Original Article

Demographics, Clinical Profile and Outcome of Children with Diabetic Ketoacidosis

Syed Fawad Saleem, Iftikhar Ahmad and Abdul Rehman

ABSTRACT

Objective: To determine the demographic data as well as clinical profile and outcome of DKA in children aged < 18 years with T1DM.

Study Design: Observational / case series study

Place and Duration of Study: This study was conducted at the Pediatrics unit 2 of Bahawal Victoria Hospital, Bahawalpur from January 2017 to November 2018.

Materials and Methods: This study was conducted on children aged ≤ 18 years admitting with T1DM with DKA. Demographic features, clinical presentation, laboratory findings and outcome were recorded for all patients.

Results: A total of 52 children of T1DM with DKA were reported during the study period. Mean age amongst all the patients was 9.8 years. Most of the patients i.e. 66.7% cases belonged to urban areas and 59.6% cases newly diagnosed cases of T1DM. The most frequent symptoms at the time of hospitalization were polyuria 88.5% and polydipsia 82.7%. Mean time for recovery amongst all was 23.4 hours while 2 (3.8%) deaths occurred during hospital stay. The most frequent complication seen were hypokalemia 20 (38.5%) and hypernatraemia 16 (30.8%).

Conclusions: Diagnosis of T1DM should be made at earliest so that DKA and its complications can be prevented in our population.

Key Words: Type 1 diabetes mellitus, ketoacidosis, polyuria, mortality, cerebral edema.

Citation of articles: Saleem SF, Ahmad I, Rehman A. Demographics, Clinical Profile and Outcome of Children with Diabetic Ketoacidosis. Med Forum 2019;30(4):29-33.

INTRODUCTION

Prevalence of Type 1 diabetes mellitus (T1DM) has been rising amongst the children in the recent decades.[1] Middle income countries are affected most by Diabetes so a country like Pakistan is at increased risk when we consider the impact of diabetes in our general population.[2]

Diabetic ketoacidosis (DKA) is known as a leading complication of diabetes specially T1DM. Poor physiologic effects of Insulin results in reduced uptake of glucose at cellular levels, resulting in a stern cycle which may go on to end up as DKA.[3] It is estimated globally that prevalence of DKA is increasing 3% annually.[3-5] In children, diagnostic criteria for DKA is defined by "International Society for Pediatric and Adolescent Diabetes (ISPAD)" in 2018 as blood glucose more than 11 mmol/L (approx. 198 mg/dL), venous pH less than 7.3, or bicarbonate less than 15 mmol/L and Ketonemia or ketonuria.[6] DKA is categorized in terms of mild, moderate or severe. Known risk factors in children for DKA include younger age, late diagnosis, poor socioeconomic status, lapse of insulin and poor access to medical facilities.[7,8] Despite growing incidence of T1DM in our country, its complications like DKA have been neglected as not much recent local literature is available concerning DKA.[9-16] Without further study on the clinical profile and demographics of T1DM patients it is not possible for us to form better protocols for the management of DKA. The objective of the study was to determine the demographic data as well as clinical profile and outcome of DKA in children aged < 18 years with T1DM.

Department of Pediatric, Bahawal Victoria Hospital Bahawalpur.

Correspondence: Dr. Abdul Rehman, Associate Professor of Pediatric, Bahawal Victoria Hospital Bahawalpur R/o 47-B, Medical Colony, Quaid e Azam Medical College, B/pur.
Contact No: 03006848195
Email: drarehman100@gmail.com

Received: January, 2019
Accepted: February, 2019
Printed: April, 2019

MATERIALS AND METHODS

This was an observational study (case series) conducted on children aged ≤ 18 years having T1DM (new as well as established cases) admitting with DKA during 1st January 2017 to 30th November 2018 in the Pediatrics unit 2 of Bahawal Victoria Hospital, Bahawalpur. The approval of this study was granted by local ethical committee. Children whose parents/guardians refused to give consent or left the ward before completion of investigations were excluded from the study. Children who were admitted more than once due to DKA during

the study period were included only once i.e. at the first admission during the study period.

