ORIGINAL ARTICLE

Assessment of the Factors That Can Predict the Occurrence of Diabetic Ketoacidosis in Type 1 Diabetic Patients

ABDUL RASHID DAYO[1], SHAFI MUHAMMAD WASSAN[2], QURRAT UL AIN SHAHID[3], ABDUL HAFEEZ SOOMRO[4], NIAZ AHMED[5], MONA HUMAIRA[6]

[1]Assistant Professor Medicine, GMMC Teaching Hospital Sukkur Pakistan
[2]Associate Professor Community Medicine, SMBBMU @GMMMC Sukkur Pakistan
[3]Consultant Internal Medicine, Fatima Memorial Hospital Lahore Pakistan
[4]Assistant Professor Medicine, Asian Institute of Medical Sciences Hyderabad Pakistan
[5]Professor Medicine, Shaheed Mohtarma Benazir Bhutto Medical College Lyari @ Lyari General Hospital Karachi Pakistan
[6]Associate Professor Medicine, Liaquat University of Medical and Health Sciences Jamshoro Pakistan
Corresponding author Abdul Rashid Dayo, Email: alimirani4u@hotmail.com

ABSTRACT

Background: Diabetes ketoacidosis (DKA) is a common acute complication seen in patients with diabetes mellitus (DM) type 1. It is avoidable by following a good management plan. The risk factors that have been previously identified for DKA are female gender, age, illiteracy, low socio-economic status, infection, poor metabolism, psychological issues, and poor compliance with the treatment.

Objective: The present study aims at the determination of age, gender, socio-economic status, DKA at the time of initial diagnosis of DM type 1, parental education regarding the disease, psychological issues, infection, metabolic control, and poor compliance with insulin treatment as the predictive factors of DKA occurrence.

Study design: A retrospective cohort study

Place and Duration: This study was conducted at GMMC Teaching Hospital Sukkur from November 2021 to November 2022

Methodology: The present study was conducted by using the medical records of patients with DM type 1. The mean age of the patients was 18.2±5.31 with a range of 0-21 years. The data were assessed for the predictive factors of DKA. The dependent variable in the study was DKA occurrence. The independent variables were, compliance with the treatment with insulin, DM type 1, age, infection, psychological issues, metabolic control, parental education, socio-economic status, and diagnosis of DM type 1 on a DKA attack. Logistic regression analysis was done the determination the factors that seemed to increase the incidence of DKA.

Results: A total of 42 patients with DM type 1 were included in the study. The incidence of DKA was 27 (64.29%) and 4 (9.52%) of these patients died. Multivariate analysis showed that infection and diagnosis of DM type 1 at the time of DKA were the most significant predictive factors for DKA.

Conclusion: Diagnosis of DM type 1 at the time of DKA and infection are the most important factors for increasing the incidence of DKA.

Keywords: Diabetic ketoacidosis, type 1 diabetes mellitus, infection, predictive factors

INTRODUCTION

DKA is an acute complication seen in patients with type-1DM which is many times fatal for the patients. It increases the morbidity as well as mortality of patients with DM type 1 [1]. The percentage mortality of patients with DKA in developing and developed countries is almost 3.4-13.4 and 0.15-0.31, respectively [2]. The economic burden imposed by DKA is immense because it includes treatment expenses, hospitalization expenses, and also maintenance therapy charges [3]. The DKA incidence rates are not static and it is influenced by the socio-economic, conditions of the healthcare facility and geographic status [4].

The prevalence of DKA is variable in different countries of the world. It ranges between 13% to 80%, seen as more prevalent in the developing countries of the world compared to the developed countries [5]. The incidence of the disease in children is lesser compared to older individuals. It is 1-10% of the children on annual basis [6]. The risk of DKA in children is inversely proportional to the nutritional status of the child. It also depends on metabolic control, first diagnosis, non-compliance, and infection. Other factors are peri-pubertal age, the presence of an eating disorder, and psychological and emotional problems [7].

A good outcome can only be expected if proper management of DKA is provided to the patient. The prognosis and outcomes of the treatment are dependent on the early identification of the symptoms, correction of dehydration, electrolyte imbalance, hyperglycemia, and acidosis [8]. The episode of DKA can be prevented by avoiding the risk factors that can potentially trigger DKA [9]. To lower the rate of mortality and morbidity modifiable predictive factors are needed to be determined. The present study aims at the identification of the characteristics that are possessed by the patients presented with DKA along with the predictive factors that are influential on DKA occurrence.

METHODOLOGY

The present study is a retrospective cohort study that assessed the medical records of 42 patients. According to the inclusion criteria of the study, the patients had DM type 1 and their age was between 0 years to 21 years. Patients with incomplete or vague medical records were not added to the study. Moreover, the patients that were overweight, obese, using certain medications that could alter the level of blood sugar, and patients with a high level of C-peptide, were not added to the study. The dependent variable in the study was DKA occurrence. The independent variables were, compliance with the treatment with insulin, DM type 1, age, infection, psychological issues, metabolic control, parental education, socio-economic status, and diagnosis of DM type 1 on a DKA attack.

