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Keywords: *diabetes mellitus type1 · diabetic ketoacidosis · pediatrics.*

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STUDY OF PATIENTS WITH DIABETIC KETOACIDOSIS ADMITTED AT THE PEDIATRIC EMERGENCY SERVICE AT CHILDREN'S HOSPITAL DR. JESER AMARANTE FARIA

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Study of Patients with Diabetic Ketoacidosis Admitted at the Pediatric Emergency Service at Children's Hospital Dr. Jeser Amarante Faria

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Abstract- A retrospective study based on the review of medical records in the Tasy system of patients admitted with diabetic ketoacidosis in the emergency service at Children's Hospital Dr. Jeser Amarante Faria, Joinville-SC. 88 medical records were analyzed, corresponding to 71 patients, nine patients with more than one hospitalization, a majority of females (78%), age range from 1.3 to 17.1 years. A mean of five days of hospitalization, with 21 cases requiring hospitalization in the intensive care unit was noted, along with severe diabetic ketoacidosis in 59 consultations. Patients who never had a diabetic decompensation were 44% of the consultations. Hypoglycemia was the most common complication (24%), and no deaths were recorded during the evaluated period. Girls with a mean age of 10 years were the main group admitted with diabetic ketoacidosis, and this medical emergency is still often the first manifestation of type 1 diabetes mellitus in our midst.

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I. INTRODUCTION

Diabetes Mellitus (DM) is a metabolic syndrome characterized by the presence of hyperglycemia, and has many possible etiologies. In pediatrics, type 1 diabetes (T1D) is the most prevalent strain of DM, and it is one of the most common childhood chronic diseases.¹

T1D has an autoimmune etiology, with increasing destruction of pancreatic beta cells, the insulin producers, which leads to their total eradication, and complete exogenous insulin dependency.² 90% of cases diagnosed in pediatrics are T1D³, and approximately 96.100 children under 15 years old develop T1D every year, with an estimate of 586.000 children and teenagers being disease carriers all around the world. Brazil holds the third position of most cases of T1D in persons under 20 years.⁴

Typical T1D symptoms are polyuria, polydipsia, polyphagia and weight loss. When all symptoms are present, a clinical diagnosis is not hard to accomplish.

However, with a late diagnosis, the patient can develop Diabetic Ketoacidosis (DK), which has high morbidity and mortality. National data shows a prevalence of 42,3% of T1D patients who were first diagnosed during an episode of DK, but the data have great regional variation.⁵

The DK is a group of many clinical and laboratorial changes caused by insufficient insulin activity and increased counter-regulatory hormone production that begins as an answer to stress situations which alter carbohydrate, fat, and protein metabolism. Glycogenolysis and gluconeogenesis occur to increase glucose production, proteolysis and lipolysis occur to provide substrates to the gluconeogenesis, which results in a ketone bodies production secondary to lipolysis. A cellular catabolism state surges after these metabolic alterations. Osmotic diuresis is a result of sugar in the urine and ketonuria, and leads to metabolic depletion of sodium, potassium and phosphorus, among other minerals.^{1,2,4} Vomiting, a result of ketonemia, added to osmotic diuresis causes severe dehydration, and the hypoperfusion state in tissues all over the body aggravates the acidosis by producing lactic acid and reducing the glomerular filtration rate. Increased glucose, ketones and urea levels lead to a hyperosmolar state that induces idiogenic osmoles production by the central nervous system cells.²

The main clinical findings in a patient during a DK state are: dehydration, ketonic breath, abdominal pain, vomiting, tachycardia, Kussmaul breathing, low blood perfusion signs, and central nervous system changes may be present.⁵ Laboratory findings include hyperglycemia (>200mg/dL), metabolic acidosis (pH<7,3 or HCO₃<15mEq/L), ketonemia and ketonuria, and anion gap elevation.¹

DK can be divided according to the level of acidosis. Mild DK when pH is 7,3-7,2 or HCO₃ is between 10-15 mEq/L; moderate DK if 7,2-7,1 or HCO₃ is between 5-10mEq/L and severe DK when pH<7,1 or HCO₃<5 mEq/L.² Complications such as cerebral edema, acidosis and other major hydroelectrolytic disorders secondary to DK are the main cause of death in children and teenagers with DM.⁴

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Treatment consists in progressive correction of the hydroelectrolytic disorders: a slow and steady reduction of sugar levels in blood along with ketogenesis can be managed with insulin doses administered after the initial expansion phase.

