Basal-Plus Insulin Regimen: Helping Patients with Diabetes Mellitus Type 2 to Maintain Blood Glucose Levels During Hospitalization

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DNP Quality Improvement Project

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Abstract

Diabetes mellitus type 2 (DM2) patients are at risk of episodes of fluctuating blood glucose levels when in the hospital. On admission at the target practice site, the home dose of oral hypoglycemic medication is typically stopped and replaced with sliding-scale insulin therapy. Hyperglycemia among the hospital population of DM2 patients is common, causing delayed healing times, increased length of stay, increased costs, and other medical detrimental factors.

A doctor of nursing practice project was based on the findings from a randomized controlled trial of a basal-plus insulin protocol that lowered the mean blood glucose level for noncritically ill hospitalized DM2 patients. In the trial, adding a long-acting basal insulin to the short-acting insulin sliding scale yielded a drop in mean blood glucose scores, with minimal risk for hypoglycemia.

A quality improvement project using Lewin’s change theory was planned and implemented using a Plan-Do-Study-Act cycle. Initially, 51 patients were started on the protocol; 4 received the protocol for the duration of their stay. Patients who otherwise qualified for the project were excluded from the project because of changes made by colleagues, a patient declining doses, patients being admitted to the intensive care unit, and patients receiving high-dose steroid therapy.

In a comparison with the mean blood glucose level of similar patients who did not receive the protocol, the mean blood glucose level of the patients who received the protocol decreased during hospitalization by 25.52 mg/dL; the mean length of stay decreased by 1.75 days. This mean decrease in hospital length of stay in days equals a decrease in cost of approximately $6973.05. In conclusion, the basal-plus insulin protocol is straightforward, simple to include in a busy hospital practice, and offers several benefits.

Keywords: Type 2 diabetes mellitus, hospital, hyperglycemia, blood glucose, insulin, sliding-scale, basal insulin
Basal-Plus Insulin Regimen: Helping Patients with Diabetes Mellitus Type 2 to Maintain Blood Glucose Levels During Hospitalization

For hospitalized diabetes mellitus type 2 (DM2) patients, the consequences of hyperglycemia are linked with unfavorable outcomes, including death (American Diabetes Association [ADA], 2021). Agreement among the three largest professional authority organizations with respect to DM2—namely, the Society of Hospital Medicine (SHM), the ADA, and the American Association of Clinical Endocrinologists (AACE)—collectively recommended to stop sliding-scale insulin as the only method for glycemic control (Nau et al., 2010). Conceptually, the insulin sliding-scale has remained a reactive, chasing method to glucose control, and not a pre-emptive approach to assertively stop hyperglycemic states. Standards of medical care in diabetes by Bakris (2016) contain the current ADA clinical practice recommendations for DM2 care and strongly suggest adding basal insulin to each treatment strategy. The Joint Commission added an accreditation program for hospitalized DM2 patients, and a team-managed development program was initiated by the SHM (ADA, 2021).

The purpose of this paper is to discuss the results of a quality improvement (QI) project regarding hospitalized patients with DM2 who are receiving hyperglycemia treatment. This project was intended to improve healthcare safety and effectiveness by changing personal practice through implementation of a protocol whose efficacy has been confirmed in a randomized controlled study. Addition of a basal-insulin protocol and study of outcomes were the primary goals.

Problem Description

Oral hypoglycemic medications that patients with DM2 were taking before hospitalization are typically stopped upon hospital admission at the target practice site. For coverage, the DNP student usually orders sliding-scale insulin therapy, a short-acting insulin therapy with a glucometer reading from finger-stick checks about a half hour before meal times and bedtime. Short-acting insulin enters the bloodstream in about 30 minutes and lasts 6 hours. Carbohydrate-controlled diets for patients with diabetes are usually ordered as well.
Before implementation of the doctor of nursing project (DNP), several hospitalized DM2 patients were observed by the DNP student to have hyperglycemia, having a blood glucose level greater than 180 mg/dL. Substantial swings in the patient’s blood glucose measurements are not uncommon, predictably remaining high. Several events that can cause blood glucose levels to rise are stress, inactivity, infection or illness, and side effects of medications, some or all of which may be experienced as an inpatient during hospitalization (Pasquel & Umpierrez, 2013). Increased hospital length of stay, cost, morbidity, mortality, readmission rates, surgical complications, and increased risk of infection are all associated with inpatient hyperglycemia. If the blood glucose level remains high, the following may occur: potential damage to the kidneys, cardiovascular system, blood vessels to the retina, or nerves; serious skin infections or skin ulcers on the feet, sometimes requiring amputation; bone and joint problems; and teeth and mouth infections (Castro, 2014).

In an effort to improve the mean glucose scores for patients admitted to the Gerald Champion Regional Medical Center (GCRMC) from January 21, 2022 to February 9, 2022, an evidence-based quality improvement (QI) project was implemented. The intervention used in the project was a basal-plus insulin regimen, achieved by adding a long-acting insulin to the short-acting insulin sliding scale. Adding the long-acting basal insulin was based on findings from a randomized controlled trial from which the findings had been peer reviewed and published (Umpierrez, Smiley, Hermayer, et al., 2013). In addition to the patients’ mean blood glucose level during hospitalization, additional measures considered in the project were length of stay and cost reduction.

