EVALUATION OF DIABETES MANAGEMENT IN A RURAL COMMUNITY HOSPITAL

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ABSTRACT

Objective: To evaluate the effectiveness of implementing standardized insulin protocols in a small, rural community hospital.

Methods: This retrospective review was performed on charts of 300 inpatients who received insulin treatment while hospitalized between January 1, 2006, and June 30, 2006. For patients who met the inclusion criteria, the collected information included the following: serum glucose level at hospital admission, glucose level that initiated the treatment protocol, time-to-fasting euglycemia, time-to-random euglycemia, and method of insulin administration. Comparisons were performed between the effectiveness of the new insulin protocols and routine insulin treatment orders.

Results: A total of 168 patients met the study inclusion criteria. The mean glucose concentration that triggered initiation of insulin treatment was 262 mg/dL, which is significantly higher (P<.001) than levels recommended by the American Diabetes Association (ADA) and the American College of Endocrinology (ACE). There was a statistically significant relationship (P = .007) between time-to-fasting euglycemia and length of hospital stay. Implementation of the standardized insulin protocol did not improve the achievement of fasting euglycemia (P = .753). Most patients never reached the target glucose level goals despite the use of standardized protocol.

Conclusion: Significant delays in initiating the insulin protocol and frequent failure in achieving target glucose levels demonstrate delayed recognition of hyperglycemia by hospital staff as well as ineffective use of standardized insulin protocols. Protocol improvement and increased hospital staff education concerning appropriate hospital target glucose levels are required to achieve ADA/ACE recommendations in small community hospitals. **(Endocr Pract. 2008;14:50-57)**

Abbreviations:
ACE = American College of Endocrinology; **ADA** = American Diabetes Association; **ICU** = intensive care unit

INTRODUCTION

The prevalence of diabetes mellitus is increasing dramatically in the United States. Approximately 21 million Americans are estimated to have diabetes mellitus (7% of the US population) with 35% of affected individuals (more than 5 million) undiagnosed (1). Consequently, nearly one-third of persons admitted to the hospital with clinically significant hyperglycemia have not previously been identified as having diabetes. In addition, hyperglycemia is an independent marker of increased hospital mortality (13%), especially in those persons with no previous diagnosis of diabetes (2). Despite this high frequency of new diabetes diagnoses in the hospital, more than one-third of patients admitted to the hospital who meet the American Diabetes Association (ADA) criteria for diabetes are still not recognized during hospitalization. If hyperglycemia is not treated, then a golden opportunity to intervene and educate is lost (3). The established benefits of intensive outpatient treatment of hyperglycemia and its effects on reducing the risk for microvascular and macrovascular complications have been well known for some time. However, the benefit of glycemic control for hospitalized patients has only recently been recognized and addressed.

Submitted for publication May 3, 2007
Accepted for publication July 6, 2007
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In this regard, study findings have shown that glucose levels that are diagnostic of diabetes mellitus (fasting glucose levels greater than 126 mg/dL or a random glucose measurement greater than 200 mg/dL) double the length of hospital stay, double the total cost of hospitalization, increase the risk of postoperative complications, and result in an 18-fold increase in hospital mortality. The benefits of intensive glucose control during acute myocardial infarction, coronary artery bypass graft, and other critical illnesses in the intensive care unit (ICU) have been documented.

Some of first clinical research studies that noted a benefit in clinical outcomes from control of hyperglycemia were publications from the Diabetes Insulin-Glucose in Myocardial Infarction (DIGAMI) Study Group. Malmberg et al reported a 52% reduction in 1-year mortality ($P<.02$) in patients who received insulin-glucose infusion that was initiated as soon as possible after onset of myocardial infarction (4). The treatment effect was most pronounced in patients without previous insulin medication and who were at low risk of cardiovascular events. Subsequent studies have noted that mortality is doubled in persons with hyperglycemia at the time of an acute myocardial infarction and that hyperglycemia serves as an independent predictor of poor long-term outcomes.

