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Original Research

Evaluation of Protocol-Guided Scheduled Basal-Nutritional-Correction Insulin Over Standard Care for Vascular Surgery Patients

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ABSTRACT

Background: Practice guidelines have recommended scheduled basal, nutritional and correction insulin to manage hyperglycemia in the hospital setting. For many decades, however, the primary practice has been sliding scale insulin.
Objective: To evaluate the efficacy and safety of an institution-specific basal-nutritional-correction insulin preprinted order (BNC-PPO).
Methods: A retrospective, single-centre chart review was conducted on patients admitted to a vascular surgery service to compare inpatient glycemia control before and after implementation of the BNC-PPO. Patients were included if they were aged 19 years or more, admitted between June 2009 and December 2010 (for pre–BNC-PPO) or between April 2011 and August 2012 (for post–BNC-PPO), required insulin before admission for their diabetes mellitus (type 1 or 2) and were prescribed insulin during their admission.
Results: For the primary outcome, the mean (±SD) daily blood glucose during hospital stay was 9.83±1.74 mmol/L for the pre–BNC-PPO group and 8.79±1.60 mmol/L for the post–BNC-PPO group (p=0.005). Mean (±SD) severe hyperglycemia episodes per patient per day had decreased in the BNC-PPO group: 1.13±0.73 and 0.80±1.02 for the before and after groups, respectively (p=0.008). Hypoglycemia (blood glucose <2.2 mmol/L and <4 mmol/L) and mild and moderate hyperglycemia episodes were no different between groups.
Conclusions: A structured and proactive approach to inpatient hyperglycemia management appears to be more effective (reduced mean daily blood glucose and severe hyperglycemia episodes) and safer (no increase in hypoglycemia episodes) in maintaining glycemia control in insulin-dependent diabetes patients.

Mots clés :
basale-prandiale-de correction
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RÉSUMÉ

Introduction : Les lignes directrices de pratique clinique ont recommandé des doses fixes d'insuline basale, prandiale et de correction pour prendre en charge l'hyperglycémie en milieu hospitalier. Cependant, depuis plusieurs décennies, la pratique a eu principalement recours à l'insuline par échelle mobile.
Objectif : Évaluer l'efficacité et la sécurité d'une ordonnance préimprimée d'insuline basale-prandiale-de correction propre à l'établissement (OPI-BPC).
Méthodes : Une revue rétrospective unicentrique de dossiers était menée auprès de patients admis à un service de chirurgie vasculaire pour comparer la régulation de la glycémie des patients hospitalisés avant et après la mise en application de l'OPI-BPC. Les patients étaient inclus s'ils étaient âgés de 19 ans ou plus, s'ils avaient été admis entre juin 2009 et décembre 2010 (avant l'OPI-BPC) ou entre avril 2011 et août 2012 (après l'OPI-BPC), s'ils avaient besoin d'insuline avant l'admission pour leur diabète sucré (de type 1 ou 2) et s'ils avaient reçu de l'insuline à l'admission.
Résultats : En ce qui concerne le critère d'évaluation principal, la glycémie quotidienne moyenne (± σ) durant le séjour à l'hôpital était de 9,83 ± 1,74 mmol/l pour le groupe avant l'OPI-BPC et de 8,79 ± 1,60

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mmol/l pour le groupe après l'OPI-BPC (p = 0,005). Les épisodes moyens (± σ) d'hyperglycémie grave par patient par jour diminuaient respectivement dans le groupe OPI-BPC : de 1,13 ± 0,73 et de 0,80 ± 1,02 dans les groupes avant et après, respectivement (p = 0,008). Les épisodes d'hypoglycémie (glycémie <2,2 mmol/l et < 4 mmol/l) et d'hyperglycémie légère à modérée n'étaient pas différents entre les groupes. *Conclusions :* Une approche structurée et proactive de la prise en charge de l'hyperglycémie des patients hospitalisés semble plus efficace (réduction de la glycémie quotidienne moyenne et des épisodes d'hyperglycémie grave) et plus sécuritaire (aucune augmentation des épisodes d'hypoglycémie) pour le maintien de la régulation de la glycémie chez les patients diabétiques insulinodépendants.

Introduction

Hyperglycemia is a common occurrence among hospitalized patients and has been linked to potential increases in morbidity and mortality (1). For many decades, insulin has been prescribed according to a sliding scale as the primary means of managing hyperglycemia in the hospital setting. This regimen involves administering a prescribed dose of insulin approximately 5 to 30 minutes before meals (typically rapid acting or regular) based on before-meal measurement of capillary blood glucose. Although simple to use, sliding scale insulin is not without its drawbacks; it is a reactive approach to glycemia management and can predispose patients to unintended hyperglycemia and hypoglycemia episodes, especially patients with type 1 diabetes mellitus when no basal insulin is provided (1). Insulin sliding scales are often ordered with glucose checks 4 times a day (breakfast, lunch, dinner and bedtime). Insulin administration at bedtime can lead to potentially dangerous nocturnal hypoglycemia.

