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The Use of Scheduled Basal Subcutaneous Insulin in Adult Surgical Patients: A Systematic Review of Current Research

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ABSTRACT

Aim: To provide a systematic review comparing basal bolus (BB) subcutaneous (SQ) insulin and sliding scale insulin (SSI) in hospitalized medical-surgical adult patients.
Background: A large body of evidence suggests that poorly controlled blood glucose levels (BGL) in hospitalized patients increases complications including morbidity and mortality. Current clinical practice guidelines recommend BB SQ insulin preferentially over SSI, but there has been limited research done to substantiate this recommendation. SSI continues to be used as the default treatment in many instances.
Data Sources: A search was performed on Cochrane Database for Systematic Reviews, Medline, and Google Scholar for research studies meeting inclusion criteria published between 2001-2007. Reference lists were manually reviewed also. One study investigating effectiveness of SSI was included because SSI regimens are frequently used as the default treatment for hyperglycemia.
Review Methods: Six studies were reviewed and evaluated using the American Diabetes Association (ADA) system for evidence ranking.
Results: Five out of the six studies substantiate the current clinical practice guidelines that conclude SSI as primary treatment for hyperglycemia is ineffective and unreliable.
Summary: Existing research supports BB SQ insulin for glycemic control in medical-surgical adult patients; however, the impact on length of stay and complication rates is not known. Therefore, there is a need for continued high-level research which includes randomized trials.

Keywords: Diabetes mellitus, hyperglycemia, basal insulin, inpatient, glycemic control, hospitalized patients

The Use of Scheduled Basal Subcutaneous Insulin in Adult Surgical Patients: A Systematic Review of Current Research

The incidence of diabetes is increasing and it has been found that approximately one third of all patients admitted to the hospital setting have hyperglycemia: some have undiagnosed diabetes mellitus (DM) while others are suffering from stress induced hyperglycemia caused by illness.[1] A large body of evidence suggests that poorly controlled blood glucose levels (BGL) in hospitalized patients increases morbidity and mortality rates and health care costs.[1-3] Despite clinical practice guidelines published by the American College of Endocrinology and American Diabetes Association Consensus Statement on Inpatient Diabetes and Glycemic Control[2] and many research studies recommending improved glycemic control in hospitalized patients, this goal continues to be controversial and wrought with complexities. Most of the large landmark studies have focused on glycemic control in intensive care or cardiac surgical settings and have identified the use of continuous intravenous insulin infusion (CIII) as the 'gold standard' for achieving tight glucose control in these populations.[1,4-7] Although the use of CIII has been proven to effectively achieve glycemic control and prevent mortality and morbidity, it is not without limitations. It has not been studied or used widely on general medical-surgical hospital units nor is it practical for all hospitals to implement. Issues such as nurse staffing required for continuous monitoring, financial implications for staffing and/or equipment, and provider knowledge and acceptance are obstacles which limit feasibility of CIII in general medical surgical populations.[2]

On the other end of the spectrum, the use of sliding scale insulin (SSI) is discouraged overwhelmingly in the literature because it treats hyperglycemia reactively, thus making glycemic control difficult and elusive.[1,2,8] With the advent of the rapid and long acting analog insulins and the strong opposition to using SSI, the balance between the 'gold standard' of CIII and the 'black sheep' of SSI lies somewhere in between.[3,9-14] Current clinical practice guidelines recommend the use of scheduled basal or basal bolus (BB) subcutaneous (SQ) insulin preferentially over SSI regimens, but there is limited research to substantiate this recommendation.[1-3] The purpose of this systematic review is to analyze current literature in an effort to answer the question "does the use of scheduled basal insulin in adult surgical patients result in decreased length of stay and complications?"

Literature Search

Cochrane Database for Systematic Reviews, Medline and Google Scholar databases were searched to find published research on the treatment of hyperglycemia in adult hospitalized patients using scheduled basal insulin. Because there is such a wealth of published information on the topic of glycemic control in the hospital setting, the time frames were narrowed to 2001-2007. arious search terms and combinations of search words were used including:

hyperglycemia, hospitalized patients, basal insulin, basal bolus insulin, sliding scale insulin, complications, length of stay, inpatient, glycemic control, and diabetes mellitus. Multiple searches resulted in numerous articles on various types of patients and insulin regimens. Reference lists of other publications were also used. The search produced a total of 15 articles addressing the use of scheduled basal insulin therapy for improved glycemic control in general hospital patients; six met the inclusion criteria and are analyzed in this review. Inclusion and exclusion criteria are included in Table 1.

