Research Article

Profile of the Patient with Confirmed Diagnosis of Diabetic Ketoacidosis in the Emergency Department of a New Zealand Hospital

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Abstract

Introduction: Diabetic Ketoacidosis (DKA) is a common, dangerous and costly acute complication in patients who suffer from Diabetes Mellitus (DM).

Objectives: The main objective is to establish the social demographic data and the relationship between DKA and some variables related to DM patients attended in the ED of Thames Hospital, New Zealand, from the 7th November 2013 to 7th November 2017.

Patients and Methods: 201 patients were included in this study. Variables related to demography, to DM, history of acute and chronic complications of DM, past medical history, clinical presentation and other simultaneous diagnosis were studied.

Results and discussion: We found a much lower percentage of patients with a previous diagnosis of type 2 DM who had a history of obesity, no type 2 DM patients who had appendectomy, higher percentage history of hypoglycemia in type 2 DM patients compared to type 1 DM. Lower percentage of type 1 DM patients with clinical feature of asthenia and/or feeling generally unwell, higher percentage of older patients with clinical feature of alteration of consciousness and / or balance with age, and only 1% of patients with simultaneous diagnosis of respiratory infection.

Conclusions: The main social demographic variables, and the variables related to signs of physical examination of our patients, do not differ in essence from other patients published in the literature. About the unexpected findings, previous history of DKA, history of obesity, simultaneous diagnosis of respiratory infection and of urinary infection were the most relevant.

Keywords: Diabetic ketoacidosis; Clinical characteristics; Emergency department; New Zealand

Introduction

Diabetic ketoacidosis (DKA) is a common, dangerous and costly acute complication in patients who suffer from Diabetes Mellitus (DM). Despite DKA being less frequent than severe hypoglycemia, it has a higher mortality rate and is the leading cause of death related to DM in pediatric patients [1].

DKA is defined biochemically, by glycemia levels higher than 250 mg/dl, with positive ketones in urine and blood, metabolic acidosis with pH equal or lower than 7.30, increased anion gap (equal or higher than 10), and decreased plasmatic bicarbonate (equal or lower than 18 mEq/l) [2].

Around the world, DKA hospitalizations have increased during the last decades, according to epidemiological studies [3,4].

DKA, as an acute complication of DM, requires urgent and expert management based on guidelines [5]. Management of DKA is considerably expensive. For example, in the United Kingdom, the cost to treat a single episode of DKA is estimated to be GBP 1,387 (around US$ 1,750) [6].

Despite DKA being the most severe acute complication of DM, this study had not been previously conducted in the Emergency Department (ED) of Thames Hospital, nor in other ED in New Zealand. In this study, we will describe the profile of the patient who attends the ED of Thames Hospital, with DKA.

Objectives

The main objective is to establish the social demographic data and the relationship between DKA and some variables related to DM patients attended in the ED of Thames Hospital, New Zealand, from the 7th November 2013 to the 7th November 2017.

Secondary objectives were to establish the relationship between DKA and clinical features, signs on physical examination and with other variables related to chronic complications of DM.

Patients and Methods

Study design

This is a descriptive, retrospective, transverse study.

This study was approved by the Clinical Director of Thames Hospital and by the Team Leader of Clinical Effectiveness of the Waikato District Health Board, New Zealand.

Study population

The universe of the study was all patients diagnosed with DKA in the ED of Thames Hospital, New Zealand, from the 7th November 2013 to the 7th November 2017.

Variables

The variables were divided in social demographic variables, variables related to DM, variables related to clinical background or past medical history, variables related to simultaneous diagnosis and variables related to history of chronic and acute complications of DM.

Method of data registry/gathering

Inclusion criteria: patients with clinical diagnosis of DKA in the ED, with biochemical confirmation. Exclusion criteria: no inclusion criteria.

Three templates were completed for each patient: for social demographic data, for clinical history, and another one for data related to physical exam and other diagnoses (see annexes 1, 2 and 3).

Analysis and data processing

Variables were described with their absolute frequency (number) and relative frequency (percentage), and depending on their distribution (normal or not normal), mean and standard deviation were used, or the median and percentiles 5 and 95. We studied 63 different variables, however, only the relevant ones are mentioned in results, discussion and conclusions.

