Inpatient blood glucose management of diabetic patients in a large secondary hospital

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Abstract

Background: Diabetes has become a major health problem worldwide, as well as in South Africa. This, coupled with the chronicity of the disease, relate to an increasing burden on health care facilities and an increasing number of hospital admissions of patients suffering from diabetes. Admissions are mostly related to diabetes itself, but the frequency of admissions for problems not related to diabetes is increasing as the prevalence of diabetes increases in the population. Proper inpatient glycaemic management is important for improving patient outcome and for reducing the risk of inpatient complications.

Objectives: The objective of this study was to evaluate current practices in the care of diabetic inpatients as well as to assess the glycaemic control that is achieved during hospitalisation.

Methods: An audit was done of clinical hospital records of adult diabetic patients admitted to Kalafong Hospital, a large secondary hospital in South Africa. All patients admitted who had type 1 or type 2 diabetes before admission, or who were newly diagnosed on admission or in hospital were included, irrespective of the discipline to which the patient was admitted. All patient admissions in the eight-month period preceding the initiation of the audit were included.

Results: The hospital records of 164 diabetic patients were audited. With regard to glucose monitoring, 60.8% of patients had irregular and erratic glucose monitoring, 37.2% had regular (either four- or six-hourly) monitoring and only 2% were monitored in relation to meals. Of the 164 patients, 160 were not fasting, 27 were treated with an insulin sliding scale at some stage during their admission, and in 14 (52%) of the patients who were on sliding scales the scale was used inappropriately. Most hospital inpatients with diabetes, i.e. 48 (30.4%), were treated with oral agents only; 29 (18.4%) were treated with oral agents plus a daily dose of NPH insulin and 17 (10.8%) with mixed insulin twice daily. Only three patients (1.9%) received insulin supplemental to their regimen. The glycaemic control treatment schedule was appropriate in only 19.5% of cases.

Conclusions: Based on our findings, the monitoring and management of blood glucose in patients with diabetes during hospitalisation in a large secondary hospital in South Africa is currently inadequate. This calls for an educational intervention for doctors and nurses working with diabetic inpatients as well as the introduction of a blood glucose management protocol.

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Introduction

Diabetes has reached epidemic proportions worldwide,[1] resulting in increased hospital admissions for patients with diabetes. In one United Kingdom hospital, the proportion of hospitalisations of patients with diabetes increased from 7.0% in 1991 to 11.1% in 2003.[2] Health insurance data in the United States indicates that diabetic patients also tend to be admitted 2.4 times more frequently and that their hospital stay is 30% longer than for non-diabetic patients.[3]

Numerous studies have been published on the advantages of good glycaemic control and associated improved outcomes. This relates mostly to more rapid recovery from infections,[4] shorter intensive care stays with reduced mortality,[5] improved prognosis after myocardial infarction,[6,7] less deep wound sepsis[8] and fewer nosocomial infections.[9,10] According to the American College of Endocrinology,[9] one way of achieving improved glycaemic control is to implement a standardised inpatient management protocol. Information on inpatient glycaemic control and methods of achieving control in diabetic patients admitted to South African hospitals are currently not available in the literature.

The aim of this study was to assess the status of glycaemic control and methods utilised in the inpatient management of diabetes in a large secondary hospital. The need for the introduction of a standardised inpatient diabetes management protocol was also assessed.

Methods

Study population

A cross-sectional audit was done of hospital records of diabetic inpatients. All patients were older than 13 years of age and were non-fasting at some stage during hospitalisation. All hospitalisations occurred during the eight months preceding the audit. Specific attention was paid to the methods of inpatient glycaemic monitoring and glucose control. Hospital records were audited independent of the reason for admission or the severity of the disease.

Data collection

Only information relating to the last hospitalisation was evaluated. Evaluation focused on the appropriateness of the method of glycaemic control for individual patients, the level of control of blood glucose and hypertension, evaluation of diabetes-related complications, and risk factors. The frequency of blood glucose and blood pressure measurements as well as the duration of hospital stay were noted. Diabetes follow-up arrangements upon discharge from hospital were also evaluated. The audit was done in a structured way after patient discharge, addressing the specific aspects mentioned above. Two independent observers audited all patient records.