Continuous insulin infusion, with a target glucose level below 150 mg/dL, in diabetic patients undergoing coronary artery bypass graft demonstrates a 0.9% cardiac-related mortality rate when compared with mortality rates of 14.5% in patients treated with subcutaneous insulin administration who have glucose levels greater than 250 mg/dL—an absolute perioperative mortality reduction of 57% (5).

In critically ill patients, hyperglycemia is fairly common, regardless of presence or absence of a previous diagnosis of diabetes (6). Krinsley found that only slight elevations of glucose levels increased mortality among patients in the ICU (7). Attaining euglycemia in critically ill patients reduces morbidity and mortality (6). The induction of protocols to maintain normal glucose levels shows beneficial effects such as decreased mortality, organ dysfunction, and length of hospital stay in patients with a wide range of illnesses and disease severities (8).

As a result of these recent studies in the hospital setting, many major US hospitals have been implementing new inpatient diabetes treatment protocols. The ADA and the American College of Endocrinology (ACE) have published a set of recommendations that reflect the evidence previously described (9). These guidelines have been generally accepted by medical staff and hospital personnel. Although there is no universal protocol, the following goals are generally accepted to achieve serum glucose levels within guidelines recommended by the ADA/ACE: (a) patients who are critically ill should have glucose levels no higher than 110 mg/dL at any time and (b) fasting serum glucose levels in noncritical care inpatients should be no higher than 110 mg/dL with postprandial serum glucose levels no higher than 180 mg/dL (10). Yet, many factors contribute to patient insulin requirements, and therefore, a single algorithm that applies to all patients equally is impractical (6). Thus, closer monitoring and frequent updates to patient insulin protocols is important.

Subsequent studies have described the ability of intensive insulin administration to achieve intensive glucose control in critically ill patient populations. These studies have been completed primarily in large metropolitan or academic institutions (11-13). However, there is a paucity of data concerning the success of implementing such protocols in smaller or rural hospitals. The purpose of this study was to evaluate the effectiveness of implementing standardized insulin protocols in a small, 75-bed, rural community hospital to achieve the serum glucose levels recommended in the new ADA/ACE guidelines for glycemic control.

METHODS

A retrospective review was performed on charts of 300 patients who received insulin treatment during the 6-month period of January 1, 2006, through June 30, 2006. Information was obtained using a pharmacy-generated patient list of those patients who had received insulin during their hospital stays.

All patients with hyperglycemia were included regardless of whether they had a history of diabetes. Inpatients being cared for in the ICU or medical/surgical unit were included (178 patients). Patients who received treatment only in the emergency department were subsequently excluded from this study (122 patients). In addition, patients admitted for diabetic ketoacidosis (10 patients) were excluded because of characteristics and treatment that differs from most other diabetic inpatients. The following parameters were recorded: sex, age, ethnicity, length of stay, type of diabetes (1 or 2), glucose level at admission, the sentinel glucose level triggering initial insulin therapy, hemoglobin A_{1c} level, average fasting glucose level, preadmission history of insulin use, method of inpatient insulin administration, time-to-fasting euglycemia, time-to-random euglycemia, number of hypoglycemic events (mild or severe), and number of days between discharge and readmission.

The admission serum glucose level was defined as the serum glucose measured as part of the patient's initial laboratory tests on hospital admission, regardless of admission time. The glucose level that triggered insulin treatment was read as the serum glucose value before the first dose of insulin was administered. Time-to-fasting and time-to-random euglycemia were calculated using the difference in time between initial insulin administration and the time when the patient reached goal serum glucose levels that have previously been described. Time-to-fasting euglycemia was determined by looking at the time of the initial insulin dose and calculating the number of minutes it took for the patient to achieve a glucose level of less than 110 mg/dL. Time-to-random euglycemia was determined by looking at the time of the initial insulin dose and calculating the number of minutes it took for the patient to achieve a serum glucose level of less than 180 mg/dL (this glucose reading could be at any point throughout the day). Fasting glucose levels were those readings taken between 4 AM and 8 AM (values obtained closest to 8 AM).

