IMPLEMENTATION OF THE AACE/ADA RECOMMENDATIONS FOR
GLYCEMIC CONTROL AT MAUI MEMORIAL MEDICAL CENTER

A DISSERTATION SUBMITTED TO THE OFFICE OF GRADUATE EDUCATION
OF THE UNIVERSITY OF HAWAI‘I AT MĀNOA IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF NURSING PRACTICE

July 2015

By

Marny Hall Moriyasu

Committee:

Jessica Nishkawa, Chairperson
Celeste Baldwin
Judy Kodama
Sandra A. LeVasseur

Keywords: insulin, sliding scale, hospital, diabetes, guidelines, in-patients
ABSTRACT

**Background:** In the past decade there has been an increased awareness of the clinical and economic burden of hyperglycemia in hospitalized patients. The in-patient setting provides an opportunity to optimize glycemic control by setting blood glucose targets and instituting therapies to slow disease progression and improve outcomes. The purpose of this evidence-based project was to improve glycemic control of hospitalized patients with diabetes at Maui Memorial Medical Center (MMMC).

**Methods:** Kurt Lewin’s Change Theory model was used to implement the American Association of Clinical Endocrinologist’s and the American Diabetes Association’s (AACE/ADA) recommendations to improve management of dysglycemia in the diabetic in-patient population. The project took place at the MMMC, which employs 400 staff nurses and has 200 attending physicians. Seven medical and surgical units in the hospital used AACE/ADA recommendations for glycemic control. Thirty patients with a diagnosis of type 1 or type 2 Diabetes Mellitus (DM), for whom insulin was ordered, were reviewed for baseline data. Forty nurses were given a ten-question multiple choice diabetes quiz to establish their baseline knowledge of current practices for care of hospitalized patients with DM. A repeat assessment was conducted eight months after the AACE/ADA recommendations were in place.

**Results:** Blood glucose within the AACE/ADA targets increased by 13% eight months after the recommendations was implemented. Hyperglycemia decreased by 5%, and Hypoglycemia decreased 8.4% from baseline. Nurses’ knowledge on in-patient diabetes care increased by 12% on a ten question multiple-choice quiz.
**Conclusion:** Implementing this project has heightened staff awareness of standards for inpatient diabetes care. Improvements in glycemic control and nurse’s knowledge was seen with the implementation of the AACE/ADA recommendations. Improvements in hypoglycemia exceeded project goals. Improvements of blood glucose within target were less than expected, but the findings were encouraging enough to continue utilizing the AACE/ADA recommendation. The findings implicate this approach is useful in reducing hyper and hypoglycemia. Practice changes recommended by the AACE/ADA appear to be frozen in place and have become part of the normal workflow on all seven nursing units.
TABLE OF CONTENT

List of Tables .................................................................................................................. vii
List of Figures .................................................................................................................. viii

Chapter 1. Introduction .................................................................................................... 1
Hospitalization and Diabetes Mellitus ............................................................................ 1
Insulin Therapy ................................................................................................................ 1
AACE/ADA Recommendations ..................................................................................... 2
Project Purpose .............................................................................................................. 4
Maui Memorial Medical Center ..................................................................................... 4
Summary ........................................................................................................................ 5

Chapter 2. Problem ......................................................................................................... 7
Introduction .................................................................................................................... 7
Background .................................................................................................................... 7
Hospitalization and Diabetes Mellitus ........................................................................... 7
Insulin Therapy .............................................................................................................. 8
Conceptual Framework .................................................................................................. 9
Unfreezing Stage ........................................................................................................... 10
Moving Stage ................................................................................................................ 16
Refreezing Stage .......................................................................................................... 16
Literature Review and Synthesis .................................................................................. 17
Advantage of Practice Change ..................................................................................... 27
Summary ........................................................................................................................ 28

Chapter 3. Methods ....................................................................................................... 30
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>30</td>
</tr>
<tr>
<td>Objectives</td>
<td>30</td>
</tr>
<tr>
<td>Project Design</td>
<td>30</td>
</tr>
<tr>
<td>Moving Stage</td>
<td>31</td>
</tr>
<tr>
<td>Definitions</td>
<td>31</td>
</tr>
<tr>
<td>Sampling Plan</td>
<td>32</td>
</tr>
<tr>
<td>Program Evaluation Plan</td>
<td>40</td>
</tr>
<tr>
<td>Ethical Considerations</td>
<td>40</td>
</tr>
<tr>
<td>Limitations</td>
<td>41</td>
</tr>
<tr>
<td>Summary</td>
<td>43</td>
</tr>
<tr>
<td>Chapter 4. Results</td>
<td>44</td>
</tr>
<tr>
<td>Introduction</td>
<td>44</td>
</tr>
<tr>
<td>Refreezing</td>
<td>44</td>
</tr>
<tr>
<td>Objectives</td>
<td>44</td>
</tr>
<tr>
<td>Description of Sample</td>
<td>45</td>
</tr>
<tr>
<td>Trend Analysis</td>
<td>46</td>
</tr>
<tr>
<td>Evolution of Project</td>
<td>50</td>
</tr>
<tr>
<td>Expected vs. Actual Outcomes</td>
<td>50</td>
</tr>
<tr>
<td>Facilitators</td>
<td>53</td>
</tr>
<tr>
<td>Barriers</td>
<td>53</td>
</tr>
<tr>
<td>Summary</td>
<td>54</td>
</tr>
<tr>
<td>Chapter 5. Discussion</td>
<td>55</td>
</tr>
<tr>
<td>Introduction</td>
<td>55</td>
</tr>
</tbody>
</table>
Interpretation of Findings ................................................................. 55
Implications and Recommendations ............................................... 59
Plans for Dissemination ................................................................ 66
Summary ........................................................................................ 67
Appendix A. In-Patient Diabetes Quiz ............................................ 68
Appendix B. Timeline ....................................................................... 71
Appendix C. Measurement Tool ...................................................... 72
Appendix D. Data Collection ........................................................... 70
Appendix E. Revised Insulin Orders ............................................... 73
References ...................................................................................... 74
LIST OF TABLES

Table 1. Mosby’s Quality of Evidence ................................................................. 18

Table 2. Communication Plan ........................................................................... 34

Table 3 Blood Glucose Results ........................................................................... 47
LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lewin’s Model of Change</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Force Field Analysis</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>Procedure Steps</td>
<td>37</td>
</tr>
<tr>
<td>4</td>
<td>Data Collection Plan</td>
<td>39</td>
</tr>
<tr>
<td>5</td>
<td>Number of Hypoglycemic Events</td>
<td>48</td>
</tr>
<tr>
<td>6</td>
<td>Time of hypoglycemia 6 months post-implementation</td>
<td>49</td>
</tr>
<tr>
<td>7</td>
<td>Changes in nurses’ knowledge</td>
<td>50</td>
</tr>
</tbody>
</table>
CHAPTER 1. EXECUTIVE SUMMARY

Diabetes Mellitus (DM) is an endocrine disorder in which there is insulin resistance or an absence of insulin production (ADA, 2014). It can be classified as Type 1 or Type 2. Type 1 DM is an autoimmune disease that usually leads to absolute insulin deficiency. Type 2 DM is an acquired defect in the utilization of insulin with a strong genetic predisposition. In both types, the condition leads to high levels of blood glucose known as hyperglycemia. If not treated properly, hyperglycemia can lead to heart disease, stroke, lower extremity amputations, kidney disease, and blindness (ADA, 2014).

Hospitalization and Diabetes Mellitus

An estimated 25 to 30 percent of all hospitalized adults have DM; the majority of these patients experience diabetes-related complications (Draznin, Guilden, Golden, & Inzucchi, 2013; Hodge & Malaskovitz, 2014; Lambert, 2011; Magaji & Johnston, 2011; Moghissi et al., 2009; Munoz et al., 2012; Umpierrez et al., 2011). Hyperglycemia has been linked to increased morbidity, mortality, and higher health care costs for those hospitalized with DM (Aston, 2013; Hodge & Malaskovitz, 2014; Magaji & Johnston, 2011; Munoz et al., 2012; Reynolds et al., 2007; Umpierrez et al., 2011). There is strong evidence to support tighter glucose control among hospitalized patients with DM (American College of Endocrinology and American Association of Clinical Endocrinologists, 2005; Reynolds et al., 2007).

Insulin Therapy

Insulin therapy is the preferred method for glycemic control in most hospital situations (Draznin et al., 2013). Upon hospitalization, patients treated with oral agents in the outpatient setting are usually transitioned to insulin therapy. This is because
hospitalized patients experience changes in nutritional status and increased stress response due to tests, procedures, surgeries, and illness. Insulin can be titrated and changed frequently to accommodate for specific patient needs.

**AACE/ADA Recommendations**

In 2009, the American Association of Clinical Endocrinologists (AACE) and American Diabetes Association (ADA) published a consensus statement supporting improved in-patient glycemic control (Moghissi et al., 2009). The AACE/ADA consensus statement included promoting the use of long-acting basal insulin, rapid- or short-acting mealtime insulin, and rapid- or short-acting corrective insulin to treat hospitalized patients with DM and hyperglycemia outside of critical care units.

Basal insulin is long-acting insulin administered either once or twice daily and lasts 22 to 26 hours. This type of insulin mimics the physiological background insulin lacking in patients with DM. Bolus insulin is rapid-acting or fast-acting insulin given in small volumes before meals. A combination of basal and bolus insulin (BBI) mimics the physiological release of insulin from the pancreas in response to food eaten and provides insulin as needed between meals and in the fasting state.