Available Knowledge

Pub-Med, CINAHL, Medline, and the Cochrane Database of Systematic Reviews were queried with the following keywords: Diabetes type 2, hyperglycemia, hospitalized, and insulin. The 430 results were then further narrowed by specifying the following limiters: humans, ages 45 years and older, English language, and published within the last 10 years. The result was 125 articles, of which 26 were randomized controlled trials.
Hyperglycemia in noncritically ill hospitalized patients has been a topic among hospitalists, family practice providers, and endocrine specialists. Use of an insulin-only treatment for hospitalized DM2 patients is strongly discouraged (ADA, 2021). Basal-plus correction is recommended for DM2 patients, even if the patient has poor oral intake, aiming for a target glucose range of 140 to 180 mg/dL without episodes of hypoglycemia, defined as less than 70 mg/dL (Pasqual & Umpierrez, 2021). Hypoglycemia management protocols, with tracking, should be reviewed regularly; hospitals will not be reimbursed for iatrogenic hypoglycemia (ADA, 2016). With respect to primary care, family practice providers discuss transitions in care and the necessity to include a multidisciplinary approach to improve the culture of treatment that guides providers away from the current approach of treating only with sliding-scale insulin (Nau, et al., 2010).

In one meta-analysis on the treatment for hyperglycemia, Seufert (2019) examined 18 reports and 15 studies, following the PRISMA guidelines. A basal-plus insulin regimen was concluded to be the best management approach for hyperglycemia (Seufert, et al., 2019). Analysis findings showed that the basal-plus insulin regimen offered minimal hypoglycemia incidents and that a minor increase in body weight was associated with the treatment. Timing of the short-acting insulin seemed to have little impact overall (Seufert, et al., 2019).

A basal-plus insulin protocol was used in a randomized, double-blind study by Meyer (2010), in which the use of short-acting regular insulin was compared to the use of glulisine, a man-made short-acting insulin. No difference was noted within the first 4 days of hospitalization. After the fourth day, it was noted that the man-made insulin was associated with slightly fewer hypoglycemic episodes, with minimally better glycemic control over time (Meyer et al., 2010).

Two studies investigated a basal-bolus technique for hospitalized DM2 patients in which short-acting insulin was eliminated completely (Umpierrez et al., 2007). In another basal-bolus study, patients were given approximately half of their long-acting glargine at bedtime and the other half divided into three doses at mealtimes (Umpierrez et al., 2011). Results for patients receiving no short-acting insulin in
these two studies were significantly less favorable than the results for patients who received a combination of long-acting and short-acting insulin.

A randomized study (i.e., RABBIT 2) comparing a basal-bolus with a basal-plus insulin correction regimen provided insulin protocols using both short-acting and long-acting insulin for hospitalized DM2 patients who were in the medical and surgical units (Umpierrez, Smiley, Hermayer, et al., 2013). Of the literature review results for the DNP project, the RABBIT 2 study provided the best results with enough details to reproduce the intervention. Researchers in the study used short-acting insulin with mealtime and bedtime coverage based on a sliding scale and glucometer reading, in addition to a long-acting insulin once daily (Umpierrez, Smiley, Hermayer, et al., 2013). Within the RABBIT 2 protocol, weight-based adjustments for the elderly (i.e., over 70 years) and those patients with decreased renal function (i.e., a serum creatinine > 2mg/dL) were included for the practitioner to easily adjust the doses (Umpierrez, Smiley, Hermayer, et al., 2013).

Rationale

Wolfe (2001) summarized information found in the Institute of Medicine (IOM) 2001 report Crossing the Quality Chasm: A New Health Care System for the 21st Century, including the six dimensions of quality focused primarily to evaluate a health system’s performance. These six dimensions are part of a five-step agenda to address the shortcomings pointed out in To Err is Human (IOM, 1999), after that report pointed out that more Americans die from medical mistakes each year than several other expected leading causes. IOM (2001) identified as Step 1, the six aims for improvement: safe, effective, patient-centered, timely, efficient, and equitable. Memorable and admirable, these aims are something to keep in awareness at all times.

The Step 2 strategy, as Wolfe (2001) continued, included 10 guiding rules that focused on the practitioner and patient relationship. Two of these 10 guiding rules, Number 5 (i.e., evidence-based decision making) and Number 6 (i.e., safety) stood out as particular strengths of this project. Patient care should be designed and delivered using the best scientific evidence available and should be safe. The QI project was expected to be successful because it is based on an evidence-based protocol that has been
shown to be safe and effective in a randomized trial (Umpierrez, Smiley, Hermayer, et al., 2013). Furthermore, the findings from the randomized trial were peer reviewed and published, with enough information to be reproduced safely.

Number 8 in the guiding rules, as Wolfe (2001) outlines, includes the anticipation of patient needs, which stresses that needs should be anticipated rather than simply being responded to in reacting to patient events. This DNP project provided a protocol that anticipated the hyperglycemia that DM2 patients often experience during hospitalization (Helme et al., 2018). Inclusion of a long-acting insulin protocol was added with the intent to prevent the hyperglycemia from occurring (Umpierrez, Smiley, Hermayer, et al., 2013).

Wolfe (2001) described Number 9 of the guiding rules found in the IOM (2001) report as a continuous decrease in waste, that care should not waste resources or the patient’s time. With a focus on efficiency and safety, this project was intended to provide an improved use of the time of the patient recovering in the hospital by optimizing blood glucose levels (Umpierrez, Smiley, Hermayer, et al., 2013). Intending to decrease hyperglycemia, the use of a readily available long-acting insulin resource was expected to produce improved healing in less time (Ilcewicz et al., 2019).

Frequently, hospitalists and many other providers avoid adding basal insulin, likely due to a perceived difficulty in calculation and fear regarding hypoglycemia (Draznin et al., 2013). The basal-plus insulin protocol adds a bedtime dose of long-acting insulin and regular short-acting insulin based on a sliding scale before meals (Umpierrez, Smiley, Hermayer, et al., 2013). The protocol is relatively straightforward and simple to order. Several studies confirm that various short-acting insulins may also be used for the sliding scale: regular insulin, glulisine, lispro, or any other short-acting insulin (Helme et al., 2018; Marín-Peñalver et al., 2016; Migdal et al., 2021). For the purposes of this QI project, however, only regular insulin was used for the short-acting insulin.