A mild hypoglycemic event was defined as any serum glucose reading less than 70 mg/dL, but more than 50 mg/dL. A severe hypoglycemic event was defined as any serum glucose reading below 50 mg/dL with or without symptoms.

No patient or physician identifiers were recorded to maintain patient and provider confidentiality. Once collected, all data were analyzed in SPSS version 14 (statistical package for the social sciences). Cross tabulations, chi-square test, descriptive statistics, and binomial tests were used to process data when applicable. The study was approved by the institutional review board of Ohio University as well as by the community hospital from which data were collected.

RESULTS

Of the 300 inpatients who received insulin during their hospital stay, 168 met the inclusion criteria for the study. One hundred twenty-two patients with hyperglycemia received insulin, but were not admitted to the hospital and therefore did not meet the inclusion criteria. Another 10 people were excluded because they had diabetic ketoacidosis, and their treatments were substantially different than the floor patients. Mean age of participants was 66 years (range, 27-96 years). The study population was composed of 96 women (57%) and 72 men (43%). Participants were predominately white (163 of 168, or 97%). Of the 168 patients, 26 (15%) had no previous diagnosis of diabetes mellitus. Most of the patients had type 2 diabetes mellitus (143 of 146, or 98%). Of the 168 patients, 69 (41%) were already taking insulin to manage their diabetes at the time of hospital admission. The mean length of hospital stay was 6.54 days (range, 1-36 days).

The mean admission serum glucose level was 224 mg/dL (range, 67-704 mg/dL). Only 71 (42%) of 168 patients had a hemoglobin A_{1c} level measured during their stay. In those patients who had hemoglobin A_{1c} measured, the mean level was 8.1% (range, 5.4%-17%). The study population's average fasting glucose level ranged from 54 mg/dL to 379 mg/dL.

There were 3 modalities of insulin administration used in this hospital during the study: sliding scale, standardized subcutaneous insulin protocol, and standardized intravenous insulin protocols (which included standardized intravenous insulin protocol, diabetic ketoacidosis protocol, and Portland surgical IV protocol). Of the 168 patients, 12 (7%) received insulin via sliding scale, 157 (93%) received insulin via the standardized subcutaneous protocol (Appendix 1), and 20 (12%) received insulin via the standardized intravenous protocol (Appendix 2).

Of the 168 patients, 38 (23%) had insulin administered at or below the recommended 180 mg/dL trigger level. Thirty-four of the 38 patients (89%) received standardized subcutaneous insulin, and 3 received sliding scale insulin (8%). Of this group of 38 patients, 33 (87%) had type 2 diabetes mellitus, 1 (3%) had type 1 diabetes mellitus, and 3 (8%) had not been previously diagnosed with diabetes.

The mean serum glucose level that triggered administration of insulin was 262 mg/dL (range, 123-704 mg/dL) (Fig. 1). Almost half of the patients (75 or 45%) did not get insulin until the glucose level rose above 250 mg/dL. The glucose level triggering treatment was significantly higher ($P<.001$) than the recommended postprandial glucose level of 180 mg/dL. Data on 3 patients were not available to determine the glucose level that triggered insulin administration.

Of the 168 patients, 110 (65%) never achieved fasting target glucose levels regardless of the protocol used. For the 58 (35%) who achieved target fasting glucose levels, the mean time-to-goal was 3.36 days (range, 3.67 hours to 20.32 days). Of the 168 patients, 147 (88%) achieved random target glucose levels with a mean time-to-goal of 21.22 hours (range, 1 minute to 6.73 days). Hypoglycemia was uncommon; mild hypoglycemic events occurred in 17 patients (10%) and severe hypoglycemia occurred in 4 (2%) patients. Of the 17 patients with mild hypoglycemia, 2 (12%) had type 1 diabetes and 15 (88%) had type 2 diabetes. Of the 4 patients with severe hypoglycemia, 1 (25%) had type 1 diabetes and 2 (50%) had type 2 diabetes. The low occurrence of hypoglycemia in the population prevented any meaningful inferential statistical analyses.