Sliding scale insulin (SSI), also known as corrective insulin, is given to correct already elevated blood glucose. It may be given in addition to the bolus (meal time) insulin if the pre-meal blood glucose is above a set target. Insulin based on sliding scale is also used for patients who are not eating due to illness, treatment, or who are awaiting surgery or tests. These types of patients would not be given bolus insulin because they are not eating. Concomitant use of these insulin regimens is a proactive method of glycemic
control and meets physiologic insulin requirements (Baldwin, Villanueva, McNutt, & Bhatnagar, 2005; Lambert, 2011; Moghissi et al., 2009; Reynolds et al., 2007).

The AACE/ADA consensus statement makes the following recommendations for in-patient glycemic control:

1. For the majority of non-critically ill patients treated with insulin, the pre-meal blood glucose should be targeted at 70 to 140 milligrams per deciliter (mg/dL), and random blood glucose values should be targeted at 180 mg/dL.

2. Scheduled subcutaneous administration of insulin, with basal, nutritional, and correctional components, is the preferred method for achieving and maintaining glucose control.

3. Prolonged therapy with sliding scale insulin (SSI) as the sole regimen is discouraged.

4. Noninsulin antihyperglycemic agents are not appropriate for most hospitalized patients who require therapy for hyperglycemia.

5. Clinical judgment and ongoing assessment of clinical status must be incorporated into day-to-day decisions regarding treatment of hyperglycemia.

In their position statement on the Standards of Medical Care in Diabetes, the ADA (2014) reiterates these recommendations, urging the use of basal, bolus, and corrective insulin, and recommends against the sole use of insulin based on a sliding scale regimen. The AACE (2011) also reiterates its position and continues to discourage the exclusive use of sliding scale insulin.
**Project Purpose**

Diabetes Mellitus is considered a chronic complex illness that affects many people within our community, and risk-reduction strategies for glycemic control should be strongly considered. The AACE/ADA has compiled numerous studies in which they have developed standards to be used in the hospital setting. The purpose of this project is to improve glycemic control of hospitalized patients with DM at MMMC and to improve nursing knowledge of best practices for hospitalized patients with DM. This could result in improved outcomes such as decreased infections, improved wound healing, and decreased length of stay (LOS) (Baker et al., 2006; Mendez et al., 2013; Newton & Young, 2006; Umpierrez et al., 2002).

**Maui Memorial Medical Center**

Maui Memorial Medical Center (MMMC) is an acute care, state-run integrated health care delivery system serving patients on Maui and neighboring islands. The hospital is affiliated with the Hawaii Health Systems Corporation, is the only acute care facility on island, and is licensed for 213 beds. According to the 2013 Hawaii State Department of Health Behavior Risk Factor Surveillance System, the prevalence of DM for Maui County is 8%. In 2013, MMMC had 10,000 admissions, of which 2,100 had a diagnosis of DM.

Prior to implementation of the AACE/ADA recommendations for glycemic control at MMMC, treatment of DM consisted of pre-printed insulin orders that provided three different sliding scale regimens. The order set included a space to order meal time insulin, yet it was rarely used. Insulin was provided reactively solely with use of sliding scale insulin. This is necessary during the first 24-48 hours of admission in some cases,
while determining the patients’ insulin needs. However, it was noted that many patients would continue to be treated with only SSI for the duration of their stay, without adding basal or bolus insulin when appropriate. In addition, the insulin orders included administering SSI at bedtime, which typically causes early morning hypoglycemia.

Hospital policy called for the night shift nursing staff to carry out morning insulin orders, which included point-of-care blood glucose testing and insulin administration. Meals were served at a later time by the day shift staff, resulting in labile blood glucose levels.

**Summary**

Lewin’s Change Theory was used to transform the way blood glucose was managed at MMMC. The glycemic management approach recommended by the AACE/ADA was implemented. Insulin orders were revised to decrease the sole use of SSI and to accentuate BBI therapy. Nurses’ work flow was revised, which led to coordination of blood glucose testing, insulin administration, and meal delivery. This provided a more physiological approach in insulin administration. Nursing education was conducted before and during project implementation and showed an improvement in nurses’ knowledge of in-patient diabetes care.

Two hospital polices were revised to reflect the AACE/ADA recommendations for insulin administration. This set a standard to decrease the variation of insulin administration among the nursing staff and also prevented the unnecessary ordering of rapid-acting insulin at bedtime. Post-project chart reviews showed increased rates of blood glucose levels within the AACE/ADA targets. Improvement in hyperglycemia was
seen, and although it was less than expected, the improvement was encouraging.

Hypoglycemic events decreased beyond project goals, and this was a favorable finding.

Implementing the AACE/ADA recommendations for glycemic control at MMMC was successful in bringing blood glucose levels within target and in improving nurses’ knowledge of in-patient diabetes care. Based on the findings, this approach is useful in reducing hyper and hypoglycemia. The potential for cost savings may be seen in improved outcomes and decreased LOS with better management of blood glucose levels.
CHAPTER 2. PROBLEM

Introduction

Hyperglycemia treated reactively often results in alternating hypoglycemia and hyperglycemia in DM patients. At MMMC, most patients with DM were treated with only sliding scale insulin for the duration of their stay and rarely receive meal time insulin. The purpose of this project is to improve glycemic control of hospitalized patients with DM at MMMC and to improve nursing knowledge of best practices for hospitalized patients with DM. This could result in improved outcomes such as decreased infections, improved wound healing, and decreased length of stay (LOS) (Baker et al., 2006; Mendez et al., 2013; Newton & Young, 2006; Umpierrez et al., 2002). This chapter will discuss the problem in detail, detailing the background and empirical evidence showing that there is a problem that needs to be solved. This chapter will also include the conceptual framework and then segue into the review of related literature.

Background

Diabetes Mellitus (DM) is an endocrine disorder in which there is insulin resistance or an absence of insulin production (ADA, 2014). It can be classified as Type 1 or Type 2. Type 1 DM is an autoimmune disease that usually leads to absolute insulin deficiency. Type 2 DM is an acquired defect in utilization of insulin with a strong genetic predisposition. In both types, the condition leads to high levels of blood glucose known as hyperglycemia.

Hospitalization and Diabetes Mellitus

An estimated 25 to 30 percent of all hospitalized adults have DM; the majority of these patients experience DM-related complications (Draznin et al., 2013; Hodge &
Malaskovitz, 2014; Lambert, 2011; Magaji & Johnston, 2011; Moghissi et al., 2009; Munoz et al., 2012; Umpierrez et al., 2011). Hyperglycemia has been linked to increased morbidity, mortality, and higher health care costs for those hospitalized with DM (Aston, 2013; Hodge & Malaskovitz, 2014; Munoz et al., 2012; Magaji & Johnston, 2011; Reynolds et al., 2007; Umpierrez et al., 2011). There is strong evidence to support tighter glucose control among hospitalized patients with DM (American College of Endocrinology and American Association of Clinical Endocrinologists, 2005; Reynolds et al., 2007).

**Insulin Therapy**

Insulin therapy is the preferred method for glycemic control in most hospital situations (Draznin et al., 2013). Upon hospitalization, patients treated with oral agents in the outpatient setting are usually transitioned to insulin therapy. This is because hospitalized patients experience changes in nutritional status and increased stress response due to tests, procedures, surgeries, and illness. Insulin can be titrated and changed frequently to accommodate for specific patient needs.

Sliding scale insulin (SSI) is generally easy to use by both physicians and nurses and was quickly adopted as a prompt treatment for hyperglycemia. Yet administering insulin on a sliding scale regimen is treating hyperglycemia reactively and often results in alternating hypoglycemia and hyperglycemia (Baldwin et al., 2005; Clement, 2004; Donaldson, 2006; Reynolds et al., 2007). This is a serious problem. If not treated properly, hyperglycemia can lead to heart disease, stroke, lower extremity amputations, kidney disease, and blindness (ADA, 2014).
The disadvantage of SSI is well documented (Baldwin et al., 2005; Clement, 2004). Nevertheless, it is a reflex physician order that the nursing staff is accustomed to. The AACE/ADA’s position statement affirms, “Typical sliding scale insulin is not effective and may be dangerous in the manner in which it is typically used, yet it remains part of common medical practice” (Moghissi et al., 2009, p. 1124). The sole use of sliding scale insulin to treat hyperglycemia is discouraged because it does not provide adequate coverage for glycemic excursions; it only corrects for an already high blood glucose and does not account for carbohydrates that the patient is about to eat.

Coordination among point-of-care blood glucose testing, insulin administration, and meal delivery is imperative (ADA, 2014; Lambert, 2011; Moghissi et al., 2009). The AACE/ADA consensus statement suggests providing scheduled meal-time insulin to normalize glucose levels based on carbohydrates eaten. Blood glucose should be checked within one hour prior to the meal and insulin administration in order to have an accurate picture of the patients’ current glycemic status. Inconsistencies in the timing of point-of-care blood glucose tests, insulin administration, and meal delivery was observed by the hospital’s Diabetes Coordinator. The inconsistencies were noted within the nursing units and between nursing units throughout the hospital. This leads to poor glycemic control, which can be improved by implementing the AACE/ADA recommendations for in-patient glycemic control.

**Conceptual Framework**

The success of this project depends heavily on the medical and nursing staff changing their behavior. Kurt Lewin’s Change Theory is recognized for mobilizing the people side of the change. Lewin’s seminal work into the study of group dynamics
explains that people must be ready and motivated before change can occur (Lewin, 1947). Lewin’s Change Theory involves a change agent that proceeds through three stages in order to establish the change as a permanent part of the system (Lewin, 1947). The three stages of Change Theory are unfreezing, moving, and refreezing.

