalization was 11.6 days (range: 1–30 days).9 out of 10 cases were newly diagnosed DM.9 out of 10 cases presented with respiratory distress, acidotic breathing. Fever was the precipitating factor in 6 children (60%) and in 1 child with type 1 diabetes, the omission of insulin led to DKA. The most common presenting complaints were polyuria and polydipsia in 7, loss of weight in 2, polyphagia and fever in 7 each, and vomiting and abdominal pain in 5. A majority (7) presented with severe DKA, 3 with moderate DKA.

Conclusion: There is need among physicians to educate patients regarding need for regular follow up, proper adherence to treatment and management during an intercurrent illness, as DKA is potentially preventable complication.The outcome of active management using standard protocols of diabetic ketoacidosis in children is excellent . The use of a standard protocol for management was associated with no complications and with zero mortality in this study

Keywords: Diabetic ketoacidosis,children,clinical profile,outcome

INTRODUCTION

Diabetic ketoacidosis is a potentially life threatening acute complication of type 1 diabetes mellitus,characterised by triad of hyperglycemia, ketosis and acedemia,accounting for a majority of deaths related to diabetes in children .Diabetic ketoacidosis is caused by a decreasing effective circulating insulin associated with elevation of counter regulatory hormones[1]. It Is more common in diabetes mellitus type 1.Careful monitoring and appropriate management are critical in order to optimize outcome. Herein we present clinical profile and outcome of diabetic ketoacidosis in children by using standard protocols.

MATERIALS AND METHODS

Children are evaluated through detailed clinical history,laboratory investigations. Among all children admitted 10 children have diabetic ketoacidosis.We selected all children under 15 years of age admitted in pediatric intensive care unit of 565 admissions out of 10 cases were diabetic ketoacidosis, in which 9 out of 10 cases were newly diagnosed. 90% cases were newly diagnosed and 10% due to omission of insulin resulting in diabetic keto acidosis .Cases evaluated for precipitating factors, prior clinical symptoms, presenting symptoms, condition at the presentation. All the appropriate investigations were done and treated the cases using standard diabetic ketoacidosis protocols. Initial dehydration part corrected using milwaukee's formula. Diabetic ketoacidosis (DKA) was diagnosed on the following criteria of International Society of Pediatrics and Adolescent Diabetes (ISPAD)[2] .

1. Blood sugar >250 mg%
2. Blood PH ≤7.3
3. Serum bicarbonate≤15 mEq/L
4. Ketonuria and Ketonemia

The severity was based on degree of acidosis[1]. First degree or Mild PH 7.2-7.3, Bicarbonate 15-18 mEq/L, second degree or moderate PH 7.1-7.2, bicarbonate 10-14 mEq/L. Third degree or severe PH <7.1, bicarbonate <15 mEq/L. Cases who were fulfilling the criteria of DKA were subjected to detailed history and physical examination with routine and relevant laboratory investigation following ADA criteria[3,4,5]. The treatment was started promptly with insulin infusion and other supportive measures. The aim was to achieve ketone free urine with near normal acid-base balance and electrolytes. The insulin infusion was discontinued, 2 hours after administration of subcutaneous insulin. Once patient had resolution of their metabolic status including the ketone free urine and were able to tolerate oral feeding.

RESULTS

Out of 565 pediatric intensive care unit admissions from January 2016 to January 2017, a total of 10 children presented with DKA (a prevalence of 1 in 56 hospital admissions). The median age at presentation was years 7.6years (range: 9 months to 14 years) with a male:female ratio of 1:4; the mean duration of symptoms before hospitalization was 11.6 days (range: 1–30 days).9 out of 10 cases were newly diagnosed DM. 9 out of 10 cases presented with respiratory distress,acidotic breathing. Fever was the precipitating factor 6 children (60%) and in 1 child with type 1 diabetes, the omission of insulin led to DKA. The most common presenting complaints were polyuria and polydipsia in 7, loss of weight in 2, polyphagia and fever in 7 each, and vomiting and abdominal pain in 5. A majority (7) presented with severe, 3 with moderate DKA. [Table 1]

Three children presented with shock requiring a fluid bolus (10 ml/kg of normal) . Chest X-ray was normal in all children, and their blood and urine cultures were sterile. Blood pH less than 7in 7 cases, continuous rather than bolus insulin infusion is associated with better outcomes. Ultrasound abdomen (to rule out pancreatitis, fibrocalculous pancreatopathy) was normal in 8 and the rest had mild hepatomegaly. The median time for the arterial blood gas to normalize and for urinary ketones to disappear were 24 hours and 48 hours, respectively, and the median duration for changing over to subcutaneous insulin was 1.5 days. Hypokalaemia was the common therapy-related complication observed in 7 children. None of the children had hypoglycaemia or cerebral oedema and there was no mortality. The average length of stay in the ICU was 4 days and for discharge from hospital (discharged when alert, able to take oral feeds well, the technique of insulin therapy taught/reinforced and warning signs explained) was 7 days.

