Perioperative hyperglycaemia and its treatment in patients with diabetes mellitus

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AN AUTOMATED REMINDER FOR PERIOPERATIVE GLUCOSE REGULATION IMPROVES PROTOCOL COMPLIANCE

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Abstract

A growing proportion of patients presenting for surgery have diabetes. Unfortunately, perioperative diabetes protocol compliance is low. Using digitalisation of the perioperative environment, an automated reminder in the preoperative assessment platform proved to increase compliance and we advocate its use throughout the perioperative process.

Introduction

The worldwide prevalence of diabetes mellitus (DM) is rising, which translates into a growing proportion of patients with DM presenting for surgery (1,2). Both hypo- and hyperglycaemia are associated with postoperative morbidity (3–6), thus glucose regulation of patients with DM during the perioperative period is of utmost importance. Unfortunately, lack of compliance is notorious (7,8). As the perioperative environment is increasingly digitalized, computer based assistance is now readily available. To study the effect of an automated reminder on protocol compliance, we measured compliance before (A) and after (B) introducing a new perioperative diabetes protocol and after implementing an automated reminder for this protocol (B+).

Methods

We conducted a prospective observational cohort study over three consecutive periods (assessment of protocol A, B and B+), including all patients with DM, undergoing in-patient surgery. Data were collected by chart review. The medical ethics committee waived obligation for informed consent (W2_184 # 12.17.0214). We identified 11 critical steps in the perioperative process. Protocol compliance was calculated as a percentage of these 11 steps (Fig. 1). The glucose target range for all patients was 4.0–10.0 mmol l^{-1}. Oral anti-diabetics had to be stopped on the morning of surgery and no additional background infusion was required for patients treated with oral anti-diabetics only. When patients used insulin, long acting insulin was to be reduced by 50% the night before surgery and a background infusion of glucose 5% at 83 ml h^{-1} was required; with the initial protocol (A), a predefined amount of 8 IU of insulin was added (without potassium). In the new protocol (B), the amount of insulin was calculated during the pre-assessment visit (total daily insulin dose/8). For intra- and postoperative management, a bolus correction schedule was introduced in protocol B. In protocol A, treatment of hyperglycaemia was left at the discretion of the treating anaesthesiologist. After the initial implementation of protocol B we introduced an automated reminder in the electronic data management system of the pre-assessment platform (B+). After identifying the patient with DM, a box opened with the text: 'Prescribe preoperative glucose management and specify units of insulin for the background infusion, if applicable'. No reminder was shown in the intra- and postoperative period. The primary outcome measure was the between-group difference in overall compliance. Subsequently, we assessed the difference in compliance for the separate stages of the perioperative process. Compliance is presented as mean with 95% confidence intervals (CI). Differences in mean compliance were calculated with One-Way ANOVA and Student's t-tests. In addition, we assessed differences in median glucose at the different stages of the perioperative process and the difference in number of hypo- and hyperglycaemic events (glucose < 4.0 mmol l^{-1} or > 10 mmol l^{-1}. Missing glucose data were classified as 'not measured according to protocol'. Glucose is presented as median (IQR). Between group differences were calculated with the Kruskal–Wallis and Mann–Whitney U test. Differences between hypo- and hyperglycaemic events were analysed employing the Chi-square test.

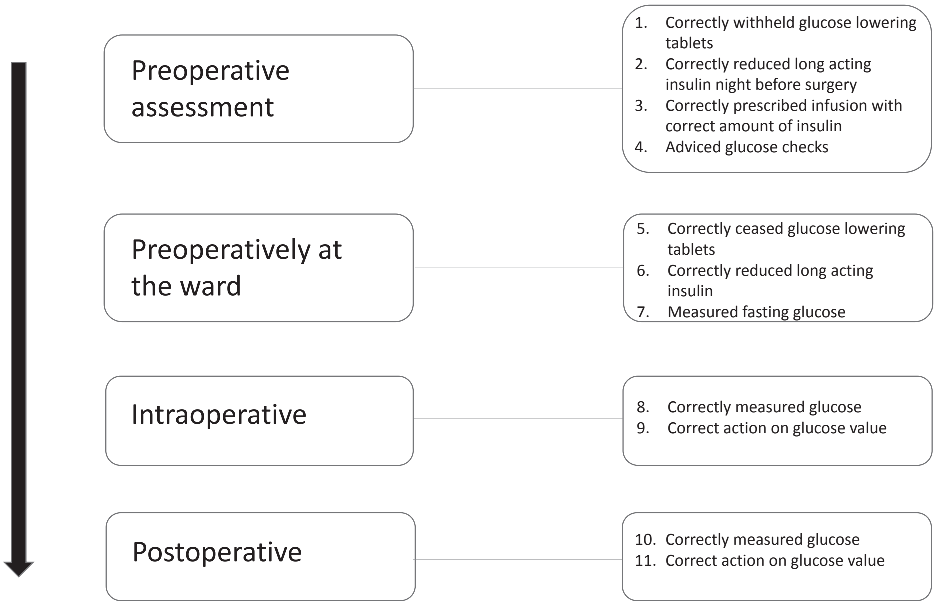

Figure 1. Eleven critical steps of compliance

Results

A total of 510 procedures were included in this study; 192 during protocol A, 144 during protocol B and 174 during protocol B+. Mean age was 63.7 (12.8) and 58.4% of the patients was male. The prevalence of DM type 1 was 7.8%. Of all patients, 44.9% used insulin (table 1). Mean overall compliance significantly decreased from 83.0% (95%CI 80.9 to 85.1) with protocol A to 74.4% (95%CI 71.0 to 77.9) after introduction of protocol B ($p < 0.001$). After implementation of the automated reminder compliance improved to 87.1% (95%CI 85.1 to 89.1), compared to protocol A ($p < 0.006$) and B ($p < 0.001$). The change in overall compliance was mostly due to improvement in compliance at the preoperative assessment platform and preoperatively on the ward. Compliance at the preoperative assessment platform increased from 82.4% (95%CI 78.2 to 86.5) with protocol A to 89.8% (95%CI 86.6 to 92.9) after implementation of the automated reminder (p