Shirey (2013) applied Lewin’s theory to conduct succession planning and to cultivate internal nurse leaders in a 200-bed community hospital. She asserted that nurses go through three steps of change in order to move from staff nurses to nurse managers and leaders. She stated that nurse leaders must be proficient with change management and advocated using Lewin’s theory as a way to mobilize the human aspect of change. The theory fits well with this performance improvement project because of the need to mobilize staff to change current practices of in-patient DM care. Lewin’s Model of Change is shown in Figure 1.

![Figure 1. Lewin’s Model of Change.](image)

**Unfreezing Stage**

According to Lewin’s theory, unfreezing is identified as the time when change is needed. It is the process of changing behavior to unfreeze the existing situation or status quo. Unfreezing works to eliminate individual resistance and group conformity. Assuring the practice change is evidence-based is one way of decreasing some of the restraining forces. Rising incidents of hyper and hypoglycemia showed that there is a need for this
According to Hodge and Malaskovitz (2014), hyperglycemia is noted to be present in 32% of all non-critically ill hospitalized patients. On the other hand, hypoglycemia can be seen in 5.7% of all patient days in non-critical patients.

The Force Field analysis is a tool developed by Lewin (1947) and was used to assess the unfreezing stage. This tool identifies facilitators and barriers that impact the ability to successfully implement change (see Figure 2). The driving force for this change is evidence-based guidelines for treatment of hospitalized patients with DM. Although there is abundant evidence for this process improvement, adding a driving force towards a change can produce a counter force (Lewin, 1947).

**Figure 2 Force Field Analysis**

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Preventers (Restraining Forces)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Identification of uncontrolled blood sugars</td>
<td></td>
</tr>
<tr>
<td>• Recommendations are evidence based</td>
<td></td>
</tr>
<tr>
<td>• EMR will provide a platform for practice change</td>
<td></td>
</tr>
<tr>
<td>• Increased patient satisfaction r/t less urinary frequency, decreased UTI’s and other infections</td>
<td></td>
</tr>
<tr>
<td>• Potential for decreased length of stay</td>
<td></td>
</tr>
<tr>
<td>• Increase safety due to less hypoglycemia</td>
<td></td>
</tr>
<tr>
<td>• Cost saving due to incentives in pay for performance r/t decreased length of stay d/t prevention of hospital acquired infections and enhanced wound healing</td>
<td></td>
</tr>
<tr>
<td>• Ongoing request for DM updates among staff nurses</td>
<td></td>
</tr>
<tr>
<td>• Providers are comfortable with ordering sliding scales</td>
<td></td>
</tr>
<tr>
<td>• Preference for hyperglycemia because of fear of hypoglycemia</td>
<td></td>
</tr>
<tr>
<td>• Nurses comfortable with using sliding scales</td>
<td></td>
</tr>
<tr>
<td>• New DM guidelines is an added burden to an already disruption in work flow with implementation of electronic medical record</td>
<td></td>
</tr>
<tr>
<td>• Time required for on-going education of staff on DM care</td>
<td></td>
</tr>
<tr>
<td>• Adding more responsibility to already busy day shift nursing staff</td>
<td></td>
</tr>
</tbody>
</table>
**Baseline glycemic assessment.** Prior to electronic medical record (EMR) implementation, blood glucose results were collected on a random sample of patient charts that were admitted, had a diagnosis of type 1 or type 2 DM, and had insulin orders. Forty-five percent of blood glucose results were found to be above, and 9% were below, the overall target range of 70-180mg/dL recommended by the AACE/ADA for hospitalized patients with DM.

**Coordination of care.** Under MMC policy, the night shift nursing staff is responsible for the morning blood glucose testing and insulin administration. The day shift nursing staff is responsible for meal delivery. This results in a time delay between blood glucose testing, insulin therapy, and meal delivery.

Night shift nurses administer insulin between 6:00 a.m. and 7:30 a.m. because this task must be completed before the end of shift. In an effort to prevent hypoglycemia, a few nurses provide patients with carbohydrate-rich food with their insulin, but this is inconsistent, and results in hyperglycemia before lunch. Some nurses defer the insulin administration to the day shift staff, despite the fact that this is not consistent with hospital policy.

Breakfast is delivered between 8:00 a.m. and 9:00 a.m. and varies among the medical and surgical units. On review, it was identified that meal delivery occurs one-half to two hours after rapid or short short-acting insulin is administered and approximately two hours after point-of-care blood glucose testing. If snacks are not given before breakfast, hypoglycemia is seen and subsequently treated. This results in alternating hyper and hypoglycemia throughout the day. This is an area where unfreezing needs to occur.
**Insulin orders.** SSI is ordered on most diabetic patients admitted, for one to two days, while insulin needs are established. In some circumstances, SSI is appropriate and necessary; for example, with patients who are not eating, with patients preparing for tests or surgery, or for those requiring artificial nutrition. Patients on an oral diet, however, should be progressed to basal and bolus insulin (BBI) therapy. However, in many situations, SSI orders are maintained, with or without basal insulin, and most often without meal-time bolus insulin.

The use of insulin in this manner does not account for insulin needs to normalize blood glucose from meals eaten. This results in prolonged hyperglycemia, which increases risk of infections, and dehydration, impairs wound healing, increases vascular permeability, and activates leukocytes and platelets, which cause an inflammatory state (Lambert, 2011; Mendez & Umpierrez, 2014; Ryan & Swift, 2014; Umpierrez et al., 2011).

The SSI orders include a bedtime dose of rapid acting insulin for blood glucose levels over 149 mg/dL which is administered between 9:00 p.m. and 10:00 p.m. This may cause the patient to experience hypoglycemia in the early hours of the morning. Hypoglycemia can lead to falls, seizures, and death, and has been associated with increased LOS, greater cost of hospitalization, and higher mortality rates during hospitalization (Hodge & Malaskovitz, 2014; Mendez et al., 2013; Turchin et al., 2009).

**Electronic medical record.** In March 2014, MMMC introduced its EMR system. This mandatory system level change created an opportune time to integrate evidence-based insulin orders, improve workflow, adjust timing of insulin administration, and provide staff education on the care of hospitalized patients with DM.
Between January 2013 and July 2014, MMMC was in the unfreezing stage. Unfreezing began with the commencement of EMR training, conducting nursing diabetes in-services, and communicating the upcoming changes. Unfreezing activities included:

1. Review of current insulin order sets.
2. Data collection on blood glucose targets within the AACE/ADA recommendations.
3. Review of the national standards for treating DM in the hospital setting and presentation to nursing administration, nurse managers, chief medical officer and pharmacy manager.
4. Drafting and presenting evidence-based recommendations to the current insulin order sets.
5. Approval of order revisions embedded in the electronic medical record by the EMR Build Team.
6. Reviewing and recommending changes to nursing work flow, timing of meals, and staffing patterns.
8. Creating *Diabetes Tips of the Week* flyers and distributing them to all medical and surgical units from March 2014 to March 2015.

**Force field analysis.** Lewin’s Force Field Analysis tool was used during the Unfreezing Stage to aid in identifying facilitators and barriers impacting successful implementation of best practices for glycemic control in hospitalized patients with DM (see Table 1).
**Nursing education.** A key step in unfreezing is to increase nurses’ knowledge of current best practices for the care of hospitalized patient with DM. This will facilitate understanding and acceptance of new practices. Through informal discussion with staff nurses, knowledge deficiency of best practices for glycemic control was identified. For example, when first shown the draft of the insulin order sets, several nurses asked if they would be administering two injections of insulin: a correction dose at the time of the finger-stick and a meal-time dose when the meal tray arrives. Clarification was given that these doses are combined in one syringe and given as one dose 5 to 15 minutes before the meal is eaten.

To obtain a baseline assessment of nurses’ knowledge, a 10-item multiple choice quiz on inpatient glycemic control was administered to a convenience sample of 40 nurses in October 2013 (see Appendix A). From the pre-test, an average score was calculated at 67%. An average score of 80% was set as the target after nursing education.

**Physician education.** Among the practice changes that will occur as this project reaches the refreezing stage is the way in which insulin is being ordered. Providers will begin to use the Computerized Physician Order Entry (CPOE) system that is built into the EMR. The revised insulin orders will include the addition of pre-meal insulin. This differs considerably from the previous paper orders, which focused on SSI. In the new order set, basal, bolus, and corrective insulin choices will populate as options in full view of the prescriber when any insulin order is selected. The new orders clearly differentiate between meal-time dose and correction dose. The chief medical officer and EMR physician champion are responsible for informing providers of new order sets and provide training for accessing orders in the CPOE.
Embedding the order sets into the EMR is not meant to override or supersede clinical judgment. The American Diabetes Association Standards of Care (ADA, 2014) emphasizes individualized care, and asserts that a blood glucose goal of less than 180 post meals are an appropriate target for most patients if it can be achieved safely. However, appropriate clinical goals are at the discretion of the provider.

**Moving Stage**

The change itself is initiated during the second stage of Lewin’s theory, Moving. The *Moving stage* comprises the actions to complete the change, and addressing the feelings, thoughts, and behaviors of people involved. This stage of Lewin’s theory will assist the change agent with helping the staff unlearn prior behavior based on old standards.

With this practice change, education can equip staff nurses to move to a new way of preventing and treating hyperglycemia. To prepare nurses for the new orders that will be utilized, the nursing staff will be provided education about basal, bolus, and corrective insulin therapy, the manner in which it is calculated, and the timing of administration. Nursing knowledge on best practices for DM care in hospitalized patients will be achieved through unit based in-services, diabetes tips of the week flyers, and monthly scheduled RN updates.

