Hyperglycaemic emergencies are a common problem

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Objective. To determine the number, type, precipitating factors and mortality associated with diabetic emergencies admitted to Groote Schuur Hospital.

Design. Administered questionnaire survey.

Setting. Groote Schuur Hospital, Cape Town.

Methods. All patients admitted from September 1991 to January 1992 with elevated blood glucose concentrations who required intravenous insulin and fluids were evaluated by an administered questionnaire prior to discharge from hospital. Patients were divided into four groups according to presence of ketosis, standard bicarbonate level and serum osmolality: (*i*) mild diabetic keto-acidosis (DKA); (*ii*) severe DKA; (*iii*) hyperosmolar state; and (*iv*) hyperglycaemia.

Results. There were 131 admissions in 122 patients. Sixty-five occurred in non-insulin-dependent diabetics, 45 in insulin-dependent diabetics and 12 in pancreatic diabetics. There were similar numbers of admissions in the four groups of hyperglycaemic emergencies. The mortality rate was 3% in the mild DKA and hyperglycaemic groups, significantly lower ($P < 0.05$) than in the hyperosmolar group (19%). The mortality rate was 11% in the severe DKA group ($P > 0.05$ v. other groups). Sixty-two per cent of participants had achieved Standard 4 to Standard 8 education. Only 39% were employed at the time of interview. Diabetic knowledge and general compliance were assessed as poor. Infections and poor compliance with hypoglycaemic therapy were the dominant precipitating factors.

Conclusion. Hyperglycaemic emergencies precipitated largely by infections and poor compliance and associated with considerable morbidity and mortality commonly require admission to hospital. Improvement in diabetic education is required to reverse the current situation.

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The majority of diabetic hyperglycaemic emergencies can be prevented by means of adequate or improved education of patients and medical staff.[1-3] This is particularly pertinent as these emergencies appear to be common, and diabetic keto-acidosis (DKA) and hyperosmolar non-ketotic coma have reported mortality rates of 0 - 14% and 14 - 70%, respectively.[4-8] The high mortality rate in the latter is probably related to the coexistence of other associated diseases and the older age of patients.[6,9]

In Cape Town the majority of diabetics in the public sector receive care at a number of ambulatory day clinics, but a considerable number attend secondary or tertiary care institutions. Non-specialist medical and nursing staff are employed at the first two but the tertiary institutions are staffed by physicians, registrars in training and accredited nurse diabetes educators.

This study was undertaken to determine the number, type, precipitating factors and mortality associated with diabetic hyperglycaemic emergencies admitted to Groote Schuur Hospital over a 5-month period in 1991 and 1992, with a view to determining the extent of the problem and identifying possible remediable factors to assist in their prevention.

Methods

All patients admitted to Groote Schuur Hospital from September 1991 to January 1992 with elevated blood glucose concentrations and who required intravenous insulin and fluids were included in the study. The patients were interviewed (by B N L) prior to discharge, a questionnaire (available on request) including sociodemographic and diabetes-related data was completed and biochemical and outcome data were collected. Consent was obtained from all participants prior to administration of the questionnaire. The study was approved by the University of Cape Town Ethics and Research Committee.

The type of diabetes, i.e. insulin-dependent diabetes (type I, IDDM), non-insulin-dependent diabetes (type II, NIDDM) and pancreatic diabetes (PD), was defined as far as possible from data of initial presentation, age of onset, proneness to keto-acidosis, need for insulin within the first 3 months of diagnosis and documented clinical or radiological evidence of chronic pancreatitis.

Decompensated diabetes suggests a continuum of metabolic abnormalities with DKA at one extreme and a hyperglycaemic hyperosmolar syndrome at the other.[6,10,11] For the purpose of this study hyperglycaemic emergencies were divided into 4 groups, not on the basis of the degree of hyperglycaemia, but of the serum osmolality, degree of ketonaemia and acid-base status on admission: (*i*) mild diabetic keto-acidosis (DKA) — standard bicarbonate > 12 < 19.5 mmol/l and semi-quantitative serum ketones > 1+; (*ii*) severe DKA — standard bicarbonate < 12 mmol/l and serum ketones > 1+; (*iii*) hyperosmolar states — serum osmolality > 330 mOsm/kg;[4] (*iv*) hyperglycaemia — serum osmolality < 330 mOsm/kg, standard bicarbonate > 19.5 mmol/1 and serum ketones < 1+.