Table 1

Inclusion criteria	Exclusion criteria
1.Adults > 18 years of age hospitalized for surgery or medical diagnosis 2. Hyperglycemia during hospitalization 3. Use of scheduled basal (intermediate or long acting) insulin given subcutaneously 4. Hospital based studies 5. Studies done in the United States	1. Pediatric patients 2. Gestational diabetes 3. Outpatient studies 4. Inpatient studies using Glucose Insulin Potassium Infusion (GIK) or Continuous Insulin Intravenous Infusion (CIII) or Continuous Insulin Infusion (CII) 5. Diabetic ketoacidosis (DKA) or hyperosmolar hyperglycemia syndrome (HHS)

The author was unable to find any studies comparing the outcomes of CIII and scheduled basal insulin therapy for hyperglycemic control in hospitalized adult patients. Since CIII is recommended in the perioperative phase and for all critically ill patients, current published research addresses how to transition from CIII to SQ basal insulin.

The quality of the research was evaluated according to the ranking system used by the American Diabetes Association Clinical Practice Guidelines[1] which was modeled after existing evaluative methods. This system was used because it was consistent with the evidence grading system used by ADA to elucidate and classify evidence that forms the basis for the practice recommendations.[1] Evidence levels range from A to E as indicated in the table. See Table 2.

Table 2

Level of Evidence	**Description**

A	Clear evidence from well-conducted, generalizable, randomized controlled trials that are adequately powered, including: • Evidence from a well-conducted multicenter trial • Evidence from a meta-analysis that incorporated quality ratings in the analysis • Compelling nonexperimental evidence, i.e., “all or none” rule developed by Center for Evidence Based Medicine at Oxford Supportive evidence from well-conducted randomized controlled trials that are adequately powered, including: • Evidence from a well-conducted trial at one or more institutions • Evidence from a meta-analysis that incorporated quality ratings in the analysis
B	Supportive evidence from well-conducted cohort studies • Evidence from a well-conducted prospective cohort study or registry • Evidence from a well-conducted meta-analysis of cohort studies Supportive evidence from a well-conducted case-control study
C	Supportive evidence from poorly controlled or uncontrolled studies • Evidence from randomized clinical trials with one or more major or three or more minor methodological flaws that could invalidate the results • Evidence from observational studies with high potential for bias (such as case series with comparison to historical controls) • Evidence from case series or case reports Conflicting evidence with the weight of evidence supporting the recommendation
E	Expert consensus or clinical experience

(American Diabetes Association. Standards of Medical Care, 2008)

Results

Six articles met the inclusion criteria and were reviewed and analyzed for this article. Table A1 includes a complete overview of the study findings and evidence rankings. Five of the six studies reviewed supported the current ADA clinical practice guidelines which disproves the use of SSI in the hospitalized adult patient;[8,15-18] four of which concluded that scheduled BB insulin therapy is beneficial over the use of SSI.[8,15-17] Using scheduled basal bolus insulin either long acting (insulin glargine) or a combination of intermediate acting (NPH) and regular, was shown to provide similar glycemic control in general surgical patients.[18] One study investigating effectiveness of SSI in treating and preventing hyperglycemia was included in the review because SSI regimens are frequently used as the default treatment for hyperglycemia in general medical and surgical patients.[16]

Only one study reviewed concluded that the use of SSI in combination with routine diabetes medications, including intermediate acting insulin, does not influence the incidence of hyperglycemia or length of stay in patients with type 2 diabetes hospitalized for other conditions.[19]

It is important to note that all reviewed studies defined hyperglycemia differently according to blood glucose levels (BGL) ranging from > 120 to 300 mg/dL. According to the ADA Standards of Medical Care, the guidelines for n on–critically ill hospitalized patients BGL should be kept as close as possible to the following ranges: 90–130 mg/dL premeal, with a midpoint of range 110 mg/dL. and generally less than 180 mg/dL.[1] Hypoglycemia is defined as a BGL less than 70 mg/dL.[1] Five of the studies defined hypoglycemia as a BGL less than 60 mg/dL.[8,15,17-19] Two studies were done only on patients previously diagnosed with type 2 DM and according to the ADA it has been proven that over 30% of hospitalized patients are previously undiagnosed with DM or have stress hyperglycemia.[1] One of the difficulties encountered was the use of the term ‘routine therapy’ in the control group which varied according to the study. The term ‘routine therapy’ did not translate to using scheduled basal SQ insulin in most instances; rather it frequently meant that blood glucose levels were allowed to be above the recommended level or the level used for the intervention group.

