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ORIGINAL ARTICLE

Managing hyperglycaemia in patients with diabetes on enteral nutrition: the role of a specialized diabetes team

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BACKGROUND/OBJECTIVES: Hyperglycaemia is commonly observed in patients with diabetes mellitus (DM) while receiving enteral nutrition (EN) in hospital, and hyperglycaemia has been shown to be associated with poor clinical outcomes. The aim of this study was to assess the glycaemic status of patients with DM who received EN during hospital admission and evaluate the impact of intervention by a specialist diabetes team (SDT) on glycaemic control and clinical outcomes of these patients.

SUBJECTS/METHODS: A retrospective review of patients with DM who required EN during hospital admission was conducted. We compared patient characteristics, glycaemic profile and clinical outcomes between patients who were managed by SDT and those who were managed by the admitting team.

RESULTS: Seventy-four patients with DM on EN were included in this study, of whom 27 were managed by SDT while on EN. Compared with patients managed by the admitting team, those who were reviewed by SDT had better glycaemic control during the period of EN as well as during the 24 h after EN was ceased. These patients also had shorter length-of-stay in hospital and lower in-patient mortality.

CONCLUSIONS: Our findings confirmed that there was a role for SDT in managing patients with DM who received EN during their hospital admission. These patients had improved glycaemic control while receiving EN and had better clinical outcomes. Further prospective studies will be required to validate the findings of this study.

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INTRODUCTION

Managing in-patient hyperglycaemia is a problem commonly faced by clinicians in hospital, and this may be related to the growing prevalence of diabetes mellitus (DM) worldwide. In 2009–2010, the average length-of-stay (LOS) in hospital was higher among patients with a principal diagnosis of diabetes (4.3 days) or additional diagnosis of diabetes (8.0 days) compared with all hospitalizations (3.1 days, Australia's Health[1]).

Studies had demonstrated that the use of enteral feeding (EN) and parenteral feeding (PN) during hospital admission was a risk factor for the development of hyperglycaemia, even in patients without previous history of diabetes.[2,3] Hyperglycaemia in these patients was associated with greater risk of adverse outcomes during admission, including higher incidence of infections, sepsis, cardiac complications, acute renal failure and death.[4,5] PN-induced hyperglycaemia was shown to be a predictor of in-patient complications and hospital mortality.[6] As yet, there is no evidence to suggest that maintaining good glycaemic control in patients receiving EN or PN will result in better clinical outcomes. There is also little information in the literature on the benefits of a specialist diabetes team (SDT) in managing hyperglycaemia in patients with DM while receiving EN.

The aim of this study was to assess the glycaemic status of patients with DM who received EN during their admission in a tertiary referral centre over a 12-month period and evaluated the impact of intervention by SDT on the clinical outcomes of these patients.

SUBJECTS AND METHODS

Liverpool Hospital is an 800-bed tertiary referral centre that provides a wide range of medical and surgical services for people living in the south-western part of Sydney. A retrospective medical record review was undertaken for in-patients with known DM who had received continuous EN between 1st January and 31st December 2013 during their admission at Liverpool Hospital. EN referred to nutrition that was provided through naso-gastric or naso-jejunal tubes while the patient was in hospital. The list of in-patients with DM on EN was provided by the Dietetics Department on a week by week basis. Patients who were admitted under the diabetes service were excluded. For patients with DM who were receiving EN, blood glucose levels (BGLs) were checked at least four times a day (0600, 1200, 1800 and 0000 hours). The admitting teams would decide whether the patient needed input from SDT in managing EN-induced hyperglycaemia for their DM patient.

SDT comprised an endocrinologist, medical registrar and diabetes nurse educator. There was no established protocol in managing hyperglycaemia during EN at Liverpool Hospital, but the SDT used regular insulin starting with 4–6 units given four hourly. If the patient has type 1 diabetes, the patient's basal insulin (for example, insulin glargine) would be continued. A member of the SDT would review the patient's BGL chart daily and make adjustment to insulin doses. The SDT would also oversee diabetes management when the patient was transitioned from EN to normal diet.