Managed 12 years old male child with severe DKA with Ph 6.9 ,Hco3 5.3,GRBs 748 mg/dl,with GCS 9/15 in life threatening condition using standard protocols of DKA. DKA is the presenting manifestation of diabetes in 25%[15 to 83%] but in this study it is 90%.DKA at diagnosis is encountered more commonly in children younger than 7 years of age and those belonging to families without ready access to medical care.[6,7,8]

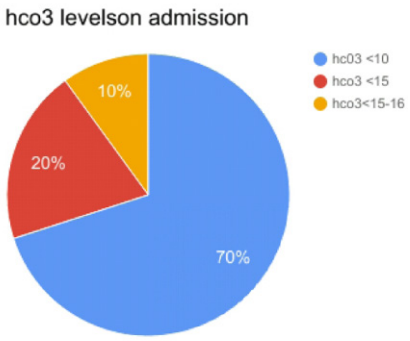
Table 1:Showing symptoms profile

Polyurea	6	60%
Polydypsia	3	30%
Vomitings	6	60%
Shock	7	70%
Acidotic breath	9	90%
Altered sensorium	8	80%
Wt loss	3	30%
Hypokalemia	8	80%
First presentation	9	90%
Constitutional symptoms	6	60%

Table 2: Showing age wise distribution of DKA

Age	Boys	Girls	Known case of diabetes type1	New Case
<5	1	3	0	4
5-10	0	2	0	2
>10	1	3	1	3
Total	2	8	1	9

Pie Chart 1



Urine ketones was 3+++ on bedside test which monitored for daily in all cases which turned out to be decreased and negative in 24hr and 48 hrs respectively. Acidotic breathing is presented in almost all cases.[Figure 2]

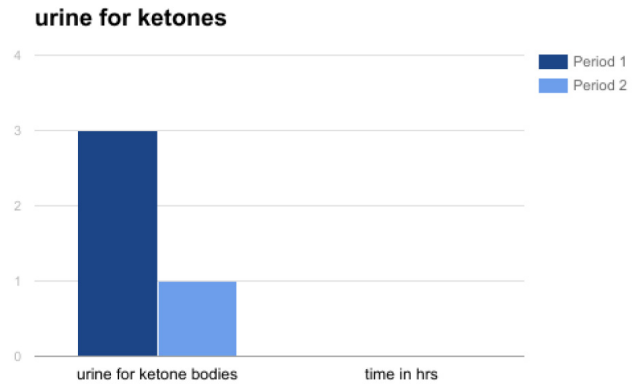


Figure 2: Period 1shows ketone bodies at presentation and Period 2 shows urine for ketones between 24-48hr

Urine for ketones is negative in all cases after 48hrs.Dose of subcutaneous Insulin and injection techniques explained for attendants and children. Before breakfast 2/3 of mixtard insulin total daily dose.before dinner 1/3 of total daily dose.On follow up at a median of 3 months, all children were doing well,on further follow up advised for diabetic complications screening.Retinopathy After 5 yr duration in prepubertal children, after 2 yr in pubertal children1-2 yearly Fundus photography Fluorescein angiography, for Nephropathy After 5 yr duration in prepubertal children, after 2 yr in pubertal children .