Studies Supporting Scheduled Basal Bolus Insulin to Achieve Glycemic Control

Umpierrez, et al., compared the efficacy and safety of a basal bolus insulin regimen to SSI in patients with type 2 DM.[15] The goal of the study was to maintain BGL < 140 mg/dL while avoiding hypoglycemia. This study, also known as RABBIT 2, enrolled 130 non-surgical insulin naïve patients with a DM diagnosis greater than 3 months admitted with BGL between 140-200 mg/dL. Exclusion criteria included patients without a previous DM diagnosis, ICU patients, use of corticosteroids, expected surgery during hospitalization, clinically relevant hepatic disease, serum creatinine ≥ 3.0 mg/dL, pregnancy, and mental conditions which would render the subject unable to understand the scope and consequences of the study. The clinical characteristics of the groups were

similar. Mean admission BGL for study and control groups were similar. Patients were randomly assigned to one of two treatment groups: BB regimen with glargine and glulisine insulins or to SSI. Those receiving glargine were started on a daily dose of 0.4 units/ kg for BGL between 140-200 mg/dL or 0.5 unit/kg for BGL between 201-400. Half of the total daily dose (TDD) was given as once daily glargine and the other half was given as glulisine before meals. If a patient was not able to eat, the glargine was given the glulisine was withheld. Patients receiving SSI received regular insulin four times a day for BGL > 140 mg/dL. Those not eating by mouth received the SSI every 6 hours or at a lower dose. There were mechanisms in place for patients whose BGL were either consistently lower or higher than the target range. Patients on the SSI with consistently high BGL >240 mg/dL after changing the protocol were switched to the BB group. Results of the study revealed patients on glargine and glulisine BB regimen had improved BGL than those on SSI (P<0.01). Mean fasting BGL for the glargine group was 147 ± 36 mg/dL versus the SSI group BGL 165 ± 41 mg/dL (P=<0.01); mean BGL during hospital stay for the glargine group was 166 ± 32 mg/dL compared to SSI group, 193± 54 mg/dL (P<0.01). The mean glucose target of <140 mg/dL was 66% in the glargine group compared to 38% of those in the SSI group. Fourteen percent of patients on SSI had persistently elevated BGL > 240 mg/dL. Interestingly, the mean insulin daily dose was higher for the glargine group than the SSI group (22 units ± 2 units and 20 units ± 1 unit, respectively). Hypoglycemia (BGL < 60 mg/dL) occurred in 2 patients in each treatment group; four values were < 60 mg/dL and none were < 40 mg/dL. The researchers concluded that BB insulin regimens improve BGL over SSI regimens in non-critical type 2 DM patients. Limitations of this study are the fairly small sample size. The authors acknowledged a large randomized trial should be conducted. The study also excluded patients without a previous DM diagnosis and as noted previously, approximately 1/3 of patients admitted to the hospital have hyperglycemia with no previous history of DM diagnosis.[2,3] Strengths of this study include the multi center participation which makes it generalizable to a larger population, the randomization, and the process in place for switching poorly controlled patients in the SSI group to the glargine group in an attempt to gain better glycemic control and not compromise the patients status by continuing to let BGL remain in an undesirable range.

Glycemic control using NPH/regular versus insulin glargine alone was compared in patients after cardiovascular surgery on a general surgical ward.[18] Ninety four hyperglycemic patients were randomized to SQ insulin regimens using twice-daily NPH/regular or once-daily insulin glargine if they required at least 1 unit/hour of intravenous insulin upon being transferred from ICU. The 94 patients were selected from a population of 165 patients 30-80 years of age who had undergone coronary artery bypass, valve replacement or repair, and peripheral vascular surgery and were treated using CIII during their ICU stay postoperatively. BGL were kept between 80-120 mg/dl while in ICU. Conversion to SQ insulin was based on the last stable CIII rate. BGL was measured four times daily, before meals and at bedtime; insulin dosages were adjusted every