According to binomial testing, the mean glucose level that triggered insulin treatment (262 mg/dL) was much higher than the glucose level recommended by the ADA/ACE ($P<.001$). In fact, 127 (76%) of the 168 patients had a serum glucose level greater than 180 mg/dL when the first dose of insulin was administered. There was a statistically significant relationship between the length of time to achieve fasting euglycemia and the length of hospital stay ($P = .007$); the longer the length of stay, the more likely it was that the patient would achieve euglycemia ($P = .004$). Regarding patients achieving fasting euglycemia, the average length of stay was 8.5 days whereas the average length of stay for patients failing to achieve recommended fasting glucose levels was 5.5 days ($P<.001$). There was no statistically significant difference in sex of those achieving fasting euglycemia ($P = .111$) or random euglycemia ($P = .059$). The population was predominantly white and com-

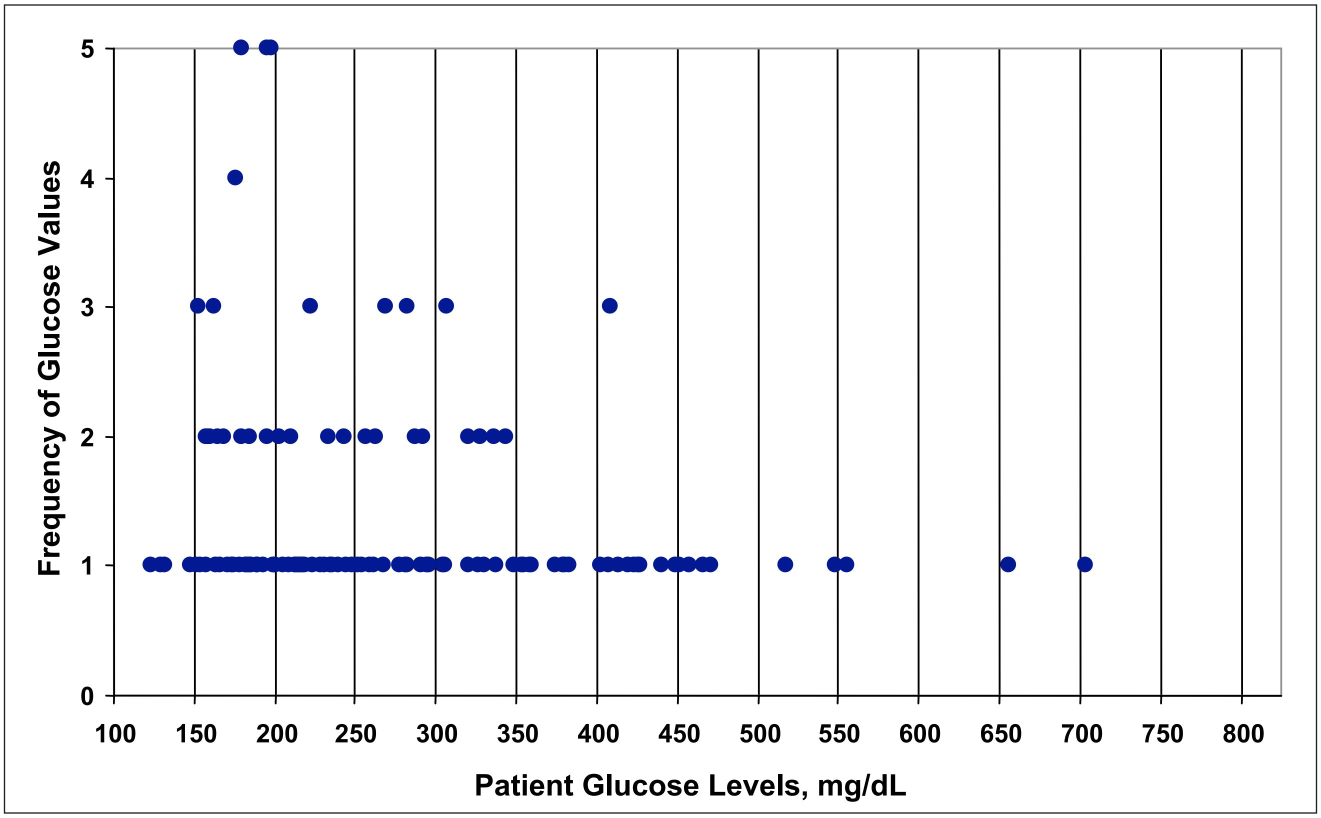

Fig. 1. Glucose levels triggering insulin treatment in 168 inpatients with hyperglycemia in a rural community hospital. According to existing treatment protocols, the recommended glucose value that should trigger insulin treatment is 180 mg/dL. Of 168 patients, 125 (76%) had glucose values that exceeded 180 mg/dL. Patient glucose values triggering insulin treatment averaged 262 mg/dL, a value significantly higher than recommended (*P*<.001).

posed of patients with type 2 diabetes; almost all patients were treated on the medical floor so correlations between demographics or setting (ICU vs medical floor) and glucose control could not be determined.

There was no significant relationship between the treatment method and achievement of fasting or random euglycemia (*P* = .601). No conclusions could be drawn from the sliding scale insulin or standardized intravenous protocol because of limited number of patients receiving those treatment modalities.

DISCUSSION

In this small community hospital, there was a very high rate of acceptance and use of standardized hospital insulin protocols by physicians in private practice. However, there was a significant delay in the initiation of these protocols and a failure of these protocols to achieve target glucose levels in a timely fashion. In fact, most patients never achieved target glucose levels despite protocol use. The mean glucose level that triggered initiation of the insulin protocol in this community hospital was 262 mg/dL, much higher than the recommended target of 150 mg/dL recommended by the ADA/ACE. The study results suggest that both nursing staff and physicians are slow to recognize hyperglycemia and initiate appropriate treatment in the hospital setting. The observation that only 34% of patients ever achieved target glucose levels even with protocol use indicates that the protocols are not being fully implemented and that patients are being discharged with unacceptably high glucose levels. The delays in therapy initiation, as well as failure of daily modification of the protocol once initiated, most likely explain these results.