The parents/guardians were interviewed about the demographic data like age, gender, area of residence, newly diagnosed or established case of T1DM, presenting symptoms and the duration of symptoms. The clinical examination and laboratory investigations like blood glucose, urine ketones, venous blood gases and serum elcotrolytes and the serum creatinine were performed and the outcome in the form of mortality or survival during the hospital stay in all the children was also noted. DKA was labeled as blood glucose >200 mg/dL, pH less than 7.3, bicarbonate less than 15 mmol/L and ketonuria. The severity of DKA was classified based on venous blood pH or bicarbonate levels as:

Mild DKA: Venous blood pH between 7.21 to 7.30 or bicarbonate level between 10 mmol/L to 15 mmol/L.

Moderate DKA: Venous blood pH between 7.11 to 7.20 or bicarbonate level between 5 mmol/L to 10 mmol/L.

Severe DKA: Venous blood pH < 7.10 or bicarbonate level <5 mmol/L.

The children were managed according to ISPAD Clinical guidelines.[6] Hyponatremia and hypernatremia was labeled when serum sodium was <135mEq/l and >145mEq/l respectively whereas hypokalemia and hyperkalemia was declared with serum potassium < 3.5 mEq/l and > 5mEq/l respectively. The diagnosis of the cerebral edema was made on deterioration in neurological function after the initial improvement in the absence of any evident cause and was confirmed on the presence of papilledema and CT scan brain findings. Serum creatinine level more than 1.5mg/dL was taken as abnormally high (deranged).

SPSS version 20.0 used for data entry and analysis. Frequency and percentages were calculated for qualitative variables while quantitative variables were presented in terms of mean and standard deviation.

RESULTS

A total of 52 children of T1DM with DKA episodes were reported during the study period. Mean age amongst all the patients was 9.8 years with standard deviation of 2.3 years. There were 29 (55.8%) patients between 10 to 18 years of age while 23 (44.2%) were less than 10 years of age. There were 22 (42.3%) male and 30 (57.7%) female in our study. We found 34 (66.7%) cases that belonged to urban areas while remaining 18 (33.3%) belonged to rural areas. A total of 31 (59.6%) cases were newly diagnosed cases of T1DM. Mean duration of symptoms prior to admission in hospital was 9.3 days with standard deviation of 2.6 days. The most frequent symptoms at the time of hospitalization were noted as polyuria 46 (88.5%) and polydipsia 43 (82.7%). Mean blood glucose at the time of admission was 408.45 mg/dl. Most of the patients, 23 (44.2%) had severe DKA.

Table No.1: Demographics and Clinical Characteristics (52 children)

Characteristics	Results
Age in years (mean ± standard Deviation)	9.8 ± 2.3
Age Distribution in years, n (%)	
< 10	23 (44.2%)
10-18	29 (55.8%)
Duration of Symptom in Days (mean ± standard Deviation)	9.3 ± 2.6
Gender, n (%): Male	22 (42.3%)
Female	30 (57.7%)
Disease Presentation, n (%)	
Newly Diagnosed	31 (59.6%)
Established Diabetes	21 (38.4%)
Area of Residence, n (%)	
Urban	34 (66.7%)
Rural	18 (33.3%)
Presenting Symptoms	
Polyuria	46 (88.5%)
Polydipsia	43 (82.7%)
Nausea / Vomiting	26 (50.0%)
Abdominal Pain	21 (40.4%)
Altered Consciousness	20 (38.5%)
Respiratory distress	13 (25.0%)
Glasgow coma scale at the time of presentation, n (%):Less than 9	6 (11.5%)
9-11	3 (5.8%)
More than 11	43 (82.7%)
Severity, n (%): Mild	13 (25.0%)
Moderate	16 (30.8%)
Severe	23 (44.2%)
Complications	
Cerebral edema	4 (7.7%)
High serum creatinine level (deranged)	3 (5.8%)
Hypokalemia	20 (38.5%)
hypernatraemia	16 (30.8%)
Outcome, n (%): Survived	50 (96.2%)
Died	2 (3.8%)
Recover Time in Days (mean ± standard deviation)	18.45 ± 4.7