**Lewin’s Change Model**

Kurt Lewin’s (1951) three-step change model was used to plan and organize the practice change expected in the DNP project. Unfreeze, change, and refreeze are the three simple actions in the model,
and they provide a well-suited model to create a clinical practice change. Although processes and outcomes change during the planning, implementation, and evaluation of a project, such changes can be made more comfortable and logical with the use of Lewin’s anchors (Manchester et al., 2014).

**Unfreeze.** An initial step is to determine what needs to change. Chaos and disequilibrium invite change to resting forces, which can be identified as the tacit knowledge acted upon and doing things the way things have always been done (Malloch, 2017). Unfreezing allows the proposition of new ideas, improved practice changes, and forward motion to elicit favorable change (Manchester et al., 2014).

For this DNP project, a 10-day reflective practice exercise allowed the examination of why clinical practice is carried out a certain way and if a better way exists. It was noted in the personal practice of the DNP student that patients with DM2 who are in the hospital are routinely placed on sliding-scale insulin yet remain hyperglycemic. Unfreezing occurred by recognizing a change must be made to safely anticipate the needs of the patient, to use evidence-based decision making, and to not waste resources or the patient’s time (Wolfe, 2001).

**Change.** Empowering action, communication, and including others stimulate the drive for change (Manchester, et al., 2014). Frequent connection, encouragement, and dismissal of negativity are a large part of dealing with the vulnerable state of change (Lewin, 1951). In addition, supportive leadership and guidance are strengths to ease the modification phase of this model (Manchester, et al., 2014).

Empowerment by having full practice authority in New Mexico allows a fully unrestricted ability to act within the scope of a certified nurse practitioner practice. During unfreezing, a needed change was identified, and now action is the obligation of the practitioner. This DNP project was assigned by the DNP program director as a solo practice change. During this step, typically one would include others in the process and encourage their actions with support and communication.

Movement for the practice change is motivated by a desire by the DNP student to improve patient outcomes. The DNP student noted that DM2 patients were hyperglycemic when treated in the routine manner of sliding-scale regular insulin only. During a literature review, an evidence-based practice was found in multiple places (Draznin et al., 2013; Migdal, et al., 2021); it indicated that the sliding scale
alone is not suitable for glycemic control in the hospital. Standard medical care for inpatient DM2 patients uses strong evidence to include a basal insulin, stressing that it is unsuitable to use short-acting sliding scale insulin by itself (ADA, 2021). Thus, the DNP student planned a practice change, the implementation of the basal-plus insulin protocol contained in the RABBIT 2 trial (Umpierrez, Smiley, Hermayer, et al., 2013), during regular hospitalist practice days. Changing the routine ordering of short-acting sliding scale insulin was initiated, and adding a long-acting basal insulin at bedtime to the DM2 patients’ medication regimen was the change made for a safe, evidence-based favorable practice adjustment (Umpierrez, Smiley, Hermayer, et al., 2013).

**Refreeze.** Lewin (1951) indicated that the changes were to be anchored into the culture. Culture change can be sustained by training and encouraging others to act and use the same steps of unfreezing, changing, and refreezing. Success should be celebrated; those celebrations act as an encouragement to continue improvement (Manchester et al., 2014).

Evidence-based, safe practice changes were anchored in the solo practice of the DNP student at this time. Sustaining this change was not difficult for the student, as the protocol became second nature in practice. Integrating the change into the GCRMC culture may be achieved by presenting favorable outcomes to the medical executive committee, along with the evidence provided during the literature review. Encouragement to implement the basal-plus insulin regimen by writing a safe, patient-centered local protocol, which is based on the RABBIT 2 results, would be a foundation for refreezing the change into culture (Umpierrez, Smiley, Hermayer, et al., 2013).

**Specific Aims**

The aim for this QI DNP project was to decrease hyperglycemia in hospitalized DM2 patients, maintaining mean blood glucose levels between 70 and 180 mg/dL. Implementation of a safe, evidence-based basal-plus insulin protocol was initiated during regular hospitalist practice to verify whether improvement in glycemic control could be made.
Methods

Context

GCRMC is a 94-bed critical access hospital in Alamogordo, Otero County, New Mexico. The hospitalist service has a staff of 3 physicians and 3 nurse practitioners on duty daily, who see all of the hospitalized patients admitted to their service during the day. Admissions from the emergency department, direct admissions from other hospitals, or consults for other services as needed are assigned on a round-robin rotation basis. One physician hospitalist covers the night shift.

Since COVID-19 emerged, travel nurses have made up the majority of the nursing staff; current daily staffing is 30 nurses. Unfortunately, the skill set of the travel nursing component is limited, leaving orders sometimes not carried out and not communicated to the providers. Lack of follow-through and not following providers’ orders has led to poor outcomes.

This QI project was conducted as a solitary practice change during real-time practice hours by a DNP student beginning January 21, 2022 and ending February 9, 2022. The immediate supervisor of the student was continually included and aware of the project, but no other colleagues were aware of the basal-plus insulin protocol initiated by the student. Colleagues changed the student’s orders without knowledge of the QI project after patients were handed off during usual continuity of care. This shortcoming could have been prevented if the Lewin (1951) change framework had been used to a fuller extent, by including the stakeholders, frequent communication and encouragement, and collaboration in changing the culture.

