Hyperglycaemic emergency admissions to a secondary-level hospital – an unnecessary financial burden

D J Pepper, N S Levitt, S Cleary, V C Burch

Background and objectives. Diabetes affects approximately 1 million South Africans. Hospital admissions, the largest single item of diabetes expenditure, are often precipitated by hyperglycaemic emergencies. A recent survey of a 200-bed hospital, serving approximately 1.3 million Cape Town residents, showed that hyperglycaemic emergencies comprised 25.6% of high-care unit admissions. A study was undertaken to determine the reasons for, and financial cost of, these admissions.

Methods. All hyperglycaemic admissions during a 2-month period (1 September - 31 October 2005) were surveyed prospectively. Admissions were classified using the American Diabetes Association classification of hyperglycaemic emergencies. Demographic data, and the reason for, duration of and primary outcome of admission, were recorded. The following costs per admission were calculated using public-sector pricing: (*i*) total costs; (*ii*) patient-specific costs; (*iii*) non-patient-specific costs; and (*iv*) capital costs.

Results. Sepsis (36%), non-compliance with therapy (32%) and a new diagnosis of diabetes (11%) were the predominant reasons for admission of 53 hyperglycaemic emergency cases. Mean duration of hospital stay was 4 days, with an in-hospital mortality of 7.5%. Mean cost per admission was R5 309. Clinical staff (25.8%), capital (25.6%) and overhead (34%) costs comprised 85.4% of expenditure.

Discussion and recommendations. Hyperglycaemic admissions, costing more than R5 300 per patient, represent a health burden that has remained unchanged over the past 20 years. Urgently required primary care preventive strategies include early diagnosis of diabetes, timely identification and treatment of precipitating causes, specifically sepsis, and education to improve compliance.

S Afr Med J 2007; 97: 963-967.

Diabetes affects approximately 1 million South Africans and contributes significantly to morbidity and mortality.[1] In 2000, disability-adjusted life years for diabetes in South Africa (390/100 000) were comparable to US figures (421/100 000)[2,3] – 4 times higher than for the rest of Africa (113/100 000).[3] Diabetes expenditure per annum is not known in South Africa, but exceeds US$44 billion in the USA.[4] Hospital admissions, the largest single item of diabetes expenditure in most countries, are related to ischaemic heart disease, cerebrovascular events, renal failure, foot pathology and hyperglycaemic emergencies.[4] Many admissions, especially hyperglycaemic emergencies, are potentially preventable with prompt diagnosis of diabetes, effective patient and health professional education, and comprehensive long-term care.[4]

Department of Medicine, G F Jooste Hospital, Cape Town
D J Pepper, MB ChB
V C Burch, MB BCh, MMed, FCP

Division of Endocrinology, Department of Medicine, Groote Schuur Hospital, Cape Town
N S Levitt, MB ChB, MD, FCP

Health Economics Unit, School of Public Health and Family Medicine, University of Cape Town
S Cleary, MA

Corresponding author: *D J Pepper (dominiquepepper@gmail.com)*

G F Jooste Hospital (GFJH) is an urban 200-bed acute adult hospital, with 46 additional off-site district-level beds in Carnation ward (on the Lentegeur Hospital site, 10 km away). GFJH provides both district and regional-level services for an estimated 1.3 million people living in the Cape Town metropole; the communities served include Khayelitsha site B, Nyanga, Brown's Farm, Crossroads, Gugulethu, Phillipi, Mitchell's Plain, Heideveld and Strandfontein.[5,6] GFJH's admissions reflect South Africa's quadruple burden of disease: HIV/AIDS, trauma, diseases of poverty (malnutrition and infectious diseases, e.g. tuberculosis), and diseases of lifestyle (e.g. hypertension and diabetes).[7] A recent survey of medical admissions (N = 859) to the hospital's 8-bed high-care unit (HCU) over a 12-month period indicated that 25.6% (N = 220) were classified as hyperglycaemic emergencies.[8] This prompted an evaluation of the reasons for, and financial costs of, hyperglycaemic admissions to GFJH. The purpose of the study was to gather data that would inform the development of appropriate primary- and secondary-level health care initiatives. This will allow re-allocation of finances from inpatient hyperglycaemic emergencies to the primary level prevention of diabetic complications.

