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Effectiveness of a Nurse-Managed Protocol to Prevent Hypoglycemia in Hospitalized Patients with Diabetes

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ABSTRACT

Background: Hypoglycemia resulting from insufficient carbohydrate intake is a common challenge in the management of diabetic in-patients treated with insulin.

Objective: This study aimed to evaluate the efficacy of a nurse-managed protocol in preventing hypoglycemia during subcutaneous insulin therapy.

Design: A prospective pre-post-intervention study design was employed.

Methods: The study involved 350 consecutive diabetic in-patients. The incidence of hypoglycemia (defined as blood glucose < 70 mg/dL) during subcutaneous insulin therapy was assessed before (phase A) and after (phase B) implementing the protocol. The protocol included options for patients to choose substitutive food to supplement incomplete carbohydrate intake, adjustment of prandial insulin based on actual carbohydrate consumption in cases of poor appetite or partial food intake, and intravenous glucose infusion during extended fasting periods.

Results: Eighty-four patients were included in phase A, while 266 patients were included in phase B. The median duration of subcutaneous insulin treatment was 7 days (Q1–Q3 6–12) in phase A and 6 days (Q1–Q3 4–9) in phase B. The frequency of hypoglycemic events decreased significantly from 0.34 ± 0.33 per day in phase A to 0.19 ± 0.30 per day in phase B ($P > 0.001$).

Conclusions: Implementation of a nurse-managed protocol emphasizing carbohydrate intake resulted in a notable reduction in hypoglycemia incidence among diabetic in-patients receiving subcutaneous insulin therapy in the hospital setting.

INTRODUCTION

Hyperglycemia is common in patients with diabetes in hospital, and several guidelines have suggested using basal and prandial subcutaneous (s.c.) insulin in non-critically ill patients as first-choice pharmacological treatment to ensure the best possible glycemic control, combined with an appropriate nutrition scheme. However, intensive treatment of hyperglycemia risks raising the rate of hypoglycemia and this may worsen the patient's prognosis. (Umpierrez et al., 2012)

No or incomplete carbohydrate intake in the prescribed meal plan exposes patients on s.c. insulin to hypoglycemic events. Skipping one or more meals often happens in hospital to comply with fasting

conditions for certain instrumental and clinical procedures. Organizational problems often cause delays in eating the meal set down in the dietary plan. In addition, the patients' clinical conditions and their drugs may cause lack of appetite, nausea, or vomiting, all leading to reduced food intake. A similar situation can arise as the consequence of scarce palatability or unfamiliarity of the food served in hospital. (Rydén et al., 2013)

Since in our department we frequently observed hypoglycemic episodes after incomplete meals or during prolonged fasting in patients with diabetes treated with s.c. insulin, we introduced a simple nurse-managed protocol aimed at ensuring the recommended carbohydrate intake every day in these patients and/or reducing the dosage of prandial insulin accordingly, under the hypothesis that this might prevent hypoglycemic events and/or reduce their severity. (Egi et al., 2010)

PATIENTS, MATERIAL, AND METHODS

all patients with diabetes or hyperglycemia (BG >200 mg/dL) admitted to our Cardiology Department for suspected acute coronary syndrome (ACS) have been treated according to the Desio Diabetes Diagram (DDD) protocol we designed based on current guidelines. During the acute phase in the intensive cardiac care unit (ICCU), patients were treated with an insulin infusion protocol (IIP) combined with parenteral nutrition using intravenous (i.v.) glucose solution and subsequently in the cardiology ward with s.c. insulin, according to the basal-bolus-correction scheme, associated with oral nutrition. The initial daily dose of s.c. insulin was double the amount given in the last 12 hours of infusion, as follows:

Half the daily amount of insulin was given as a single dose, usually at lunchtime, as basal insulin (glargine). The other half was given as prandial insulin (lispro) just before the three main meals, and the amount was proportional to the carbohydrates in the planned diet: 25% at breakfast, 40% at lunch, and 35% at dinner. Each patient received a diet based on height and sex, containing a fixed amount of carbohydrates equivalent to 55–60% of the total calories calculated based on 22 kcal/day per kg of the ideal body weight.