Outcome measures

Outcome measures that were evaluated were: glycaemic control during hospitalisation as well as at time of discharge, time until glycaemic control after admission, hypertension control in hospital and at time of discharge, duration of hospital stay and patient outcome, and the frequency of in-hospital disease and treatment-related complications.

Appropriateness of inpatient management of diabetes was based on the inpatient management guidelines of the American Diabetes Association.[11] The criteria included three aspects for patients on insulin who were non-fasting: basal insulin, prandial insulin and supplemental or adjustment insulin. The appropriateness for inpatients on oral agents is unclear due to the scarcity of studies investigating the roles of various oral agents.[12] For the study on which this article is based, use of oral agents was considered appropriate if non-fasting patients' glycaemic control was good.

Data management

Data were captured electronically on Microsoft Access. Statistical analysis was done by using SPSS 14 for Windows (SPSS Inc, 1989–2005) statistical software. All descriptive data and proportions are reported as percentages and continuous variables are reported as means with standard deviations (SD) or, in the case of ordinal and skew data, as medians with inter-quartile ranges. Comparisons were done by using appropriate parametric or non-parametric tests dependent on the type and distribution of data.

Ethical issues

This study was done after ethics approval was obtained from the Ethics committee of the Faculty of Health Sciences of the University of Pretoria. All patient and treating physician identification information was removed from the data after the audit of clinical records was completed.

Results

Patient and hospitalisation characteristics (Table I)

During the eight-month period, 164 patients with diabetes were admitted to Kalafong Hospital (a large secondary hospital in Gauteng, South Africa). The median duration of admission was 7.5 days with a range of 1 to 87 days, and an inter-quartile range of 3 to 13 days. Only patients admitted to the adult units of the hospital (patients older than 13 years) were included in this audit. The mean age of patients at the time of admission was 58.5 years with a SD of 15.3 years (a range of 13 to 86 years). Predominantly females (n = 119, 72.6%) were hospitalised. The mean age of females was higher than that of males although this was not statistically significant, 60.2 vs 54 years (p = 0.21). No significant difference was demonstrated in the duration of diabetes between the two gender categories, 6.2 vs. 5.4 years (p = 0.59). Of the 164 patient records audited, 103 mentioned the duration that patients had diabetes. The median duration of diabetes in hospitalised patients was 3.7 years with an inter-quartile range of 1.1 to 9.25 years. A major contributor to the skewness of the distribution of the duration of diabetes is the fact that 19 patients were newly diagnosed during the audited admission. Of note is that 3.9% of patients had had diabetes for more than 20 years. Most patients were admitted to Internal Medicine (medical) units (97 patients, i.e. 59.1%). Two patients were admitted to the ICU first and then transferred to Internal Medicine. The admission to the ICU in both cases was for medical reasons.

Table I: Patient demographics

Audit of diabetic inpatients	n = 164	Mean/ Median	Standard deviation /Range
Patient age (mean years)		58.5	SD 15.3
Duration of hospitalisation (median days)		7.5	Range: 1–87 IQR*: 3–13
Duration of diabetes in patients with diabetes diagnosed before hospitalisation (median years)†		3.7	IQR*:1.1–9.25
		Number	Percentage
Newly diagnosed		19	11.6%
Gender	Females Males	119 45	72.6% 27.4%
Diabetes treatment before hospitalisation ‡	None Diet only Oral agents Combination (oral and insulin) Insulin twice daily Insulin basal bolus	19 12 82 12 21 2	11.6% 7.3% 50.0% 7.3% 12.8% 1.2%
Department hospitalised to	Internal medicine Surgery Orthopaedics Ophthalmology Gynaecology, but excluding obstetric patients	99 40 11 11 3	60.4% 24.4% 6.7% 6.7% 1.8%
Primary reason for hospitalisation§	Diabetes control Cardiovascular disease including stroke Renal disease Respiratory disease Gastro-intestinal diseas Leg and foot problems Orthopaedic problems Eye disease Malignancies Other	48 32 9 18 14 12 14 18 3 14	29.3% 19.5% 5.5% 11.0% 8.5% 7.3% 8.5% 11.0% 1.8% 8.5%
Patient outcomes	Improved and discharged Died Unchanged Transferred for tertiary care Self-discharge	126 12 17 2 6	76.8% 7.3% 10.4% 1.2% 3.7%
Complications in hospital		15	9.1%