Practice guidelines and healthcare providers recommend a more proactive approach to hyperglycemia management in the hospital setting (2–4). The use of basal, nutritional and correction (BNC) insulin more closely mimics physiological insulin secretion. In healthy persons, pancreatic beta cells secrete insulin continuously to maintain basal metabolic glucose regulation and extra insulin in response to meals. A patient with type 1 diabetes would generally use a basal (long-acting) insulin once or twice daily (depending on the insulin type used and associated duration of action) to inhibit hepatic glucose production (5) and nutritional (short or rapid acting) insulin before meals. Nutritional insulin would be omitted from the patient's insulin regimen if the patient is not eating. The third component is correction insulin (short or rapid acting), which is administered to manage any unanticipated before-meal hyperglycemia.

Patients with diabetes undergoing surgery tend to have longer hospital stays and increased morbidity and mortality compared with people who do not have diabetes (1). Recently, Umpierrez et al (6) looked at the use of basal-bolus insulin using glargine and glulisine compared to sliding scale insulin in general surgery patients. The results supported the use of a basal-bolus regimen (improved glycemia control); however, further research is needed to replicate findings. A recent meta-analysis was conducted to determine the effect of intensive glycemia control (defined as fasting glucose between 5.6 and 10 mmol/L) in non-critically ill hospitalized inpatients on death, stroke, myocardial infarction, infection and hypoglycemia (7). The investigators found a reduction in infections in the intensive control group and a trend toward increased hypoglycemia in the intensive control group. All other outcomes failed to reach statistical significance. Consensus guidelines recommend glucose targets in the non-critically ill population between 5 and 8 mmol/L before meals and less than 10 mmol/L on random checks (2).

Hypoglycemia is a serious risk associated with insulin therapy, potentially leading to poor outcomes, increased length of stay, ventricular arrhythmias and mortality (1). A structured preprinted order for BNC insulin administration has been suggested to improve glycemia control and lead to safer administration practices (2). In 2009, a BNC preprinted order (BNC-PPO) was developed in collaboration with pharmacy, nursing and endocrinology to provide guidance on the use of a BNC approach to prescribing insulin at our institution. The BNC-PPO was implemented on the vascular surgery unit in January 2011. In this study, we wanted to evaluate its effectiveness and safety compared to standard care (primarily sliding scale) in patients with diabetes.

Methods

A single-centre, retrospective chart review was conducted at our institution to compare inpatient glycemia control before (pre–BNC-PPO) and after (post–BNC-PPO) implementation of the BNC-PPO (Figure 1). The pre–BNC-PPO group would have received standard care with respect to insulin ordering. Standard care in this study is defined as sliding scale insulin with or without basal insulin with or without nutritional insulin. Patients were included if they were aged ≥19 years or more, admitted to a vascular surgery unit between June 2009 and December 2010 (for pre–BNC-PPO) or between April 2011 and August 2012 (for post–BNC-PPO), required insulin before admission for their diabetes (type 1 or 2) and were prescribed insulin during their admission. A vascular surgery patient population was chosen for our study owing to the high incidence of diabetes in this population and the higher anticipated usage of insulin before admission. Patients were identified through a computer-generated report that captured patients admitted to the vascular service during the specified date ranges and were prescribed regular insulin during their stay. We selected patients with diabetes who required insulin before admission, as these patients are at greater risk of poor glycemia control if their basal insulin requirements are withheld upon admission.

Patients in the post–BNC-PPO arm were required to have been prescribed insulin using the BNC-PPO. If a patient had more than 1 admission during the prespecified time periods, their data were included pending meeting inclusion criteria. Patients were excluded if they had an endocrinology consult during admission; were in hospital for ≤3 days; were admitted to the intensive care unit during their stay; had diabetic ketoacidosis on admission or were using an insulin pump. All patient charts were reviewed retrospectively by a pharmacy resident (M.H.) for further eligibility and data collection. This study was approved by the University of British Columbia Clinical Research Ethics Review Board, Fraser Health Research Ethics Board and the Vancouver Coastal Health Research Institute.

The primary objective was to determine whether the BNC-PPO has resulted in more effective glycemia control for patients with diabetes during their hospital stay. That was calculated through the mean daily blood glucose over length of stay.

Our secondary glycemia control objectives included evaluating the safety of the BNC-PPO through hypoglycemia and hyperglycemia episodes per day and daily glucose variability. Hypoglycemia episodes were defined as a capillary blood glucose reading less than 4 mmol/L. We categorized the hyperglycemia episodes as mild, moderate and severe. Mild was defined as capillary blood glucose between 8.1 and 9.9 mmol/L, moderate as