This study only recorded time required to achieve euglycemia, not whether it was maintained. However, the investigators observed that achieving euglycemia was often only "a brush with normalcy." Often, after target glucose levels had been achieved, the glucose level was elevated at the next measurement and never returned to target levels again during hospitalization. The low success rate of achieving glucose levels at or below recommended values for both fasting and random goals and maintaining those values must to be addressed by future studies.

The study also did not account for differences in the types of insulin used because the community hospital almost universally uses regular insulin for intravenous use, insulin aspart for subcutaneous administration, and insulin glargine for basal insulin. The authors thought that use of other insulins was negligible, and data were therefore not collected or analyzed regarding various insulin types or whether insulin type affected patient outcomes. In addition, fewer than 10% of the patients were treated in the ICU after the exclusion of those with diabetic ketoacidosis. Therefore, this study focused on evaluating the use of insulin protocols in a medical unit of a community hospital.

Surprisingly, this study demonstrates that implementing a standardized subcutaneous insulin protocol in a community hospital setting does not result in a statistically significant improvement in glucose control compared with the sliding-scale coverage. The protocols used were based on the assumption that glucose patterns for each patient would be monitored at least 3 to 4 times a day and that insulin orders would be updated daily by the physician on the basis of the patient's response to the insulin treatment. This study did not evaluate the frequency of glucose monitoring for each patient. However, we observed that attending physicians were not checking glucose levels or updating insulin orders frequently enough. There was no guideline in the protocol to incorporate the total correction insulin doses used the preceding day into the patient's maintenance insulin regimen. Therefore, the standardized protocols were still being used as glorified sliding-scale regimens. A critical component to successful insulin protocol implementation is frequent monitoring and daily adjustments of insulin with incorporation of a maintenance insulin replacement protocol.