Table No.2: Laboratory Parameters at the time of Presentation

Laboratory Parameters	Mean ± Standard Deviation
Blood Glucose, mg/dL	405.45 ± 88.1
pH	7.12 ± 0.13
pCO_2	16.2 ± 3.4
HCO_3	5.6 ± 0.23
Na	132.25 ± 11.2
K	5.08 ± 1.6
Cl	103.23 ± 6.8
Creatinine	1.13 ± 0.32

Mean time for recovery amongst all was 23.4 hours. The most frequent complication seen was hypokalemia 20 (38.5%) and hypernateremia 16 (30.8%). There were 2 (3.8%) deaths occurred during hospital stay (Table-1). Both were newly diagnosed cases and having brain edema along with high serum creatinine(deranged).

As far as laboratory parameters of the cases at the time of presentation were concerned, mean pH, pCO_2, HCO_3, Na, K and Cl are shown in table-2.

DISCUSSION

DKA is known to be one of the major causes of mortality amongst T1DM.[2] The mean age of cases in the present study was 9.8 years and 55.8% were between the age of 10 to 18 years. A recent study from Indonesia also found that most of the DKA cases having T1DM were teenagers which correlates with the findings of the current study.[1] A study conducted in Saudi Arabia also noted a mean age of 11 years that was more close to what we found as well.[17] Indian researchers also found mean age of 11.4 years.[18]

In the present study 57.7% were females. Pulangan AB and colleagues recently found a little higher ratio of females to males (1.4 to 1).[1] Pulungan et al[19] found a more higher prevalence of females as compared to male as well. Some other authors found the same pattern which might be due to puberty related hormonal changes like growth hormone as well as estrogen. At the same stage both genders, male and female, react differently to these hormonal shifts, estrogen levels are much higher in girls as compared to boys when they approach puberty.[20]

There were 66.7% cases that belonged to urban areas in the present study. Razavi Z et al[21] in a 7 year study from Iran found that 61% of the cases reported with DKA having T1DM belonged to urban areas.

We recorded newly diagnosed cases of T1DM to form 59.6% cases. Razavi et al[21] noted an even higher number i.e. 82% were newly diagnosed cases of T1DM with DKA. Presentation of DKA is similar to few other illnesses and this could be the reason why so many of the cases end with being diagnosed so late. The delay in diagnosis has been found to be a cause of increased mortality in cases of T1DM.[22] Pediatricians and general public must be provided about the possible risk factors and their preventions to eliminate the risk of late diagnosis.

Most frequent symptoms of DKA has been described as polyuria and polydipsia along with nausea/ vomiting as well as altered level of consciousness.[17,21, 23] Our results fell well in line with the previous findings. Our study showed respiratory distress in 25% cases while it was 58.6%-87.1% in other studies.[1,9,18]

Similar to some previous results,[1, 21,24] severe DKA turned out to be the most common type. Some other like Schober et al[25] from Australia and Oyarzabal et al[26] found small number of cases with severe DKA. These differences could be due to differences in approach to healthcare facilities or due to a delay in the diagnosis by the healthcare professional.

Hypokalemia along with hyponatraemia were the most common complications found in our study. Our results were found to be consistent with some other studies.[27,28]

Glasgow coma scale score at presentation was less than 9 in 11.5% cases, 9-11 in 5.8% while 12 and above in 82.7% cases. Similar results were obtained in the study by Syed M et al. [30]

The frequency of cerebral edema as a complication of management was variable in different studies. Our study showed cerebral edema in 7.7% while Pulungan AB et al [1] showed 6.2% cases were having cerebral edema. None of the children developed cerebral edema during the treatment in the study by Lone SW.[9]

The mortality varies from study to study. Our study showed mortality 3.8% cases similar to that of Bhardwaj P[18] while Niaz Z et al[16] showed high rate of mortality i.e. 15.9%. Other studies [1,9,17] showed no mortality. Both the cases that died in our study were newly diagnosed cases and having brain edema along with deranged serum creatinine.