24 hours. The outcome measures were hypoglycemic BGL (<60 mg/dL), BGL within the target range of 80-140 mg/dL, and BGL >200 mg/dL. The two groups were well matched in terms of gender, age, body mass index, ethnicity, duration of DM, preoperative glycosolated hemoglobin (Hgb A1c), and mean hospital stay. Sixty four patients (68%) were not previously diagnosed with DM; however Hgb A1c results were suggestive of DM in 20 % of those patients. Results revealed overall glycemic control was similar in both groups. Mean glucose for those on NPH regimen was 124 mg/dL (range 96-173) compared to 131 mg/dL (97-180) on glargine. In patients with a previous diagnosis of DM, mean glucose was 133 mg/dL on NPH compared to 154 mg/dL on glargine (P=0.016). In patients without history of DM, mean BGL was similar at 118 mg/dL with NPH and 124 mg/dL with glargine (P=0.024). Overall, 62.7% of BGL were between 80-140 mg/dL after NPH compared to 59.8% with glargine. Hypoglycemia (<60 mg/dL) was significantly lower with glargine (0.5%) compared to NPH (2%) (P=0.036). Limitations to this study included the lack of an assessment of daily oral caloric intake and the use of regular insulin instead of the newer rapid acting analog insulins which are recommended.[1,3,10,13] Additionally, there was a small sample size (*n*=94) and the study was conducted at a single institution. The strengths are the adherence to the ADA's Standards of Care and the randomization of the groups, the homogeneity of the population and the inclusion of all patients with hyperglycemia.

Baldwin and colleagues attempted to standardize therapy for hyperglycemia utilizing BB insulin and compared the use of BB with SSI.[8] The objective was to reeducate medical staff on management of inpatient hyperglycemia without the use of SSI. In an interventional comparison study of 186 general medical patients admitted with BGL > 140 mg/dL, patients requiring insulin were treated with BB (*n*=88) and compared to historical control patients who received SSI (*n*=98). None of the study patients had SSI while 100% of the controls had SSI. Sixty eight percent of the study group was on twice-daily NPH/regular insulin as compared with 32% of controls; 30% of the study patients were on oral diabetic agents and none were on combination NPH/regular and oral agents compared to 37% controls on oral agent and 15% controls on NPH/regular and oral agent regimen. The mean BGL for study patients was 150 ±37 mg/dL compared to control patients of 200 ± 51 mg/dL (P< 0.01). For BGL > 250 mg/dL, the study group was 6.5% compared to the control group at 20.5% (P<0.01). Hypoglycemia (BGL < 60 mg/dL) was 3.5% in the study group and 1.4% in the control group (P=0.01). For BGL 80-140 mg/dL, the study group was 43.8% compared to 22 % in controls. The researchers found that the median length of stay was 6.3 days in control group (SSI) compared with 4.4 days in patients treated with the study group (intermediate or long acting insulin). A major weakness in this study was the use of historical control patients. The study was successful in showing the improvement of hyperglycemia using a scheduled BB regimen over SSI while meeting the goal of decreasing hypoglycemic events and the adherence to the ADA's Standards of Care guidelines for BGL.

In a prospective cohort study, Schnipper, et al., sought to determine the current state of glucose management and the relationship between insulin ordering practices and glycemic control in a hospitalist-run general medical service in an academic teaching hospital.[17] In 107 consecutive patients with DM or hyperglycemia (>200mg/dL) admitted to three general medical service teams, data was collected on all orders related to glycemic management and four bedside BGL's per day. Primary outcomes were rate of hyperglycemia defined as BGL > 180 mg/dL per patient and mean BGL per patient day. Clinical data was extracted for 5 days of hospitalization. Types of insulin ordering practices were reviewed which included: basal insulin (intermediate or long acting insulin), scheduled prandial insulin (regular, lispro, or aspart given before each meal), and daily adjustments to insulin orders, use of different SSI regimens, and the percentage of the total daily dose given as basal insulin. Forty seven patients (43%) had basal insulin ordered, and 4% had an order for scheduled prandial insulin; 89 patients had SSI orders written. Of the patients on SSI, 47% were prescribed basal insulin, 39% were prescribed oral agents, and 24% were prescribed neither. Thirty one percent (317 of 1022) of the BGL taken were greater than 180 mg/dL; 35% of patients had at lest 40% of their BGL greater than 189 mg/dL; 11% of patients had at least on e BG < 60 mg/dL. Although there was a consistent percentage of BGL > 180 mg/dL per patient over the first 5 days of hospitalization, the researchers found no evidence of change in prescribed basal insulin. Variation of glycemic control was noted by medical team and floor of the hospital. After adjustment for a variety of clinical factors, the use of SSI alone was associated with worse glycemic control (daily average BGL 20 mg/dL higher than that for those prescribed scheduled insulin or no SSI at all (95 % CI). Limitations of this study were small sample size, the use of one institution, and being conducted on chart reviews. Patients in the study were identified by diagnosis, a diabetic medication, or a laboratory BGL > 200 mg/dL automatically abstracted daily lab results; these factors could have limited the identification of patients who were not previously diagnosed with DM. Only 9 patients without a previous DM diagnosis were included in the study.