This study aims to demonstrate the characteristics of the patients who were admitted at the emergency room while in DK, how they were managed and the cases outcomes.

II. METHODS

Retrospective study with data obtained by reviewing the emergency room archives at the Children's Hospital Dr. Jeser Amarante Faria, Joinville-SC. There were included patients admitted at the Emergency room in the period between January 2013 and December 2017 who were clinically diagnosed with DK and had the following laboratorial findings: hyperglycemia ($>200\text{mg/dL}$), metabolic acidosis ($\text{pH} < 7.3$ or $\text{HCO}_3^- < 15\text{mEq/L}$), ketonemia or ketonuria. The International Classification of Diseases used to filter out the charts found in the medical records on the PHILIPS

Tasy system (Philips Healthcare, Cambridge, MA, USA) were E10.1, E13.1, E14.1 and E10.0. Incomplete or lost charts were excluded from the study. Starting from the data bank built as a Microsoft Excel 2013 sheet, the data was analyzed and presented as statistics. This research was approved by the Hospital Hans Dieter Schmidt/SES/SC ethics and research committee, under the authorization number 3.098.043.

III. RESULTS

There were 97 hospitalizations of 88 patients with DK. Nine patients were hospitalized more than once (one patient arrived seven times at the hospital, another one five times, another one was four times, and six patients were hospitalized two times each, in a time span of five years), totalling 28 admissions. Of these 88 patients, 68% were girls (60). Age range varied from 1.3 to 17.1 years, and 10.7 years were the average age (Table 1).

DK as a T1D first manifestation corresponded to 48 medical attendances, 49% of the total ($p\text{-value} = 0,920$) (Figure 1).

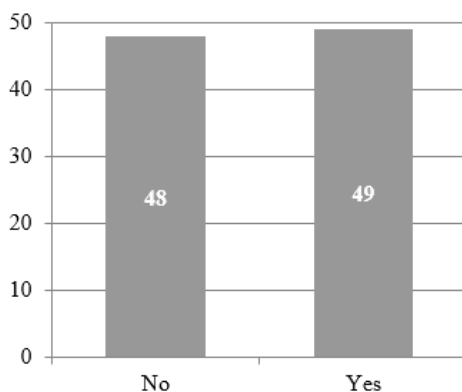


Figure 1: DK as a T1D first manifestation

Severe cases corresponded to 65.9% of the medical attendances, 20.6% were moderate, and 13.4% were the mild cases, considering pH and HCO_3^- levels of the arterial gasometry that was first collected.

Among the 97 hospitalizations, 27 were admitted in the Intensive Care Unit (ICU). The patients were, on average, five days in the ICU, but two of them stayed for more than 20 days (one patient during his leukemia treatment and another presented cerebral edema as a complication).

In 28 cases there were complications, hypoglycemia being the most common in 19.5%, hypocalcemia in 9.2%, hypercalcemia in two and hyponatremia in one occasion. Cerebral edema was the most serious complication, happening in one patient but with no deaths.

IV. DISCUSSION

T1D incidence all over the world increased in the last decades, especially among children under 5 years old. An estimate of 30 thousand Brazilians are T1D carriers, and Brazil occupies the third position of countries where T1D has the most prevalence.⁴

It is imperative to recognise the profile of the patients who present DK at the emergency room, as this is the main cause of death among diabetic children and teenagers².