Our study showed deranged serum creatinine level in 5.8% cases while other studies showed variable results about acute kidney injury which might be transient. None of the children developed acute kidney injury in the study by Lone SW et al[9]. 10.27% cases developed acute kidney injury in study by Abbas Q et al [31] while 64.2% cases developed AKI in the study by Hursh BE et al[32]

As far as limitations of the current study are concerned, there are few. The sample size in the current work was relatively small so studies with more centers be involved, with more active information seeking as well as bigger sample size will have more concrete evidence. Despite all these limitations, we feel that the results of our study have given an ample insight about the patient profile of DKA in our area.

CONCLUSION

Diagnosis of T1DM should be made at earliest so that DKA and its complications can be prevented in our population.

Author's Contribution:

Concept & Design of Study:	Syed Fawad Saleem
Drafting:	Iftikhar Ahmad
Data Analysis:	Abdul Rehman
Revisiting Critically:	Syed Fawad Saleem, Iftikhar Ahmad
Final Approval of version:	Syed Fawad Saleem

Conflict of Interest: The study has no conflict of interest to declare by any author.

REFERENCES

1. Pulungan AB, Batubara JR, Tridjaja B, Soesanti F, Fadiana G, Annisa D, et al. Profile of Diabetic Ketoacidosis in Children with Diabetes Mellitus in a Tertiary Care Hospital in Jakarta: A Retrospective Study. Acta Scientific Paediatr 2019;2(2):24-9.
2. Ogurtsova K, da Rocha FD, Huang Y, Linnenkamp U, Guariguata L, Cho NH, et al. IDF Diabetes Atlas: Global estimates for the prevalence of diabetes for 2015 and 2040. Diabetes Res Clin Pract 2017;128:40–50.
3. Naeem M. Update Regarding Diabetic Ketoacidosis in Children and Controversies in Management. Qual Prim Care 2017;26(2): 49-52.
4. Newhook LA, Curtis J, Hagerty D, Grant M, Paterson AD, Crummel C, et al. High incidence of childhood type 1 diabetes in the Avalon Peninsula, Newfoundland, Canada. Diabetes Care 2004; 27: 885-8.
5. Dunger DB, Sperling MA, Acerini CL, Bohn DJ, Daneman D, Danne TP, et al. European Society for Paediatric Endocrinology/Lawson Wilkins Pediatric Endocrine Society consensus statement on diabetic ketoacidosis in children and adolescents. Pediatr 2004;113: 133-40.
6. Wolfsdorf JI, Glaser N, Agus M, Fritsch M, Hanas R, Rewers A, et al. ISPAD Clinical Practice Consensus Guidelines 2018: Diabetic ketoacidosis and the hyperglycemic hyperosmolar state. Pediatr Diabetes 2018;19(Suppl.27):155–77.
7. Baker PR, Steck AK. The past, present, and future of genetic associations in type 1 diabetes. Curr diabetes reports 2011;11: 445.
8. Lange K, Swift P, Pankowska E, Danne T. Diabetes education in children and adolescents. Pediatr Diabetes 2014;15:77–85.
9. Lone SW, Siddiqui EU, Muhammad F, Atta I, Ibrahim MN, Raza J. Frequency, clinical characteristics and outcome of diabetic ketoacidosis in children with type-1 diabetes at a tertiary care hospital. J Pak Med Assoc 2010; 60: 725-9.
10. Jabbar A, Farooqui K, Habib A, Islam N, Haque N, Akhter J. Clinical characteristics and outcomes of diabetic ketoacidosis in Pakistani adults with Type 2 diabetes mellitus. Diabet Med 2004; 21: 920-3.
11. Shera AS, Miyan Z, Basit A, Maqsood A, Ahmadani MY, Fawwad A, et al. Trends of type 1 diabetes in Karachi, Pakistan. Pediatr Diabetes 2008; 9: 401-6.
12. Akhter J, Jabbar A, Islam N, Khan MA. Diabetic ketoacidosis in a hospital based population in Pakistan. J Pak Med Assoc 1993; 43: 137-9.
13. Qayyum AA, Lone SW, Ibrahim MN, Atta I, Raza J. Effects of diabetes self management education on glycaemic control in children with insulin-dependent diabetes mellitus. J Coll Physicians Surg Pak 2010; 20: 802-5.
14. Naveed D, Bilal N, Nasir B, Lodhi BUR. Precipitating factors for diabetic ketoacidosis. KUST Med J 2009; 1: 6-8.
15. Sheikh AAI, Malloush A. Diabetic ketoacidosis: more cases seen during summer vacation. Pak J Med Sci 2009; 25: 512-5.
16. Niaz Z, Razzaq A, Chaudhary UJ, Awais M, Yaseen MA, Naseer I, et al. Mortality review of diabetic ketoacidosis in Mayo Hospital, Lahore - Pakistan. Biomedica 2005; 21: 83-5.
17. Naeem MA, Al-Alem HA, Al-Dubayee MS, Al-Juraibah FN, Omair A, Al-Ruwaili AS, et al. Characteristics of pediatric diabetic ketoacidosis in patients in Saudi Arabia. Saudi Med J 2015;36(1):20-5.
18. 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 2017;5(12):5402-5.
19. Pulungan AB, Juwita E, Pudjiadi AH, Rahmayanti S, Tsaniya I. Diabetic Ketoacidosis in Adolescents and Children: A Prospective Study of Blood versus Urine Ketones in Monitoring Therapeutic Response. Acta Med Indones 2018;50(1):46-52.
20. Onyiriuka AN, Ifebi E. Ketocidosis at diagnosis of type 1 diabetes in children and adolescents: frequency and clinical characteristics. J Diabetes Metab Disord 2013;12(1):47.
21. Razavi Z, Hamidi F. Diabetic Ketoacidosis: Demographic Data, Clinical Profile and Outcome in a Tertiary Care Hospital . Iran J Pediatr 2017;27(3):e7649.
22. Varadajan P, Suresh S. Delayed diagnosis of diabetic ketoacidosis in children – a cause for concern. Int J Diabetes Dev C 2015;32(2):66-70.
23. Otieno CF, Kayima JK, Omonge EO, Oyoo GO. Diabetic ketoacidosis: risk factors, mechanisms and management strategies in sub-Saharan Africa: a review. East Afr Med J 2005;82(12 Suppl):S197–203.
24. Razavi Z. Frequency of ketoacidosis in newly diagnosed type 1 diabetic children. Oman Med J 2010;25(2):114–7.
25. Schober E, Rami B, Waldhoer T. Austrian Diabetes Incidence Study G. Diabetic ketoacidosis at diagnosis in Austrian children in 1989-2008: a population-based analysis. Diabetologia 2010; 53(6):1057–61.

