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Outcome of children with diabetic ketoacidosis treated with a modified protocol

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ABSTRACT

Introduction: The majority of children with moderate diabetic ketoacidosis (DKA) and all children with severe DKA should be treated in a medical facility. This is unique issues that arise in DKA in the young. **Aim:** Study was undertaken to analyze the outcome of children with DKA treated with a modified protocol. **Materials and Methods**: We have analyzed 35 patients with DKA admitted in our Pediatric Intensive Care Unit. Patients were managed according to a modified protocol. Laboratory parameters measured were blood glucose, urinary ketones, electrolytes, urea creatinine, and arterial blood gas. **Results:** Over a period of 12 months, 35 patients of DKA are admitted, out of these, 10 (29%) were male and 25 (71%) were female. Age group ranged between 4 months and 13 years with mean age of 5.63 years. Diabetes mellitus was newly diagnosed at presentation in 40% (14 cases) of cases, 43% (15 cases) of cases were due to non-compliance, and 17% (6 cases) were due to fever (stress). The presenting most common symptoms were polyuria/polydipsia (68.5%). Most commonly observed clinical sign was 54.2% (19 cases) had dehydration, majority of the cases (42%) presented in our institute are due to poor compliance. 40% of cases are newly diagnosed. Of these newly diagnosed cases, 5.7% (2 cases) of cases who were infants, presented in severe respiratory distress, thought to be severe bronchopneumonia had come out to be DKA. Out of 35 **case**s hospitalized, 32 cases (91.4%) recovered without any complications of DKA. Average recovery time in these patients is 23.15 h. 2 **case**s died due to uncontrolled septicemia despite good glucose control and stabilization of their ketoacidosis state. **Conclusions:** There should be high index of suspicion necessary on the part of the clinician.

Key words: Cerebral edema, children, diabetic ketoacidosisdiabetic ketoacidosis

INTRODUCTION

Diabetic ketoacidosis (DKA) has been reported to be the leading cause of overall morbidity and mortality in children and adolescents with Type 1 diabetes mellitus. Cerebral edema has been estimated to occur in ~1% of all DKA episodes and accounts for 50–60% of diabetes-related deaths in children. The mortality rate from cerebral edema has been reported to be 20–50% and 15–35% of survivors are left with permanent neurologic deficits. Diabetes is a disorder of the endocrine system characterized by the body's inability to use blood glucose.

There are two main types of diabetes as Juvenile onset and mature onset. Juvenile onset diabetes can affect anyone of any age but is more common in people under 30 years and tends to develop in childhood, hence its name. Other names for Juvenile onset diabetes include Type 1 diabetes or insulin-dependent diabetes mellitus.

Type 1diabetes is being increasingly reported from many centers in India and the rise in incidence could be apparent due to improved diagnostic facilities such as routine use of glucometer, or it could be a reflection of true increase in the incidence as seen in the western world.[1] DKA is one of the major complications of Type 1 diabetes in childhood associated with increased risk of morbidity and mortality due to electrolyte and acid-base disturbances if left untreated. About 25–40% of newly diagnosed diabetic patients present with DKA, especially under the age of 5 years.[2] A mortality rate of about 5% has been reported.[3] In our study, the mortality rate is 8.75%. DKA is identified by three clinical features: Hyperglycemia, ketonuria or ketonemia, and acidosis. Many patients with diabetes may present with hyperglycemia; however, DKA is not diagnosed without the other two clinical features being present.

This study was undertaken to analyze the outcome of children with DKA treated with a modified protocol and to assess the predictors of prognosis based on clinical and laboratory parameters.

MATERIALS AND METHODS

Place of Study

Pediatric Intensive Care Unit (PICU) in Niloufer hospital, Hyderabad.

Duration of Study

The duration of the study was 12 months, from September 2013 to August 2014.

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Cases

All the children presented in DKA during this period are taken for the study. Age group ranged between 4 months and 13 years. The total number of cases studied is 35 (10 male and 25 female).

- Clinical parameters measured are in my study duration of illness before admission, Glasgow coma scale EMV score at presentation, and severity of dehydration,
- Laboratory parameters measured are blood glucose, blood urea, urinary ketones, serum electrolytes (serum sodium and serum potassium), serum creatinine, arterial blood gas analysis, and infection screen (in some cases), blood urea nitrogen=blood urea/2.14,
- Treatment given is fluid therapy, insulin therapy, correction of ketoacid accumulation, serum potassium correction, and bicarbonate therapy.

