Glycaemic Control in the General Intensive Care Unit: A Proposed Quality Improvement Project

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Introduction

- Critical illness-induced hyperglycaemia is estimated to affect 40-90% of critically ill patients irrespective of premorbid diabetes status.[1]
- It is the consequence of various immunological, inflammatory, and hormonal alterations that are induced by critical illness leading to increased hepatic gluconeogenesis and glycogenolysis, and peripheral insulin resistance.[1]
- Hyperglycaemia in critically ill patients is associated with an increase in mortality, and short-term morbidity; including increased ventilator weaning time, infection rate, and intensive care unit (ICU) length of stay, see figure 1.[2,3]
- This audit and quality improvement project's main objective is to explore at what level the targets of glycaemic control (as those clarified in the local and national protocols) in our unit are achieved. Secondary objectives are a) identifying the factors that strongly affect glucose control in our critically ill patients, b) ways to optimise the current glucose control protocol in the general ICU.

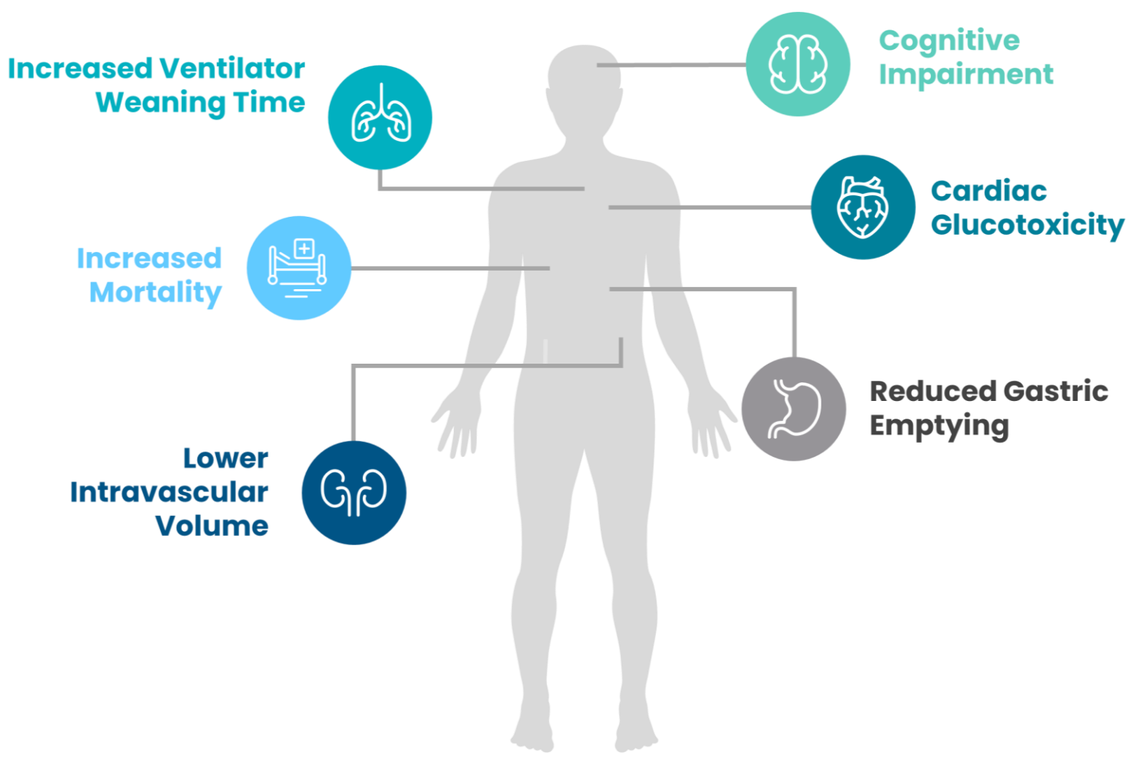

Figure 1. Pathophysiological consequences of Stress Hyperglycaemia.[1-3]

Methods and Materials

- Data during the first week of admission, data from 58 critically unwell patients admitted to the general ICU in University Hospitals Plymouth was collected.
- Average blood glucose concentration (BGC), feeding modality, and degree of absorption were recorded for each four-hour period from admission.
- Timing of reinstatement of regular diabetic medications and/or variable rate intravenous insulin infusion (VRIII) commencement was also recorded.
- Time in euglycaemic range (TIER) defined as the percentage of four-hour periods within the euglycaemic range during the first week of admission was used as a performance metric.
- The euglycaemic range for all patients in this audit was 4.6-10.0mmol/L in concordance with international guidance.[4]