Methods

We conducted a prospective survey of all hyperglycaemic emergencies admitted to GFJH from 1 September to 31 October 2005. A hyperglycaemic emergency was defined as any

patient with an elevated blood glucose concentration, and the perceived need by the admitting doctor to initiate intravenous insulin and fluid therapy.[9,10] All hyperglycaemic emergencies were admitted to the HCU in order to ensure 2-hourly monitoring and supervision of intravenous insulin and fluid therapy; a lack of sufficient nursing staff in the general medical wards precludes such intensive monitoring. An intern was responsible for the daily management of these patients, while the medical registrar on call attended to problems after hours. Specialist physicians conducted daily HCU ward rounds. Because of limited nursing staff, minimal diabetic education was offered to hyperglycaemic patients admitted to GFJH.

Hyperglycaemic emergencies were classified according to the American Diabetes Association's classification of hyperglycaemic emergencies.[11] A further category, hyperosmolar diabetic ketoacidosis (HODKA), was added in this study because the measured outcomes in this group differed from those observed in the diabetic ketoacidosis (DKA) and hyperosmolar hyperglycaemic state (HHS) groups. Data collected for each patient included demographic group, and reason for, duration of and primary outcome of admission. HbA1c on admission is not a routine investigation in our setting because of cost constraints, and therefore did not form part of our analyses. Cost calculations were determined using the following formulae: (*i*) total costs = patient-specific costs + non-patient-specific costs; (*ii*) patient-specific costs = medication costs + laboratory costs + imaging costs + procedure costs + clinical staff costs; (*iii*) non-patient-specific costs = capital costs + overhead costs; and (*iv*) capital costs = building costs + equipment costs. All costs were calculated utilising public-sector pricing. Patient-specific costs were determined using the 'ingredients approach', which involves identifying the specific components of all services utilised during admission.[12] Data were collected for each component of the patient's hospital admission (emergency unit (EU), HCU, GFJH medical ward and Carnation ward) – duration of stay, duration of doctor consultation, quantities and types of medication, laboratory investigations, X-rays and procedures utilised. Clinical staff costs were calculated per EU visit and per inpatient day. The estimated annual nursing cost was calculated as the product of annual cost per nursing shift group and the number of shift groups required per annum. The daily nursing cost was obtained by dividing the annual nursing cost by 365. Doctors' estimated annual cost was determined as the sum of their basic salary, overtime and scarce-skills allowance. Doctors' costs were calculated per hourly consultation with the patient. Non-patient-specific costs (i.e. capital costs and overhead costs) were obtained from a costing audit of HIV/AIDS admissions to GFJH in 2003/2004.[13] An inflation factor of 1.188 (obtained from Statistics South Africa) was used to adjust the 2003/2004 figures to September 2005.[14]

Data were entered onto an Excel (Microsoft) spreadsheet and analysed using Microsoft Excel Software 2003. Data were expressed as means and medians (range). The University of Cape Town's Research Ethics Committee approved the study.

Results

There were 53 hyperglycaemic emergencies admitted during the 2-month survey period (Table I); 32 (60%) were female and 34 (64%) were Xhosa-speaking. Sepsis (36%), non-compliance with therapy (32%) and a new diagnosis of diabetes mellitus (11%) accounted for most admissions. No precipitating cause was identified in 8%. The remaining 13% of hyperglycaemic admissions ('other') included diagnoses such as pancreatitis, alcohol binge, cerebrovascular accident and chronic renal failure. Medical sepsis comprised septicaemia (*N* = 5), pneumonia (*N* = 4), urinary tract infection (*N* = 3), pelvic inflammatory disease (*N* = 1) and disseminated tuberculosis (*N* = 1). Surgical sepsis comprised superficial skin abscess (*N* = 4) and gangrene of the foot (*N* = 1).

The mean duration of hospital stay was 4 days, and the overall in-hospital mortality of hyperglycaemic emergencies was 7.5% (Table I). Admission diagnoses for in-hospital deaths

Table I. Profile of inpatient hyperglycaemic emergencies

	SDKA (*N* = 9)	MDKA (*N* = 17)	HODKA (*N* = 8)	HHS (*N* = 7)	HD (*N* = 12)	All admissions (*N* = 53)
Median age (range) (yrs)	44	49	56	61	46	49
(17 - 71)	(20 - 72)	(22 - 68)	(49 - 76)	(22 - 65)	(17 - 76)	
Reason for admission (*N*)						
Sepsis	3	7	4	2	3	19
Non-compliance	4	7	1	2	3	17
Newly diagnosed	0	1	0	0	5	6
Other	1	1	2	2	1	7
No cause identified	1	1	1	1	0	4
Inpatient deaths (*N*)	1	1	0	2	0	4

SDKA = severe diabetic ketoacidosis, ; MDKA = mild/moderate diabetic ketoacidosis; HODKA = hyperosmolar diabetic ketoacidosis; HHS =hyperosmolar hyperglycaemic state ; HD = hyperglycaemia with dehydration.

included septic shock, disseminated tuberculosis, chronic renal failure and cerebrovascular accident. All patients admitted because of poor compliance, surgical sepsis, 'unknown cause' or a new diagnosis of diabetes mellitus were discharged home in a stable state. Only 64% of medical sepsis patients were discharged in a stable state; 21% died and 15% were transferred to the nearby tertiary hospital.