Annually spot urine sample for albumin : creatinine ratio 24 hr excretion of albumin,for macrovascular disease after age 2 yr , every 5 yr ,for Thyroid disease at diagnosis every 2-3 yr or more frequently based on symptoms or the presence of antithyroid antibodies Thyroid peroxidase, thyroglobulin antibodies for Celiac disease at diagnosis every 2-3 yrs tissue transglutaminase, endomysial antibody Transglutaminase antibodies .One should identify and address the factors underlying this phenomenon,including poor socio economic status,poor access to health care and psychosocial concerns,such as lack of parental supervision,eating disorders,psychiatric issues and misconceptions like withholding insulin during stress such as starvation,vomiting or infections.15 to 20 children present with DKA in the emergency department in All India Institute of Medical sciences,in our study 10 cases are presented with diabetic ketoacidosis.[9,10,11]

DISCUSSION

Diabetic ketoacidosis is a life-threatening condition caused by a decrease in effective circulating insulin along with an increase in counter regulatory hormones (glucagon, catecholamines, cortisol and growth hormone) leading to hyperglycaemia, hyperosmolarity, increased lipolysis, ketonaemia and metabolic acidosis.The median age at presentation in our series 6 years, the frequency is higher among girls[Table 2]. Most of our patients had new-onset DM. This could be because of lack of awareness among the parents of these symptoms being due to diabetes. Polyuria and polydipsia due to hyperglycaemia were the most common clinical symptoms in contrast to impaired level of consciousness as reported. The major precipitating factors for DKA are infections (most commonly viral fever, pneumonia and urinary tract infections), vomitting insulin, inadequate insulin administration during an intercurrent illness and intake of drugs such as high dose glucocorticoids, atypical antipsychotics and diazoxide.

The administration of appropriate intravenous fluids, rational use of sodium bicarbonate, leads to cutaneous vasoconstriction thereby reducing the absorption of insulin.5 of our patients received bicarbonate therapy. Hypokalaemia was the most common complication observed in our series as in other studies.Cerebral oedema accounts for 57% of all deaths due to DKA and typically occurs 4–12 hours after the onset of treatment, though it can be present before treatment has commenced or at any time during treatment,8 and is often precipitated by overzealous administration of fluids. In our study, none of the children developed cerebral oedema and there were no deaths.The majority of children with DKA had new-onset DM and hypokalemia was a common occurrence.

DKA, though a life-threatening event, can have a good outcome with no complications and mortality when diagnosed and managed using a standard protocol. Ketoacidosis severe insulinopenia (or lack of effective insulin action) results in a physiologic cascade of events in 3 general pathways: 1. Excessive glucose production coupled with reduced glucose utilization raises serum glucose. This produces an osmotic diuresis, with loss of fluid and electrolytes, dehydration, and activation of the renin–angiotensin–aldosterone axis with accelerated potassium loss. If glucose elevation and

dehydration are severe and persist for several hours, the risk of cerebral edema increases. 2. Increased catabolic processes result in cellular losses of sodium, potassium, and phosphate.[3] Increased release of free fatty acids from peripheral fat stores supplies substrate for hepatic ketoacid production.

When ketoacids accumulate, buffer systems are depleted and a metabolic acidosis ensues. Therapy must address both the initiating event in this cascade (insulinopenia) and the subsequent physiologic disruptions3. Reversal of DKA is associated with inherent risks that include hypoglycemia, hypokalemia, and cerebral edema. Any protocol must be used with caution and close monitoring of the patient. Adjustments based on sound medical judgment may be necessary for any given level of diabetic ketoacidosis of glucose into cells, to subdue hepatic glucose production, and to halt the movement of fatty acids from the periphery to the liver. Diabetic Ketoacidosis Treatment Protocol initial insulin bolus does not speed recovery and may increase the risk of hypokalemia and hypoglycemia.[12]

Therefore, insulin infusion is typically begun without a bolus at a rate of 0.1 units/kg/hr. This approximates maximal insulin output in normal subjects during an oral glucose tolerance test. Rehydration also lowers glucose levels by improving renal perfusion and enhancing renal excretion.[13]

The combination of these therapies usually causes a rapid initial decline in serum glucose levels. Once glucose goes below 180 mg/dL (10 mmol/L), the osmotic diuresis stops and rehydration accelerates without further increase in the infusion rate. Repair of hyperglycemia occurs well before correction of acidosis. Therefore, insulin is still needed to control fatty acid release and ketosis after normal glucose levels are reached. To continue the insulin infusion without causing hypoglycemia, glucose must be added to the infusion. [14,15]

We typically recommend that glucose be added as a 5% solution when the serum glucose has decreased <300 mg/dL and as a 10% solution when the serum glucose has decreased <200 mg/dL. The insulin infusion can also be lowered from the initial maximal rate if, despite the above outlined interventions, the serum glucose falls further. Repair of fluid deficits must be tempered by the potential risk of cerebral edema. It is prudent to approach any child in any hyperosmotic state with cautious rehydration. The effective serum osmolality (E osm = 2 × [Na uncorrected] + [glucose]) is an accurate index of tonicity of the body fluids, reflecting intracellular and extracellular hydration better than measured plasma osmolality. It is calculated with sodium and glucose in mmol/L.[5] This value is usually elevated at the beginning of therapy and should steadily normalize. A rapid decline, or a slow decline to a subnormal range, may indicate an excess of free water entering the vascular space and an increasing risk of cerebral edema.