Finally, one of the major concerns of both nursing and medical staff with regard to aggressive insulin therapy is the fear of hypoglycemia. The study results demonstrate that the occurrence of hypoglycemic events, both mild and severe, is infrequent in the community hospital setting. Findings from previous studies have demonstrated that routine sliding-scale regimens actually increase the frequency of hypoglycemia (14). Thus, although fear of hypoglycemia is real to the health care team, it is overstated and less likely to occur with protocol use. This study demonstrates that even in a small community hospital setting, insulin protocols can be introduced without undue fear of hypoglycemia.

A number of weaknesses are present in this study. Data collected from this study were captured from chart review in a retrospective manner. Quality of the data is dependent on the quality of charting. Patients were not randomized, but rather a convenience sample was obtained from the first 300 patients who received insulin in the hospital in a 6-month time period. We were not able to capture mortality data so these outcomes were not included.

Setting a lower glucose trigger level of 150 to 180 mg/dL for initiation of the insulin protocols will reduce the time delay of initiating the protocol that we observed in this study. In addition, implementation of a minimum frequency of 4 glucose assessments per day, lower random and fasting target glucose levels (80 to 120 mg/dL), and an algorithm for daily maintenance insulin adjustments would also reduce the time it takes to achieve and maintain in-hospital target glucose levels. However, the success of establishing lower glucose target levels for initiating or changing therapy in these protocols must be elucidated in future studies.

Previous studies evaluating the success of implementing intensive inpatient insulin protocols focused on large urban tertiary hospitals. Our study examined a small community hospital in a rural setting. The results suggest that although acceptance of such protocols by nursing and medical staff is good, there are significant delays in implementation and limited success in achieving and maintaining target glucose levels. Given the high prevalence of diabetes, cardiovascular disease, and stroke in the Appalachian region compared with national prevalence data (Schwartz et al, unpublished data, 2007), implementing protocols to achieve intensive glucose control in small, rural community hospitals is important.

It could be argued that rural hospitals do not have the resources available to implement such protocols compared with hospitals in large metropolitan areas. This study demonstrates, however, that insulin treatment protocols are accepted and implemented in the rural hospital setting. Yet, the protocols must be more specific and designed to prompt the primary care physician to continually update insulin orders as already suggested. Subsequent to these findings, this rural community hospital has changed its protocols to now require more frequent monitoring and daily insulin updates, and we anticipate follow-up investigations to determine if these changes are beneficial.

CONCLUSION

Intensive glucose control in the hospital setting improves patient outcomes and reduces total costs. The implementation of complex insulin treatment protocols in tertiary care centers has proven challenging, but achievable. This study describes our experience implementing an intensive insulin treatment protocol in a small, rural hospital. Results indicate that the initial protocols are not specific or aggressive enough to achieve target glucose levels as outlined in current ADA/ACE hospital guidelines. The evolution of more specific inpatient diabetes protocols for community hospitals will hopefully help overcome the unintended treatment inertia observed in this study and facilitate the movement toward more aggressive treatment of hyperglycemia for all hospitalized persons with diabetes.

ACKNOWLEDGMENT

The authors would like to acknowledge the Ohio University College of Osteopathic Medicine, Research and

Scholarly Affairs Fellowship and Grace Brannan, PhD, for support of this project.

DISCLOSURE

The authors have no conflicts of interest to disclose.