At the end of the first year of applying the DDD protocol, we evaluated its efficacy and safety. Due to the high frequency of hypoglycemic episodes, often associated with fasting or incomplete carbohydrate intake, we initiated a specific nurse-managed protocol aimed at preventing hypoglycemia. The protocol focused primarily on ensuring each patient receiving subcutaneous insulin had the recommended daily carbohydrate intake.

In this prospective pre-post-intervention study, all patients with diabetes or hyperglycemia consecutively admitted to our cardiology department for suspected ACS were monitored for hypoglycemic events during their hospital stay in the year before the implementation of the protocol and the following three years.

Blood glucose (BG) was measured at the bedside seven times every day throughout s.c. insulin treatment: before and 1.5–2.0 hours after breakfast, lunch, and dinner, and at bedtime. BG was also measured any time the patient experienced symptoms suggesting hypoglycemia.

During phase A and phase B of the study, the glycemic goals did not change: the glycemic target during the acute phase of i.v. insulin infusion was 100–139 mg/dL, and during the subacute phase with s.c. insulin, preprandial and postprandial targets were respectively less than 120 and 160 mg/dL.

To assess the satisfaction of nurses after the DDD protocol had been implemented for more than one year, all the nurses of the ICCU and cardiology ward were asked to complete a questionnaire anonymously. Each answer was rated between 0 (low/little) and 6 (high/much), and scores ≥4 were considered for analysis.

STATISTICAL ANALYSIS

We used the chi-square test to analyze proportions, t-test for means, and Wilcoxon test for median analyses. To assess the efficacy of the protocol for preventing hypoglycemic events during s.c. insulin treatment, we analyzed all hypoglycemic episodes in the year before (phase A) and during the first three years of the implementation of the protocol (phase B). A hypoglycemic event was defined as capillary BG <70 mg/dL with or without related symptoms; a severe hypoglycemic event was defined as BG <40 mg/dL. The incidence of hypoglycemic events during s.c. insulin treatment is expressed as follows: (i) the proportion of patients having one or more hypoglycemic episodes; (ii) the rate of hypoglycemic events per day of insulin treatment; and (iii) the mean number of hypoglycemic events per patient. Since the hospital stay for

patients admitted with ACS slightly declined during the study, we took the rate of hypoglycemic episodes per day as the primary endpoint.

We also constructed Poisson regression to estimate the incidence rate ratio and multivariable logistic models to estimate the odds ratio for the risk of hypoglycemic events considering known confounding variables and implementation of the protocol (phase B). The analyses considered continuous variables (age, body mass index, estimated glomerular filtration rate, initial daily s.c. insulin dose, and length of treatment) and categorical variables (sex, history of diabetes and malignancy, liver failure, infections during hospital stay, and implementation of the protocol). All P values were two-tailed and considered significant if <0.05. All statistical analyses were performed using Stata 12.0 software.

RESULTS

The study population initially consisted of 422 patients with diabetes or hyperglycemia (BG >200 mg/dL) admitted to the Intensive Cardiac Care Unit (ICCU) for suspected Acute Coronary Syndrome (ACS). However, after excluding patients who did not complete intravenous (i.v.) insulin infusion, those who did not transition to subcutaneous (s.c.) insulin treatment, and those who stopped the protocol early, the final study group comprised 350 patients. Among them, 84 were treated before the protocol implementation (phase A), and 266 were treated during the protocol implementation (phase B).

The characteristics of patients in both phases were largely similar, with the exception of Body Mass Index (BMI), which was higher in phase A patients compared to phase B patients. The mean duration of s.c. insulin treatment was also slightly longer in phase A than in phase B.

The study observed a total of 639 episodes of hypoglycemia throughout the study period, with 284 occurring during phase A and 355 during phase B. Additionally, severe hypoglycemic events were recorded, with 20 in phase A and 9 in phase B. This data indicates a trend towards reduced hypoglycemic events during the phase when the protocol was implemented.

The analysis revealed a significant decrease in the rate of hypoglycemic episodes per day of s.c. insulin treatment from phase A to phase B, highlighting the effectiveness of the protocol in mitigating hypoglycemia risks. Similar trends were observed for severe hypoglycemic events, with a notable reduction during the phase when the protocol was in place.