Therefore, patients should not be allowed oral fluids until rehydration is well underway and significant electrolyte shifts are no longer likely. Limited ice chips may be given as a minimal oral intake. All fluid intake and output should be closely monitored. Calculation of fluid deficits using clinical signs is difficult in children with DKA because intravascular volume is better maintained in the hypertonic state. For any degree of tachycardia, delayed capillary refill, decreased skin temperature, or orthostatic blood pressure change, the child with DKA will be more dehydrated than the child with a normotonic fluid deficit. Correct a deficit of 85 mL/kg (8.5% dehydration) for all patients in the 1st 24 hr. Children with mild DKA rehydrate earlier and can be switched to oral intake.

CONCLUSION

DKA is now a recognised acute complication in type 1 diabetes in children. 90% of the children presented in severe DKA.Infections followed by poor compliance are the major precipitating causes. There is need among physicians to educate patients regarding need for regular follow up, proper adherence to treatment and management during an intercurrent illness, as DKA is potentially preventable complication.The outcome of active management using standard protocols of diabetic ketoacidosis in children is excellent . The use of a standard protocol for management was associated with no complications and with zero mortality in this study.Timely diagnosis , appropriate management, careful monitoring and apprehending complications are critical to ensuring a favourable outcome.

REFERENCES

1. Nelson textbook of pediatrics 21st edition.2769-2774.
2. Umpierrez GE, Khajavi M, Kitabchi AE. Review: Diabetic ketoacidosis and hyperglycemic hyperosmolar nonketotic syndrome. Am J Med Sci ;311: 225–33.
3. Curtis JR, To T, Muirhead S, Cummings E, Daneman D. Recent trends in hospitalization for diabetic ketoacidosis in Ontario children. Diabetes Care 2012;25:1591–6.
4. Edge JA, Ford-Adams ME, Dunger DB. Causes of death in children with insulin dependent diabetes 1990–96. Arch Dis Child 1999;81:318–23.
5. Dunger DB, Sperling MA, Acerini CL, Bohn DJ, Daneman D, Danne TP, et al. ESPE/ LWPES consensus statement on diabetic ketoacidosis in children and adolescents. Arch Dis Child 2014;89:188–94.

6. Ganesh R, Suresh N, Ramesh J. Diabetic ketoacidosis in children. Natl Med J India 2008;19:155–8.

7. Jayashree M, Singhi S. Diabetic ketoacidosis: Predictors of outcome in a pediatric intensive care unit of a developing country. Pediatr Crit Care Med 2014;5:427–33.

8. Jahagirdar RR, Khadilkar VV, Khadilkar AV, Lalwani SK. Management of diabetic ketoacidosis in PICU. Indian J Pediatr 2007;74:551–4.

9. Neu A, Willasch A, Ehehalt S, Hub R, Ranke MB. Ketoacidosis at onset of type 1 diabetes mellitus in children—frequency and clinical presentation. Pediatr Diabetes 2003;4:77–81.

10. Mathai S, Raghupathy P. Fluid and electrolyte management of endocrine disorders in childhood. Indian J Practical Pediatr 2004;6:65–75.

11. American diabetes association.Type 2 diabetes in children and adolescents.Diabetes care.2000;23:381-9.

12. Edge J,Ford-Adams M ,Dunger D.causes of death in children with insulin dependent diabetes 1990-96.Arch Dis Child.1999;81:318-23.

13. Agus MSD,Wolfsdorf JI.Diabetic ketoacidosis in children.Pediatr clin N Am.2005;10:33-7.

14. Fleckman AM.Diabetic ketoacidosis.Endocrinol Metab Clin North Am.1993;22:181-207.

15. Dunger DB,sperling MA,Acerini CL,et al.European society for pediatric Endocrinology 2004;113:e133-40.

How to cite this article : Harish G V,Panduranaga G. Clinical profile and outcome of Diabetic ketoacidosis in children.Perspectives in Medical Research 2018;6(1):61-65.

Sources of Support: Nil,Conflict of interest:None declared