Compliance with the treatment was interpreted as compliance with the recommended dose of insulin and the proper administration of insulin. Infection was interpreted as the instance of a urinary tract infection, intestinal infection, and infections detected by laboratory findings during the first 24 hours of stay in the hospital. The metabolic control was assessed based on HbA1C during the three months after the episode of DKA. The socio-economic status of the family was defined based on the overall income of the family.

The team of researchers filled out questionnaires after assessment of the data collected from the healthcare facility. The analysis of the data was done by bivariate analysis. The data was analyzed in the IBM SPSS version 26.

RESULTS

A total of 42 patients were considered in the study after assessing them according to the inclusion and exclusion criteria. The basic characteristics of the patients have been given in table 1.

Table 1: Basis characteristics of the patients in the study (n=42)

Variables	Frequency	Percentage
Gender		
Male	13	30.95
Female	29	69.04
Age (Years)		
0-10	6	14.28
11-21	36	85.71
Parent literacy level		
Illiterate	19	45.23
High school level	12	28.57
Degree level	11	26.19
Socio-economic status		
Low	10	23.80
Middle	11	26.19
High	21	50
Diagnosis of DM type 1 at the first episode of DKA		
Yes	23	54.76
No	19	45.23
Nutrition		
Normal	24	57.14
Malnourished	18	42.85
Infection		
Present	22	52.38
Absent	20	47.61
Metabolic control		
Good	4	9.52
Poor	38	90.47
Compliance with insulin therapy		
Yes	8	19.04
No	34	80.95
Psychological issues		
Yes	17	40.47
No	25	59.52
Mortality	4	9.52

Table 2: Bivariate analysis of the predictor factors of DKA

Predicting factors	Non-DKA	DKA	OR	95% CI	P-value
Gender					
Male	8	5	2.06	0.66-0.68	0.23
Female	7	22			
Diagnosis of DM type 1 at the first episode of DKA					
Yes					
No	7	16	7.25	2.14-24.50	0.01
	8	11			
Infection					
Present	6	16	7.1	2.06-24.35	0.001
Absent	9	11			
Metabolic control					
Poor	2	2	2.85	0.56-14.19	0.24
Good	13	25			
Compliance to treatment					
Yes					
No	6	2	3.82	0.76-19.23	0.09
	9	25			
Psychological issues					
Yes	7	10	2.16	0.61-7.86	0.09
No	8	17			
Socio-economic status					
Low					
Middle + High	7	3	1.93	0.54-7.01	0.32
	8	24			
Education of parents					
Illiterate	6	13	1.52	0.52-4.85	0.43
Literate	9	14			

Table 3: Multivariate analysis of the dependent and independent variables

Predictors	OR	95% CI	P-value
Psychological problem	1.73	0.32-9.42	0.52
Infection	6.25	1.44-26.45	0.01
Metabolic control	2.84	0.43-19.54	0.28
Compliance	3.99	0.46-33.48	0.28
Female gender	0.52	0.12-2.33	0.36
The first diagnosis of DM type 1 on DKA episode	5.33	1.44-19.54	0.011
Infection	5.22	1.48-19.33	0.015

DKA occurred in 27 (64.29%) patients out of 42 patients. The relevant symptoms seen were shock, vomiting, nausea, abdominal pain, Kussmaul breathing, and reduced consciousness.

The bivariate analysis showed that the infection and analysis of DM type 1 at the first episode of DKA, had phenomenally different proportions compared to other variables. The bivariate analysis is given in table 2. A multivariate analysis was done between dependent and independent variables. Table 3 shows the multivariate analysis.

DISCUSSION

Ketoacidosis is a complication of DM type 1 which occurs after a severe deficiency of insulin production in the body. The present study consists of 42 total patients. A total of 27 (64.29%) presented with DKA.The DKA incidence in patients with type 1 DM ranges from 13% to 80% as per the geographical condition of the country. The environmental effects are not clear yet. According to the study of Himawan et al, the incidence of DKA is more predominant in developing countries compared to the developed countries. They describe that the incidence of DKA in Jakarta was 76.9%, while 56.7% of patients only had one episode of DKA. Overall 13.3% of patients presented with two episodes of DKA and 30% presented with three or more episodes [11]. On the other hand, the studies of Rewers et al and the study of Gillani et al reported 18.6% and 44.5% incidences of DKA in DM type 1 patients [12, 13]. The incidence was higher in the present study due to geographical variation.

The symptoms seen in the present study were shock, vomiting, nausea, abdominal pain Kussmaul breathing, and reduced consciousness. Similar symptoms were seen in the study of Pulungan et al and Wolfsdorf et al [14, 15]. Identification of the symptoms is important for the provision of immediate and proper treatment so the patient can be saved from mortality.

A total of 4 (9.52%) patients died in the present study due to DKA episodes. The rate of mortality in the present study is higher compared to that in developed countries. However, it was similar to the developing countries. The mortality reported in Pakistan is 7.5% as per the study of Naveed et al. with a considerable economic burden due to hospitalization [16].