**Refreezing Stage**

In the third and final stage of Lewin's Change Theory, *refreezing*, individuals establish new habits and work place equilibrium. Without this stage, the change is easily undone. The strength of Lewin’s theory is that it is practical and straightforward.
Literature Review and Synthesis

A literature search was completed using PubMed, CINAHL, Academic Search Premier, National Guideline Clearinghouse, and the Cochrane Library. MeSH terms searched included “diabetes,” “hyperglycemia,” “in-patient,” “outcome measures,” “guidelines,” “standards,” and “insulin therapy.” Key words included “diabetes,” “inpatient,” “acute care,” “guideline,” “insulin,” “quality improvement,” “diabetes education,” “staff development,” and “nursing knowledge.” A search of the Cochrane Library revealed several randomized controlled trials (RCT) that tested the AACE/ADA recommendations. Also found in the Cochrane Library were several discussions on hyperglycemia in the Intensive Care Unit (ICU) setting where intravenous insulin is the primary treatment for hyperglycemia. These studies were not reviewed because this practice change focuses on glycemic management for the non-ICU setting.

Additional articles were found from the reference list of pertinent studies. Criteria for studies reviewed were methods for glycemic control of adult hospitalized patients with diabetes in the non-ICU setting.

In all, 55 articles were reviewed and 26 were critiqued and used as the basis for this practice change. Mosby’s Quality of Evidence tool was used to evaluate the strength of evidence of these journal articles (see Table 1). The selected articles were synthesized and organized into sub concepts Clinical Outcomes, Applying the AACE/ADA Standards, and Length of Stay and Financial Outcomes.
Table 1.

Mosby’s Quality of Evidence.

<table>
<thead>
<tr>
<th>Levels of Evidence</th>
<th>Reviewed Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level I</td>
<td>Meta-analysis</td>
</tr>
<tr>
<td>Level II</td>
<td>Experimental design (Randomized Controlled Trial)</td>
</tr>
<tr>
<td>Level III</td>
<td>Quasi-experimental design</td>
</tr>
<tr>
<td>Level IV</td>
<td>Well-designed case-controlled or cohort studies</td>
</tr>
<tr>
<td>Level V</td>
<td>Correlation studies</td>
</tr>
<tr>
<td>Level VI</td>
<td>Descriptive or qualitative study</td>
</tr>
<tr>
<td>Level VII</td>
<td>Authority opinion or expert committee reports</td>
</tr>
<tr>
<td>Other</td>
<td>Performance Improvement; Review of Literature</td>
</tr>
</tbody>
</table>

**AACE/ADA standards for glycemic control.** The ADA standards for glycemic control in 2006 are the same standards adopted by the AACE/ADA in 2009. To address inpatient hyperglycemia, several studies tested the basal/bolus/correctional insulin concept used for the AACE/ADA recommendations, seven of which will be discussed in this section. The Cochrane Library revealed three randomized controlled trials (Smiley, 2011; Umpierrez et al., 2007; Umpierrez et al., 2011) and 1 quasi-experimental study (Roberts, Aguilar-Loza, Esterman, Burt, & Stranks, 2012). Three additional studies (Gosmanov, Goorha, Stelts, Peng, & Umpierrez, 2013; Munoz et al., 2012; Newton & Young, 2006) also found improvements in glycemic control when using AACE/ADA recommendations.

Mathioudakis and Golden (2015) compared in-patient glucose management guidelines published by the ADA (2014), the AACE/ADA (2009), and the Endocrine Society (2012). Although other guidelines exist, the authors chose these studies because they pertained to patients in the non-ICU setting. The guidelines were found to be in alignment with outcome measures, glycemic targets, and management approaches using
BBI therapy. However, the guidelines differed in use of oral agents, transitioning from intravenous insulin to subcutaneous insulin, and nutritional therapy.

Umpierrez et al. (2007) conducted the hallmark RCT, called the RABBIT 2 trial, that compared scheduled basal/bolus insulin to sliding scale insulin in the non-ICU setting. This trial involved 135 patients and showed a significantly higher percentage of patients achieving goal glucose levels without an increase in hypoglycemia. The fasting and pre-meal blood glucose levels target in this study was < 140 mg/dL. Of the BBI group, 66% of patients achieved blood glucose targets versus 38% of patients in the SSI group. In the SSI group, despite increasing doses, 14% had blood glucoses that remained over 240 mg/dL.

In a follow-up study, Umpeirrez et al. (2011) conducted a prospective multicenter randomized controlled trial RCT to study the effects of BBI and SSI in surgical patients. This study found similar results as the RABBIT 2 Trial: significant improvement in glucose control with basal bolus therapy, however, found higher rates of hypoglycemia. Results also revealed decreased post-operative complications.

In a randomized controlled trial involving 211 patients, Smiley et al. (2011) found that using a SSI regimen increased glycemic variability among diabetic patients. Treatment with BBI therapy decreased wide variations in blood glucose levels but did not reduce complications. However, when adjusted for age, gender, and severity of surgery, there was no difference in complications between groups.

Another study tested BBI and SSI and found basal bolus therapy to be superior to SSI in glycemic control, and contrary to the Smiley et al. (2011) study, showed reduced complications. In a retrospective study involving 40 patients, Gosmanov et al. (2013)
compared BBI to SSI to treating dexamethasone-induced hyperglycemia in diabetic patients with malignancies. After insulin treatment, the basal bolus group had an average blood glucose of 219, verses 301 for the patients treated with SSI. Three patients in the SSI group were transferred to the intensive care unit for management of diabetic ketoacidosis or hyperosmolar hyperglycemic states versus no transfers in the basal bolus insulin group.

Three studies found that implementing BBI therapy resulted in reduced mean average blood glucose levels. In patients undergoing cardiac bypass surgery, Newton and Young (2006) compared BBI to SSI therapy before the AACE/ADA consensus statement was published. Their study reports improvement in the average hospital blood glucose levels from 177 to 151 ($p < 0.0001$). Munoz et al. (2012) implemented strategies outlined by the AACE/ADA (2007) for inpatient glycemic control in a tertiary care teaching hospital, which resulted a significant decrease in weighted mean blood glucose levels between 150-165 mg/dL for patients in the medical ICU and an 18% reduction in hypoglycemia events. Roberts et al. (2012) conducted a study similar to the RABBIT 2 study. One hundred twenty-four patients treated prospectively with BBI were compared with a retrospective review of 96 patients treated with SSI. Patients treated with BBI had blood glucose levels 28 to 66 mg/dL lower than their baseline levels, and these levels remained lower throughout the study. Patients treated with SSI had no reduction in blood glucose levels.

Of the studies that compared BBI and SSI, two studies found that BBI was related to higher rates of hypoglycemia than SSI. In the RABBIT 2 Surgery study, Umpierrez et al. (2011) found a significant difference in hypoglycemia, defined as a blood glucose
level of < 70 mg/dL. Hypoglycemia occurred in 23.1% of patients in the basal bolus group and 4.7% of patients in the SSI treated group. Severe hypoglycemia (< 40 mg/dL) was reported in 3.8% of patients in the basal-bolus and not at all in the SSI group; this result was not statistically significant. Roberts et al. (2012) also found the rates of hypoglycemia to be greater in the BBI group than the SSI group: 3.3% versus 1.4%. This is in contrast to the RABBIT 2 study (Umpierrez, et al. 2007) that did not find a significant difference in hypoglycemia rates among both insulin therapies.

The research consistently reveals that insulin regimens based on SSI results in decreased glycemic control. However, there are mixed results as to whether BBI increases the rate of hypoglycemia events. In addition to these studies, there are multiple experts that recommended using the AACE/ADA standards for glycemic control of hospitalized patients. (Draznin et al. 2013; Lansang & Umpierrez, 2008; Magaji & Johnston, 2011; Reynolds et al., 2007). In particular, Reynolds et al. (2007) have published recommendations for inpatient diabetes management. These studies are in agreement with management approaches recommended by the AACE/ADA. This provides strength for using these standards for glycemic control in the general medical and surgical patient populations.

**Indicators of poor outcomes.** The AACE/ADA standards of care have shown to be effective in treating and preventing hyperglycemia in the in-patient setting, and as well as in promoting improved glycemic control. It is well known that hyperglycemia and hypoglycemia cause short and long term complications (Hodge & Malaskovitz, 2014; Lansang & Umpierrez, 2008; Magaji & Johnston, 2011; Umpierrez et al., 2002). Dysglycemia and clinical outcomes in the hospital setting were explored and found to be
addressed in several studies. Seven studies found that dysglycemia is associated with poor outcomes, and one study found no association.

A meta-analysis of 12 randomized controlled trials concerning peri-operative glycemic control found that lower blood glucose concentrations were attained with intensive insulin therapy (random blood glucose target < 140 mg/dL versus conventional therapy (random blood glucose target <180 mg/dL). There were no differences in peri-operative outcomes between tighter glucose control and conventional control, although more hypoglycemia was seen with controlling for tighter glucose targets (Buchleitner, Martínez-Alonso, Hernández, Solà, & Mauricio, 2012).

In an early study on the effects of hyperglycemia and outcomes, Pomposelli et al. (1998) found that post-operative patients with hyperglycemia on day one after surgery had an infection rate of 2.7 times that observed (31.3% vs. 11.5%) in patients with DM 2.7 times higher than in patients whose blood glucose values were < 220 mg/dL. When minor infection of the urinary tract was excluded, the relative risk for “serious” postoperative infection increased to 5.7% when any blood glucose level on the first post-operative day was > 220 mg/dL. Although somewhat dated, this study is significant because it has been cited by many researchers and is cited in several subsequent studies (Baker et al., 2006; Smiley, 2011, Umpierrez et al., 2007; Umpierrez et al., 2011; Yendamuri, Fulda, Tinkoff, & Barie, 2003).

