Predictors of sliding scale insulin use by housestaff physicians in the management of hospitalized patients with diabetes mellitus

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Objective: To identify predictive factors for the use of sliding scale insulin (SSI) by the housestaff physicians for in-hospital management of diabetes mellitus (DM). **Design**: Prospective cohort study. **Materials & methods**: A total of 215 consecutive patients admitted to the medical or surgical wards of two urban University-affiliated hospitals, with DM as a primary or secondary diagnosis, were prospectively followed to discharge. Demographic, laboratory and clinical data were obtained from in-hospital records. A survey was administered to the primary housestaff physicians regarding the potential reasons for prescribing SSI versus proactive antihyperglycemic therapy (standing insulin dose and/or oral antidiabetic agents). **Results:** SSI was prescribed for 71.2% of the patients and the lowest blood glucose (BG) at which insulin was given was recorded at 150–199 mg/dl (13.2% [of patients]), 200–249 mg/dl (81.1%) and 250–299 mg/dl (6.7%). Factors that predicted the use of SSI by housestaff physicians included the admission service, surgery versus medicine (odds ration [OR]: 6.0, 95% confidence interval: 5.5–23.3; $p = 0.01$), concern regarding wide swings of BG (OR: 5.56 [1.8–16.8]; $p < 0.01$), using the SSI results to estimate the standing dose of insulin (OR: 5.22 [1.8–14.7]; $p < 0.01$) and high BG on admission (OR: 3.92 [1.3–12.3]; $p < 0.02$). **Conclusion:** SSI is commonly prescribed for hospitalized patients with DM. It is more likely to be prescribed on the surgical wards compared with medical service. Perception among house staff regarding the wide swings of BG and the perception of the utility of the SSI to calculate standing-dose insulin were significant predictors for its use. Given the previous reports indicating higher in-hospital BG with the use of SSI, which leads to several complications, increased understanding of the reasons behind the use of SSI by house staff would help develop educational programs aimed at changing this practice in favor of more physiologic insulin regimens.

Keywords: antihyperglycemic therapy, blood glucose , diabetes mellitus, housestaff physicians, plasma glucose, sliding scale insulin

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Diabetes mellitus (DM) is one of the most common comorbid conditions among hospitalized patients. In year 2000 12.4 % of all hospital discharges carried the diagnosis of DM. [1,2]. Furthermore patients with DM have longer hospital stay with increased complications and a higher number of procedures as well as a higher admission rate to intensive care units [3,4].

Tight glucose control has been shown to afford better outcomes in terms of decreased hospital stay and nosocomial infection in people with DM [5,6,13]. In these patients, there is also strong data suggesting decreased long-term mortality with intensive treatment of hyperglycemia during hospitalization. [7].

Sliding scale insulin (SSI) is a common practice in hospitalized patients with DM and is used in more than 70% of cases [8,9]. Data from our group and others [9,10,14] have shown, that the use of SSI resulted in significantly higher intra-hospital glycemia. SSI is usually practiced by housestaff physicians and generally transmitted as a tradition among trainees [11,12,14].

Furthermore education of housestaff physicians has been shown in a recent study to result in better outcomes of DM management, associated with reduction in the use of SSI prescription [8]. However in order to be effective, such educational programs need to emphasize on the predictors of SSI among housestaff physicians. Knowledge of predictors of SSI use could help to develop strategies to help eliminate that practice of SSI and promote better methods for management of hospitalized patients with DM.

The objective of our study was to identify predictors of the use of SSI among house staff physicians. Our cohort was divided into two groups, an SSI (where SSI was used) and non-SSI group (where SSI was not used in any part of the in-hospital DM management) group.

Materials & methods

In a prospective cohort study we evaluated the care provided to diabetic patients in two major University-affiliated hospitals in Brooklyn (NY, USA). Approval was granted by the Institutional Review Board in both institutions prior to study commencement.

Demographic, clinical and laboratory data were collected prospectively over an 8-week period. Patients were eligible for the study if they have DM as a primary or secondary admitting diagnosis and as a result, we identified 215 patients who qualified. Decisions regarding the use of SSI versus standing-dose antidiabetic medications were left to the discretion of the treating physician. A detailed questionnaire was administered to the primary housestaff physicians caring for the patients. These surveys were anonymous to increase the reliability of the information provided by the house staff on the reasons for selecting SSI as a method of treating diabetic patients.