RESULTS

Over a period of 12 months, 35 patients of DKA are admitted, out of these, 10 (29%) were male and 25 (71%) were female. Age group ranged between 4 months and 13 years with mean age of 5.63 years. Out of these 35 patients, 2 (5.7%) patients were infants, 26 (74.28%) patients were above 6 years.

Symptomatology

The most common symptoms that were elicited in patients either just before admission or at the time of diagnosis of ketoacidosis. Diabetes mellitus was newly diagnosed at presentation in 40% (14 cases) of cases, 43% (15 cases) of cases were due to non-compliance, and 17% (6 cases) were due to fever (stress). The presenting symptoms were polyuria/polydipsia (68.5%), nausea/vomiting (60%), change in sensorium (57%), hyperventilation (48%), and abdominal pain (20% without any specific underling cause).

Most commonly observed clinical sign was 54.2% (19 cases) had dehydration, followed by 51.4% (18 cases) of cases had acidotic breathing, 51.4% (18 cases) of cases had altered level of consciousness, 17.1% (6 cases) of cases had fever, and 11.4% (4 cases) of cases had hypotension.

Blood sugar levels at admission varied between 315 mg% and 1046 mg%. The mean blood sugar was 566.51%. The mean blood sugar in those who had altered sensorium compared to those who did not was 310.48 (18 cases) and 298.6 (17 cases), respectively. The calculated Fisher *t*-test value is 1.34 which is less than the tabulated $t = 2.10$. $P > 0.05$ even at 95% confidence intervals, so the observed difference is due to chance.

Blood gas analysis revealed mean pH to be 7.06 (range 6.8–7.25). The mean pH in those who had altered sensorium compared to those who did not was 6.99 (18 cases) and 7.14 (17 cases), respectively. The calculated Fisher *t*-test value is 1.25, which is less than the tabulated $t = 2.10$. $P > 0.05$ even at 95% confidence intervals, so the observed difference is due to chance.

Patients with disturbed conscious level had a mean serum osmolality of 310.48 (18 cases) while those who did not manifest this sign had mean osmolality of 298.6 (17 cases). This difference is statistically significant ($P < 0.05$) as the calculated Fisher $t = 3.98$ which is more than the tabulated $t = 2.10$. High serum osmolality at the time of presentation correlated well with the altered level of consciousness.

In the search for a precipitating cause for the DKA, it was observed that missing doses of insulin were noted to be dominating the clinical picture. 40% of cases were newly diagnosed as diabetic and 18% of cases are presented with fever. The patients had stopped insulin for variety of reasons including depression, being "fed up," unable to purchase, and feeling that they were well enough not to require insulin.

Outcome of Treatment

Out of 35 cases hospitalized, 32 cases (91.4%) recovered without any complications of DKA. Average recovery time in these patients is 23.15 h. Two cases died due to uncontrolled septicemia despite good glucose control and stabilization of their ketoacidosis state.