Because this DNP project was conducted in a relatively short time period of 21 days, a limited number of patients were included because their hospitalization extended beyond the time period. With the results of this QI project being from a small, stand-alone sample, it is anticipated that the QI project can be repeated with the buy-in of stakeholders, once the small but favorable results are presented. Rewriting of hospital policy to include the basal-plus insulin protocol is a future possibility.

The PICOT question for the DNP project was formed during a 10-day reflective practice exercise. During the exercise, the DNP student considered the reasons that the administration of oral
antihyperglycemic medications is stopped upon the admission of hospitalized DM2 patients and is substituted with a sliding-scale insulin regimen. A reflective review of the student’s patients within the electronic medical record (EMR) provided evidence that the DM2 patients treated with a short-acting insulin sliding scale were not achieving adequate glycemic control during their hospital stay. The following elements of a PICOT question were formed:

P (Patient, Population, Problem): Noncritically ill hospitalized patients aged 64 to 98 years with DM2 and hyperglycemia

I (Intervention): Implementation of a basal-plus insulin regimen protocol from the RABBIT 2 trial

C (Current practice): Mean blood glucose levels of admitted patients placed on sliding-scale short-acting insulin are frequently hyperglycemic

O (Outcome, Objective): Maintain mean blood glucose level to remain between 70 mg/dL and 180 mg/dL

T (Time): 21 days

**Intervention**

This DNP project was designed to be implemented by the DNP student only. Patients under the care of the student received the intervention and were tracked throughout their hospitalization. Care was assumed by one or more of the other hospitalists during the student’s days off. On site, the student’s direct practice supervisor was aware of the practice change and was kept up to date with any changes. The nursing staff was not aware of the protocol and was expected to follow the orders as written.

Patients identified by the DNP student as potentially benefiting from the use of a basal-plus insulin protocol were noncritically ill DM2 adults admitted to the hospital from January 21, 2022 to February 9, 2022. A detailed basal-plus insulin regimen using both short-acting and long-acting insulin for hospitalized DM2 patients was documented in the RABBIT 2 trial (Umpierrez, et al., 2013), outlined below:
**Insulin Glargine Orders**

- Stop oral and noninsulin injected antiglycemic medications on admission.
- Start insulin glargine total daily dose (TDD): 0.25 units per kg of body weight.
- Reduce TDD to 0.15 units per kg of body weight if patients are > 70 years old, or if serum creatinine > 2.0 mg/dL.
- Administer insulin glargine once daily at the same time of day.
- Issue an order for sliding-scale short-acting insulin.
- Administer supplemental short-acting insulin following the sliding-scale protocol for blood glucose levels >140 mg/dL as shown in Table 1.
- If the patient is eating, give sliding-scale insulin before each meal and at bedtime. Use the dose found in “usual” column, shown in Table 1.
- If the patient is not eating, give sliding-scale insulin every 6 hours. Use the dose found in the “sensitive” column, shown in Table 1.

**Insulin Glargine Adjustment**

- If the fasting and predinner blood glucose level is between 100 mg/dL and 140 mg/dL and no hypoglycemia is present the previous day, make no changes.
- If the fasting and predinner blood glucose level is between 140 mg/dL and 180 mg/dL and no hypoglycemia is present the previous day, increase glargine TDD by 10% every day.
- If the fasting and predinner blood glucose level is > 180 mg/dL and no hypoglycemia is present the previous day, increase glargine TDD by 20% every day.
- If the fasting and predinner blood glucose level is between 70 and 99 mg/dL and no hypoglycemia is present, decrease glargine TDD by 10% every day.
- If a patient develops hypoglycemia (blood glucose level < 70 mg/dL), the glargine TDD should be decreased by 20%.
Blood Glucose Level Monitoring

- Blood glucose levels will be measured with a glucometer before each meal and at bedtime if the patient is eating.
- Blood glucose levels will be measured every 6 hours if the patient is not eating.

Table 1

Supplemental Sliding-Scale Short-Acting Insulin

<table>
<thead>
<tr>
<th>Blood glucose (mg/dL)</th>
<th>Usual (Eating) Units</th>
<th>Insulin sensitive (Not eating) Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>141–180</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>181–220</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>221–260</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>261–300</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>301–350</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>351–400</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>&gt;400</td>
<td>16</td>
<td>14</td>
</tr>
</tbody>
</table>

Note. Adapted from “A randomized study comparing a basal-bolus with a Basal-plus insulin correction insulin regimen for the hospital management of medical and surgical patients with type 2 diabetes: Basal plus trial,” by G.E. Umpierrez, D. Smiley, K. Hermayer, A. Kahn, D.E. Olson, C. Newton, S. Jacobs, M. Rizzo, L. Peng, D. Reyes, I. Pinzon, M.E. Fereira, V. Hunt, A. Gore, M.T. Toyoshima, and V.A. Fonseca, 2013, Diabetes Care, 26(supplementary data, table 1). (https://ada.silverchair-cdn.com/ada/content_public/journal/care/36/8/10.2337_dc12-1988/3/dc121988supplementarydata.pdf?Expires=1652030938&Signature=073~KRNHu9y-wsANIAhWIIxHN5iTFl2ResbxUL-JYHpfPAm3yMRjDgNCt~PAqYwm4DoTHuhEvwFp~QeOAK00yOvxV0f9H4bs20w3qZnWnQXd4igPXMm9CT46fguwdccBo4Bn5hc9sSu1BOH7QA6gYvBFUHX0Yp-OQn2ZDDx4NHgfoahLeUKr195msMCzFjruhHLotNe8JNEcFEFQAJtOnBJC5gqqUpdJGTr~G6A9PVOIfspNaGBsSu43ViNrQkLOHMlMz43ucoLWZRHA5leEfwKOYbUb1sY2dCt5stAFVTzrZy-
Study of the Intervention

The approach of comparing glucose levels of the patients who received the basal-plus insulin regimen to glucose levels of a similar group of patients who did not receive the regimen was used to determine whether the outcomes were due to the intervention. Immediately following the intervention period, information was queried from the electronic medical record (EMR) by a query expert from the hospital information technology department to obtain mean blood glucose levels during January 21, 2022, through February 9, 2022. Also included were length of stay, age, and gender of each patient. An identical query was performed for a similar time frame from the previous year for all DM2 patients treated by the DNP student. Patients from the previous year did not receive the intervention, and their glucose levels and some other data were used for comparison to establish the impact of the intervention. All collected information was given to the DNP student for evaluation.