We obtained all necessary data for cost calculation for 47 of the 53 hyperglycaemic emergency cases admitted. The mean cost per hyperglycaemic admission was R5 309; this varied according to the type of hyperglycaemic emergency (Table II). SDKA and HODKA admissions had higher mean patient-specific and clinical staff costs compared with other groups. Table III indicates that laboratory and clinical staff costs, specifically doctor costs, comprised the bulk of EU costs. HCU costs predominantly comprised capital costs, overhead costs and clinical staff costs, specifically nursing costs. Ward admission costs comprised mainly non-patient-specific costs. Overall, clinical staff (doctors and nurses), capital, and overhead costs comprised 25.8%, 25.6% and 34% of hyperglycaemic admission costs respectively. The estimated annual cost of hyperglycaemic admissions to GFJH in 2005, assuming 26 admissions per month, would have been R1 688 418. One patient, admitted with HODKA secondary to peripheral gangrene, was not included in the cost analysis because his admission duration (27.5 days) and admission cost (R27 904) greatly exceeded that of any other admission surveyed.

Discussion (Table IV)

It is alarming to note that despite 'improved' access to primary health care facilities in South Africa, the number and profile of hyperglycaemic emergencies admitted to large public hospitals remains unchanged from studies conducted 10 - 20 years ago. The number of hyperglycaemic emergencies admitted per month in our study (approximately 26) is similar to data obtained from studies conducted at Groote Schuur Hospital (GSH) in 1991[9] and Baragwanath Hospital (BH) in 1986.[10] However, as the sizes of the drainage populations in these two previous studies are not known, incidence comparisons are not possible. The commonest reasons for admission in the 1991 GSH study – sepsis (47%) and non-compliance (26%) – remain unchanged in our study. The in-hospital mortality rates were 9.1% for GSH (1991)[9] and 10.4% for BH (1986).[10] Our mean in-hospital mortality rate of 7.5%, and the mortality rate reported in a more recent study of hyperglycaemic emergencies admitted to BH (6.8% for DKA patients and 16.6% for HHS patients),[15] suggests that mortality rates may be declining. It is encouraging to note that the latest BH data are almost comparable to data reported by experienced centres in the USA (3.4 - 4.6% for DKA and 15% for HHS).[16] A shorter duration of admission was found in our study (Table II) compared with

Table II. Cost (South African rands) per hyperglycaemic emergency admission according to diagnostic category

	SDKA (*N* = 7)	MDKA (*N* = 14)	HODKA (*N* = 7)	HHS (*N* = 7)	HD (*N* = 12)	All admissions (*N* = 47)
Mean total duration of admission (days)	4.0	3.4	5.3	3.2	4.5	4.0
Cost per admission						
Mean patient-specific cost*	1 158.32	570.97	1 090.91	599.93	572.73	775.03
Mean clinical staff cost	1 712.81	1 093.24	1 953.72	968.03	1 233.60	1 369.81
Mean overhead cost	1 904.41	1 493.96	2 404.16	1 288.80	2 060.34	1 804.65
Mean capital cost	1 585.13	1 093.52	1 931.84	955.76	1 434.33	1 360.00
Mean cost per admission	6 360.67	4 251.68	7 380.63	3 812.53	5 300.99	5 309.49

*Excluding clinical staff cost.
SDKA = severe diabetic ketoacidosis; MDKA = mild/moderate diabetic ketoacidosis; HODKA = hyperosmolar diabetic ketoacidosis; HHS = hyperosmolar hyperglycaemic state; HD = hyperglycaemia with dehydration.