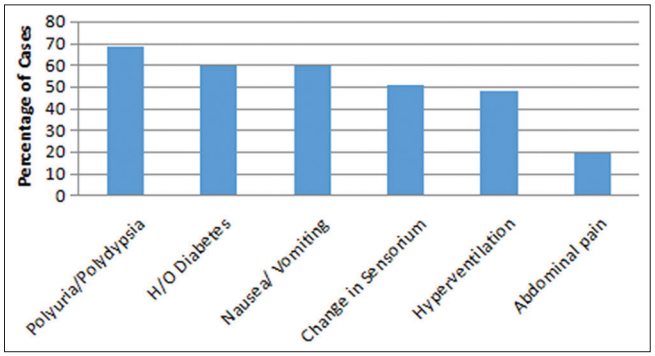

Figure 1: Symptoms at presentation

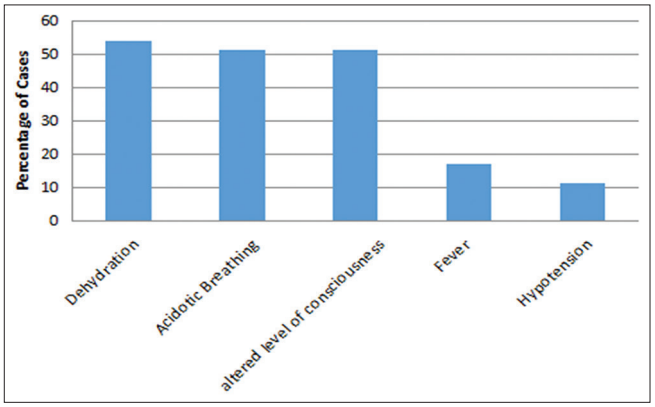

Figure 2: Signs at examination

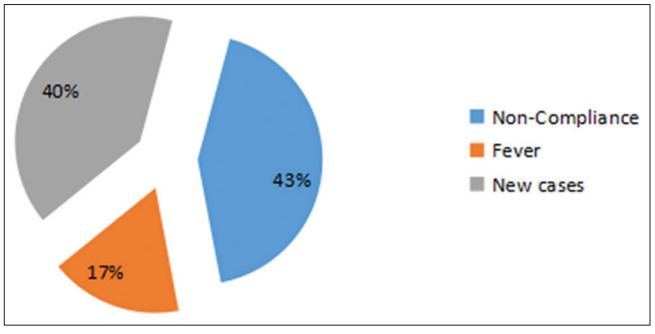

Figure 3: Precipitating causes

Table 1: Laboratory investigations

Parameters	Results	Mean	*P*
Blood sugar levels	315 mg% and 1046 mg%	566.51%	*P*>0.05
Blood gas analysis			
Mean pH	6.8–7.25	6.99	*P*>0.05
Mean serum osmolality	285–335	310.48	*P*<0.05

One case which is admitted with a history of missing two doses of insulin the previous day with head injury expired 16 h after admission (computed tomography [CT] - scan brain not done as the patient condition is not stable to mobilize him from PICU).

DISCUSSION

The incidence of DKA in our hospital is (0.12%). DKA continues to be common with a relatively constant incidence in the western countries despite improvement in general medical care.[4] Incidence of 35 cases over a 12 months period seen in one medical unit certainly highlights the extent of the problem. The higher representation of females presenting with ketoacidosis is true of most series as in this one.[5]

In this series, 40% of patients never knew they had diabetes mellitus and were diagnosed for the first time during an acute presentation. The typical symptoms related to uncontrolled hyperglycemia that dominates the clinical presentation. Even after the patients recovered from their ketoacidosis state, they were unable to recall all their symptoms. Slightly more than half of the patients had nausea and vomiting. Abdominal pain as presenting feature in DKA is not uncommon, occurring in about 20% of cases.[6,7] Hyperventilation could reflect one of two possibilities – one of which is compensation for metabolic acidosis and the other is pneumonia. The clinically detectable dehydration is due to large fluid losses. In DKA, patients may lose fluid easily through osmotic diuresis, vomiting, fever, and hyperventilation (Figures 1and 2).

The lack of biochemically demonstrable hypokalemia in patients with DKA is not unexpected. Despite their total body potassium deficit, studies have shown that only in 4–10% of patients is the plasma potassium less than normal.[3] In our study, 11.4% of cases presented with hypokalemia (Table 1).

The high mean serum osmolality at presentation is not surprising in view of the marked dehydration in most of these cases. This study also documents previous observations that disturbance of conscious is most closely linked to the degree of dehydration.[3,8] We had mortality of about 8.57% which compares with the average mortality of about 0–20% described in diabetic literature.[9-11] Despite achieving good blood sugar levels and correction of metabolic acidosis, we lost 3 patients of these 2 were due to uncontrolled septicemia and 1 due to head injury.

CONCLUSION

Majority of the cases (42%) presented in our institute are due to poor compliance. 40% of cases are newly diagnosed. Of these newly diagnosed cases, 5.7% (2 cases) of cases who were infants, presented in severe respiratory distress, thought to be severe bronchopneumonia had come out to be DKA. Hence, high index of suspicion is necessary on the part of the clinician (Figure 3).

In my study, it has been shown that the altered level of consciousness at the time of presentation is correlated well with the serum osmolality than with blood glucose and pH. However, it has also been shown that, when DKA is managed in a PICU setting using modified standard protocol, the outcome is rewarding in children and is associated with no complications. Our study has limitations as we have not been able to measure serum ketone and perform CT scan of the brain for our patients and perform rigorous biochemical monitoring in every child as suggested by most western literature due to economic reasons. Yet clinical assessment, adequate tests and PICU setup seem to be the key to successful management of DKA.

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