An identification of the risk factors implicated in diabetic ketoacidosis (DKA) in type 1 and type 2 diabetes mellitus

Mudly S, MMed Sc
Department of Pharmacology, University of KwaZulu-Natal
Rambiritch V, PhD
Department of Pharmacology, University of KwaZulu-Natal
Mayet L, MMed Sc
Department of Medicine, Diabetes Unit, Addington Hospital, KwaZulu-Natal

Correspondence to: Dr S Mudly, e-mail: sallymudly@icon.co.za

Abstract

Background
Despite improvements in therapy and disease monitoring, diabetic ketoacidosis (DKA) remains a potentially fatal consequence of diabetes. This retrospective study was undertaken to establish and identify those risk factors that are responsible for the onset of DKA.

Methods
The medical records of 77 patients from Addington Hospital, who satisfied the criteria for inclusion in the study of DKA, were reviewed (60 type 1 diabetes mellitus (DM) patients and 17 type 2 DM patients).

Results
More juveniles were admitted for multiple DKA episodes (65%) than non-juveniles (35%). DKA was present in 23% of newly diagnosed type 1 DM patients on first presentation. Infection was present in 40% of type 1 DM patients with single DKA episodes, and in 45% of type 1 DM patients with multiple DKA episodes. A total of 23.2% of all admissions for single DKA involved non-compliance with medication usage and was implicated in 32% of multiple DKA episodes. Family and/or school problems presented in 7% of single DKA episodes and in 4% in multiple DKA episodes. In the present study, the overall mortality rate was 2.5% (n=2).

Conclusions
This study showed that the most important risk factors implicated in DKA are infection, non-compliance and newly diagnosed diabetes, followed by family and/or school problems, low socio-economic status and omission of insulin.

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Introduction

Despite improvements in the therapy and disease monitoring of diabetes mellitus (DM), diabetic ketoacidosis (DKA) remains a potentially fatal consequence.[1] DKA accounts for most hospitalisations and is the most common cause of death in type 1 DM.[2]

DKA is a state of absolute or relative insulin deficiency aggravated by ensuing hyperglycaemia, dehydration and acidosis-producing derangements in the intermediary metabolism. In South Africa, diabetes and diabetic emergencies, e.g. DKA, are common, but there is little information on the clinical characteristics and outcomes of such emergencies admitted to hospitals.[3] Few studies are currently available in South Africa and no recent evaluation of DKA has been conducted in KwaZulu-Natal, South Africa. There has also been a call for a worldwide review of all aspects of DKA in view of the fact that most of the research pertaining to the management of DKA dates to twenty years ago.[4]

Thus, the aim of this study was to identify the risk factors implicated in DKA in both newly diagnosed and established diabetics.

Methodology

This is a retrospective descriptive study of all patients admitted for diabetic ketoacidosis (DKA) at Addington Hospital from January 1995 to January 2004. Ethics clearance was obtained from the ethics committee of the University of KwaZulu-Natal.

The medical records of 123 DKA patients were reviewed and 77 of these satisfied the entry requirements of the study. These included all DKA admissions, whether newly diagnosed or established diabetic patients, on insulin therapy. The study population was South Africans. The terminology to describe ethnicity is both colloquial and based on the Census of 2002, where individuals categorised themselves as black when referring to South Africans of African origin, as Coloured when referring to those of mixed ethnicity, as Indian when referring to those of Indian origin and as White when referring to Caucasians.[5] Hereinafter we will refer to the various race groups as Africans, Coloureds, Indians and Whites.

The biochemical criteria for the diagnosis of DKA included hyperglycaemia (blood glucose > 12 mmol/l), with a venous pH < 7.3 and/or serum bicarbonate level of 15 mmol/l or lower, and ketonaemia and ketonuria.[6]

The research instrument was a data sheet that was used to capture the patients' information from the DKA admission records.

Results

The demographics of the study population is presented in Table I.

Patients with DKA admissions were categorised into juveniles (≤ 17 years old) and non-juveniles (> 17 years old) for type 1 DM. Of the total of 77 patients, 36.4% (n = 28) were categorised as juveniles and 63.6% (n = 49) were non-juveniles (made up of 32 type 1 DM and 17 type 2 DM patients), as illustrated in Table I.

The most important risk factors that were identified were infection, non-compliance and newly diagnosed diabetes. Other risk factors were family and/or school problems, low socio-economic status, and omission of insulin, as illustrated in Table II.

Discussion

Of the six risk factors identified, infection emerged as the most prominent factor precipitating DKA in all subgroups, i.e. type 1 DM patients ≤ 17 years and > 17 years and type 2 DM patients, both in single DKA (40%) and in multiple DKA (45%) episodes.

Table I: Type 1 diabetes mellitus (DM) and type 2 DM patient demographic profile

		TYPE 1 DM		TYPE 2 DM	TOTAL
		≤ 17 Years	> 17 Years		
Number of patients		28	32	17	77
Percentage (%)		36.4	41.6	22	100
Age range (years)		1 – 17	20 - 61	19 - 73	
Mean age (yrs) ± SD		14± 3.35	35.2±11.67	44.8±12.12	
Gender n (%)	Male	12 (42.9)	17 (53.1)	9 (52.9)	38
	Female	16 (57.1)	15 (46.9)	8 (47.1)	39
Total n (%)		28 (100)	32 (100)	17 (100)	
Race n (%)	African	13 (46)	18 (56)	12 (70)	43
	Indian	5 (18)	7 (22)	2 (12)	14
	Coloured	7 (25)	0 (0)	2 (12)	9
	White	3 (11)	7 (22)	1 (6)	11
Total n (%)		28 (100)	32 (100)	17 (100)	