26. Oyarzabal IM, Cuartero GB, Castellanos BR, Lacruz TM, Gila GA, Casado GI, et al. Ketoacidosis at onset of type 1 diabetes mellitus in pediatric age in Spain and review of the literature. Pediatr Endocrinol Rev 2012;9(3):669–71.
27. Carlotti AP, St George-Hyslop C, Bohn D, Halperin ML. Hypokalemia during treatment of diabetic ketoacidosis: clinical evidence for an aldosterone-like action of insulin. J Pediatr 2013;163(1):207–12 e1.
28. Kanwal SK, Bando A, Kumar V. Clinical profile of diabetic ketoacidosis in Indian children. Indian J Pediatr 2012;79(7):901–4.
29. Chiarelli F, Marcovecchio ML. DKA management and outcomes. Int J Pediatr Endocrinol 2013; (Suppl 1):16
30. Syed M, Khawaja FB, Saleem T, Khalid U, Rashid A, Humayun KN. Clinical profile and outcomes of paediatric patients with diabetic ketoacidosis at a tertiary care hospital in Pakistan. J Pak Med Assoc 2011;61(11):1082-7.
31. Abbas Q, Arbab S, Haque AU, Humayun KN. Spectrum of complications of severe DKA in children in pediatric Intensive Care Unit. Pak J Med Sci 2018;34(1):106-9.
32. Hursh BE, Ronsley R, Islam N, Mammen C, Panagiotopoulos C. Acute Kidney Injury in Children With Type 1 Diabetes Hospitalized for Diabetic Ketoacidosis. JAMA Pediatr 2017; 171(5):e170020.