Increased morbidity and mortality was associated with hyperglycemia in four studies. Umpierrez et al. (2002) conducted a review of 2,030 inpatient records and reported that patients with new hyperglycemia had a higher in-hospital mortality rate (16%) compared with patients with a prior history of DM (3%) (p < 0.01) and subjects
with normoglycemia (1.7%; p < 0.01). Mendez et al. (2013) found a relevant risk for death in 90 days to be increased by 8% for patients who had hyperglycemia. In a similar study, Baker et al. (2006) studied 348 hospitalized patients with Congestive Obstructive Pulmonary Disease and showed a significant correlation between hyperglycemia and poor outcomes. Risk of death increased by 10% (95% CI 0 - 22) for every 18 mg/dL of rise in blood glucose above 160 mg/dL. When implementing a BBI therapy protocol, Newton and Young (2006) found that improvements in average blood glucose levels were associated with decreased central line infections.

Two studies found hyperglycemia to be associated with increased transfers to ICU. Becker, Moldoveanu, Cukierman, and Gerstein (2007) studied 391 patients hospitalized with pneumonia and found that 30% of patients with hyperglycemia were admitted to the ICU with sepsis versus 8% of patients who did not have hyperglycemia. In addition, cardiovascular events occurred in 40% of patients with hyperglycemia versus 26% of patients who did not have hyperglycemia. In a retrospective study, Gosmanov et al. (2013) found that patients treated with SSI not only had higher blood glucose levels but also increased rates of transfers to ICU for treatment of ketoacidosis or hyperosmolar states.

In contrast to the above studies, Estrada, Young, Nifong, and Chitwood (2003) did not find hyperglycemia, defined in this study as blood glucose ≥ 200, to be associated with poor outcomes in surgical patients. Patients who had DM had higher rates of infection whether or not their blood sugars were in control peri-operatively. In patients undergoing cardiac surgery, Estrada et al. (2003) found that peri-operative blood glucose
level was not associated with increased mortality or higher infection rates, although hyperglycemia was found to be associated with increased postoperative length of stay.

One study looked at hypoglycemia and clinical outcomes. In this retrospective study of 2,582 patients, Turchin et al. (2009) found an association between the number and severity of hypoglycemic episodes with inpatient mortality and length of stay. Hypoglycemia occurred in 7.7% of diabetic patients admitted to a large tertiary care hospital and was associated with an 85% increase in the odds of death ($p < 0.009$). Inpatient mortality increased threefold for every 10 mg/dL decrease in the lowest blood glucose ($p < 0.0058$).

Collectively, these findings suggest that inpatient dysglycemia, independent of whether or not a person is diagnosed with DM, is a marker of poor outcomes. On the other hand, hyperglycemia was found to be associated with increased postoperative length of stay. Hypoglycemia, however, increased risk of mortality in majority of cases.

**LOS and financial outcomes.** Inpatient stays under Medicare Part A are paid by Diagnostic Related Groups (DRG). Each DRG payment is based on what the average cost of hospital care is for each specific diagnosis (CMS, 2015). The hospital may incur a financial lost for a patient whose LOS is longer than the DRG allows for due to complications from hyperglycemia.

Seven studies found a correlation between hyperglycemia, LOS, and financial outcomes (Baker et al.; (2006); Estrada et al. (2003); Hodge and Malaskovitz, (2014); Mendez et al. (2013); Newton and& Young (2006); Turchin et al. (2009); Yendamuri, Fulda, Tinkoff, and& Barie (, 2003)). Evidence revealed prolonged hospital stays were correlated with hyperglycemia.
Baker et al. (2006) reported that the LOS was five days longer in a retrospective study of hyperglycemia in COPD patients. Of the 348 patients admitted with chronic obstructive pulmonary disease (COPD), those who had hyperglycemia (defined in this study as blood glucose > 160) had an average LOS of 12 days verses versus 7 seven days for those patients with COPD who did not have hyperglycemia. Yendamuri et al. (2003) found hyperglycemia to be an independent predictor of LOS among trauma patients. Hospital LOS was six days and ICU LOS was three days longer for patients with both mild and moderate hyperglycemia. This study defined mild hyperglycemia as admission with blood glucose (BG) > 135, and moderate hyperglycemia as admission with BG > 200. Hodge and Malaskovitz (2014) conducted a literature review of 126 hospitals and found that patients with a diagnosis of DM spent one extra day in the hospital on average and had double the related costs than those admitted for the same diagnosis without DM.

Both Newton and Young (2006) and Estrada et al. (2003) reported that LOS and hospital costs correlated with hyperglycemia. Newton and Young (2006) found that implementing the ADA standards of care for hospitalized patients resulted in reduced length of stay in hyperglycemic patients from 6.01 days to 5.75 days when the standards were implemented. The ADA standards for glycemic control in 2006, when the Newton and Young (2006) study was conducted, are the same standards that were adopted by the AACE/ADA in 2009. This resulted in a reduction of 0.26 hospital days per patient and over $2 million in 1 one year. In a study comparing LOS to increments of blood glucose levels, Estrada et al. (2003) found that LOS among cardiac surgery patients with DM was 0.76 days longer for every 50 mg/dL increase in glucose and that costs increased by $2824 per patient.
Mendez et al. (2013) also used increments in blood glucose levels to test correlations with LOS. Their study of 4262 patients with hyperglycemia admitted during a two-year period found a correlation between hyperglycemia, glucose variation, and length of stay. In this study, LOS increased by 4.4% for every 10 mg/dL increase in the standard deviation of blood glucose results \((p = 0.001)\) and LOS increased by 9.7% for every 10 point increase in coefficient of variation or the standard deviation ratio of dispersement. The relative risk of death in 90 days increased by 8% for those who had hyperglycemia.

One study found a correlation between LOS and hypoglycemia. Turchin et al. (2009) found that the LOS increased by 2.5 days for each day with hypoglycemia. This was attributed to effects of hypoglycemia such as falls, seizures, time needed to adjust medications, or delays of tests and procedures that consequently lead to an extension of the hospital stay.

In summary, the studies about LOS lacked consistency in how LOS was measured and did not agree on a definition for hyperglycemia. Yet there is strength in these studies that show a correlation between dysglycemia, LOS, and costs.

**Literature review summary.** These studies demonstrate that glycemic control is important for the safe management of hospitalized patients with DM. Approaches that are in line with the AACE/ADA consensus statement appear to provide improved glucose control, better outcomes, and decreased costs of care for hospitalized non-ICU patients with DM. Overall, the majority of studies critiqued comprised level III evidence; most studies critiqued were quasi-experimental due to lack of randomization. The older studies
report similar outcomes as the recent studies. These studies confirm that dysglycemia leads to poor outcomes and that has not changed over time.

**Advantage of Practice Change**

According to Rogers (1983), the characteristics of an innovation impact the rate of its adoption, such as relative advantage and compatibility. There are several relative advantages of this practice change: improved quality, improved patient outcomes, and convenience of incorporating evidence in the EMR order sets. The Institute of Medicine’s (IOM) report on *Crossing the Quality Chasm* (2001) describes using information technology and evidence-based practices among their key rules for the redesign of health care. This practice change allows the hospital to be in line with the IOM’s design for quality. Utilizing clinical guidelines will lessen confusion among staff and increase safety due to standardization of treatment protocols. Convenience and less confusion will facilitate the change. Other advantages, such as decreased length of stay and cost savings, may not be realized by the staff closest to the bedside, but could make an impact on the financial health of the hospital.

This project is compatible with the current direction of the hospital launching the EMR and using it to its fullest potential. The practice change is compatible with the hospital’s mission to provide quality healthcare services incorporating contemporary practices (Maui Memorial, n.d.). For all medical surgical units, this practice change will be challenging because it requires learning and behavioral change as health care providers move from the status quo to innovative practices.

There is a moderate degree of complexity in this practice change. Nurses and providers will be exposed to new knowledge, learn the current best practices in DM, learn
to use the EMR, and correctly provide insulin therapy. Lewin’s Change Theory poses the question “Why does a process continue at its current level under the present circumstance?” (Lewin, 1947). At MMMC, it was identified that the seasoned nurses trained the newer nurses in the old standards. The degree of complexity of the practice change may be greater for the seasoned nurses who have the old practices deeply ingrained in their work flow.

This was a mandatory change in controlling glycemia at MMMC; however, nurses were allowed to try different approaches in carrying out the changes. After carrying out the work flow changes to coordinate blood glucose testing, insulin and meals, nurses were given the opportunity to discuss what did and did not work well. The trial allowed nurses to be involved in how this practice change was implemented.

Once the night shift nurses were relieved from administering morning insulin doses, an immediate decrease in the incidence of hypoglycemia was observed. More observations of improved glucose levels were also noted when the second chart review was completed. These observations should facilitate this practice change.

**Summary**

This chapter discussed the problem in-depth, which covered the background and the empirical evidence showing that there is a problem that needs to be solved. This chapter also discussed the conceptual framework and presented a review of related literature.

Between January 2013 and July 2014 Maui Memorial was in the unfreezing stage. The practice of using paper charts, old work flows, and conventional insulin orders were based on old standards. The literature supports the use of AACE/ADA standards and
results in improvements in clinical and economic outcomes. This project aims to improve glycemic control among hospitalized patients with DM at MMMC and to improve nurse’s knowledge of best practices for hospitalized patients with DM. The evidence indicates unfreezing the status quo and adoption of current AACE/ADA best practices should prove beneficial to patient outcomes.