Questions asked in the housestaff survey included demographics such as age, sex, race, level of training, whether US or international medical graduates and department affiliation (medicine vs surgery). Possible reasons for prescribing SSI were also solicited including the severity of patient's illness, convenience, concerns regarding hypoglycemia, instructions by attending supervisor and use of SSI to estimate the actual dose of insulin in the long term. To ensure uniformity of results, trained researchers at both institutions conducted the surveys.

Table 1. Demographic characteristics of patients treated with and without sliding scale insulin during hospitalization.

Parameter	SSI n = 153 (71.2%)	Non-SSI 62 (28.8%)	p-value
Age	59.5 ± 1.075	61.1 ± 2.1	NS
Duration of diabetes (years)	12.08 ± 1.1	14.8 ± 2.6	NS
Hemoglobin A1c %	9.0 ± 0.35	8.2 ± 0.37	NS
Admission PG (mg/dl)	245.4 ± 35.6	234.9 ± 13.3	NS
Fasting BG (mg/dl)	172.5 ± 6.5	140.1 ± 10.5	0.02
Average in-hospital BG (mg/dl)	190 ± 5.8	163 ± 9.2	0.01
Length of hospital stay (days)	11.26 ± 2.6	10.09 ± 4.4	NS
Hypoglycemic episodes	1 (0.8%)	2 (6.3%)	NS
Presence of comorbid conditions	76%	65%	NS

Note: Comorbid conditions included hear failure, stroke, asthma, chronic obstructive pulmonary disease and infections: including pneumonia, urinary tract or systemic infections. Data presented as the mean ± SEM.
BG: Blood glucose; NS: Not significant; OR: Odds ratio; PG: Plasma glucose; SSI: Sliding scale insulin.

Statistical analysis

Using SPSS® version 13.0, student t-test was applied for comparison of the continuous variables such as age, duration of DM, hemoglobin (Hb)A1C and blood glucose (BG) level between the two groups.

A logistic model was used to examine the predictors for using SSI by house staff. Factors examined included instructions by attending physician, admission to surgery versus medicine, concerns for BG swings, instructions by attending supervisor, use of SSI to estimate the actual dose of insulin, and plasma glucose (PG) on admission. In the model we also assessed the effect of the demographic characteristics, such as age, sex, country of medical school graduations of the housestaff physicians, as a predictors for the SSI use. Results were presented as mean ± SEM and odds ratio (OR) with 95% confidence interval (CI).

Results

Table 1 describes baseline demographic characteristic of the study population. For the entire cohort of 215 (mean age: 61 ± 2.1 years), 55.8% were female. Mean duration of DM was 12.7 ± 1.03 years and length of hospitalization 10.9 ± 2.3 days. There were no differences in age (59.5 ± 1.075 vs 61.1 ± 0.1, p = NS), duration of DM (12.08 ± 1.1 vs 14.8 ± 2.6, p = NS), HbA1C (9.0 ± 0.35 vs 8.2 ± 0.37, p = NS) for the SSI and non-SSI group, respectively. Of the total cohort only 53.4% had HbA1c measurements recorded. There were also no significant differences in the presence of comorbid conditions, admission PG or hypoglycemic episodes between the two groups (Table 1).

Out of 215 patients, 182 were admitted to medical ward, 33 were hospitalized on the surgical floor. In our cohort, 153 (71.2%) patients were placed on SSI (SSI group), and 62 (28.8%) treated with a standing dose of insulin (non-SSI group). SSI was started, 3–4 times/day, with the lowest BG 150–199 mg/dl (13.2%), 200–249 mg/dl (81.1%), 250–299 mg/dl (6.7%), noting that some patients might be undergoing a procedure or imaging study that hinder the ability to follow the routine BG measurements. The average in- hospital BG level (calculated as the mean of the 3–4 times BG values

obtained per day, generally fasting, pre-lunch and dinner and at bed-time), in non-SSI group was 163 ± 9.2 mg/dl compared with the SSI group (190 ± 5.8 mg/dl; p = 0.01). Fasting BG was also better controlled in the non-SSI group (140.1 ± 10.5 mg/dl vs 172.5 ± 6.5 mg/dl; p = 0.02) in the SSI group. There were no significant difference in the incidence of hypoglycemia between the two groups – one episode of BG less than 60 mg/dl in the SSI group versus two episodes in the non-SSI (p = NS).