REFERENCES

1. **Centers for Disease Control and Prevention**. National diabetes fact sheet: general information and national estimates on diabetes in the United States, 2005. Centers for Disease Control and Prevention Web site. http://www.cdc.gov/diabetes/pubs/pdf/ndfs_2005.pdf. Accessed March 26, 2007.
2. **Umpierrez GE, Isaacs SD, Bazargan N, You X, Thaler LM, Kitabchi AE**. Hyperglycemia: an independent marker of in-hospital mortality in patients with undiagnosed diabetes. *J Clin Endocrinol Metab*. 2002;87:978-982.
3. **Levetan CS, Passaro M, Jablonski K, Kass M, Ratner RE**. Unrecognized diabetes among hospitalized patients. *Diabetes Care*. 1998;21:246-249.
4. **Malmberg K, Rydén L**, **Hamsten A**, **Herlitz J**, **Waldenström A**, **Wedel H**. Effects of insulin treatment on cause-specific one-year mortality and morbidity in diabetic patients with acute myocardial infarction. DIGAMI Study Group. Diabetes Insulin-Glucose in Acute Myocardial Infarction. *Eur Heart J*. 1996;17:1337-1344.
5. **Furnary AP, Gao G, Grunkemeier GL et al**. Continuous insulin infusion reduces mortality in patients with diabetes undergoing coronary artery bypass grafting. *J Thorac Cardiovasc Surg*. 2003;125:1007-1021.
6. **Van den Berghe G**. Insulin therapy for the critically ill patient. *Clin Cornerstone*. 2003;5:56-63.
7. **Krinsley JS**. Association between hyperglycemia and increased hospital mortality in a heterogeneous population of critically ill patients. *Mayo Clin Proc*. 2003;78:1471-1478.
8. **Krinsley JS**. Effect of an intensive glucose management protocol on the mortality of critically ill adult patients [erratum in *Mayo Clin Proc*. 80:1101]. *Mayo Clin Proc*. 2004;79:992-1000.
9. **ACE/ADA Task Force on Inpatient Diabetes**. American College of Endocrinology and American Diabetes Association Consensus Statement on Inpatient Diabetes and Glycemic Control. *Diabetes Care*. 2006;29:1955-1962.
10. **Garber AJ, Moghissi ES, Bransome ED et al**. American College of Endocrinology position statement on inpatient diabetes and metabolic control. *Endocr Pract*. 2004;10(Suppl 2):4-9.
11. **González-Michaca L**, **Ahumada M**, **Ponce-de-León S**. Insulin subcutaneous application vs. continuous infusion for postoperative blood glucose control in patients with non-insulin-dependent diabetes mellitus. *Arch Med Res*. 2002;33:48-52.
12. **Marik PE, Raghavan M**. Stress-hyperglycemia, insulin and immunomodulation in sepsis. *Intensive Care Med*. 2004;30:748-756.
13. **McMullin J, Brozek J, Jaeschke R, et al**. Glycemic control in the ICU: a multicenter survey. *Intensive Care Med*. 2004;30:798-803.
14. **Queale WS, Seidler AJ, Brancati FL**. Glycemic control and sliding scale insulin use in medical inpatients with diabetes mellitus. *Arch Intern Med*. 1997;157:545-552.

Appendix 1.

Standardized subcutaneous insulin protocol of a rural community hospital. Of 168 study patients, 157 (93%) received insulin under this protocol.

Standardized Subcutaneous Insulin

Patient label

Blood glucose monitoring:

- ❑ Before meals and at bedtime
- ❑ Every ____ hours
- ❑ 90 minutes post prandial

Goal: pre-meal blood glucose = 80-150 mg/dL

Aspart = Novolog (Humalog)…onset of action 15 minutes
Regular = Novolin (Humulin)…onset of action 30 minutes
Glargine = Lantus duration of action up to 36 hours
NPH = Novolin N (Humulin N) duration of action up to 24 hours

Correction Scale: [Must choose (circle) an algorithm: (low - high - individualized)]