A retrospective observational study at a university affiliated hospital was conducted in an attempt to determine the efficiency and effectiveness of current prescribing practices related to short and intermediate acting insulin in preventing and treating acute hyperglycemia in hospitalized patients with DM or hyperglycemia.[16] Ninety consecutive adult patients who had orders for 'as needed' regular or lispro SSI during a one month period were identified using a search on drug utilization. Clinical information was collected to reveal the conditions surrounding the use of insulin during the first 5 days after SSI was ordered. The therapeutic target BGL was 90-130 mg/dL. Basal intermediate or long acting insulin was administered in 34% of patients; oral diabetic agents were administered in 20% of patients; both oral diabetic agents and insulin were administered concurrently in 2% of patients; SSI was used alone in 43% of patients. The median BGL for initiation of SSI was 151 mg/dL in 52% of patients and 7% of patients began at 120 mg/dL. SSI regimens were never adjusted in

81% of patients. Glycemic control of patients on SSI was variable and consistently suboptimal in 84% of patients. When reevaluated the effects of SSI by follow up BGL, showed BGL were within therapeutic range in 12% of patients. Hypoglycemic occurrences were low (1.6%); all of these patients were receiving SSI and none were receiving basal insulin. The patients with better glycemic control did not differ significantly among types of medical service or with regards to day of hospitalization. Limitations of this study were the retrospective and uncontrolled design and the small sample size.

Studies Inconclusive in Supporting Basal Insulin in Achieving Glycemic Control

One study reviewed compared the effects of SSI with routine diabetes medications on the frequency of hyperglycemia (BG >300mg/dL) and hypoglycemia (BG < 60mg/dL), combined glycemic events, and length of hospitalization.[19] A multi-center randomized controlled trial of hospitalized inpatients from ten family residency programs at five different sites across the US was conducted using a non-blinded, convenience sample of 153 individuals admitted with co-morbid illness and a concurrent diagnosis of type 2 DM. The control group (*n*=78) received routine diabetes medications which included oral diabetic medications and any standing dosage of intermediate and/or regular insulin; the intervention group (*n*=75) received a combination of SSI regimen and their routine diabetes medications. To estimate an effect size of 0.6 for statistical significance in difference in glycemic variations among the groups, the sample size was determined to be 150. To enroll 150 patients, the initial sample size was overestimated at 200 to account for attrition rates. The clinical and demographic characteristics for both groups were similar upon randomization; admission and discharge diagnosis matched in 78.7% of intervention patients and 68% of control patients (P=0.14). Patients in the control group were receiving more intermediate acting insulin than the study group (50% control, 33.3% study. P=0.04); 43% or patients were receiving combination oral agents and intermediate insulin, 5.3% were diet controlled. The researchers detected no differences by using SSI with routine medications or the use of routine medications alone in frequency of hyper or hypoglycemia or length of hospitalization. Glycemic events, defined as BGL > 300 mg/dL or <60 mg/dL, occurred in 36% of patients regardless of treatment group. Three independent predictors of glycemic events were identified by multivariate analysis: patients using intermediate acting insulin as part of their routine medications, those with admitting BGL > 250 mg/dL, and those on corticosteroids during hospitalization. Routine diabetic medications were adjusted among the groups based on need and were not monitored or controlled. Glycemic control was not assessed in this study so it is not known if one group had better control than the other. There were multiple limitations of this study. The study was conducted on a convenience sample and was limited to known type 2 DM patients and can not be generalized to type 1 DM patients or those with stress induced hyperglycemia. The physicians were not blinded to the treatment assignment nor were patients on long acting insulin in the study. The hyperglycemic event of BGL >300 mg/dL

does not meet the ADA Standards of Care. The strength of this study is the randomization and the sample size, which is larger than most trials done thus far.