The purposes of this project are to improve glycemic control of hospitalized patients with DM at MMMC and improve nursing knowledge of best practices for hospitalized patients with DM. Adoption of best practices for hospitalized patients with DM could result in improved outcomes such as decreased infections, improved wound healing, and decreased length of stay (LOS) (Baker et al., 2006; Mendez et al., 2013; Newton & Young, 2006; Umpierrez et al., 2002). It is expected that the project will be used to its fullest potential by MMMC. It is also anticipated that the project is compatible with the hospital’s mission to provide quality healthcare services incorporate contemporary practices. ("Maui Memorial," 2014).

The project could result in improved outcomes such as decreased infections, improved wound healing, and decreased length of stay (LOS) (Baker et al., 2006; Mendez et al., 2013; Newton & Young, 2006; Umpierrez et al., 2002). It is expected that the project will be used to its fullest potential. It is also anticipated that the project would be compatible with the hospital’s mission to provide quality healthcare services incorporate contemporary practices (Maui Memorial, n.d.).
CHAPTER 3. METHODS

Introduction

This chapter uses Lewin’s moving stage to discuss how the project was conducted and is organized into several different sections: (a) objectives, (b) project design, (c) moving, (d) definitions, (e) sampling plan, (f) setting, (g) sample, (h) recruitment/marketing plan, (i) data collection plan procedures, (j) program evaluation plan, (k) ethical considerations, (l) limitations, and (m) summary.

Objectives

The overall goal of this quality-improvement project is to improve management of hyperglycemia among hospitalized patients with DM at MMMC. This will entail improving nurses’ knowledge of current best practices for in-patient DM care and incorporating the standard of care into the EMR insulin orders. The outcome objectives are to improve the number of blood glucose test results that are within the AACE/ADA recommendations, decrease hypoglycemia events, and increase nurses scores on a ten-question, in-patient diabetes quiz.

Project Design

A quality improvement design is used to gather information about current practices in DM care at Maui Memorial and to take action and improve future performance. Nurses perform direct patient care and are in a position to identify the drivers and barriers of changes in insulin delivery and can work towards improving the process. Nurse managers will structure the work setting to facilitate this change.

At MMMC, policy changes are reviewed by the hospital’s Provision of Care (POC) committee. The committee comprises nurse leaders, the EMR physician
champion, clinical informaticists, and ancillary department managers. The use of the POC committee facilitates coordination of quality improvement efforts by communicating steps in changes, gathering, and presenting feedback. The Diabetes Coordinator ensures that evidence-based care is provided, collects post-implementation data, and ensures that they meet the requirements of the project aims. The Director of Nursing (DON) provides clerical, medical, and pharmacy department resources to ensure that the quality improvement efforts are successful.

**Moving Stage**

The project objectives were met using Lewin’s second stage of Change Theory, moving. The moving process occurred from June 2014 to April 2015 with implementation of the AACE/ADA recommendations commencing in July 2014. Having seen the pre-implementation data and research, nursing and medical leaders showed a strong interest in this practice change and were eager to move forward. Moving activities include revising orders, presenting revisions, conducting nursing education, building new order sets in the EMR, and revising the work flow for day shifts to administer insulin.

**Definitions**

For this project, the following operational definitions were used:

1. The random blood glucose target is defined as 70-180 mg/dL. Blood glucose levels above or below this range are considered above target and below target respectively.

2. Hypoglycemia is any blood glucose result obtained from a patient on insulin that is less than 70.
3. *Staff nurses* are licensed registered professional nurses who provide direct patient care on medical surgical units.

4. *Blood glucose levels* are results of blood glucose tests obtained by point of care testing via finger stick blood glucose performed by staff nurses.

5. *Basal insulin* is defined as long-acting, meal time, and correctional insulin.

6. *Bolus insulin* is defined as long-acting, meal time, and correctional insulin.

7. *Corrective insulin* is defined as long-acting, meal time, and correctional insulin.

8. *Sliding scale insulin* is given by predetermined amounts in response to already high blood glucose.

**Sampling Plan**

**Setting.** Maui Memorial Medical Center is a 213-bed, acute care, tertiary hospital on the island of Maui. The island has been designated as a medically underserved area by the United States Department of Health and Human Services (U.S. Department of Health & Human Services Administration, 2014). The hospital employs 400 staff nurses and has 200 attending physicians. Nurses work 12 hour shifts. It is a state hospital, and the strategic plan includes developing legislation to allow the hospital to enter a public private partnership.

**Sample.** All six medical and surgical units in the hospital used the AACE/ADA recommendations for glycemic control. The intensive care unit was excluded from this project because insulin is administered via intravenous drip infusions. The Labor and Delivery and Post Partum units were also excluded because the AACE and the ADA have separate guidelines for this population.
Thirty patients with a diagnosis of type 1 or type 2 DM, for whom insulin was ordered, were reviewed for baseline data. Patients with hyperglycemia but without a diagnosis of DM were excluded from the sample. A repeat assessment of 30 patient charts was conducted six months after the AACE/ADA standards were in place, and then quarterly assessments will be conducted.

Forty nurses were given a 10-question multiple choice diabetes quiz to establish their baseline knowledge of current practices for care of hospitalized patients with DM (see Appendix A). The quiz was repeated in April of 2015 and the two mean scores were compared to assess changes in knowledge.

**Recruitment/Marketing plan.** The launch of this project began with the Nurses Diabetes Conference in November 2013. The conference exposed nurses and other health care providers to the current standards of care set forth by the AACE and ADA (Moghissi et al., 2009). This exposure planted seeds that prompted questions from the staff about the manner in which we care for diabetic patients and was a vital aspect of marketing this practice change. Marketing plan activities included: 1) emails to nursing administration to provide information and request input about implementing changes; 2) nursing in-services; 3) physician grand rounds; 4) meetings that engaged all levels of nursing; and 5) a visual display of *diabetes tips of the week* flyers, which were brightly colored to attract the attention of those nearby (see Timeline, Appendix B).

Meetings have been the most effective marketing strategy. Involving people in this project enhanced communication throughout the hospital and allowed for immediate
feedback. Communication was vital to marketing this quality improvement project (see Table 2, Communication Plan).

<table>
<thead>
<tr>
<th>Type of Communication</th>
<th>Communication Schedule</th>
<th>Communication Mechanism</th>
<th>Who Initiates</th>
<th>Recipient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduce Quality Project</td>
<td>Before start of projects</td>
<td>Meetings, Emails</td>
<td>Project coordinator</td>
<td>Chief nurse executive, Chief of Staff, DON, Pharmacy Manager, Quality Manager</td>
</tr>
<tr>
<td>Staff Education</td>
<td>Initiation of projects</td>
<td>Flyers, in-services, verbal communication to staff</td>
<td>Project coordinator and Clinical Education Manager</td>
<td>Nurse managers, staff nurses, health care providers</td>
</tr>
<tr>
<td>Information to Physicians</td>
<td>At start of EMR implementation</td>
<td>Emails, Grand Rounds</td>
<td>Endocrinologist</td>
<td>Physicians</td>
</tr>
<tr>
<td>Tracking</td>
<td>Monthly</td>
<td>Email</td>
<td>Project coordinator</td>
<td>All staff nurses involved in patient care, Quality Manager, DON</td>
</tr>
<tr>
<td>Changes to project</td>
<td>As needed as changes occur</td>
<td>Pre work shift huddle and email</td>
<td>DON, Pharmacist, Project coordinator</td>
<td>CNE, DON, Nurse managers</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Mid year and end of project</td>
<td>Presentations at Meetings</td>
<td>Project coordinator</td>
<td>CNE, DON, Nurse Managers</td>
</tr>
</tbody>
</table>

Table 2. Communication Plan.
Presenting the evidence. The evidence-based recommendations for administering insulin and the results of chart reviews were presented to the Director of Nursing (DON), the pharmacy manager, and the quality director. All were in favor of moving forward with the practice change and agreed that nursing and physician education would be needed.

Nursing practice. Approval to develop an all-day DM update conference was obtained from the former Director of Nursing, who has since retired. The hospital-wide conference was accomplished with the help of many community members: an endocrinologist, a nurse practitioner who is certified in diabetes education, a podiatrist, and two nutritionists. In addition, a pharmaceutical company sponsored an expert speaker who presented on discharge planning for the diabetic patient. To attain pre-implementation baseline knowledge of DM care, a ten-question diabetes quiz was administered to all registered nurse attendees. In-services were continued during the moving stage so that nurses would be exposed to the updated DM standards.

Physician practice. Physicians were educated on current evidence-based practices for in-patient glycemic control by the hospital-affiliated endocrinologist. A grand-rounds type of in-service was conducted and, although geared for physicians, it was open to all hospital staff. The grand-rounds in-service was key to the next step, implementing the practice change throughout the hospital.

Diffusion of practice change. Further meetings to update the nursing administration on the current status of glycemic control and nurses’ knowledge was completed in the months that followed. This was delayed because of the implementations of the hospital’s EMR system. Once the EMR was in operation, plans to move forward
with the AACE/ADA recommendations for glycemic control were carried out. These key stakeholders agreed that an improvement in glycemic control was needed and that revising hospital policies would be the next step. In addition to the in-services, the practice change was diffused via announcements at daily bed briefings, flyers, and nurse managers meetings.