* IQR: inter-quartile range
† Mentioned in 103 of audited hospital records
‡ No data available in 16 patient records audited
§ Note that more than one primary admission diagnosis were present in some patients

Inpatient deaths

Most patients improved (76.8%), but a significant proportion of patients died during hospitalisation (7.3%): two males and 10 females. Of the 12 patients who died, three died of chronic renal failure, three of end-stage heart failure, two had acute coronary syndromes of which one was complicated by diabetic keto-acidosis (DKA), one died of pulmonary tuberculosis, one of hypoglycaemic brain injury, one patient died after a femur fracture and one patient had a diabetic foot with sepsis. The mean age of patients who died was higher, although non-significant, namely 66 years in comparison to 57.9 years in the case of those who left the hospital alive ($p = 0.73$). No statistically significant difference in the duration of diabetes could be demonstrated between patients who died (5.8 years) and those who were discharged alive (5.94 years) ($p = 0.96$).

Newly diagnosed patients

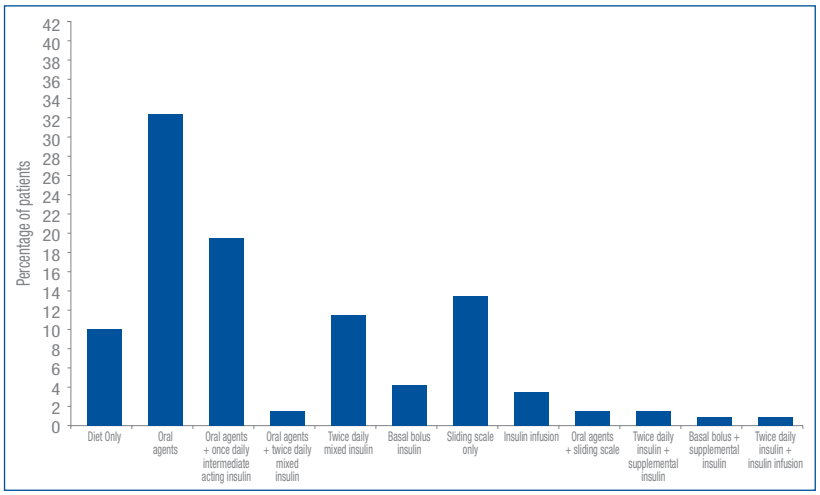
Nineteen of the 164 patients admitted were diagnosed with diabetes for the first time during hospitalisation. Of these, three patients presented with DKA, three were admitted with symptoms of diabetes, one patient had a stroke, three had foot ulcers, three presented with infections and one patient each with bowel obstruction, miscarriage and femur fracture.

Inpatient treatment (Figure 1)

Only four patients (2.4%) were kept nil per mouth at some stage during hospitalisation, and two patients (1.2%) received tube feeding. Of the four patients who were nil per mouth, three were treated with an insulin sliding scale and one received oral agents. Of the two patients who received tube feeding, one was on twice-daily insulin, and one did not receive any anti-diabetic treatment. The latter patient was however only controlled on diet before admission.

Most non-fasting patients were treated with oral agents (48 patients, 30.4%). Twenty-nine patients (18.4%) were treated with oral agents and once-a-day NPH-insulin. Thirteen per cent of patients, who were non-fasting, were on a regular insulin sliding scale only (20 patients). Twice-daily mixed insulin was prescribed to 17 patients (10.8%). Only three patients (1.9%) received meal-related supplemental insulin in addition to their treatment regimen. Fifteen patients (9.1%) were documented to have received an insulin infusion at some stage during admission. Twelve of them had DKA and received insulin infusions as part of the DKA treatment regimen. One patient was admitted with a stroke, one with renal failure and one patient received cancer chemotherapy.

