Diabetes affects approximately 1 million South Africans and contributes significantly to morbidity and mortality. In 2000, disability-adjusted life years for diabetes in South Africa (390/100 000) were comparable to US figures (421/100 000) – 4 times higher than for the rest of Africa (113/100 000). Diabetes expenditure per annum is not known in South Africa, but exceeds US$44 billion in the USA. 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.
as hyperglycaemic emergencies. 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 reallocation 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. 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. 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 group, and reason for, duration of and primary outcome of admission. HbA1c on admission is not a grouping for the study because of limited diabetes complications.

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%

| Table I. Profile of inpatient hyperglycaemic emergencies |
|---------------------------------------------|------------------|------------------|------------------|------------------|
| Median age (range) (yrs)                    | SDKA (N = 9)     | MDKA (N = 17)    | HODKA (N = 8)    | HHS (N = 7)      | HD (N = 12)      | All admissions (N = 53) |
| Reason for admission (N)                    | 44 (17 - 71)     | 49 (20 - 72)     | 66 (22 - 68)     | 61 (49 - 76)     | 46 (22 - 65)     | 49 (17 - 76)         |
| 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.
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 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 and Baragwanath Hospital (BH) in 1986. 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

<table>
<thead>
<tr>
<th>Table II. Cost (South African rands) per hyperglycaemic emergency admission according to diagnostic category</th>
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<tr>
<td><strong>Mean total duration of admission (days)</strong></td>
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<tr>
<td>SDKA ($N = 7$)</td>
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<tr>
<td>Mean per admission</td>
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<tr>
<td>Mean patient-specific cost*</td>
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<tr>
<td>Mean clinical staff cost</td>
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<td>Mean overhead cost</td>
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<tr>
<td>Mean capital cost</td>
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<td>Mean cost per admission</td>
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</tbody>
</table>

*Excluding clinical staff cost.

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<table>
<thead>
<tr>
<th>Table III. Breakdown of cost per patient admitted and estimated annual total cost (South African rands)</th>
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</thead>
<tbody>
<tr>
<td><strong>Emergency unit</strong></td>
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<td>Duration of admission (hours)</td>
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<td>Imaging</td>
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<td>Medication</td>
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<td>Laboratory</td>
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<td>Nurses</td>
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<tr>
<td>Doctors</td>
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<tr>
<td>Capital</td>
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<tr>
<td>Overheads</td>
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<tr>
<td>Total costs</td>
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</table>

Estimated annual cost | 1 688 417.82
More data are required to validate this finding.

compared with other hyperglycaemic admissions.

duration of hospital stay, and cost per admission, gangrene may be associated with a much longer
that hyperglycaemic emergencies precipitated by
the limited data obtained in our study, it appears
regardless of their location within a hospital. From
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overestimated the cost of hyperglycaemic emergency
per patient.

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admissions. The
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),
while diabetic hyperglycaemic emergencies admitted
to USA hospitals in 2003 cost US$6 500 - 13 000
per patient.1516
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
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the limited data obtained in our study, it appears
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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.

| Table IV. Comparison of hyperglycaemic emergency admissions |
|-----------------|-----------------|-----------------|-----------------|
| Number/month   | GFJH            | GSH6            | BH6            | USA            |
| Reason for admission | 26             | 26              | 2420           | Acute illness (18%) |
|                  | Sepsis (36%)    | Sepsis (47%)    | Non-compliance | Non-compliance (59%)22 |
| Mortality rate  | 7.5%            | 9.1%            | 10.4%10        | DKA: 6.8%    |
|                  |                 |                 | DKA: < 5%      | HHS: 16.6%15  |
| Duration of admission (days) | 4              | 7 - 9          |                 | HHS: 19%10   |
| Cost per admission | R5 300 = US$757 |                 |                 | US$6 500 - 13 00017 |

GFJH = GF Jooste Hospital, Cape Town; GSH = Groote Schuur Hospital, Cape Town, 1991; BH = Baragwanath Hospital, Johannesburg, 198617 and 1997; USA = United States of America data, 1997 - 2003; DKA = diabetic ketoacidosis; HHS = hyperosmolar hyperglycaemic state.

GSH study – sepsis (47%) and non-compliance (26%) – remain unchanged in our study. The in-hospital mortality rates were 9.1% for GSH (1991)17 and 10.4% for BH (1986).17 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).15 A shorter duration of admission was found in our study (Table II) compared with hyperglycaemic admissions to GSH (7 - 9 days).17 This could be attributed to the medical bed pressure experienced at GFJH.17

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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,22 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
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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 at primary-care level to prevent these
admissions.

Diabetic retinopathy is the fifth leading cause of global blindness, affecting an estimated 1.8 billion people and responsible for 4.8% of blindness. In South Africa, it is the third leading cause of blindness after cataract and glaucoma, and is responsible for 5% of blindness (0.04% of the total population). Cataract and refractive error are prioritised for the first phase of Vision 2020 in South Africa, while strategies to deal with diabetic retinopathy are recommended as a priority for the second phase. These strategies will include provision of adequate screening and argon laser treatment.

The prevalence of diabetes differs in different population groups in South Africa. Among black and coloured South Africans, diabetes has risen from 3% to 12% over the past 10 years. Overall, the prevalence is conservatively estimated to be 3 - 5% (30 000 - 50 000 per million population). The prevalence of retinopathy in people with diabetes is estimated to be 20% (6 000 - 10 000 per million population), and the prevalence of blindness among these is estimated to be 5% (300 - 500 blind per million population).

The objective of this study was to evaluate the retinopathy status of patients with diabetes seen at a primary care clinic in Cape Town and to assess the adequacy of the current diabetic screening programmes.

**Methods**

Two hundred and forty-eight consecutive patients with type 2 diabetes were seen at Robbie Nurock Day Hospital in Cape Town between 15 September 2005 and 21 November 2005. An interview elicited the duration of their diabetes, and whether or not they had had previous fundoscopy. Examination included best corrected visual acuity and undilated fundoscopy using a direct ophthalmoscope. If retinopathy was detected, or if the view was not adequate, fundoscopy was repeated with pupil dilatation. Retinopathy status