In this study, patients' demographic details including their age, duration and type of DM, DM therapy and primary reason for admission were recorded. Their BGL measurements in the 24 h before commencing EN, the last 24 h during EN and the first 24 h following cessation of EN were documented. Clinical outcomes including LOS, evidence of blood culture proven septicemia, need for intensive care admission, new onset acute myocardial infarction (AMI) and in-patient death were recorded.

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Statistical methods

All continuous variables were presented as mean and s.d. (median and inter-quartile range if non-nominally distributed). The χ^2-test and *t*-tests were performed to compare variables between patients who received intervention from diabetes team and those who were managed by admitting team. For variables that were non-nominally distributed, the Kruschal–Wallis test was used. The analysis was performed by STATA 7.0 (Texas, TX, USA). A *P*-value < 0.05 was considered statistically significant.

This study was approved by the Sydney South West Human Ethics Committee.

RESULTS

In 2013, we identified 74 in-patients with diabetes who required continuous EN during admission. The patients were admitted for a multitude of reasons and that included septic shock, acute delirium, status epilepticus, cerebral vascular accidents, intra-cerebral bleeding, pancreatitis, surgical resection of upper neck tumour and neck abscess. Among these patients, 39 (52.7%) were admitted under surgical teams, whereas the rest were under the care of physicians. Four patients suffered from type 1 DM, whereas the rest had type 2 DM. Their mean age was 68.5 ± 10.9 years, whereas their mean duration of DM was 15.0 ± 9.4 years. Twenty patients (27.0%) were on insulin therapy before admission, and only six patients were diet controlled. Sixty-two patients had HbA1c assessed during admission and the mean HbA1c was 7.7 ± 2.1%. The patients received EN for a mean of 21.3 ± 15.4 days.

Twenty-seven patients (36.5%) were reviewed by SDT at the request of the admitting team to help manage hyperglycaemia during EN. There was no difference in age, duration of diabetes, diabetes therapy and gender with regards to whether the patients were reviewed by SDT (Table 1). The proportion of patients admitted under surgical teams and duration of EN was also not different between the two groups. However, patients for whom the SDT was consulted had higher HbA1c compared with those who were managed by the admitting team themselves. The mean BGL during the period of EN was significantly lower among patients who were seen by SDT, and their glycaemic control was also better in the 24 h after EN was stopped (Table 2).

Patients who were managed by SDT had a higher proportion of BGLs within the range of 5–10 mmol/l, compared with those who were managed by the admitting team (73.7 versus 49.9%, $P < 0.001$). The proportion of BGL values that was in the hypoglycaemic range (BGL < 4.0 mmol/l) was not different between the two groups (1.1 versus 0.8%, $P = 0.688$) (Table 2). The lowest documented BGL in the SDT group was 2.6 mmol/l, and all the other hypoglycaemic episodes in the entire cohort were between 3.0 and 4.0 mmol/l.

In terms of clinical outcomes, for the entire cohort, the median LOS was 33 days (inter-quartile range 21–48 days) and 18 patients died during admission (mortality rate 24.3%). Patients who were reviewed by SDT had significantly shorter LOS in hospital and lower in-patient mortality compared with those who were managed by the admitting team (Table 3). There was no difference in the outcomes of other co-morbidities such as new onset AMI, need for admission to intensive care unit and blood culture proven septicemia. After adjusting for factors including age, duration of diabetes, insulin therapy before admission and HbA1c, involvement of SDT remained an independent predictor for shorter LOS but not for lower in-patient mortality rate.