The mean blood glucose level was calculated using the serum blood glucose level and the point-of-care glucometer readings. The DNP student checked for accuracy of inclusion and exclusion criteria by manually checking the progress notes of individual patients. Accuracy was ensured by checking the medication administration record (MAR) for confirmation of protocol adherence. The terms hospital stay and length of stay are used interchangeably in this document; they apply to the period from admission to discharge from the hospital.

Plan-Do-Study-Act Cycle

Based on the framework from the model for improvement (Langley et al., 2009), the Plan-Do-Study-Act (PDSA) cycle is included in improvement courses provided by the Institute for Healthcare Improvement (IHI). Testing a targeted change involves developing a plan to test the change (Plan); implementing the test (Do); learning, observing, and analyzing the effects of implementing the test (Study); and establishing which adaptations should be made to the test (Act). Any changes made to the plan require additional PDSA cycles, with each cycle documenting every change, and each cycle
improving on the preceding cycle (IHI, 2017). Because of the relatively short intervention time period, only one PDSA cycle was completed in this QI project.

**Measures**

Processes chosen to improve quality and safety of care included implementation of the basal-plus insulin regimen to decrease the mean blood glucose of DM2 patients during hospitalization. In a retrospective chart query, patients who received the basal-plus insulin regimen were compared to similar patients from a similar time period a year prior but who did not receive the basal-plus insulin regimen. Data on the length of stay were also obtained to provide a cost inference.

To assess for completeness and accuracy of the outcomes, progress notes were reviewed by the DNP student to check for accuracy and completeness. Progress notes were also assessed to identify and remove patients who were moved to the intensive care unit (ICU) or the COVID-19 unit, were counted twice, or received high-dose steroids during the study period. Accuracy was assured by careful manual review of individual patient medication administration records (MAR) by the student for all patients who initially met the inclusion criteria. This was done to verify the correct administration of the insulin protocol. Some patients were excluded if their inclusion eligibility changed during the project period.

**Analysis**

Measurement of information acquired from a QI project includes complexities that are not always calculable. Several unseen and imprecise actions are present in establishing quality that are not concrete, or assessable. The simple results gleaned from this project provide a modest attempt from which to draw inferences.

Results obtained from the data query were examined and organized in an Excel spreadsheet by the DNP student. Some patients were excluded because they no longer met the inclusion criteria for some period of time during the DNP project. The mean length of stay and mean blood glucose figures for both the intervention and nonintervention groups were calculated using the mathematical “mean” function on Excel. Demographics were manually derived from chart review, and percentage of gender, and mean age were calculated by hand. Patients included were few in number, so evaluation was not a demanding task.
Mean blood glucose level during hospitalization was used to determine effectiveness of the addition of the basal insulin. Elevation of blood glucose level in the hospital setting is multifactorial and likely was due to unseen variances. Frequently, increased blood glucose level in the hospital environment can be attributed to the following causes: stress, inactivity, infection or illness, and side effects of medications (Pasquel & Umpierrez, 2013).

Hospital length of stay was included in the information gathered for analysis, therefore providing a basis for an inference of cost (Phillips et al., 2017). Length of stay includes hospital admission through hospital discharge, which can include a multitude of variances by numerous occurrences, diagnoses, treatments, and conditions. Comparing the length of stay between the intervention group and the nonintervention group may loosely suggest a correlation between improved outcomes and may be associated with decreased costs.

**Ethical Considerations**

This DNP QI project began as a proposal, reviewed and approved by the DNP Chair. Following approval by the project chair, the DNP student worksite supervisor reviewed the proposal and approved the project to be conducted at the worksite. GCRMC provided the DNP student with an endorsed letter of support, which secured the project site (see Appendix A). In addition, the DNP student submitted a QI project application to the University of Texas at El Paso (UTEP) Institutional Review Board (IRB; see Appendix B). The IRB reviewed the application and determined that the proposed project did not qualify as research and that it was a QI project (see Appendix C). Thus, the UTEP IRB exempted this DNP project from full IRB approval. There were no conflicts of interest to report.

**Results**

Because this DNP project was conducted starting January 21, 2022 through February 9, 2022, a relatively short time period, a limited number of patients were included because their hospitalization extended beyond the time period. With the results of this QI project being from a small, stand-alone sample, it is anticipated that the QI project can be repeated with the buy-in of stakeholders, once the small
but favorable results are presented. Rewriting of hospital policy to include the basal-plus insulin protocol is a future possibility.

Colleagues changed the DNP student’s insulin orders without knowledge of the QI project after patients were handed off during usual continuity of care. This shortcoming could have been prevented if the Lewin (1951) change framework had been used to a fuller extent, by including the stakeholders, frequent communication and encouragement, and collaboration in changing the culture. Future projects will most likely include input and agreement from stakeholders.