Table II: Risk factors for patients classified by type of diabetes mellitus for patients with single and multiple DKA

Variable n (%)	TYPE 1DM				TYPE 2DM
	SINGLE DKA EPISODES		MULTIPLE DKA EPISODES		SINGLE DKA EPISODES
	≤ 17 yrs	> 17 yrs	≤ 17 yrs	> 17yrs	
Number of patients n (%)	28(36.4)	32(41.6)	22(65)	12(35)	17(22)
BMI	19.00 ±4.48	26.95 ±4.93	18.95 ±4.0	23.66 ±5.20	26.86 ±4.23
Risk factors n (%)					
Infection	11(39.3)	13(41)	35(51)	10(32)	5(29)
Non-compliance	6(21.4)	8(25)	22(32)	10(32)	9(53)
Newly diagnosed diabetes	7(25)	7(22)	-	-	-
Family and/or school problems	4(14.3)	-	4(6)	-	1(6)
Low socio-economic status	-	3 (9)	-	3 (10)	2(12)
Omission of insulin	-	1(3)	8(11)	8(26)	-
Number of DKA episodes n (%)	28(100)	32(100)	69(100)	31(100)	-
Average number of DKA episodes per patient	1.0	1.0	3.1	2.6	-

Females were more prone to infection than males, both in the juveniles and the non-juveniles (63% vs. 37%). The most common infections identified in the present study included urinary tract infections, upper respiratory tract infections, pneumonia and tuberculosis.

Umpierrez et al.[7] and Jabbour et al.[8] reported that intercurrent illnesses, such as infection (upper respiratory tract, urinary tract, cutaneous infections), accounted for 30% to 40% of DKA episodes in white populations. In the study done by Newton et al. on 138 patients with 176 episodes of DKA, infection was identified as the precipitating factor in 38% of all the patients with DKA.[9] These included urinary tract infection, upper respiratory tract infection, pneumonia, cellulitis and cutaneous abscesses, which were present in 22% of the patients with type 1 diabetes and 48% of the patients with type 2 diabetes.

The results from the present study compare favourably with both national and international studies, in that infection was the prominent precipitating factor in both single DKA episodes (40%) and in multiple DKA (45%), with upper respiratory tract infection and urinary tract infection being two of the most common causes. The reason for the high infection rate in DM and DKA may be due to lowered immunity and greater susceptibility to bacterial and fungal infections, especially during poor glycaemic control.

Newly diagnosed diabetics
Patients were classified as newly diagnosed diabetics if the episode of DKA was the first manifestation of diabetes, and if they had not been diagnosed or prescribed any diabetic treatment previously. DKA occurred in 23% of newly diagnosed type 1 DM patients on first presentation.

Non-compliance
Non-compliance was identified in all three subgroups. A total of 23.2% of all admissions for single DKA episodes involved non-compliance with medication usage, which was implicated in 32% of multiple DKA episodes. In type 2 DM, this featured was the single most significant factor (53%).

Results from the present study indicate that non-compliance with treatment is emerging as a dominant precipitating risk factor for DKA. These results differ from previous studies, involving mostly white populations, in whom infection represented the most common precipitating event (30% to 40%).[7, 8] Several cultural and socio-economic barriers, such as a low literacy rate, limited financial resources and limited access to health care, may explain the lack of compliance.

In their multicentre study in the USA, Glaser et al. reported that illness in association with non-compliance was implicated in recurring episodes of DKA.[10]

Family and/or school problems and low socio-economic status
Family and/or school problems and low socio-economic status did not feature prominently in the present study. Family and/or school problems presented in 7% of single DKA episodes and in 4% of multiple DKA episodes, whereas it was implicated as a major precipitating factor in other studies.[11,12] Of all the patients studied at Addington Hospital, 51.9% (n = 40) were of average income and 48.1% (n = 37) were identified as being of below-average income. The percentages presented in the present study may be an underestimate, given that the data was collected retrospectively and was taken from admission records, which recorded fees payable to the hospital according to socio-economic status. Therefore, low socio-economic status as a risk factor could not be fully justified.

Omission of insulin
Omission of insulin did not feature prominently, either in single or in multiple DKA episodes. This may be due to the intensive, constructive and dedicated education at the diabetes clinic at Addington Hospital and also the realisation of the importance of taking insulin among type 1 diabetic patients.

Conclusion
Despite the improvement in insulin therapy and disease monitoring, mortality from DKA has not improved and a 1–2% mortality rate has persisted since the 1970s. Thus a major goal of diabetes management is to prevent DKA through closer scrutiny of the early symptoms of diabetes and stricter supervision of established diabetic patients. The present study has identified those risk factors that were responsible for the onset of DKA in newly diagnosed and established diabetic patients. The tremendous economic burden of type 1 DM and its acute complications, e.g. DKA, makes this illness an important clinical and public health problem.

In the present study, DKA occurred in 23% of newly diagnosed type 1 DM in single-DKA episodes. Of the six risk factors identified in the single-DKA episodes, infection and non-compliance were identified as major precipitating factors, whereas infection, non-compliance and omission of insulin emerged as major risk factors in multiple DKA episodes.

Two patients (2.5%) admitted in DKA in the present study died during their hospital stay. Both were type 1 DM patients and their deaths were most probably related to the underlying precipitating cause of metabolic decompensation. The deaths occurred between three and eight days after the resolution of hyperglycaemia and/or ketoacidosis.

On the basis of this study, it is therefore recommended that diabetic patients should receive intensive education to minimise the occurrence of DKA. The immediate identification of infection and intensive antibiotic treatment for diabetic patients, improved access to healthcare for socio-economically disadvantaged families and routine screening of all susceptible DM subjects be advocated.

Disclosure
Neither author has any real or apparent conflict of interest with the content presented here.

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