Serum osmolality was calculated by means of the formula 2 (Na+K) + urea + glucose. Serum ketones were measured semi-quantitatively using reagent strips (Ketodiastix/ Ketodiabur R). Where there was a mixture of ketosis and hyperosmolality, two independent physicians assessed which was dominant for the purpose of group allocation on the basis of the emphasis of the clinical presentation. This

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included age, type of diabetes and the extent to which the acidosis or hyperosmolar state was of major danger to the patient.

Knowledge of diabetes was assessed by means of the following questions: (*i*) what is diabetes? (*ii*) how is it treated? and (*iii*) what are the symptoms of hyperglycaemia? A scoring system ranging from good to poor was used to grade the response. General compliance, i.e. hospital attendance patterns and compliance with diet, exercise programmes and hypoglycaemic therapy, was measured by direct questioning of participants and perusal of hospital records. Lack of compliance specifically relating to the current admission was evaluated by questioning of the patient for omission of hypoglycaemic therapy or lack of dose adjustment in the face of symptomatic hyperglycaemia. Despite the knowledge that infections may not always be evident in patients with poorly controlled diabetes, infection (symptoms, signs and bacteriological cultures) and other medical illnesses on admission were sought as precipitating factors. Patients were asked what actions they took when they developed the symptoms of hyperglycaemia that precipitated their hospital admission.

The results are expressed as mean values. The Wilcoxon rank sum and chi-square tests were used to test significance of difference where appropriate.

Results

There were 131 admissions in 122 patients, whose sociodemographic profile according to type of diabetes is given in Table I. The level of formal education was low in all groups and the rate of unemployment relatively high in the patients of working age. There were 101 previously diagnosed diabetics, 54 of whom had NIDDM, 37 IDDM and 10 PD; 21 were newly diagnosed, and 11 of these had NIDDM, 8 IDDM and 2 PD.

There were similar numbers of patients in the four groups of hyperglycaemic emergencies (Table II). The mean age of patients with DKA was significantly lower than that of the hyperosmolar group. The majority (82%) of patients were assessed as having poor knowledge of diabetes. Ninety-six per cent did not respond to their early symptoms of hyperglycaemia. The rate of general non-compliance was high; 62% had either previously documented non-compliance or admitted to being non-compliant. The majority of these patients were unaware that poor compliance could lead to a hyperglycaemic emergency.

The following precipitating factors for hyperglycaemic emergencies were identified: (*i*) infections, particularly respiratory and urinary tract (47%); (*ii*) non-compliance with hypoglycaemic therapy prior to admission (26%);

Table I. Sociodemographic data on patients according to types of diabetes

	NIDDM		IDDM		PD	
	No.	(%)	No.	(%)	No.	(%)
Patients	65		45		12	
Age (yrs) (range)	63	(27 - 91)	30	(14 - 60)	42	(26 - 56)
Diabetes duration (yrs) (range)	10	(0 - 40)	6	(0 - 20)	6	(0 - 21)
Sex						
Male	28	(43)	19	(42)	9	(75)
Female	37	(57)	26	(58)	3	(25)
Education level						
< Std 4	27	(42)	7	(16)	6	(50)
Std 4 - 8	38	(58)	31	(69)	5	(42)
> Std 8	0	(0)	7	(15)	1	(8)
Occupation						
Employed	5	(8)	14	(31)	4	(33)
Unemployed	24	(37)	26	(58)	5	(42)
Pensioners	28	(43)	2	(4)	0	(0)
Disability grant	8	(12)	3	(7)	3	(25)
Follow-up						
Day hospital	40	(62)	7	(16)	3	(25)
General practitioner	6	(9)	1	(2)	0	(0)
General outpatient department	2	(3)	5	(11)	2	(17)
Diabetes clinic	6	(9)	24	(53)	5	(42)
Newly diagnosed	11	(17)	8	(18)	2	(16)