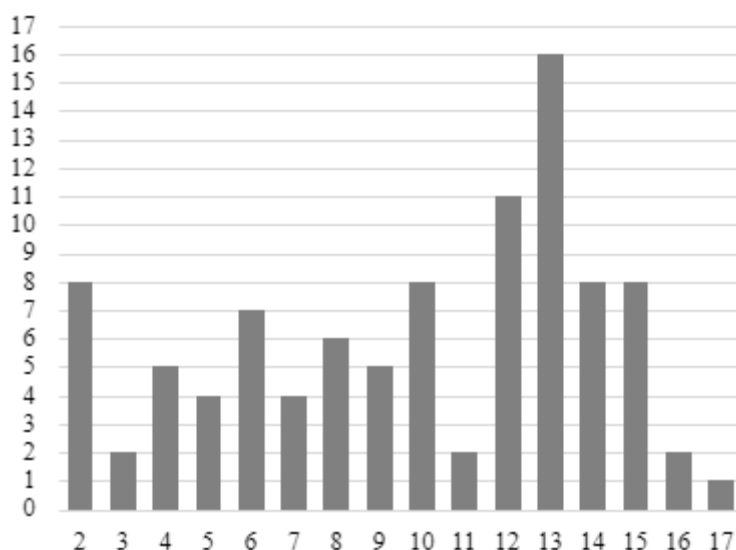


Figure 2: Distribution graphic of number of hospitalization x age in years

By observing the age distribution graphic (Figure 2), it is clear that the teen years are the period in which it is most difficult to accomplish a good metabolic control, therefore the highest incidence of DK complications happen during this period.⁶

In this study, 49.4% (p -value = 0,920) of the hospitalizations corresponded to first decompensation situations. In a large national study, the Brazilian T1D Study Group (BrazDiab1SG)⁴, 3591 patients with T1D (56% feminine sex) were evaluated at public institutions, and it was found that 42.3% of patients with T1D were diagnosed with the condition during a DK episode, a similar result was obtained in our study, like in other literatures. The glycemc decompensation is usually longer and more severe in newly diagnosed patients with T1D.⁶

Insulin was first used in the 1950s, when the mortality rate was up to 10%. Today, there are specialized centers with focus on the treatment of DK, where the mortality rate in general is below 1%.⁴ Fortunately, no deaths were recorded at the analyzed period. Cerebral edema, considered the most feared complication, occurred only once, with a positive outcome.

The analysis of the patients characteristics in this study showed that DK was most frequent in girls at 10 years of age. It still is very common that the first manifestation of T1D is the sudden and serious DK. Although a medical emergency, the appropriate management increases the chances of a positive outcome.

Author's contributions

Study design: Kohara SK

Data collection: Gomes P, Horochoski L, Castro EPB, Silva JAM

Data analysis: Gomes P, Horochoski L, Castro EPB, Silva JAM

Manuscript writing: Gomes P, Horochoski L, Castro EPB, Silva JAM

Manuscript revision: Gomes P, Kohara SK

Study supervision: Kohara SK

Declaration: The data underlying the research text are contained in the manuscript in the form of tables. However, the database contains patient records and personal data, which is why they will be available on demand with the corresponding author.

Conflict of interests

The authors declare that they have no conflict of interest.

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Table 1: Data collection

Hospitalization number	Age (years)	Sex (M/F)	DK as a T1D first manifestation	Severity	Admitted in ICU	Complications
1	6,8	Female	No	Severe	No	No
2	15,8	Male	Yes	Severe	No	No
3	6,8	Male	No	Moderate	No	No
4	14,7	Female	Yes	Moderate	No	No
5	11,5	Female	Yes	Severe	No	No
6	10,5	Female	Yes	Moderate	No	No
7	13,7	Female	Yes	Severe	No	No
8	15,1	Female	Yes	Severe	No	No
9	6,7	Female	No	Severe	No	No
10	12,2	Male	No	Severe	Yes	No
11	13,5	Female	No	Moderate	Yes	No
12	8,1	Male	No	Mild	No	No
13	12,6	Female	Yes	Severe	Yes	No
14	15,1	Male	No	Severe	No	No

Hospitalization number	Age (years)	Sex (M/F)	DK as a T1D first manifestation	Severity	Admitted in ICU	Complications
15	13,5	Male	Yes	Severe	Yes	No
16	7,2	Female	No	Moderate	No	No
17	13,5	Female	Yes	Mild	No	No
18	3,1	Female	Yes	Severe	No	No
19	9,8	Female	No	Mild	No	No
20	7,4	Female	No	Severe	No	No
21	14,6	Male	Yes	Severe	No	No
22	15,9	Male	Yes	Severe	Yes	No
23	14,2	Female	Yes	Mild	No	No
24	15,8	Female	Yes	Severe	No	No
25	1,8	Female	No	Severe	No	No
26	13,4	Female	Yes	Severe	No	No
27	10,4	Female	Yes	Severe	No	Hyperkalemia
28	5,0	Female	Yes	Moderate	No	Hypoglycemia
29	4,1	Female	No	Moderate	No	No
30	10,0	Male	No	Severe	Yes	Hypokalemia
31	10,1	Female	No	Severe	No	No
32	12,6	Female	Yes	Severe	No	Hypoglycemia
33	13,1	Female	Yes	Moderate	No	Hypoglycemia
34	13,3	Female	Yes	Severe	No	No
35	14,1	Female	Yes	Moderate	No	No
36	10,7	Male	No	Severe	Yes	No
37	14,9	Female	Yes	Severe	No	No
38	5,1	Female	Yes	Moderate	No	Hypoglycemia
39	16,8	Female	Yes	Moderate	No	No
40	10,5	Male	No	Severe	No	No