**Policy revisions.** There are three hospital policies which affect insulin administration: High Risk Medication Alert Policy, Medication Administration Policy, and the Point-of-Care (POC) Glucose Test Policy. During POC committee meetings, revisions were made to change the timing of insulin administration and point-of-care blood glucose testing in these policies. Modifications continued on all three polices until there was an agreement on the process for insulin administration. The hospital’s lead pharmacist presented policy changes to the Pharmacy and Therapeutics (P&T) committee. Concurrently, the insulin orders were revised to reflect the AACE/ADA recommendations of providing basal, bolus, and corrective insulin, and this was built as the default order in the EMR. Policy revisions were approved by both the POC and P&T committees in mid July 2014.
**Required resources.** Because nursing in-services are incorporated in the staffing budget, there were no additional resources required for this quality improvement project. Time spent on this project is in the cost pool of nursing administration. Surveillance of glycemic control and staff education is already in the job description of the diabetes coordinator.

**Process and outcome variables.** Post-implementation data on glycemic control and nurses’ knowledge of best practices for the hospitalized diabetic patient were collected and analyzed for the continuous improvement of this project. The EMR system was used to conduct chart reviews on five charts from each medical and surgical unit, for a total of 30 charts, to assess glucose values within the AACE/ADA targets. The data was extracted manually, de-identified, and entered into an Excel spreadsheet. All values from the day of the patient’s admission were removed because these values do not reflect
hospital treatment. Data were grouped into three categories--below, within, or above target levels--and compared to the baseline data. The percent of blood glucose within the three categories were recorded. See Figure 4 for Data Collection Plan.

The Abbott Database is an online database in which point-of-care blood glucose results are kept. Blood glucose results were obtained using this database. The data were collected and used to track above and below target results over time, from pre-implementation to 6-months post-project implementation.

The nurse’s inpatient diabetes quiz was repeated in April 2015, 17 months after monthly in-services began, to assess knowledge retention of the AACE/ADA standards of care for hospitalized patients with DM. Item analysis identified areas where knowledge efforts should be concentrated on in the future. The average percent of correct answers among 40 nurses was reported, and compared to the scores from the baseline assessment of November 2013 (see Table 4).
The objectives of the data collection plan included:

1. Improve coordination of BG test, insulin administration, and meal delivery by July 2014;

2. Incorporate AACE/ADA standards into insulin order sets by July 2014;

3. Improve nurses’ knowledge of care for hospitalized patients with DM from an average score of 67% to a minimum of 80% on a ten-question *In-Patient Diabetes* quiz by April 2015;

4. Improve the number of blood glucose test results that are within the AACE/ADA recommendations from 46% to 80% by April 2015;

5. Decrease hypoglycemia events from 9% to 2% by April 2015.
Instruments. A two-part measurement system, adopted from the Institute for Healthcare Improvement, was used to assess the adequacy of glucose control over time: blood glucose levels within the target range, as well as hypoglycemia events before and after implementation of this quality improvement project (see Appendix C). To calculate the percent of blood glucose levels within the target range, the total number of blood glucose tests done in the 30 charts was divided by the number of blood glucose levels above, below, and within target. To record baseline data from paper charts, a data collection tool was created using Microsoft Excel (see Appendix D). The percentage of blood glucose within target was compared to a second chart review conducted over a one-year post-EMR implementation. The 10-question nurses’ knowledge assessment of the ADA standards of care for patients with diabetes was used pre- and post-implementation of nursing in-services on DM care within 11 months. The pre-test was administered in February 2014, while the post-test was administered in March 2015.

Program Evaluation Plan

A single time series design was selected for the project evaluation because this design detects any noticeable improvements in blood glucose values and in nurses’ knowledge. Baseline measurements and target outcomes were compared to determine if project objectives were met.

Ethical Considerations

This project is in line with provision 7.3 of the nursing code of ethics, “advancing the profession through knowledge development dissemination and application to practice” (Code of Ethics for Nurses, 2010, p. 1). As health care providers, we have an obligation to provide treatment based on recent scientific research. As employees, we
have a responsibility to bring our health care organization up to current standards to maximize the possible benefits of current research. Utilizing evidence-based practices in glycemic control accomplishes our duty to do what is good and do no harm.

This quality improvement project will provide tools for physicians and nurses to use in caring for patients with DM. Physicians have the autonomy to tailor their practice to meet individual patient needs. This is in line with the AACE/ADA recommendations, which sets targets for most patients with DM, but also recognizes that care must be individualized ("aace.com/publications/position-statements," 2005). Patient care was not manipulated for this quality improvement project; however, it was being revised. In its current state, there was no randomization, and this project lacked a control group. Blood glucose data collected electronically was de-identified when exported to the Excel spreadsheet. In addition, the author has taken the Collaborative Institutional Training Initiative course in Human Subjects Protection as an added measure to ensure ethical responsibility.

Patients provided consent for treatment when admitted to Maui Memorial Medical Center (MMMC), and additional informed consent was not required for this project. Approval from nurse managers and hospital administrators regarding the use of evidence-based practices for DM care was secured; hence, work flow changes were conducted after agreement was reached between physicians, nurses, pharmacists and administration.

Limitations

This project has several limitations. First, the baseline chart sample size was small. Five charts per unit were reviewed over a two-week period for a total of 30 charts. This may not adequately represent the population of charts from diabetic patients treated
with insulin during that two week period. Second, which physician wrote the insulin order was not taken into consideration during the chart review, and physician’s names were not recorded. There is a possibility that there is an unequal distribution of physicians represented in the charts reviewed for the baseline assessment, and they may have written insulin orders using the old standards.

As for the nurse’s knowledge assessment, the baseline assessment was conducted on a convenience sample of 24 nurses who signed up for the diabetes update conference in November 2013. A larger sample of nurses may have been a better representation of the entire population of nurses at MMMC. Therefore, in the following week, an additional 16 nurses who did not attend the conference were found and agreed to take the quiz. In addition, the grand rounds physician in-service conducted by the endocrinologist was well attended but only a few of the attendees were hospitalists responsible for writing the majority of insulin orders. This limited the diffusion of current best practices for in-patient glycemic control to the medical staff.

Lastly, the Abbott Database system only archives six months of data, and anything beyond six months is automatically deleted. This was not discovered until a year into the project when the project coordinator was given access to the system. Pre-implementation data from the Abbott Database system was retrieved for only one month prior to the actual project implementation. Having six months’ worth of blood glucose values to examine the overall glycemic control may have provided for a stronger evaluation of the impact of this practice change.
Summary

This chapter described the methods used for this practice change and provides information on the setting, sample, and tools being utilized. In addition, this chapter explains the data collection and project procedures, plans for evaluation, ethical considerations, and limitations. The data presented here suggests that Maui Memorial is in a good position to enhance DM care through implementation of standardized order sets, revision of the work flow surrounding insulin administration, and ensuring increased knowledge about these standards.

Implementing current best practices in treating DM requires a substantial amount of behavior change among both medical and nursing staff. When skills, knowledge, and attitudes are addressed, the staff were comfortable with the new system, and the practice change has a better chance of being sustained.
CHAPTER 4. RESULTS

Introduction

This chapter includes the sample descriptions and an analysis of outcomes. The outcomes measured were pre- and post-project implementation of glycemic control and nurses’ knowledge. The data is reflective of the purpose of this project, to improve glycemic control of hospitalized patients with DM at MMMC and to improve nursing knowledge of best practices for hospitalized patients with DM. The evolution of the project section explains the progress of the project, expected and actual outcomes, and barriers and facilitators to meeting project objectives.

Refreezing Stage

Refreezing is the final stage in Lewin’s Change Theory. According to Lewin (1947), when relearning occurs, refreezing can begin. While education was provided, it was evident that some nurses’ resisted change because they believed the current workflow worked well. The nurses had developed ways to maintain their current workflow by providing extra snacks and delaying insulin until the very end of their shift, or by omitting insulin altogether. These workflow processes developed by the nurses were unfrozen, education was provided during the moving phase, and now, in order to maintain a sustained practice change, refreezing was necessary.

Objectives

All objectives, with the exception of objective four, were successfully met before project completion in June 2015. The fourth objective showed positive trends but did not meet the benchmark set at the beginning of the project.
The first objective was to improve coordination of blood glucose test, insulin administration, and meal delivery. This was met in July 2014 when the EMR and new workflow was implemented. Insulin administration now coincides with meals and refreezing the workflow has occurred.

The second objective was to develop insulin orders that reflect AACE/ADA standards by July 2014. This was met in early July 2014 (See Appendix E). Hospital polices were also revised to coincide with insulin orders.

The third objective was to improve nurses’ knowledge of in-patient DM care. This was met through the delivery of multimodal education efforts. Post education quiz scores increased significantly from 67% before education to 79% after the education.

The fourth objective was to improve the number of blood glucose test results that were within the AACE/ADA guidelines from 46% to 80% by April 2015. This objective was not met. Although the number of blood glucose values within target improved from 46% to 59%, the previously set benchmark was not reached.

The final objective was to decrease hypoglycemia events from 9% to 2% by April 2015. This objective was met. The post-implementation hypoglycemia rate was found to be 0.6%.

**Description of Sample**

**Blood glucose results.** At the start of this project, MMMC had six designated units for medical and surgical patients. In the final months, the hospital permanently opened a seventh unit previously used for overflow patients. Blood glucose data from five charts from the newly open unit were included in the post-implementation results. Extracted blood glucose test results were categorized to below, within, or above target.
All blood glucose results from the first 24 hours of admission were excluded from the data collected. The pre-implementation chart review included 446 blood glucose results. There were 695 blood glucose results used for the post-implementation evaluation.