Errors in using the glucometer properly caused erroneously high readings. For instance, the following glucometer procedure by nursing staff caused erroneously high readings for a patient: wiping the finger with an alcohol swab, sticking the finger quickly, and squeezing the finger to elicit a drop of blood for a sample. For one patient, the alcohol wipe was not yet dry; thus, the blood sample was hemolyzed from the trauma of the squeeze to elicit blood from the vessel. Point-of-care blood glucose values for that patient were in the mid 200 mg/dL; thus, the nurse was treating the patient with insulin in accordance with a falsely elevated glucometer reading. The serum blood glucose level for this patient was regularly near 90 mg/dL; however, the false glucometer reading in the 200 mg/dL range was causing the patient to receive insulin when it was not required. This patient spent an evening in the ICU for close monitoring, after the overtreatment of insulin resulted in symptomatic hypoglycemia, causing lethargy. Fortunately, the patient fully recovered and was returned to the medical-surgical floor the next morning. This patient did not receive any basal insulin and was not included in the results. A clinical reminder was made for the staff and was discussed with the unit manager, restoring reliability for the floor nursing practice (Appendix D).

Fifty-one patients with DM2 were followed and treated by the DNP student, the basal-plus insulin protocol was ordered for these patients. Of the 51 patients, 25 patients were removed from the QI project due to ICU admission, duplicate entry, or COVID-19 high-dose corticosteroid therapy. These patients were not included because they did not meet the noncritically ill inclusion criteria. Of the remaining 26 patients, 22 patients were omitted for the following reasons: hospitalist colleagues changed the basal-plus
insulin protocol on subsequent hospitalization days, one patient declined the glargine injection at bedtime, or the nurse determined that the glargine dose at bedtime was not appropriate. No hypoglycemic events or mortality were found during a manual review of progress notes. Four patients received the full basal-plus insulin protocol regimen during their hospitalization (see Figure 1).

**Figure 1**

*Inclusion and Exclusion of Identified Patients*

Comparison was made with four similar DM2 patients under the DNP student’s care at about the same time the previous year. The patients from the previous year did not receive a basal-plus insulin regimen. Demographics for the groups were different; mean age was older in the intervention group by 7.25 years, and the intervention group had more female patients, as shown in Table 2.
Table 2

Mean Age and Gender Composition by Group

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Intervention group</th>
<th>Nonintervention group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean)</td>
<td>76 years</td>
<td>68.75 years</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>3 75%</td>
<td>Female 2 50%</td>
</tr>
<tr>
<td>Male</td>
<td>1 25%</td>
<td>Male 2 50%</td>
</tr>
</tbody>
</table>

One of the specific aims was to use the basal-plus insulin protocol to decrease hyperglycemia in DM2 patients while hospitalized, and the other was to maintain mean blood glucose levels between 70 mg/dL and 180 mg/dL. The mean blood glucose level decreased in the intervention group to 160.98 mg/dL from 186.5 mg/dL in the nonintervention group (see Figure 2). It should be noted that greater than 180 mg/dL is defined as hyperglycemic in this protocol, which was exceeded by the nonintervention group.

Figure 2

Mean Blood Glucose Level in the Intervention and Nonintervention Groups
Note. Mean blood glucose values in the intervention group (blue) and nonintervention group (orange). The horizontal line in each box represents the mean for that group.

Mean length of stay measured in days was compared in the two groups. A decrease by 23% in the intervention group was realized. Mean length of stay in the nonintervention group was 7.5 days (180 hours), compared to 5.75 days (138 hours) in the intervention group, shown in Figure 3.

**Figure 3**

*Intervention and Nonintervention Length of Stay*

---

Found within the EMR, an hourly telemetry medical-surgical room charge at GCRMC was $166.025, which included only the hospital room. Mean length of stay for the intervention group was 5.75 days (138 hours), and for the nonintervention group, 7.50 days (180 hours). Hospital room cost for mean length of stay in the intervention group was $22,911.45, and for the nonintervention group the mean cost was $29,884.50, shown in Figure 4. The difference is a savings of $6,973.05 for the intervention group.
Figure 4

Comparison of Mean Costs for Length of Stay for Intervention Group and Nonintervention Group

Discussion

Summary

Because use of the protocol had already been shown to lower blood glucose levels, the expected result in the DNP project was that the mean blood glucose levels would decrease during hospitalization. The mean blood glucose level for the intervention group was 160.98 mg/dL, compared to the mean blood glucose level of 186.5 mg/dL for the nonintervention group. Notably, the nonintervention group’s mean blood glucose was above the hyperglycemia cutoff value of greater than 180 mg/dL. That the length of stay decreased by 1.75 days in the intervention group suggests that the basal insulin may have facilitated an earlier discharge. Overall cost approximately decreased by $6,973.05 for the intervention group, as inferred from the length of stay. Adding the basal-plus insulin regimen was easy to implement and maintain, even during a busy hospital day.

Interpretation
Outcomes from this project do not lend themselves to a direct comparison to the randomized controlled trial from which the protocol was extracted. The RABBIT 2 trial was a large, multicenter endeavor with two arms and was powered enough to support multiple measures. Nevertheless, mean blood glucose levels were reduced in the basal-plus insulin group in both the RABBIT 2 trial and in this DNP project. The intervention group did not have any hypoglycemic events nor mortalities in the randomized controlled trial, nor in the DNP project.

**Limitations**

Since this DNP project was performed by the student only, the results are limited. The positive results, however, may be presented to the medical executive committee for further consideration for protocol inclusion. An opportunity to shorten patient healing times, length of stay, cost, and improved outcomes would be attractive incentives for the hospital to consider.

Several hospitalist colleagues changed the regular insulin sliding scale to a lispro sliding scale. The use of the short-acting insulin may have slightly varied the result. Some of these patients could have been included in the project if the protocol included short-acting insulins other than regular insulin. Only the regular insulin sliding scale was used in this project, and inclusion of other short-acting insulins may be an addition to include in planning the next cycle. During continuity of care, other providers completely discontinued or changed the dosage of the basal insulin. Hospitalists’ resistance to change from the insulin sliding scale has been reported in a few studies (Ilcewicz et al., 2019; Meyer et al., 2010).