A result is considered statistically significant when the "p" level is equal or lower than 0.05. For the association among variables, we used the coefficient of correlation of Pearson (r), Spearman (rho), or Kendall (tau). The tests of joint distributions of homogeneity / heterogeneity of Pearson (chi-square) or Exact Fisher test (F), and meaning of difference of Mann-Whitney (U) or Student (t), according to the characteristics, scales and distributions of the variables involved in the comparisons. All the statistical tests are two sided with a significance level of 0.05 (or less).

We used the statistical program SPSS 17.0 for Windows©, SPSS Co, Chicago, Illinois, USA.

Results

We recorded the frequency, percentage and simple comparisons of gender, age range, family history of DM, treatment of DM, treatment compliance/diet/control of DM. They are summarized in Table 1.

In Table 2, we summarize the frequency, percentage and simple comparisons of variables related to acute and chronic complications of DM.

In Table 3, we summarize the frequency, percentage and simple comparisons of past or current alcohol drinker, and past or current drug user.

Non-classifiable (NC): patient younger than 15 (arbitrary value).

Non alcohol drinker: every patient that drinks or drank up to: 2 standard drinks a day for women and no more than 10 standard drinks a week, 3 standard drinks a day for men and no more than 15 standard drinks a week and at least 2 alcohol-free days every week (arbitrary value).

Drug user: we defined this as a behavior alteration that leads (or led) to an inability to control the use of a legal or illegal drug or medication.

Only the following variables had a relevant result and will be consider in discussion and conclusions: obesity (BMI of 25 or more), appendectomy, relevant weight loss (≤5 kg in the last 3 months; arbitrary value), polyuria and / or polydipsia, asthenia and / or feeling generally unwell, consciousness and / or balance impairment, simultaneous diagnosis of respiratory infection and simultaneous diagnosis of urinary infection.

In Table 4 are summarized the frequency, percentage and simple comparisons of the variables.

Item	No Previous Diagnosis of DM n = 96	T1DM	T2DM	Total
		n = 63	n = 42	n = 201
Male	63 (65.6%)	24 (38.1%)	33 (78.6%)	120 (59.7%)
Female	33 (34.4%)	39 (61.9%)	9 (21.4%)	81 (40.3%)
>15	3 (3.1%)	9 (14.3%)	0 (0%)	12 (6%)
≤15	93 (%)	54 (%)	42 (%)	189 (94%)
FH T1DM	12 (12.5%)	15 (23.8%)	0 (0%)	27 (13.4%)
FH T2DM	42 (43.8%)	6 (9.5%)	21 (50%)	69 (34.3%)
FH T1DM and T2DM	6 (6.3%)	0 (0%)	0 (0%)	6 (3%)
No FH DM	36 (37.5%)	42 (66.7%)	21 (50%)	99 (49.3%)
OHD	0 (0%)	0 (0%)	33 (78.6%)	33 (16.4%)
Insulin	0 (0%)	63 (100%)	0 (0%)	63 (31.3%)
OHD + Insulin	0 (0%)	0 (0%)	9 (21.4%)	9 (4.5%)
Compliance	0 (0%)	20 (31.7%)	24 (57.1%)	44 (21.9%)
Non compliance	0 (0%)	43 (68.3%)	18 (42.9%)	61 (30.4%)
No TDC DM	96 (100%)	0 (0%)	0 (0%)	96 (47.7%)

Treatment of DM: Oral Hypoglycemiant Drugs (OHD).
DM treatment compliance/diet/control of DM: Compliance, no compliance.
No previous history of DM: no TDC DM
Family history of DM: FH T1DM and T2DM, no FH DM.

Table 1: Frequency, percentage and simple comparisons of gender, age range, DM family history, DM treatment, DM compliance of treatment /diet/control (TDC).

Previous history of:	No Previous Diagnosis of DM n = 96	T1DM	T2DM	Total
		n = 63	n = 42	n = 201
DKA	0 (0%)	34 (54%)	18 (42.9%)	52 (25.9%)
Hypoglycemia	3 (3.1%)	27 (42.9%)	31 (73.8%)	61 (30.3%)
Nonketotic hyperosmolar coma	0 (0%)	0 (0%)	6 (14.3%)	6 (3%)
Diabetic foot	0 (0%)	0 (0%)	7 (16.7%)	7 (3.5%)
Diabetic neuropathy	0 (0%)	6 (9.5%)	13 (31%)	19 (9.5%)
Diabetic retinopathy	0 (0%)	3 (4.8%)	13 (31%)	16 (8%)
Diabetic nephropathy	0 (0%)	0 (0%)	4 (9.5%)	4 (2%)

Table 2: Frequency, percentage and simple comparisons of variables related to acute and chronic complications of DM.