Discussion

Clearly, more research is needed on the use of scheduled basal SQ insulin in general medical-surgical adult patients with hyperglycemia. Based on the extensive research done on critically ill patients and CIII, glycemic control has been shown to improve outcomes such as mortality and morbidity, decreased LOS, complications and costs. Similar research needs to be conducted in other hospitalized patient populations using scheduled basal SQ insulin regimens.

Five out of the six studies reviewed substantiated the current ADA clinical practice guidelines and supports the use of SSI as the primary treatment is ineffective and unreliable for controlling hyperglycemia.[8,15-18] SSI can also increase risk for hypoglycemia in some instances, but was not shown conclusively to do so in the reviewed studies. Of the multicenter randomized controlled trials reviewed, one did not directly study the use of scheduled BB insulin therapy, but rather the use of SSI and the use of other diabetic medications which included basal insulin.[19] The other multicenter randomized trial compared the use of BB insulin regimens to SSI in type 2 DM patients who had not previously been on insulin.[15] A prospective cohort study was conducted on chart reviews of patients with diabetes mellitus or hyperglycemia over 5 days hospitalization to determine current state of glucose management and the relationship between insulin ordering practices and glycemic control.[17] An interventional study of general medical patients admitted with hyperglycemia who were given BB compared historical patients who received SSI.[8] A retrospective observational study investigating efficiency and effectiveness of SSI in treating and preventing hyperglycemia[16] was included in the review because SSI regimens are frequently used as the default treatment for hyperglycemia in general medical and surgical patients. SSI was also compared to the use of BB insulin in several of the aforementioned studies. The two randomized trials using long acting insulin (glargine) supports that it does achieve the target ADA glycemic control in type 2 DM and hyperglycemic patients without increased hypoglycemic episodes.[15,18]

Recommendations for initiating a system level practice change for improved glycemic control include gathering baseline data such as patient preferences, LOS, and complication rates, resource allocation and availability, disseminating current research findings and practice recommendations, initiating a pilot project, determining reasonable institution based outcomes and goals, and analyzing the results of process data. Additionally, a consultant and liaison to the nursing staff, patients and physicians should be utilized to facilitate dialogue about the practice change, identify real and potential issues, and provide appropriate resources to promote resolution and problem solving. A cost-benefit analysis to support the need for providing adequate human and nonhuman resources to this change in

process should be included as part of the proposal. Lack of staff or institutional support can be dealt with by providing current research findings which support the need for change and the use of evidence based practice, advantages to a pilot study, and the benefits to staff, physicians and other providers, the leaders and above all, patients.

There are many obstacles to implementing the use of scheduled BB regimens: ease and familiarity with prescribing SSI, fear of hypoglycemia among nurses, physicians, and patients, common perceptions that BGL up to 200 mg/dL is acceptable and does not need to be treated, skepticism over existing research in glycemic control and evidence based practice, and the apprehension or apathy in learning and implementing a new practice approach. The phenomenon known as 'clinical inertia', the recognition of a problem but not acting on it, can be caused by lack of knowledge, understanding, and fear of current practice guidelines in the inpatient control of hyperglycemia.[17] The use of SSI is deeply rooted in the inpatient prescribing practices and culture and change will not be easy. These obstacles should be anticipated and planned for by providing adequate education and resources for staff and providers and quality improvement programs to provide a feedback mechanism.

Conclusions

There is a lack of randomized controlled studies conducted on the use of scheduled BB SQ insulin in general medical /surgical adult inpatients. Based on the studies done thus far and the landmark studies done with CIII and critically ill patients, improved glycemic control in hospitalized patients has been shown to decrease mortality and morbidity and hospital costs. This conclusion is substantiated by current literature and clinical practice recommendations as noted previously. Of the six available studies on adult hospitalized patients, the author concludes that scheduled BB insulin therapy is beneficial over the use of SSI regimens. Only one study reviewed indicated that the use of SSI in combination with routine diabetes medications, including intermediate acting insulin, does not influence the incidence of hyperglycemia or length of stay in patients with type 2 diabetes hospitalized for other conditions.[19]

This review concluded existing research on the use of scheduled basal SQ insulin for treatment in adult hospitalized patients on general medical-surgical units is limited and was able to identify gaps in existing research and the need for future research which includes large randomized trials. Until further research becomes available, existing research supports the use of scheduled basal SQ insulin for improving glycemic control in general medical-surgical adult patients; however, the impact on length of stay or other complications has not been scientifically proven. While the lack of evidence is limited, the data presented in this review can increase knowledge on existing research and its limitations, as well as the positive findings that would support a change in practice. There is no foolproof method that works for every patient or every institution and to fully

actualize the definition of evidence based practice, we must be conscientious and judicious in the use of current best evidence in making decisions in the care of patients. Therefore, it would be prudent to acknowledge the limitations of current research and proceed slowly to accommodate particular needs or issues that may arise within an institution initiating change.