Table III. Breakdown of cost per patient admitted and estimated annual total cost (South African rands)

	Emergency unit	High-care unit	Ward	Carnation ward	Total	% Total costs
Duration of admission (hours)	12.6	27.4	46.4	9.0	95.4	
Imaging	28.72	8.09	0	0	36.81	0.7
Medication	57.74	144.01	27.51	5.06	234.32	4.4
Laboratory	270.94	213.85	17.29	1.82	503.90	9.5
Nurses	54.72	662.29	156.18	30.35	903.54	17.0
Doctors	221.59	133.00	93.51	18.17	466.27	8.8
Capital	78.21	620.89	553.37	107.53	1 360.00	25.6
Overheads	128.64	554.51	939.03	182.47	1 804.65	34.0
Total costs	840.56	2 336.64	1 786.89	338.20	5 309.49	
Estimated annual cost					1 688 417.82	

Table IV. Comparison of hyperglycaemic emergency admissions

	GFJH	GSH[9]	BH	USA
Number/month	26	26	24[10]	
Reason for admission	Sepsis (36%) Non-compliance (32%) Newly diagnosed (11%)	Sepsis (47%) Non-compliance (26%)		Acute illness (18%) Non-compliance (59%)[20]
Mortality rate	7.5%	9.1%	10.4%[10] DKA: 6.8% HHS: 16.6%[15]	DKA: < 5% HHS: 15%[16]
Duration of admission (days)	4	7 - 9		
Cost per admission	R5 300 = US$757			US$6 500 - 13 000[17]

GFJH = GF Jooste Hospital, Cape Town, 2005; GSH = Groote Schuur Hospital, Cape Town, 1991; BH = Baragwanath Hospital, Johannesburg, 1986[10] and 1997;[15] USA = United States of America data, 1997 - 2003;[17] DKA = diabetic ketoacidosis; HHS = hyperosmolar hyperglycaemic state.

hyperglycaemic admissions to GSH (7 - 9 days).[9] This could be attributed to the medical bed pressure experienced at GFJH.[17]

This is the first South African study evaluating the financial costs of hyperglycaemic admissions. The mean inpatient cost per hyperglycaemic emergency admission was estimated to be just over R5 300 (the equivalent of US$757, using an exchange rate of R7 per US$1 in September 2005). This figure is unacceptably high, given the potentially preventable nature of the problem. Comparatively, in 2005, the mean inpatient HIV/AIDS admission cost at GFJH was estimated at R4 630 (adjusted for inflation),[13] while diabetic hyperglycaemic emergencies admitted to USA hospitals in 2003 cost US$6 500 - 13 000 per patient.[18,19] It could be argued that we have overestimated the cost of hyperglycaemic emergency admissions, since our patients were admitted to a HCU. However, our data indicate that a substantial portion of the HCU cost was derived from medication, laboratory test monitoring and nursing care (50%). If these patients were admitted directly to the general wards, as is common practice elsewhere, these costs would still be applicable since acutely ill patients require more medication, monitoring and nursing care regardless of their location within a hospital. From the limited data obtained in our study, it appears that hyperglycaemic emergencies precipitated by gangrene may be associated with a much longer duration of hospital stay, and cost per admission, compared with other hyperglycaemic admissions. More data are required to validate this finding.

Recommendations

Preventive health care initiatives are urgently needed at a primary and secondary-care level. Primary care objectives should include: (*i*) early diagnosis of diabetes; (*ii*) timely identification and treatment of precipitating causes of hyperglycaemia; and (*iii*) education to improve compliance with diabetic treatment. Diabetic health education should ideally be offered to patients in their home language. Given the results of our survey, and the demographic profile of South Africans,[20] this is unlikely to be English; trained and motivated staff who engage patients in their home language and with culturally appropriate tools, is therefore a priority. In addition, another important reason for non-compliance with antihyperglycaemic therapy, i.e. poor access to medication from community health care centres because of long waiting times and non-availability of drugs, needs to be addressed.

We need to implement cost-effective strategies that improve the quality of inpatient care and outcome of admissions. Firstly, we need to target the high medical sepsis mortality with earlier diagnosis and treatment at primary-care level. Secondly, relevant diabetic education needs to be provided to all hyperglycaemic emergency patients, in their home language, before discharge. Thirdly, a survey of surgical sepsis, specifically gangrene, needs to be conducted to determine whether inpatient admission duration and costs in this group can be reduced significantly.

In conclusion, South Africa is a resource-limited nation with a quadruple burden of disease. With the advent of district-based health care systems in South Africa the onus is on districts to determine cost-effective approaches to treating illnesses that cause significant morbidity and mortality. The potential adverse outcomes and high costs of hyperglycaemic emergency admissions necessitate cost-effective approaches at primary-care level to prevent these admissions.

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Accepted 22 May 2007.