Previous history of:	NC	No Previous Diagnosis of DM n = 96	T1DM	T2DM	Total
	n = 12		n = 63	n = 42	n = 201
Alcohol drinker	12 (6%)	24 (25%)	18 (28.6%)	12 (28.6%)	54 (26.9%)
Drug user	12 (6%)	3 (3.1%)	3 (4.8%)	1/42 (2.4%)	7 (3.5%)
Nonclassifiable (NC): patient younger than 15 (arbitrary value).					

Table 3: Frequency, percentage and simple comparisons of past or current alcohol drinker, and past or current drug users.

	No Previous Diagnosis of DM n = 96	T1DM	T2DM	Total
		n = 63	n = 42	n = 201
Obesity history	24 (25%)	0 (0%)	1 (2.4%)	25 (12.4%)
Appendectomy history	13 (13.5%)	7 (11.1%)	0 (0%)	20 (10%)
Weight loss	85 (88.5%)	6 (9.5%)	19 (45.2%)	110 (54.7%)
Polyuria and / or polydipsia	90 (93.8%)	9 (14.3%)	16 (25.4%)	115 (57.2%)
Asthenia and / or feeling unwell	21 (21.9%)	9 (14.3%)	17 (40.5%)	47 (23.4%)
Alteration of consciousness and / or balance	3 (3.1%)	3 (4.8%)	7 (16.7%)	13 (6.5%)
Respiratory infection	0 (0%)	0 (0%)	2 (4.8%)	2 (1%)
Urinary infection	6 (6.2%)	16 (25.4%)	12 (28.6%)	34 (16.9%)

Table 4: Frequency, percentage and simple comparisons of variables related to clinical history, clinical features and simultaneous diagnosis.

Discussion

We cannot compare our data with similar studies in New Zealand´s ED, because to our knowledge, no previous data had been published before. Therefore, we had to compare our data with other studies out of New Zealand.

The main social demographic variables of our patients do not differ in essence from other patients published in the literature.

Regarding the variables related to signs on physical examination, no data was found relevantly different from other studies.

About not expected findings, previous history of DKA, history of obesity, simultaneous diagnosis of respiratory infection and of urinary infection were the most relevant.

Regarding DM patients in previous published studies, the great majority of authors do not specify if DM was T1DM or T2DM. Furthermore, no author specified if DM was previously known or not.

When mentioning all patients, we refer to patients with and without previous diagnosis of DM.

In our study, 54% of patients with previous diagnosis of T1DM had history of DKA, and 42% of T2DM had history of DKA. In the literature, Shera, et al. [7] report 21% of the history of DKA in T1DM patients, and Javor, et al. [8] report 36%. According to Gill, et al. [9], 59% of patients with a previous diagnosis of DM had a history of DKA. According to Shibeshi, et al. [10], 25% of patients with a previous diagnosis of DM had a history of DKA.

It is expected to find a higher percentage of DKA history among patients with previous diagnosis of T1DM than T2DM. This is explained because of the pathogenesis of the illness, and because an acute decompensation of T1DM is more probable to happen than in T2DM.

It is worth mentioning that the history of DKA in the present study is higher compared to the published studies, among patients with previous diagnosis of T1DM, and T2DM.

If a patient had previous DKA history, it was more probable to have another episode of DKA in the future, because of the general condition of the patient, lifestyle, and the level of commitment to follow treatment and recommendations about DM.

In our study, 30% of patients had hypoglycemia history. In the group with no previous diagnosis of DM, 3% had previous hypoglycemia history, 42% in the T1DM and 73% in the T2DM. In the literature, Cosmescu, et al. [11] published 27% of hypoglycemia history in pediatric patients with previous diagnosis of T1DM, Soliman, et al. [12] reported 28%, Gill, et al. [13] 12%. This result is remarkable. It was expected to have a higher percentage of hypoglycemia history among patients with previous T1DM, but the percentage among T2DM patients was higher than among T1DM patients. Up to 24% of patients with T2DM were on treatment with oral hypoglycemiant drugs and insulin.

One reason for this difference could be the treatment with insulin and fast acting sulfonylureas. Another plausible explanation could be that T1DM patients are usually younger and can tolerate better hypoglycemias, while T2DM patients are usually older and tolerate worse the episodes of hypoglycemia.