Few patients were able to be included in the analysis. With buy-in by the stakeholders, hospitalist partners, and the floor nursing staff, more patients would be included. Participating and input involving all stakeholders would likely improve this project.

**Conclusions**

For the intervention group, success was attained in the reduction of length of stay and cost as well as in patient mean blood glucose maintenance being below the hyperglycemic level. The straightforward formula in the basal-plus insulin protocol allowed for easy fine-tuning of basal insulin for elderly patients or patients with reduced renal function, making the protocol uncomplicated and easy to add to a busy
hospitalist practice. No hypoglycemic episodes were attributed to use of the basal insulin during this DNP project. However, fear of hypoglycemia is one reason that hospitalists fail to use anything other than the short-acting insulin sliding scale (Liu et al., 2017; Nau et al., 2010).

Several comorbidities in noncritically ill patients require more glycemic surveillance. Hyperglycemia superimposed on pneumonia or chronic obstructive pulmonary disease in hospitalized patients has been found to increase both length of stay and morbidity (Ferriera et al., 2019). Respiratory patients typically receive steroid treatment, requiring increased glycemic support. Renal failure and elderly patients are particularly vulnerable and need insulin adjustments for optimal care (Wang & Draznin, 2013).

In 2008, Medicare stopped paying for nosocomial diabetic ketoacidosis or for comas due to hypoglycemia or hyperglycemia (Zhuo, et al., 2015). The basal-plus insulin regimen may be a relatively simple and effective method to safeguard against the problem. Hospitals and providers have a large financial stake in initiating effective, evidence-based glycemic protocols, as well as a duty to their patients (Liu et al., 2017).

Complex decision making for treatment of hospitalized DM2 patients becomes more complicated as treatment choices increase (Pasquel & Umpierrez, 2021). Elderly patients and those with renal failure have increased vulnerability, requiring intense, proactive DM2 monitoring as a priority beginning at hospital admission. The basal-plus insulin regimen provides a solid, relatively simple-to-use structure, improving hospital practice until other trials and solutions are presented in the future.

Other Information

Funding

Grateful acknowledgement is due to the Paso del Norte Health Foundation Graduate Fellows Program Award for Academic Excellence and Leadership for their support and encouragement in translational research. The foundation was not involved in study design, data collection, analysis, result interpretation, or preparation of this manuscript.
References


https://doi.org/10.1016/j.dsx.2018.08.028

https://doi.org/10.1016/j.jcjd.2017.12.010


November 1, 2021

University of Texas at El Paso
ORSP
Institutional Review Board
500 W. University Avenue
El Paso, Texas 79968

Dear UTEP IRB:

The purpose of this letter is to grant Marcia Hammons, MSN, APRN, AGACNP-BC, a DNP Student at the University of Texas at El Paso, permission to conduct a Quality Improvement Project at Gerald Champion Regional Medical Center. The QI project, “Basal Plus Regimen: helping DMT2 non-critical patients maintain mean blood glucose levels during hospitalization” entails using a Basal Plus Regimen protocol from the RABBIT 2 Trial, which allows for weight-based adjustments for the elderly (over 70), and for those with decreased renal function (creatinine ≥ 2mg/dL). A combination of long-acting insulin as well as mealtime and bedtime coverage of short acting insulin will be utilized, according to the protocol. Outcome predicted is a change in clinical practice improving the hospitalization stay of patients with DMT2 while maintaining mean blood glucose levels between 70mg-180/dL.

I, Christine Hobson, MSN, APRN, ACNP-BC do hereby grant permission for Mrs. Hammons to conduct the QI project at Gerald Champion Regional Medical Center.

Sincerely,

Christine Hobson, MSN, APRN, ACNP-BC
Appendix B

The University of Texas at El Paso
Institutional Review Board Office
Quality Improvement Project Application

Instructions: This form must be reviewed and completed in its entirety. Please type and submit this form along with finalized copies of all project related materials via IRBNet in a timely manner. Attention to these elements will facilitate the IRB’s review of your project. The IRB will then determine whether the submission is a QI project or research. For further guidance or assistance, please contact the IRB office at (915) 747-7693 or by email at irb.orsp@utep.edu.

A. Project Information:

<table>
<thead>
<tr>
<th>Project Manager</th>
<th>Marcia W. Hammons, MSN, APRN, AGACNP-BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department</td>
<td>School of Nursing</td>
</tr>
<tr>
<td>University Title</td>
<td></td>
</tr>
<tr>
<td>Faculty Advisor, Mentor, or Committee Chair</td>
<td>Dr. Hector Morales, APRN, PMHCNS-BC</td>
</tr>
<tr>
<td>Project Title</td>
<td>Basal Plus Regimen: Helping DMT2 non-critical patients maintain mean blood glucose levels during hospitalization</td>
</tr>
<tr>
<td>Additional Study Personnel (If applicable)</td>
<td>N/A</td>
</tr>
<tr>
<td>CITI Group Completed</td>
<td>☑ Yes, ☐ No</td>
</tr>
</tbody>
</table>

B. Literature Review:

In this section describe the significance of the proposed project and why it is being conducted. Provide appropriate references.

The significance of this project, non-critically ill-hospitalized patients aged 64-98 years with type 2 diabetes mellitus (T2DM) and hyperglycemia will achieve mean blood glucose levels between 70mg/dl and 180 mg/dl during hospitalization. At this time, the present intervention is not effective and patients continue to have uncontrolled T2DM and increased blood sugar.