Hospitalization number	Age (years)	Sex (M/F)	DK as a T1D first manifestation	Severity	Admitted in ICU	Complications
41	12,1	Male	Yes	Moderate	No	No
42	4,7	Female	No	Mild	No	Hypoglycemia
43	13,2	Female	No	Mild	No	Hypokalemia
44	13,1	Male	Yes	Severe	No	No
45	4,5	Female	No	Mild	No	No
46	6,1	Female	Yes	Moderate	No	No
47	8,3	Female	Yes	Moderate	No	Hypoglycemia
48	8,9	Female	Yes	Severe	No	No
49	8,9	Female	Yes	Severe	Yes	Hypoglycemia
50	2,1	Male	No	Severe	No	No
51	5,9	Female	Yes	Severe	Yes	Hypoglycemia
52	15,1	Male	Yes	Severe	Yes	No
53	6,9	Female	No	Moderate	No	No
54	2,0	Female	No	Severe	Yes	Hypokalemia
55	15,6	Female	No	Severe	Yes	Cerebral edema
56	11,2	Female	Yes	Moderate	No	No
57	12,3	Female	Yes	Severe	No	Hypoglycemia
58	13,2	Female	Yes	Severe	No	No
59	13,4	Female	Yes	Severe	No	No
60	13,5	Female	Yes	Severe	No	No
61	13,9	Female	Yes	Severe	No	No
62	14,8	Female	Yes	Severe	No	No
63	10,1	Male	Yes	Severe	No	No
64	13,1	Male	Yes	Severe	No	No
65	16,0	Female	Yes	Severe	No	No
66	5,4	Female	Yes	Severe	No	No

Hospitalization number	Age (years)	Sex (M/F)	DK as a T1D first manifestation	Severity	Admitted in ICU	Complications
67	17,1	Male	Yes	Severe	Yes	Hypoglycemia
68	8,4	Male	No	Moderate	No	No
69	6,6	Male	No	Mild	No	Hypoglycemia
70	6,3	Female	No	Severe	Yes	No
71	8,0	Male	No	Moderate	No	No
72	12,4	Female	Yes	Severe	Yes	Hypokalemia
73	12,8	Female	Yes	Severe	Yes	Hypokalemia
74	13,1	Female	No	Severe	Yes	No
75	3,2	Male	No	Mild	No	Hypoglycemia
76	12,7	Male	No	Mild	No	No
77	14,8	Female	No	Severe	Yes	Hypokalemia
78	7,1	Male	Yes	Mild	No	Hypoglycemia
79	7,4	Male	Yes	Severe	No	Hypoglycemia
80	15,0	Male	No	Severe	No	No
81	1,5	Female	No	Mild	Yes	No
82	1,3	Male	No	Severe	No	No
83	14,8	Male	Yes	Severe	Yes	No
84	2,4	Male	No	Mild	No	Hypoglycemia
85	9,1	Male	No	Severe	No	No
86	9,3	Male	No	Severe	Yes	Hypokalemia
87	13,1	Female	No	Severe	No	No
88	12,3	Male	No	Severe	No	No
89	4,5	Male	No	Severe	Yes	Hypokalemia
90	2,5	Male	No	Moderate	Yes	No
91	2,5	Female	No	Severe	Yes	Hypokalemia
92	4,5	Male	No	Severe	Yes	Hypokalemia

Hospitalization number	Age (years)	Sex (M/F)	DK as a T1D first manifestation	Severity	Admitted in ICU	Complications
93	10,3	Female	No	Severe	Yes	No
94	12,8	Male	No	Severe	No	No
95	12,6	Female	No	Severe	Yes	Hypernatremia
96	9,1	Male	No	Moderate	No	No
97	9,5	Female	No	Severe	No	No