- Administer in addition to usual scheduled insulin dose
- Titrate daily if post-prandial FSG are high
- ❑ Aspart (or)
- ❑ Regular

Pre-meal Blood Glucose mg/dL	Low Dose Algorithm (sensitive patient) Patients on 40 units or less/day	High Dose Algorithm (resistant patient) Patients over 40 units/day	Individualized Algorithm
150-199	1 unit	2 units	____ units
200-249	2 units	4 units	____ units
250-299	3 units	6 units	____ units
300-349	4 units	8 units	____ units
Over 349	5 units	10 units	____ units

To convert to basal insulin: Give 50% of previous (24 hour total) correction units as basal insulin dose

Insulin orders	Breakfast	Lunch	Dinner	Bedtime
Prandial: ❑ Aspart (or) ❑ Regular	____ units	____ units	____ units	____ units
Basal: ❑ Glargine [daily] (or)	____ units			____ units
❑ NPH [bid to tid] (or)	____ units		____ units	____ units
❑ Novolog 70/30	____ units		____ units	____ units

For Blood glucose below 60 mg/dL:

- ❑ Call Doctor
- ❑ If Patient can eat or drink, give 15 grams of fast acting carbohydrates:
  4 oz or juice or non-diet soda, 8 oz non-fat milk, or Glutose (one tube = 15gm)
- ❑ If patient is NPO, give Dextrose 50%, 25ml IV push
- ❑ Accu-Cheks every 15 minutes, repeat above steps for blood glucose below 80 mg/dL

Physician :________________________ Date: ____/____/____ & Time ________

❑ Faxed to Pharmacy

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Appendix 2.

Standardized intravenous insulin protocol of a rural community hospital. Of 168 study patients, 20 (12%) received insulin under this protocol.

Standardized Intravenous Insulin

Patient Label

Indication: Hyperglycemia defined as 2 glucose readings over 180 mg/dL

- Goal blood glucose level= _____ mg/dL (usual 80-180 mg/dL floor patient; 80-110 ICU)
- Standard infusion (regular insulin): 100 units /100ml in 0.9% NaCl [1 unit/ 1 ml]

❑ Initiate infusion based on weight:

❑ 0.03 units / kg / hour ***OR***

❑ 2 units / hour

- FSG every hour

80-150 mg/dL = no change in drip rate

more than 50 mg/dL rise from previous FSG = increase rate by 1 unit/hour

more than 30 mg/dL drop from previous FSG = decrease rate by 0.5 units/hour

treat elevated BG with IV boluses of aspart insulin (every 2 hours) :

❑ call physician for BG over ______ mg/dL for bolus dose

❑ use correction scale :[Choose (circle) algorithm: (low - high - individualized)]

Blood Glucose mg/dL	Low Dose Algorithm (sensitive patient) Patients on 40 units or less/day	High Dose Algorithm (resistant patient) Patients over 40 units/day	Individualized Algorithm
150-199	1 unit	2 units	____ units
200-249	2 units	4 units	____ units
250-299	3 units	6 units	____ units
300-349	4 units	8 units	____ units
Over 349	5 units	10 units	____ units

For ***HYPO***glycemia:

Blood Glucose mg/dL	**ACTION**
Less than 60	Stop insulin infusion; give D50% 25ml IVP; Recheck BG in 30 minutes When BG over 70 mg/dL restart insulin infusion at 50% previous rate
60-69	Stop insulin infusion; if previous BG over 100 mg/dL give D50% 25 ml IVP Recheck BG in 30 minutes; when BG over 70 restart insulin at 50% previous rate
70-79	If greater than previous BG, continue at current rate If lower than last BG by 20 mg/dL or more, decrease rate by 50% If lower than last BG by less than 20 mg/dL, decrease rate by 0.5 units/hour Recheck BG in 30 minutes
80-150	Same rate…..patient is in target range; titrate drip to stay in target range

Physician :________________________ Date: ____/____/____ & Time ________

❑ Faxed to pharmacy

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