Table 1. Demographics of patients with diabetes where glycaemic control was managed by specialist diabetes team (SDT) or their admitting team while they were on enteral nutrition

	Managed by admitting team N = *47*	*Managed by SDT* N = *27*	P-*value*
Age (years) ± s.d.	70.1 ± 10.6	65.7 ± 11.0	0.091
No. of patients who are male (%)	30 (63.8)	22 (81.5)	0.110
Duration of diabetes, years ± s.d.	14.7 ± 9.2	15.4 ± 10.0	0.747
No. of patients with type 1 diabetes (%)	2 (4.3)	2 (7.4)	0.564
Diabetes therapy before admission			
No. on insulin therapy (%)	14 (29.8)	6 (22.2)	0.481
No. on diet alone (%)	5 (10.6)	1 (3.7)	0.293
Glycosylated haemoglobin (HbA1c)			
% ± S.d.	7.0 ± 1.1	8.7 ± 2.8	0.001
mmol/mol ± s.d.	53 ± 30	71 ± 30	
Admission glucose level (mmol/l) ± s.d.	10.2 ± 5.1	12.1 ± 4.8	0.124
No. of patients admitted under surgical team (%)	20 (44.1)	15 (55.6)	0.552

Table 2. Glycemic control of patients with diabetes during the 24 h before (Period 1), the last 24 h of EN (Period 2) and the 24 h after EN (Period 3): comparison of patients managed by admitting team and specialist diabetes team (SDT)

	Managed by admitting team N = *47*	*Managed by SDT* N = *27*	P-*value*
Total number of BGL recorded	493	282	
Mean duration of EN (days) ± s.d.	21.3 ± 16.0	21.4 ± 14.4	0.991
Mean BGL during 24 h before EN (mmol/l) ± s.d. (Period 1)	9.3 ± 2.9	9.8 ± 2.8	0.459
Mean BGL during EN (mmol/l) ± s.d. (Period 2)	11.1 ± 3.2	8.6 ± 2.0	0.001
Mean BGL during 24 h after EN was stopped (mmol/l) ± s.d. (Period 3)	9.7 ± 4.1	7.3 ± 1.7	0.007
BGL < 4.0 mmol/l in Periods 2 and 3, no., (%)	3 (0.81)	2 (1.10)	0.688

Abbreviations: BGL, blood glucose level; EN, enteral nutrition; SDT, specialist diabetes team.

Table 3. Clinical outcomes of patients with diabetes who were on enteral nutrition

Number	*Managed by admitting team*	*Managed by SDT*	*P-value*
Median length of stay (days) (interquartile range)	37 (23–50)	27 (19–36)	0.047
New acute myocardial infarction (%)	3 (6.3)	0	0.180
Blood culture positive septicemia (%)	12 (25.5)	5 (18.5)	0.490
Need for intensive care admission (%)	26 (55.3)	15 (55.6)	0.984
In-hospital mortality (%)	15 (31.9)	3 (11.1)	0.045

Abbreviation: SDT, specialist diabetes team.

DISCUSSION

We confirmed that in-patients with DM who received EN had prolonged LOS in hospital and high in-patient mortality. However, our study was the first to show that patients on EN who were reviewed by SDT had better glycaemic control during the period of EN as well as during the 24 h after EN was ceased. Furthermore, these patients had shorter LOS in hospital and lower mortality rate.

The incidence of malnutrition could be as high as 40% in critically ill patients, and this was shown to be associated with an increased risk of hospital complications, higher mortality rate and longer LOS in hospital.[2] Nutrition guidelines stated that patients who cannot consume adequate nutrients orally (60% of nutrition requirement) for at least 5 days in the critically ill or 7–14 days in the general population should be a candidate for specialized nutrition support.[7] Improving the nutritional state of patients may restore immunological competence and reduce the frequency and severity of infectious complication in hospitalized patients. Nutritional support may be in the form of PN or EN. Although both forms of nutritional support had been shown to be effective in preventing malnutrition, EN is often preferable to PN in clinical practice. This could be due to lower costs of EN and non-reliance on central venous catheter, but there was also the belief that EN provided nutrition through a more physiological route.[8] However, patients on EN often developed hyperglycaemia, and this was observed in up to one-third of adult in-patients in the hospital.[3] The use of EN may be associated with several complications that can impact the care of hospitalized patients. EN may cause bacterial colonization of the stomach, high gastric residual volumes with subsequent risk of aspiration pneumonia and diarrhoea.