Table II. Clinical data and outcome in the 4 categories of hyperglycaemic emergency

	No.	Mean age (yrs)	Mean hospital stay (days)	Mortality		NIDDM	IDDM	PD
				No.	(%)			
Mild DKA	31	41†	7	1*	(3)	12	15	4
Severe DKA	37	38†	7	4	(11)	7	26	4
Hyperosmolar	31	62	9	6	(19)	27	3	1
Hyperglycaemic	32	50	8	1*	(3)	21	8	3

* $P < 0.05$ v. hyperosmolar group.
† $P = 0.0035$ v. hyperosmolar group.

(*iii*) coincidental illness — steroid therapy, pancreatitis and strokes (13%); and (*iv*) unknown factors (13%). The mean hospital stay was 7 days, with a calculated cost of R2 100 per patient incorporating a daily rate of R300 excluding medication, investigations and intravenous fluids.

The mortality rate was similar in the severe DKA and hyperosmolar groups (Table II). The 12 deaths occurred in 10 patients with NIDDM, 1 with IDDM and 1 with PD. Septicaemia, secondary to urinary tract infection or pneumonia, was the presumed cause of death in 8 patients. A cerebrovascular accident, renal failure and an ischaemic limb each accounted for 1 death. No immediate cause of death could be identified in 1 patient.

Discussion

This study has demonstrated that diabetic hyperglycaemic emergencies are commonly admitted to Groote Schuur Hospital (approximately 26 per month) and that the more severe forms (severe DKA and hyperosmolar groups) are associated with significant mortality. This is of concern as hyperglycaemic emergencies are, in principle, preventable. That education can be successful in this regard is indicated by the findings of Huddle and Gill from Baragwanath Hospital, who documented the admission of 60 hyperglycaemic emergencies over a 2-month period in 1981.[1] Following the institution of patient education and careful monitoring, they were able to reduce the number of admissions to 48 over a similar period in 1986, with an associated decline in the mortality rate from 25% to 10%.

A large number of patients in this study were drawn from the historically disadvantaged communities that primarily utilise the public sector health services. Only 8 of the 122 patients had received education beyond Standard 8. There was therefore a relatively low level of formal education, a poor knowledge of the symptoms of hyperglycaemia and an apparent lack of understanding of the action demanded by the presence of hyperglycaemia. The high patient numbers at primary care clinics, where half of the patients received their care, and the absence of specific diabetes education programmes are likely to result in poor knowledge and understanding of diabetes. In addition, it is recognised that diabetic emergencies are more common in communities which are economically deprived and have less formal education.[2]

It was apparent that the study patients did not merely comprise those receiving care at primary level clinics, but the type of diabetes, age, exposure to diabetes educators and type of hyperglycaemic emergencies were different, reflecting that more patients with IDDM attend the tertiary than the primary level, which is to be expected. Clearly, optimal understanding of diabetes has not even been achieved by patients attending the diabetes clinic at Groote Schuur Hospital with all its resources, as fully one-third of the study sample received their care from this clinic.

Active diabetes education of patients and health workers in the community is likely to result in early intervention in the management of infections, improve compliance and decrease admission rates as demonstrated by Huddle and Gill.[1] In this light, the observation that 62% of patients did not receive treatment prior to arrival at Groote Schuur Hospital is of concern. This represents a lack of knowledge by primary health workers of the importance of initiating therapy as early as possible in hyperglycaemic emergencies. The heavy patient load and lack of specific treatment protocols at primary care facilities could have played a role in this.

The mortality associated with severe DKA in this study was similar to the worst reported series.[8] The low mortality associated with hyperosmolar states, compared with other studies, was probably related to the lack of coma on admission and/or fewer associated disease states.

In conclusion, hyperglycaemic emergencies commonly admitted to Groote Schuur Hospital are associated with considerable morbidity and mortality, and are also costly to the community. In the restructuring of the community health services, attention will have to be given to improvement of the level of diabetes education of patients and staff, which should lead to improved compliance, patient empowerment and a reduction in admissions and mortality for diabetic emergencies.

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