Table 1. Patient characteristics per protocol

	Protocol A (n=192) (n, %)	Protocol B (n=144) (n, %)	Protocol B+ (n=174) (n, %)	p-value
Male	116 (60.4)	80 (55.6)	102 (58.6)	0.67
Age, mean (SD)	64.2 (12.8)	63.4 (12.4)	63.4 (13.3)	0.79
DM type				
DM 1	18 (9.4)	10 (6.9)	12 (6.9)	0.60
DM 2	171 (89.1)	130 (90.3)	158 (90.8)	0.85
DM other	3 (1.6)	4 (2.8)	4 (2.3)	0.74
OAD	138 (71.9)	95 (66.0)	134 (77.0)	0.09
Insulin	90 (46.9)	68 (47.2)	71 (40.8)	0.39
Duration of surgery (minutes), median (IQR)	121 (68-240)	125 (80-225)	115 (71-225)	0.30

DM: diabetes mellitus. OAD: oral antidiabetic drugs.

< 0.001). Furthermore, the preoperative compliance on the ward was 67.2% (95%CI 59.3 to 75.1) and 63.8% (95%CI 55.5 to 72.1), with protocol A and B respectively, compared to 81.4% (95%CI 75.1 to 87.7) with protocol B+ ($p < 0.001$). The mean intraoperative compliance did not differ between protocols; 73.0% (95%CI 69.0 to 76.9) with protocol A, 69.6% (95%CI 64.9 to 74.4) with protocol B and 70.9% (95%CI 66.8 to 75.1) with protocol B+ ($p = 0.555$). The mean postoperative compliance was comparable in all groups; 90.1% (95%CI 86.7 to 93.5), 89.7% (95%CI 85.9 to 93.5) and 90.3% (95%CI 87.0 to 93.6) for protocol A, B and B+ ($p = 0.976$), respectively. The perioperative glucose values are shown in Fig. 2. There was no significant overall improvement in glucose control. Fasting glucose and

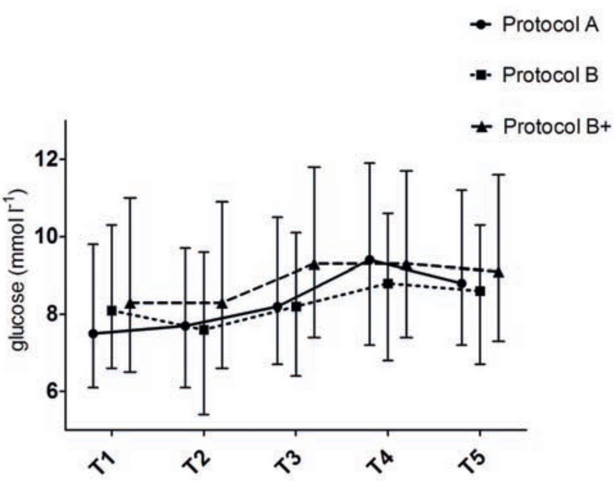

Figure 2. Perioperative median glucose with interquartile range per protocol; T1: Preoperative (n=465), T2: First glucose intraoperative (n=217), T3: Last glucose intraoperative (n=217), T4: First glucose postoperative (n=387), T5: Last glucose postoperative (n=365).

the proportion of patients presenting for surgery with hyperglycaemia was significantly increased with protocol B+ as compared to protocol A ($p = 0.013$ and 0.043). The incidence of pre- and intraoperative hypoglycaemia had significantly decreased from 5 and 9% with protocol A to 0% and 0% in protocol B+ ($p = 0.006$ and $p = 0.026$).

Discussion

In this study we showed that a preoperative automatic reminder significantly improved protocol compliance in the preoperative period, which was not sustained in improved compliance throughout the whole perioperative period. As perioperative diabetes protocol compliance is reported to be as low as 34.7% (7), this is an important finding. Surprisingly, increased preoperative compliance was not accompanied by improved glucose regulation. This shows that using decision support does not guarantee improved clinical outcome (9). In our case, lack of improvement in intra- and postoperative compliance could explain the unchanged overall glucose control. Furthermore, due to the fairly high compliance with protocol A, it proved more challenging to improve glucose regulation with only moderate changes in the new protocol. Paradoxically, the higher fasting glucose values, the higher incidence of preoperative hyperglycaemia and the lower incidence of pre- and intraoperative hypoglycaemia with protocol B+ were most likely due to the increased compliance to the reduction of 50% in insulin dosing the night before surgery. Clinical trials investigating the optimal perioperative diabetes regulation are unfortunately lacking. Only one study assessed different preoperative insulin strategies and administration of eighty percent of the evening dose of insulin was accompanied by a 5% hypoglycaemia rate (between 2.3 and 4 mmol l^{-1}) (10). Combined with our analyses, we changed our protocol to administering 75% of the long-acting insulin dose the night before surgery.

In conclusion, to improve protocol compliance of perioperative diabetes protocols, we advocate using automated reminders throughout the whole perioperative process. Furthermore, while we are awaiting comparative studies on perioperative diabetes management, one should evaluate the consequences of improved protocol compliance, as this further contributes to our knowledge on optimising perioperative diabetes protocols.

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