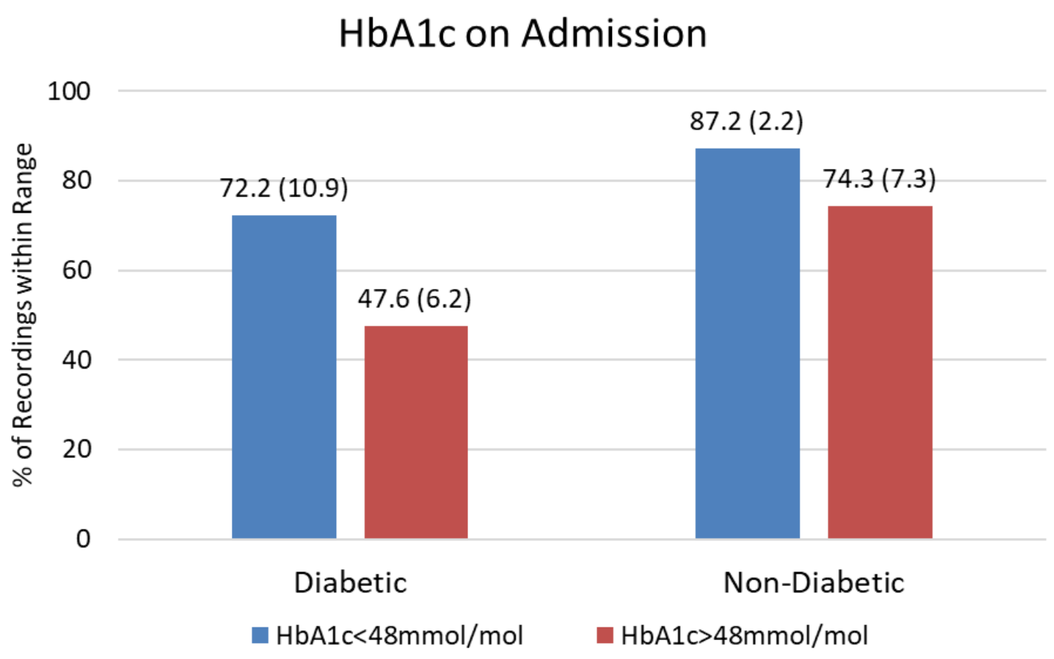

Figure 2. Percentage TIER (Standard Error [SE]) stratified by diabetes and HbA1c status

	All	Diabetic	Non-Diabetic
Time interval between BGC daily (hours)	2.7 (0.1)	2.6 (0.1)	2.8 (0.1)
Time interval between readings when BGC >10mmol/L (hours)	1.9 (0.1)	2.0 (0.1)	1.8 (0.1)
Time to Start VRIII from BGC > 10mmol/L (hours)	6.7 (1.0)	6.2 (1.2)	7.2 (1.6)
Duration of hyperglycaemia (hours)	14.4 (2.0)	18.4 (3.3)	10.7 (2.1)

Table 1. Mean time intervals (SE) for BGC monitoring and hyperglycaemic episodes.

Results

- Pre-admission diabetes status had a profound effect on mean percentage TIER (54.3% SE: 5.6 versus 84.8% SE: 2.6 for diabetic and non-diabetic patient respectively).
- Further stratification for admission HbA1c level above or below 48mmol/mol revealed that well controlled diabetic patients were exempt from this (mean TIER of 72.2% SE: 10.9 versus 47.6% SE: 6.2 for diabetic patients whose HbA1c was above 48mmol/mol), see figure 2.
- A very similar effect was present for diabetic patients with a body mass index above 30kg/m^2.
- Acute steroid use during admission resulted in a reduction in TIER for diabetic patients (38.8% SE: 5.9 versus 64.0% SE: 7.5), but this effect was not present in non-diabetic patients.
- Type of nutritional support and degree of absorption of feed did not impact TIER significantly, regardless of diabetic status, as noted in figure 3.
- Of the patients who received a variable rate intravenous insulin infusion (VRIII) to treat hyperglycaemia, the mean time interval between the initial hyperglycaemic event and the initiation of the VRIII was 6.7 hours (SE: 1.0).
- The mean time interval between hyperglycaemia and return to euglycaemic range was 14.4 hours SE: 2.0 (18.4 hours SE: 3.3 for diabetic patients versus 10.7 hours SE: 2.1 in non-diabetic patients), see table 1.