Figure 1: In-hospital treatment regimens among non-fasting diabetic patients



Twenty-seven patients (16.5%) were on an insulin sliding scale only, at some stage during hospitalisation. Insulin sliding scales were utilised as follows in the various departments: Internal Medicine 15 patients (15.5%), surgery nine patients (22.5%) and orthopaedics three patients (27.3%). Fifty-two per cent (14 of 27) of patients on insulin sliding scales received it inappropriately because they were non-fasting. Of these, eight were from Internal Medicine and six from surgical disciplines.

Appropriateness of treatment to control blood glucose

The inpatient diabetes treatment schedule was considered appropriate in 32 (19.5%) and inappropriate in 110 (67.1%) of the 164 patients. In 22 (13.4%) of the patient hospital records audited, insufficient information was available, making it impossible to decide if treatment was appropriate or not.

Inpatient glycaemic monitoring

Most inpatients (60.8%) had their blood glucose checked irregularly and haphazardly by ward staff. This could have been due to the lack of a ward schedule for testing blood glucose, or failure on the part of doctors to prescribe appropriate orders. About one-third had their blood glucose tested regularly according to a timed schedule, either four hourly or six hourly. Only three (2%) patients had their blood glucose tested in relation to meal consumption.

Hypoglycaemic events

Of the 164 patients admitted to hospital, ten were admitted with hypoglycaemia. In six cases, hypoglycaemia was corrected before the patients left the emergency unit. No hypoglycaemic events were recorded in patients admitted for hypoglycaemia after the third day of hospitalisation. Of the 154 patients not hospitalised for hypoglycaemia, 45 (29.2%) had at least one hypoglycaemic episode while in hospital. Of these, 20 patients (13%) had one episode, four had two hypoglycaemic episodes and 21 patients had three or more hypoglycaemic events during their hospital stay. No differences in the number of hypoglycaemic events could be demonstrated between patients on different treatment regimens.

Inpatient glycaemic control

The mean blood glucose on the first day of admission was 10.4 mmol/l (SD 4.2) with a range of 3.8 to 25.6 mmol/l. This improved to 8.53 mmol/l (SD 3.4) on the last day of hospitalisation. This improvement is statistically significant ($p = < 0.001$, paired sample t-test). This relates to a mean difference in blood glucose from the first to the last day of hospitalisation of 2.37 mmol/l (95% CI: 1.78 to 2.95). An HbA1c (glycated haemoglobin) was done on 71 (43.3%) patients at the time of admission. The mean HbA1c value for these patients was 11.3% (SD 4.3). In 67 (40.9%) patients hospitalised with diabetes, glycaemic control was achieved. For this purpose, control was defined as all blood glucose measurements for 24 hours monitored to be between 3.5 and 10 mmol/l.

Inpatient blood pressure control

Thirty-nine per cent of patients were hypertensive on admission and received antihypertensive therapy in hospital. The mean systolic blood pressure improved from 131 mmHg on the first day of hospitalisation to 125.4 mmHg on the last day of hospitalisation ($p = < 0.001$). This relates to a mean reduction in systolic

blood pressure of 5.61 mmHg (95% CI: 2.37 to 8.85). Diastolic blood pressure improved from a mean of 78.1 to 76.6 mmHg (p = 0.004), which represents a mean improvement of 1.47 mmHg (95% CI: -0.84 to -3.78).

Patient follow up and readmissions

From the audit of patient records, 70.7% referred to follow-up arrangements made for patients. It is uncertain for which proportion of these patients arrangements were made for follow up of diabetes or the primary presenting problem.

Of the 164 patients, 31 (18.9%) were readmitted to hospital within six months after discharge. This was due to various reasons; only four (12.9%) were readmitted for glycaemic control, three (9.6%) for foot problems, seven (22.6%) for eye problems, of which four readmissions were for cataract surgery on a second eye, four patients were readmitted for cancer chemotherapy, four for follow-up surgical procedures and five for other chronic medical problems.