About history of nonketotic hyperosmolar coma, we found it in 5% of the patients with no previous diagnosis of DM, 0 patients with previous diagnosis of T1DM, and 14% of T2DM. We could not find any studies in the literature. Because of pathogenesis, nonketotic hyperosmolar coma is exceptional among T1DM

patients. It has a high mortality rate, and is more frequent among elderly people. Despite nonketotic hyperosmolar coma is quite rare among T1DM, in these patients, the mortality rate is even higher.

In our study, 0 patients with T1DM had diabetic foot history, and 16% of T2DM patients did. Regarding diabetic foot history in previous studies, among patients with previous diagnosis of DM, Feleke, et al. published 35% [14], and Pankaj, et al. 9%. [15] These authors did not specify if patients were T1DM or T2DM.

About diabetic neuropathy history, it was found in 9% of T1DM patients and 31% of T2DM. Similar percentages were published by Jaiswal, et al. [16] among adolescent patients (8% for T1DM and 26% for T2DM), showing that the prevalence of diabetic neuropathy is more frequent in T2DM than in T1DM. In other studies, Shera, et al. [7] published 3% and Gibb, et al. [17] 33% in T1DM. Among DM patients, Harzallah, et al. [18] reported 24% and Lundman, et al. [19] 27%.

In our study, there was a diabetic retinopathy history in 5% of patients with T1DM, and 31% of T2DM. Regarding diabetic retinopathy history in the literature, among patients with DM, Harzallah, et al. [18] published 8% of patients and Lundman, et al. [19] 27%; none of the authors specified if their patients were T1DM or T2DM. Among patients with T1DM, Shera, et al. [7] reported 7%, and Gibb, et al. [17] 42%. This can be explained like the previous variable. This is a consequence of microangiopathy; it takes over 20 years to develop it that is the reason why it is more common among patients with previous diagnosis of T2DM than T1DM.

No diabetic nephropathy history was found in T1DM in our study, but it was found in 9% of T2DM patients. In the literature, Lundman, et al. [19] reported 13% of patients and El Mahdi, et al. [20], 11% (they did not specify the proportion of T1DM or T2DM). Among T1DM patients, Shera, et al. [7] published 5% of patients, and Gibb, et al. [17] 11%. This could be explained like the previous variable. It is a consequence of the microangiopathy, it takes over 20 years to develop it; that is the main reason why it is more common among T2DM than T1DM.

Regarding to past or current alcohol drinkers, we had a lower percentage compared to published studies: 26%. Literature shows higher percentages: Kelly, et al. 35% [21], Umpierrez, et al. 51% [22], and Wilson, et al. 94% [23]. It is possible that alcohol intake in our general population might be also lower, but we lack comparative data among alcohol drinkers in our population, related with others.

We reported that 3.5% of our patients were past or current drug users; this incidence is significantly lower than other studies. In the literature, data rank from about the 13-14%, of Umpierrez, et al. [22], Kelly, et al. [21], and Warner, et al. [24], the 45% of Nyenwe, et al. [25], and finally Isidro, et al. [26], who reported a

70% of all patients were current or past drug users. We suppose this has something to do with the drug intake in the general population, but again, we lack comparative data among drug intake with other populations

We reported 12% of total patients with obesity history. 25% of patients had no previous diagnosis of DM, 0 patients had a history of T1DM, and only 1 patient (2%) T2DM. Our data matches with other T1DM results, but not with T2DM. For example, Kelly, et al. [21] reported that 56% of DKA patients with previous T2DM diagnosis had also an obesity history. Newton, et al. [27], reported up to 70%. We believe that this huge discrepancy can only be explained due to a lack of previous diagnosis of obesity in T2DM (despite being obese). As these patients already did have a previous diagnosis of DM, usually an additional obesity diagnosis was not added. As these patients are already diagnosed with DM, they usually had a treatment, diet and recommendations about the illness. This could explain the higher percentage (24 patients) of obesity history among patients with no previous diagnosis of DM, as they were not under any treatment for DM.

In our study, 10% patients had appendectomy: 13% in the group of patients with no previous diagnosis of DM, 11% of T1DM, and 0 patients of T2DM. Pawlowicz, et al. [28], reported a 4% of appendectomy in their DKA patients. The clinical significance of this feature is unknown to us, and we cannot find a plausible explanation for this. We can speculate that previous episodes of hyperglycemia or DKA produced abdominal pain, and this could mimic acute abdomen, including appendicitis.