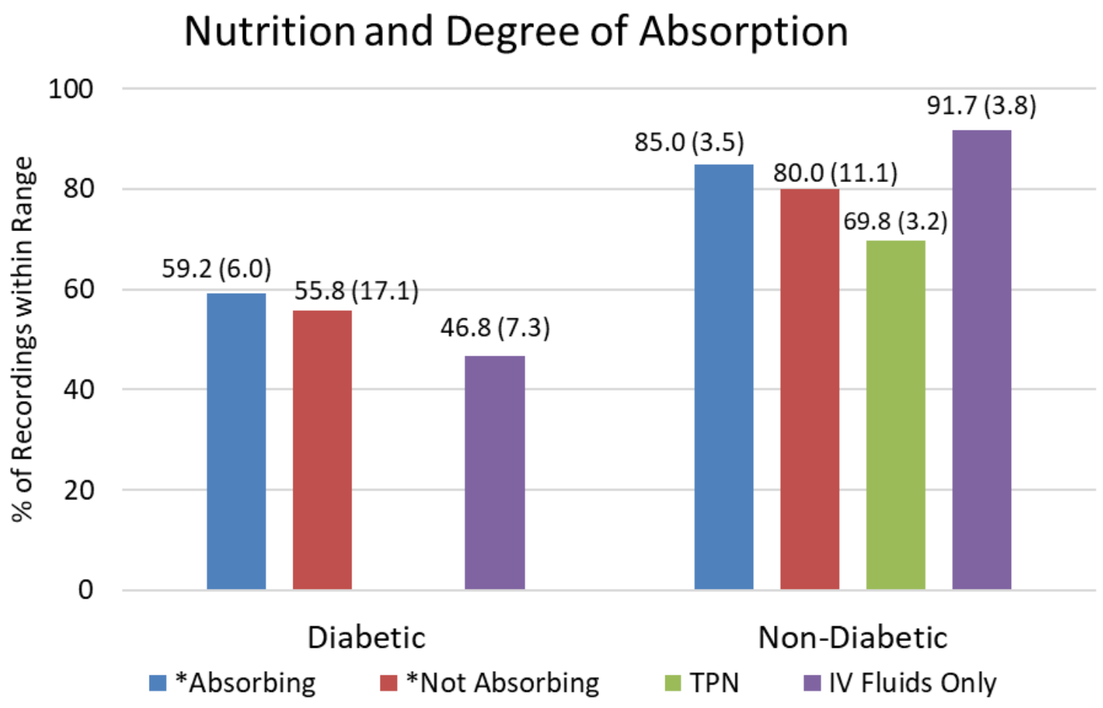

Figure 3. Percentage TIER (SE) stratified by diabetes and nutritional status. *: enteral feeding route

Discussion

- The results of this audit indicate that patients with raised BMI, poor pre-admission glycaemic control, and/or acute steroid use on the capability of the current protocol to manage glucose levels, particularly in diabetic patients.
- Additionally, in our unit, there is a prolonged time-period to regain control of BGC levels in these patients. This is likely related to insulin insensitivity that is accounted for until failure of the standard VRIII protocol has occurred.
- Interestingly, the expected impact of type of nutritional support had no significant bearing on TIER. This is likely related to glucose absorption abnormalities during critical illness, regardless of gastric motility.[5]

Admission Characteristic	**Score**
Past Medical History of diabetes	1
HbA1c >48mmol/mol on day of hospital admission	1
Acute use of Steroids on this admission	1
BGC not responding to initial standard VRIII doses (if already started pre-admission or at the point of ICU admission)	1
More than 100U/day in total for regular insulin use	1
BMI more than 30 kg/m^2	1

Table 2. Proposed risk stratification tool for newly admitted general ICU patients.

Conclusions

- Given the above findings, we have created a risk stratification tool to be implemented on admission for all patients, aiming to facilitate early identification and appropriate management of abnormal BGC (table 2).
- This intervention is awaiting approval and assessment for local and general applicability will be made soon.

References

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