Discussion

The results of the study on which this article is based show that glycaemic control in a significant proportion of diabetic inpatients is still sub-optimal, with only 40.9% achieving control. Hypoglycaemic events occurred frequently, as 29.2% of inpatients had at least one hypoglycaemic event in hospital. The mean blood glucose improved significantly during admission: from more than 10 mmol/l on the first day of hospitalisation to 8.53 mmol/l on the last day of hospitalisation.

The monitoring of blood glucose in diabetic inpatients is not optimal due to the erratic and irregular monitoring schedule in 60.8% of patients. Time-based monitoring, that is four or six hourly, is appropriate for patients who are fasting or who receive continuous tube feeds or total parenteral feeding, but not for patients who receive meals. Only six of the 164 patients (3.6%) were fasting or received tube feeding, in which case time-based monitoring would be appropriate, but time-based monitoring was utilised in only 37.2% of the patients. The optimal monitoring schedule in at least 158 of the 164 diabetic inpatients would have been meal-related. Thus, at the time of this study only three patients (2%) were monitored optimally.[11,13]

The optimal way of treating hospitalised non-fasting diabetic patients would be to administer the patients' usual treatment, with adjustment to compensate for a more fixed and regulated hospital diet. In addition, patients should receive meal-related supplemental insulin according to blood glucose levels. The administration of insulin according to a four- to six-hourly sliding scale in patients who are receiving meals in hospital is inappropriate.[14] This audit indicated that sliding scales were still used inappropriately in 14 of the 164 patients.

Several limitations hampered this study. Firstly, this audit did not include any admission of paediatric patients, thus the findings are only applicable to patients older than 13 years of age who are admitted to adult hospital units. Secondly, the audit was done in only one large secondary hospital with limited resources. The assumption was made that it is typical of circumstances in similar hospitals in South Africa. This hospital serves a large community of mostly medically uninsured patients of lower socio-economic status.

The findings of this audit are congruent with other studies from other parts of the world. An audit done at the Mayo clinic[15] indicated that 11% of patients had at least one hypoglycaemic event during admission, and 71% of patients had at least one blood glucose measurement higher than 11.1 mmol/l. A study done at a tertiary care facility in India[16] showed that glycaemic control was achieved in 48%, was sub-optimal in 15%, and poor in 37% of hospitalised diabetic patients. In a study by Cook et al,[17] the mean duration of hospital stay for diabetic patients was 5.7 days and most admissions to hospital were for cardiovascular (33%), endocrine and metabolic (13%), as well as for infective conditions (14%). The average duration of hospital stay for diabetic patients in the study by Jiang et al was 6.8 days for patients who had a single hospitalisation in comparison to 7.4 days in patients with multiple admissions.[18] This study also reported that 30% of diabetic patients had two or more admissions over a period of one year. In a Spanish study, the mean duration of hospital admission was 11.4 days for diabetic patients.[1] In a UK study, the mean duration of hospital stay was 19 days (range 1–300+) compared to the median length of stay of all hospital patients of 10 days.[1] The management of diabetes in this UK study was considered inappropriate in 29% of patients who were not referred to a diabetes management team. The same study also indicated that 28% of patients were treated with diet alone, 52% with oral hypoglycaemic agents, 15% with insulin only and 5% with a combination of insulin and oral agents.

The American College of Endocrinology advises that the upper limit for glycaemic control in hospitalised diabetic patients should be 6.1 mmol/l pre-prandial and 10.0 mmol/l maximal.[13] This target is currently not achieved in most patients in this audit as well as in numerous patients reported in other studies. The guideline is clear and methods to achieve this target should be developed and implemented. Probably the most important way to achieve glycaemic control is through proper education and training of physicians and nurses, implementation of adequate blood glucose monitoring schedules and protocols for management of hyperglycaemia.

The overall finding of this audit is that the inpatient management of diabetes by means of glucose monitoring and glycaemic control is currently inadequate. Doctors and nurses caring for diabetic inpatients should be educated in the management of diabetes, and proper protocols for inpatient management should be implemented.

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