About the clinical feature of recent weight loss, it was found in 88% of the patients with no previous diagnosis of DM, in 9% of T1DM, and in 45% of T2DM. In the literature, among all patients, Iddi, et al. [29] reported 7% of weight loss, and Westerberg, et al. [30] 81%. Among DM patients, Harzallah, et al. [18] published 76% (none of these authors specified what type of DM were their patients). Among patients with T1DM, Shera, et al. [7] reported 79%. In this variable, it is worth mentioning that from the group of patients with no previous diagnosis of DM, there were 81% onset of T1DM, and 19% onset of T2DM. We cannot give a convincing explanation about the difference of percentage between patients with previous diagnosis of T1DM and T2DM in this study. Besides this, we have no explanation about why the percentage is higher among the patients with no previous diagnosis of DM.

In our study, 57% of total patients had clinical features of polyuria and/or polydipsia, 94% in the group with no previous diagnosis of DM, 14% of T1DM, and 25% of T2DM. Literature show similar results: Rajasoorva, et al. [31] reported 58%, Nazneen, et al. [32] 58%, and Iddi, et al. [29] 41%. Among previously diagnosed DM patients, Pankaj, et al. [15] published 26% and Harzallah, et al. [18] 87%. We cannot find a reasonable explanation of this high percentage in our study of patients with

no history of DM that presented polyuria and / or polydipsia, compared to patients with previous diagnosis of DM.

Regarding asthenia and / or feeling general unwell, 23% had them, 14% of T1DM patients, and 40% of the T2DM. Literature shows that among all patients, Alourfi, et al. [33] reported 23% and Westerberg, et al. [30] reported 62%. Among DM patients, Pankaj, et al. [15] published 16% (but they do not specify what type of DM). This could be explained because of the older age. In our study the proportion of this feature in T1DM is much lower than in T2DM. The cause of feeling asthenic and unwell is multifactorial, and because of this, under many variables, and very difficult to explain.

An alteration of consciousness and / or balance was found in 4.8% of T1DM, and 16% of T2DM. In similar studies, among all patients, Rajasoorva, et al. [31] reported 61%, Pankaj, et al. [15] 30%, Kakusa, et al. [34] 64%, and Hamed, et al. [35] 60%. We do believe that the older the patient, the worse the general condition on arrival to the emergency department, and this could explain why it is more frequent among T2DM. However, in the published studies the situation is the opposite: the younger the patient, the higher the clinical feature of alteration of consciousness and / or balance (especially in pediatric patients). Once again, we cannot find a good explanation about our results and the different results in the literature.

No T1DM patients in our study had simultaneous respiratory infection, and 5% of T2DM did. In other studies, among all patients (i.e.: with and without previous DM diagnosis), Kakusa, et al. [34] reported 16%, Hamed, et al. [35] 27%, and Satti, et al. [36] 36%. Among previous known DM patients (but once again, T1DM and T2DM are together), Feleke, et al. [14] published 37%, Pankaj, et al. [15] 37%. We cannot find a plausible explanation of why this is the most common simultaneous diagnosis in the published studies, and in comparison, there is a very low percentage of this variable in the present study.

In our study, 17% of all patients presented simultaneous diagnosis of urinary infection; this was found in 25% of T1DM patients, and 28% of T2DM. In other studies, among DM patients, Feleke, et al. [14] published 14%, Pankaj, et al. [15] 37%, and Hamed, et al. [35] 31%. We cannot find a reasonable explanation of these differences among patients with and without previous diagnosis of DM, nor for the difference with other published studies.

The main limitation of our study is that it is a retrospective study, with the underlying inconveniences. Despite the fact that there are treatment guidelines about DKA in our hospital, there is no specific form (as in other hospitals) for fulfilling all standardized data. It is probable that some (or many) data were not taken, as in free text the busy emergency doctor could had forgotten.

Conclusions

The main characteristics of our patients do not differ in essence from other patients published in the literature.

Nonetheless, in this study, compared with the literature data, there is a significantly lower percentage of patients who were past or current alcohol drinkers, of past or current drug users, of patients with a previous diagnosis of T2DM who had a history of obesity, of patients with respiratory infection, and less asthenia among patients with previous diagnosis of T1DM.

On the contrary, we had a considerably higher percentage of patients with a previous episode of DKA, a higher percentage of patients with history of weight loss, and polyuria and / or polydipsia among patients with no previous diagnosis of DM.

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