References

1. American Diabetes Association. Standards of medical care: 2007. *Diabetes Care*, 30 (supplement 1): S4-38).
2. American College of Endocrinology and American Diabetes Association Consensus Statement On Inpatient Diabetes and Glycemic Control (2006). *Diabetes Care*, 29 (8): 1955-1962).
3. Clement, S. et al on behalf of the Diabetes in Hospitals Writing Committee (2004). Management of diabetes and hyperglycemia in hospitals. *Diabetes Care,* 27(2): 553-591.
4. Krinsley, J. (2006). Perioperative glucose control. *Current Opinion in Anesthesiology*, 19: 111-116.
5. Pittas, A., & Siegel, R., & Lau, J. (2004). Insulin therapy for critically ill hospitalized patients. *Archives of Internal Medicine*, 164: 2005-2011.
6. Meijering, S., Corstjens, A., Tulleken, J., Meertens, J., Zijlstra, J. & Ligtenberg, J. (2006). Towards a feasible algorithm for tight glycaemic control in critically ill patients: a systematic review of the literature. *Critical Care*, 10 (1): R19.
7. Van den Berghe, et al. (2001). Intensive insulin therapy in critically ill patients. *The New England Journal of Medicine,* 345 (19): 1359-1367.
8. Baldwin, D., Villaneuva, G., McNutt, R., & Bhatnagar, S. (2005). Eliminating inpatient sliding- scale insulin. *Diabetes Care*, 28 (5): 1008-1011.
9. Abourizk, N., Vora, C., & Verma, P. (2004). Inpatient diabetology. *The New England Journal of Medicine,* 19: 466-471.
10. Braithwaite, S. (2006). The transition from insulin infusions to long-term diabetes therapy: the argument for insulin analogs*. Seminars in Thoracic and Cardiovascular Surgery*, 18 (4):366-78.
11. Hassan, E. (2007). Hyperglycemia management in the hospital setting. *American Journal of Health System Pharmacy*, 64, Supplement 6: S9-S14.
12. Magee, M. (2006). Insulin therapy for intensive glycemic control in hospital patients. *Hospital Physician*, April: 17-27, 38.
13. Magee, M. & Clement, S. (2004). Subcutaneous insulin therapy in the hospital setting: issues, concerns, and implementation. ACE Inpatient Diabetes and Metabolic Control Consensus Conference. *Endocrine Practice*, 10, Supplement 2: 81-88.
14. Meneghini, L. & Hirsch, I. (2006). Pharmacotherapies for diabetes management: an update for the practicing clinician. *Seminars in Thoracic and Cardiovascular Surgery*, 18(4):379-89.

15. Umpierrez, G., et al. (2007) Randomized study of basal bolus insulin therapy in the inpatient management of patients with type 2 diabetes (RABBIT 2 Trial). *Diabetes Care*, 30 (9): 2181-2186.
16. Golightly, L., Jones, M., Hamamura, D., Stolpman, N., & McDermott, M. (2006). Management of diabetes mellitus in hospitalized patients: efficiency and effectiveness of sliding-scale insulin therapy. *Pharmacotherapy,* 26(10): 1421-1432.
17. Schnipper, J., Barsky, E., Shaykevich, S., Fitzmaurice, G., & Pendergrass, M. (2006). Inpatient management of diabetes and hyperglycemia among general medicine patients at a large teaching hospital. *Journal of Hospital Medicine,* 1(3), 145-150.
18. Yeldandi, R., Lurie, A., & Baldwin, D. (2006). Comparison of once-daily glargine with twice-daily NPH/Regular insulin for control of hyperglycemia in inpatients after cardiovascular surgery. *Diabetes Technology and Therapeutics*, 8(6); 609-616.
19. Dickerson, L., Ye, X., Sack, J., & Hueston, W. (2003). Glycemic control in medical in patients with type 2 diabetes mellitus receiving sliding scale insulin regimens versus routine diabetes medications: a multicenter randomized controlled trial. *Annals of Family Medicine,* 1 (1): 29-35.

Table A1