The present study found two important predictive factors that can cause DKA in patients with DM type 1. These two predictors are infection and detection of DM type 1 at the first episode of DKA. The study of Naveed et al gave similar results compared to our study [16]. The rationale is that the infection enhances the effect of glucagon, cortisol, growth hormone, and epinephrine. This enhancement results in an anti-insulin-like effect and leads to the formation of ketone bodies. The accumulation of ketone bodies results in DKA [17]. Also, chronic hyperglycemia decreases the immune function and increases the susceptibility of a person to attain an infection [18].

CONCLUSION

In conclusion, 64.29% of patients had DKA with type 1 DM with a rate of mortality of 9.52%. Diagnosis of DM type 1 at the first episode of DKA and infection were two significant predictors of DKA occurrence in such patients.

Funding source: None
Conflict: No conflict of interest

REFERENCE

1. Dhatariya KK, Glaser NS, Codner E, Umpierrez GE. Diabetic ketoacidosis. Nature Reviews Disease Primers. 2020 May 14; 6(1):40.
2. Indonesia ID. Konsensus Nasional Pengelolaan Pengelolaan Diabetes Melitus Tipe-2 pada Anak dan Remaja. UKK Endokrinologi Anak dan Remaja, IDAI. 2015:40.
3. Cashen K, Petersen T. Diabetic ketoacidosis. Pediatrics in Review. 2019 Aug; 40(8):412-20.
4. Modi A, Agrawal A, Morgan F. Euglycemic diabetic ketoacidosis: a review. Current Diabetes Reviews. 2017 Jun 1; 13(3):315-21.
5. Evans K. Diabetic ketoacidosis: update on management. Clinical Medicine. 2019 Sep; 19(5):396.

6. Cohen M, Shilo S, Zuckerman-Levin N, Shehadeh N. Diabetic ketoacidosis in the pediatric population with type 1 diabetes. Major topics of type. 2015 Nov 14; 1:95-119.
7. Almeida MC, Claudino DA, Grigolon RB, Fleitlich-Bilyk B, Claudino AM. Psychiatric disorders in adolescents with type 1 diabetes: a case-control study. Brazilian Journal of Psychiatry. 2018 Feb 1; 40:284-9.
8. Gosmanov AR, Gosmanova EO, Dillard-Cannon E. Management of adult diabetic ketoacidosis. Diabetes, metabolic syndrome and obesity: targets and therapy. 2014 Jun 30:255-64.
9. Wilson JF. Diabetic ketoacidosis. Annals of internal medicine. 2010 Jan 5; 152(1):ITC1-1.
10. Himawan IW, Pulungan AB, Tridjaja B, Batubara JR. Komplikasi jangka pendek dan jangka panjang diabetes mellitus tipe 1. Sari Pediatri. 2016 Nov 29; 10(6):367-72.
11. Himawan IW, Pulungan AB, Tridjaja B, Batubara JR. Komplikasi jangka pendek dan jangka panjang diabetes mellitus tipe 1. Sari Pediatri. 2016 Nov 29; 10(6):367-72.
12. Rewers A, Chase HP, Mackenzie T, Walravens P, Roback M, Rewers M, Hamman RF, Klingensmith G. Predictors of acute complications in children with type 1 diabetes. Jama. 2002 May 15; 287(19):2511-8.
13. Syed Wasif G, Syed Azhar Syed S, Shameni S. Prediction and rate of infections in diabetes mellitus patients with diabetes ketoacidosis in Penang, Malaysia. Open Journal of Epidemiology. 2012 Feb 17; 2012.
14. Pulungan AB, Mansyoer R, Batubara JR, AAP BT. Gambaran klinis dan laboratoris diabetes mellitus tipe-1 pada anak saat pertama kali datang ke bagian IKA-RSCM Jakarta. Sari Pediatri. 2016 Dec 6; 4(1):26-30.
15. Wolfsdorf JI, Allgrove J, Craig ME, Edge J, Glaser N, Jain V, Lee WW, Mungai LN, Rosenbloom AL, Sperling MA, Hanas R. ISPAD Clinical Practice Consensus Guidelines 2014. Diabetic ketoacidosis and hyperglycemic hyperosmolar state. Pediatric diabetes. 2014 Sep; 15:154-79.
16. Naveed D, Bilal N, Nasir B, Lodhi BR. Precipitating factors for diabetic ketoacidosis. KHYBER MEDICAL UNIVERSITY JOURNAL. 2009; 1(1).
17. Kerl ME. Diabetic ketoacidosis: pathophysiology and clinical and laboratory presentation. Compendium. 2001 Mar; 23(3):220-8.
18. Brooke J, Stiell M, Ojo O. Evaluation of the accuracy of capillary hydroxybutyrate measurement compared with other measurements in the diagnosis of diabetic ketoacidosis: a systematic review. International Journal of Environmental Research and Public Health. 2016 Sep; 13(9):837.