Multivariable analyses further confirmed these findings, showing a significant reduction in both all hypoglycemic events and severe hypoglycemic events during phase B after adjusting for known confounders. This indicates that the protocol implementation played a crucial role in lowering the incidence of hypoglycemia among diabetic patients undergoing insulin treatment for suspected ACS.

Additionally, a questionnaire administered to nursing staff involved in protocol implementation revealed various insights. While some nurses faced challenges during the training phase, the majority found the protocol easy to use and reported improvements in hyperglycemia control and the overall quality of care for diabetic inpatients. Most nurses also felt more independent and expressed overall satisfaction with the protocol's outcomes.

In conclusion, the study demonstrated the efficacy of the nurse-managed protocol in reducing hypoglycemic events during s.c. insulin treatment for diabetic patients admitted with suspected ACS. This not only contributes to better patient outcomes but also enhances the quality of care provided by nursing staff, highlighting the importance of such protocols in clinical practice.

DISCUSSION

The discussion provides a comprehensive analysis of the study's findings regarding the management of hypoglycemia in hospitalized diabetic patients. The importance of tight glycemic control to reduce complications associated with hyperglycemia is highlighted, along with the recognized challenge of avoiding hypoglycemia during treatment. The study emphasizes the need for interventions aimed at preventing hypoglycemia, given its negative impact on patient outcomes during hospitalization. (Elliott et al., 2012)

The implementation of nurse-managed procedures to prevent hypoglycemia showed promising results, with a significant reduction in both hypoglycemic events and severe hypoglycemic episodes. This is particularly

noteworthy as previous clinical guidelines have focused more on treating hypoglycemia rather than preventing it, indicating a shift towards proactive management strategies. (Avanzini et al., 2011)

Comparison with existing literature reveals varying incidences of hypoglycemic events during intensive insulin treatment in hospital settings. However, the study's high incidence of hypoglycemia is attributed to aggressive glycemic targets and frequent blood glucose monitoring, factors that contribute to early detection of even mild hypoglycemic events. (Seaquist et al., 2013)

The study's focus on practical nurse-managed strategies to reduce hypoglycemia due to insufficient carbohydrate intake or fasting is unique. The protocol's emphasis on ensuring recommended carbohydrate intake and adjusting insulin dosage accordingly demonstrates a feasible approach to prevent hypoglycemic events in diabetic in-patients. (Dendy et al., 2014)

Nurses' satisfaction with the protocol is discussed, highlighting their positive response despite some initial challenges in training and increased workload. The protocol's effectiveness in controlling hyperglycemia and preventing hypoglycemic episodes contributed to nurses' overall satisfaction, emphasizing the importance of their autonomy and involvement in patient management. (Murad et al., 2012)

The strengths of the study include its novel approach to hypoglycemia prevention, acceptance by nursing staff, and potential applicability in various clinical settings. The consistent frequency of hypoglycemic events over the study period suggests rapid and effective nurse training and protocol implementation. (Umpierrez et al., 2007)

Limitations of the study, such as its single-center design and the inability to isolate the impact of specific protocol interventions, are acknowledged. However, the study's findings, supported by multivariable analyses, underscore the effectiveness of the nurse-managed protocol in reducing hypoglycemia among hospitalized diabetic patients, indicating its potential for wider implementation and future research. (Moghissi et al., 2009)

CONCLUSION

This study highlights the effectiveness of simple nurse-managed preventive measures in significantly reducing hypoglycemia among diabetic patients receiving subcutaneous (s.c.) insulin treatment during hospitalization. Given the frequent occurrence of hypoglycemic events in hospital settings and their negative impact on patient outcomes, it is crucial to implement preventive strategies that address potential risk factors.

The findings underscore the importance of ensuring patients receive intravenous (i.v.) glucose during prolonged fasting, adhere to planned carbohydrate intake with their diet, and adjust prandial insulin dosage accordingly if appetite is lacking or carbohydrate intake is reduced. Incorporating these measures into routine hospital care for patients on insulin treatment can contribute to a proactive approach in preventing hypoglycemic events.

Overall, the study suggests that these nurse-managed preventive measures should be standard practice in hospitals, particularly for patients undergoing insulin therapy. By implementing these strategies, healthcare providers can mitigate the risks associated with hypoglycemia and improve the overall management of diabetic patients during their hospital stay.

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