**C. Project Site(s):** *Please include Site Authorization Letter allowing permission to conduct project*

Check the box that best describes the status of your project:

☑ Project will be implemented at project manager’s place of employment.

☐ Project will be reviewed by another IRB and/or Ethics Committee

Provide the institution name and contact person:

---

**D. Summary of Project Activity:**

Briefly state the purpose of this project activity:

If applicable, list your PICO question:

Non-critically ill hospitalized patients aged 64-98 years with type 2 diabetes mellitus and hyperglycemia will achieve mean blood glucose levels between 70mg/dL and 180 mg/dL during hospitalization

P: Non-critically ill hospitalized patients aged 64-98 years with diabetes mellitus type 2 who are hyperglycemic

I: Implementation of Basal Plus Regimen protocol from the RABBIT 2 Trial.

C: Patients removed from oral glycemic medication and placed on an insulin sliding scale, remaining hyperglycemic.

O: Mean blood glucose between 70-180 mg/dL

T: 1 hour

What is the overall goal of this project? Please include the specific population geared to benefit from this project:

Non-critically ill hospitalized patients aged 64-98 years with type 2 diabetes mellitus and hyperglycemia will achieve mean blood glucose levels between 70mg/dL and 180 mg/dL during hospitalization

Describe how the project will be implemented. List what procedures you will follow and what the project participants will be exposed to. Please provide details:

I intend to use a Basal Plus Regimen protocol from the RABBIT 2 Trial, which allows for weight-based adjustments for the elderly (over 70), and for those with decreased renal function (creatinine ≥ 2mg/dL). A combination of long-acting insulin as well as mealtime and bedtime coverage of short acting insulin will be utilized, according to the protocol. The patients will be exposed to hypoglycemic medication and monitor as needed.

Describe how the project team will collect, manage, and analyze data:

I will collect, manage and analyze all non-patient identifiable data which will be stored in the EMR.

---

**E. Ethical Considerations:**

**E1. Does this project include inclusion and exclusion criteria?**

If yes, please describe:

Inclusion criteria: Hospitalized non-critical Type 2 Diabetes Mellitus (T2DM) patients ages 64-98.

Exclusion: Not meeting the inclusion criteria

**E2. Will you be audio or video recording during any portion of this project?**

If yes, please describe:

**E3. Does the project pose any risk to the individual(s)?**

If yes, please describe how the risk/benefit ratio has been weighed and explain how you will address this concern:

---

QI Application
Revised March 2017
E4. Is there a possibility of coercion or undue influence?  
If yes, please describe how you will address this concern:  

YES ☐ NO ☑

E5. Is there a possibility that data collected may be compromised? If yes, please describe the measures taken to ensure confidentiality and security.  

YES ☐ NO ☑

E6. Will identifiable data be made available to anyone other than the Project Manager? 
If yes, explain who and why they will have access to the identifiable data:  

YES ☐ NO ☑  N/A ☑

E7. Will the results of the project be disseminated? Check all that apply.  
Publication ☑ Presentation ☑  

YES ☑ NO ☐  N/A ☐

Acknowledgment of Responsibility

Principal Investigator Assurances-Conflict of Interest and Fiscal Responsibility

Do you or any person responsible for the design, conduct, or reporting of this project have an economic interest in, or act as an officer or director of any outside entity whose financial interests may reasonably appear to be affected by this project?  
If yes, please explain any potential conflict of interest  

YES ☐ NO ☑

Do you or any person responsible for this project have existing financial holdings or relationships with the sponsor of this study?  
If yes, please explain any potential conflict of interest  

YES ☐ NO ☑  N/A ☑

Principal Investigator Certifications:

With this submission I certify that:  
☑ I agree to fully ensure that this project will be conducted in an ethical manner.  
☑ I agree that the information provided in this form and all other supporting documents are accurate and complete.  
☑ I accept responsibility for making sure all personnel involved in the project have been appropriately trained.  
☑ I understand that any changes in procedure with affect to participants must be submitted to the IRB Office for written approval prior to their implementation. Furthermore, I understand that any significant changes in risk for participants must be immediately reported in writing to the UTEP IRB Office.
Appendix C

Institutional Review Board

Office of the Vice President for Research and Sponsored Projects
The University of Texas at El Paso IRB
FWA No: 00001224
El Paso, Texas 79968-0587
P: 915-747-7093  E: irb.orsp@utep.edu

Date: November 15, 2021

To: Marcia Hammons, MSN

From: University of Texas at El Paso IRB

Study Title: [1809395-1] Basal Plus Regimen: Helping DMT2 non-critical patients maintain mean blood glucose levels during hospitalization

IRB Reference #: College of Nursing

Submission Type: New Project

Action: NOT RESEARCH

Review Type: Administrative Review

Approval Date: November 15, 2021

Thank you for your submission of New Project materials for this research study. The University of Texas at El Paso IRB has determined this project does not meet the definition of human subject research under the purview of the IRB according to federal regulations.

We will put a copy of this correspondence on file in our office.

If you have any questions, please contact the IRB Office at irb.orsp@utep.edu or Bernice Caad at (915) 747-6590 or by email at bcaad@utep.edu. Please include your study title and reference number in all correspondence with this office.

Sincerely,

[Signature]

Dr. Lorraine Torres, Ed.D, MT(ASCP)
IRB Chair
Appendix D

Dear Nursing and Nursing Assistants:

When checking patient glucose with the glucometers, please remember to:

Allow the finger to dry after using the alcohol prep pad before sticking the finger

Do not squeeze the finger to get the blood to come out

Both of these actions cause the glucometer to give a false high reading.

The patient will get insulin when they do not need it

Thank you for your help! Any questions, please ask the nursing educator or the charge nurse.