Factors that predicted the use of SSI by house-staff physicians included the admission service, surgery versus medicine (OR: 6.0; 95% CI: 1.5–23.3; p = 0.01), concern regarding wide swings of BG (OR: 5.56 (95% CI = 1.8 – 16.8; p < 0.01), using the SSI results to estimate the standing dose of insulin: OR =5.22 (95% CI = 1.8 – 14.7; p < 0.01) and high PG on admission: OR = 3.92 (95% CI = 1.3 – 12.3; p = 0.02) (**Table 2**). Other factors including demographic background such as age of the physician, race, and medical school graduation didn't seem to play a role in decision making process of prescribing SSI by house staff physicians.

Discussion

Our study, performed at two urban, teaching hospitals, indicates that SSI is frequently used as a treatment of in-patient DM. The practice of prescribing SSI, despite years of persistent criticism, passes through the generations without the evidence for its rationale.

In our study 71.2% of diabetic patients were receiving SSI. This is consistent with previous studies, which generally examined more than 70% of hospitalized patients being treated with SSI [9,10]. Again, our data confirm that the use of a standing antidiabetic regimen, insulin and/or hypoglycemic agents, generally resulted in better glycemic control. For those treated with and without SSI, in our study, mean BG was 190 and 163, respectively. According to the current evidence, this substantial decrease in the mean BG (27 mg/dl), might have a long-term impact on CVD risk for these patients [7]. Furthermore, our data showed that in 81.1% of those receiving SSI, no treatment was initiated for BG levels less than 200 mg/dl, thus allowing hyperglycemia to go untreated.

Table 2. Predictors of SSI use by house staff for hospitalized patients with DM.

Predictor	OR	95% CI	p-value
Admission to surgery vs medicine	5.91	1.5–23.3	0.01
Concern for BG swings	5.56	1.8–16.8	<0.01
Using the SSI to calculate standing-dose requirement for insulin	5.22	1.8–14.7	<0.01
PG on admission > 250 mg/dl	3.92	1.3–12.3	0.02

BG: Blood glucose; CI: Confidence interval; OR: Odds ratio; PG: Plasma glucose; SSI: Sliding scale insulin.

Management of DM, especially in hospitalized patients, is a complex task. Since patients with DM are frequently hospitalized with co morbid conditions, glucose control is rarely a primary focus of in-patient care. This practice often leads to hyperglycemia and its adverse effects such as prolonged wound healing, decreased immune function and increased susceptibility to infection [15,16].

Addressing this serious management issue, in March 2004 the American Association of Clinical Endocrinology led a consensus conference during which experts from around the world recommended specific glycemic targets for hospitalized patients. For patients admitted to the general hospital floor, recommended goals are 110 and 180 mg/dl for pre- and postprandial glycemia, respectively. In intensive care units, mean BG should be below 110 mg/dl. However for safe and efficient implementation of these recommendations, without using SSI, new protocols with standardized algorithms are currently in development [17].

Furthermore, accumulating evidence has indicated the effectiveness of a multidisciplinary approach in achieving better glycemic control [5,6], consisting of a dietician, an endocrinologist and a nurse educator, in one study, which resulted in a reduction in nosocomial infections from 9 to 5% with tight control of glycemia as compared to the control group [6]. In another prospective study [5], intensively- treated patient with primary diagnosis of DM had shorter hospital stay as compared with the conventionally treated cohort (5.5 vs 7.5 days). In this study 3-month readmission rate was also much lower in the intervention group compared with control (15 vs 32%).

Finally, in a recent study by Baldwin and colleagues, authors optimistically affirmed that house staff can effectively be taught the management of in-patient DM, with the elimination of use of SSI from the current practice [9]. Interestingly, Baldwin's data revealed a decrease in the use of SSI by 60% among surgical staff, indicating that the rationale for physiological insulin therapy providing basal and preprandial coverage can be effectively imprinted into medical train-

Highlights

- Sliding scale insulin (SSI) is frequently prescribed by housestaff physicians for hospitalized patients with diabetes. In our study, 72% of subjects with diabetes received SSI.
- Predictors for the use of SSI among housestaff physicians included admission to surgical service, concerns regarding wide swings in blood glucose and the belief that it could be used to estimate standing dose of insulin for long-term treatment.
- Compared to SSI, the use of a standing antidiabetic regimen with insulin and/or oral hypoglycemic agents resulted in better glycemic control and a similar length of hospitalization.
- Targeted educational programs for housestaff physicians are needed in order to achieve better inpatient glycemic control for the diabetic population.

ing. Identifying predictors of the use of SSI in our current study, such as admission to surgery and addressing the concerns regarding BG swings, could lead to the development of more targeted educational programs that result in better management of hospitalized patients with DM.

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