A Task Force set up by Clinical Guidelines Subcommittee of the Endocrine Society recommended that insulin therapy should be initiated in patients on EN with BGL above 7.8 mmol/l (Umpierrez *et al*.[9]). For patients on continuous EN, it was recommended that basal insulin in combination of regular short acting insulin would be appropriate. There were a number of studies that examined protocols to manage hyperglycaemia in patients with DM on EN. A small study with only 22 patients demonstrated that premixed insulin given three times a day for up to 72 h was a safe option in managing patients on EN, when compared with twice daily premixed insulin or basal-bolus regimen.[10,11] In fact hypoglycaemia was observed less frequently in three times daily premixed insulin group than patients on basal-bolus regimen. Another study with over 159 patients on EN showed that neutral protamine Hagehorn (NPH) insulin (given every 4 hourly or 6 hourly) was more effective for blood glucose control in patients receiving continuous EN than sliding scale insulin aspart[10,11] Moreover, hypoglycaemia was no different between the NPH groups and the insulin aspart group. Kowrytkowski *et al*.[12] compared the use of sliding scale regular insulin and insulin glargine in the management of 50 patients who developed hyperglycaemia while on EN. They did not find any significant differences in glycaemic control or adverse effects between these two insulin regimens, but almost half of the patients on regular insulin needed the addition of insulin NPH to keep BGL below 10 mmol/l.

At our institution, the SDT used regular insulin given every 4 h in managing hyperglycaemia in patients on EN, with the dose of insulin adjusted according to BGL. One of the advantages of using regular insulin was that if the nasogastric tube was dislodged or was blocked, resulting in interruption of EN, the next dose of regular insulin could be omitted to avoid hypoglycaemia. If the same problem occurred to patients who were only on long or intermediate acting insulin (usually at larger doses), hypoglycaemia could be an issue due to the prolonged effects of these insulin preparations. However, for the two patients with type 1 diabetes managed by SDT, basal insulin such as insulin glargine was also given to prevent possible diabetic ketoacidosis should regular insulin doses be omitted for whatever reasons.

As the decision to refer to SDT was made by the admitting team, there would be a bias regarding which patients were reviewed by SDT. Despite the fact that patients who were reviewed by SDT had higher HbA1c, these patients actually had better glycaemic control during the period of EN and had shorter LOS as well as lower in-patient mortality. This suggested that the availability of an SDT was highly effective in improving these patients' glycaemic profile while they were receiving EN. Their expertise in diabetes management also ensured safer transition from EN to normal diet, as indicated by better glycaemic profile for these patients during the 24 h after EN was stopped. We hypothesize that having a SDT in hospital helps maintain better glycaemic control for these patients, which in turn may shorten their LOS and improve their clinical outcomes. However, we acknowledged that the reasons for prolonged LOS for patients were multifactorial, and we could not conclude that input from SDT directly reduced LOS. A prospective study is therefore necessary to show whether having an SDT to manage patients with DM on EN proves to be cost-effective for the hospital.

There were a few limitations in our study. This was a relatively small retrospective study, and the strength of our conclusions would be diminished because of the existence of differences between the two groups. The admitting teams may have chosen to consult SDT for a number of reasons and their own ability to manage EN-induced hyperglycaemia would differ greatly. Finally, this study excluded patients who did not have known DM, but these patients could also develop hyperglycaemia while on EN. Their LOS and in-patient mortality rates were not available for comparison.

In conclusion, this study demonstrated that involvement of SDT may result in better glycaemic control in patients with DM receiving EN in hospital, and this may have beneficial effects on their clinical outcomes. A larger prospective randomized trial involving SDT using standardized protocols to manage hyperglycaemia during EN would be worthwhile to validate the findings of this study.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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