**Pre-implementation group.** A convenience sample of forty nurses took the pre-education In-patient Diabetes Quiz. They were all licensed registered nurses employed at MMMC and provided care to diabetic patients on the medical and surgical units. Whether these nurses received previous nursing diabetes education was not collected; however, it is important to note that according to the clinical education staff, MMMC has not provided nurses with in-services on diabetes care since 2006.

**Post-implementation group.** A second convenience sample of another forty nurses took the computerized version of the same quiz 17 months after the pre-implementation education, at the conclusion of this project. These nurses were also employed on the medical and surgical units at MMMC. These nurses attended either unit-based diabetes in-services or formal classroom RN Updates at MMMC with the same content. Additional demographic information about the nurses was not collected.

**Trend Analysis**

**Changes in insulin orders.** The initial EMR insulin orders were similar to the paper orders and listed sliding scale rapid- or fast-acting insulin before meals and at 9:00 p.m. These orders were revised so that they default to scheduled basal, meal time, and corrective insulin. The order for rapid-acting insulin at 9:00 p.m. was eliminated (see Appendix E).
Policy changes. Policy #300-109-17, High-Risk Medication Alert section E.2. was revised and now reads, “Sliding scale/corrective insulin regimens using regular or rapid acting (lispro or aspart) insulin will only be given with meals and not routinely at bedtime unless the physician specifically orders it.”

Policy #300-109-08, Medication Administration Policy Section G, has an added instruction that reads “short-acting insulin is given 30 minutes to 60 minutes prior to meals, and rapid-acting insulin is given 15 minutes before the meal, with the meal, or immediately after the meal.”

Glycemic control. The percentage of blood glucose results within target was calculated according to the IHI (2014) Glycemic Control tool (see Appendix C). Results from the six medical and surgical units chart review indicated MMMC had a baseline of 46% blood glucose tests within the AACE/ADA recommendations. A total of 446 blood glucose results were reviewed when developing the baseline. Hypoglycemia (glucose < 70) was found to occur in 9% of the results. Forty-five percent of the blood glucose results were above the target of 180 at baseline and were considered hyperglycemic (see Table 3).

Table 3. Blood Glucose Results

<table>
<thead>
<tr>
<th></th>
<th>Pre Implementation Data</th>
<th>Post Implementation Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Target &lt;70 mg/dL</td>
<td>9% (40 results)</td>
<td>0.6% (4 results)</td>
</tr>
<tr>
<td>Within Target 70-180 mg/dL</td>
<td>46% (205 results)</td>
<td>59.3% (412 results)</td>
</tr>
<tr>
<td>Above Target &gt;180 mg/dL</td>
<td>45% (201 results)</td>
<td>40% (279 results)</td>
</tr>
<tr>
<td>Total BG test reviewed</td>
<td>446</td>
<td>695</td>
</tr>
</tbody>
</table>

Post-implementation data revealed that 59.3% of blood glucose values were within the AACE/ADA target of between 70 and 180, a 13.3% increase from the
baseline. Blood glucose levels below target were 0.6%, an 8.4% decrease from baseline (see Table 5).

Hypoglycemic events were trended from six weeks pre-implementation to nine months post-implementation utilizing the available Abbott Database information. Monthly rates of hypoglycemia decreased from 73 events in the month of June 2013, to 39 events in April 2014. Data prior to June 2013 were not accessible (See Figure 5).

**Abbott Database Hypoglycemia**

![Abbott Database Hypoglycemia Graph](image)

Figure 5. Number of hypoglycemic events from Abbott Database.

In order to examine trends in the timing of hypoglycemia, data from September 2014 to February 2015 were collected and analyzed. It was found that 33% of hypoglycemia events occurred between 6:00 a.m. - 9:00 a.m (see Figure 6).
Nursing knowledge. The scores from the 40 nurses who completed the pre-implementation diabetes quiz were compared to the scores of 40 nurses who took the computerized version of the same quiz 17 months after the pre-implementation phase. Test results were compiled, generating an average score of 67% before education, and an average score of 79% post education. Questions 3 and 4 had the most incorrect answers in the pre-implementation quiz. Twenty-seven responses were incorrect for question 3, pertaining to goals for blood glucose of hospitalized patients with DM. Twenty-four responses were incorrect for question 4, relating to the level of blood glucose that may impair wound healing. Post-implementation quiz results showed only a slight rise in question 3, suggesting nurses at MMMC are still unfamiliar with target blood glucose levels for hospitalized patients with DM (see Figure 7).

All other questions with the exception of question 6 showed improvements. Score from question 6 decreased from 100% of nurses answering correctly on the pre-test, to
88% of nurses correct on the post-test. The decrease in scores for question 6, which pertains to timing of blood glucose, insulin and meals, was unexpected.

![Pre and Post Quiz Results](image)

*Figure 7. Changes in nurses’ knowledge.*

**Evolution of Project**

The project started with the project coordinator meeting with the Chief Nursing Executive (CNE), who provided initial support for the quality improvement efforts. Within three months of the launch of the project, the CNE was on a leave of absence but attempted to provide support and direction via phone and email. Despite this, the project coordinator was able to carry out unfreezing activities. The CNE eventually retired and eight months into the project, the DON agreed to serve as the project’s adviser. This is when the project quickly moved forward.

**Expected vs. Actual Outcomes**

**Improve glycemic control.** This project set out to change the way diabetes care was being delivered at MMMC. It was anticipated that with this practice change, a greater improvement in blood glucose levels within the AACE/ADA recommendations
would be seen. The actual improvement was less than expected. Nevertheless, the findings were striking enough to continue standard insulin order sets, workflow changes, and continue nurse education.

**Standard insulin order sets.** The initial plan to revise insulin orders was devised early in this project and included three order sets: basal insulin, bolus (mealtime) insulin, and corrective insulin. As the project evolved, it was decided to merge each of these into one order set, with the basal and bolus insulin on top. This simplified work for providers ordering insulin for patients who are eating a regular diet.

**Nurse education.** The first diabetes update in-service was a hospital-wide, all-day education session that involved a variety of topics related to diabetes, including in-patient care and recommendations. Initially, the plan was to conduct another hospital-wide all-day in-service the following year, but due to logistics and state regulations, subsequent sessions were conducted each month in the Clinical Education Department and once on each of the nursing units. These education sessions focused on in-patient care and recommendations.

The initial plan was to educate all nurses, but unfortunately, only 42.3% (180 out of 425) nurses attended an diabetes educational session. One reason for this is that many of the sessions did not coincide with nurse schedules. Another reason could be that the sessions were not mandatory. The *Diabetes Tip of the Week* flyers were introduced to serve as a convenient form of education and reach a larger audience.

**Workflow.** Education efforts pre-implementation were to prepare nurses for the upcoming changes in administering insulin. On the first day of implementation, there was confusion among staff nurses who either were not attentive to or did not receive
information provided about when to conduct finger stick glucose levels or administer insulin. Those who knew about the new process helped those who did not understand the new process. After responding to multiple questions in the first week, all staff were on board with the new workflow.

Refreezing requires validation and addressing concerns of the new standards. After voicing their concerns, nurses were able to provide input in planning the workflow. The units varied on how they would carry out the new standards. Two units decided to assign the charge nurse, who is not assigned patients, to conduct all glucose checks within the hour before meal delivery. Other units decided that nurses would conduct glucose checks to their assigned patients before meal delivery. Allowing each unit to determine what works best for them provided the nurses with a feeling that they had control over this new situation and also let them make the best choice for their unit and patients.

**Project support.** It was hoped that as information regarding diabetes care was diffused and support was sought, a diabetes team would evolve. The initial meeting was attended by only two staff nurses, an infection control nurse, and a quality control nurse. Although these nurses expressed interest in improving diabetes care, they were unable to assist in project activities. While a specific diabetes team never came together, assistance and advice was provided by the pharmacy manager, quality nurses, infection control nurse, Chief of Clinical Affairs physician, and a community endocrinologist in order to provide support and advice on order sets and in disseminating the AACE/ADA recommendation.
Facilitators

Lewin (1947) stated that in order to create a change, one has to belong to the group. Midway through this DNP project, the project coordinator gained employment at MMMC. This facilitated the moving and refreezing phases of this practice change. The project coordinator transitioned to an influential leadership position and served as a member of several committees making diffusion of this practice change easier and more successful.

The DON was instrumental in facilitating this project. Her connection with the management of all departments made it possible to obtain the necessary data and permission to accomplish project goals. Before she became involved in the project, the management was unstable. When the DON took on the role, she was able to offer stability and a renewed focus for completing the project goals.

Barriers

Two significant barriers were encountered during the course of the project. First, the EMR system selected for MMMC has the capabilities of producing daily census reports. However, it does not provide reporting of monthly or annual data. This made it difficult to obtain aggregated statistical information, such as monthly rates of diabetes admissions or demographic information about patients. Some information could be obtained by the Financial Services Department or Health Information System Services, but data-gathering was difficult and fragmented. In addition, much of the data was assembled by manually transferring data onto paper data collection instruments. This data was then manually entered into a Microsoft Excel database for analysis. Additionally, glucose testing times and each hospital unit’s results had to be separated manually on the
exported report. Moving data manually is not only time consuming but also has a greater potential for errors.

Second, diabetes is usually a secondary diagnosis and does not receive the attention that a primary diagnosis does. The project coordinator noticed an overall lack of interest in diabetes care of hospitalized patients and had to be persistent in order to conduct the unit based in-services.

Summary

This quality improvement project endeavored to improve glycemic control at MMMC. The five goals of this project were: (1) to coordinate the timing of blood glucose testing, the type of insulin administered, and timing meal delivery; (2) to develop standardized insulin order sets that reflect the AACE/ADA standards; (3) to increase nurses’ knowledge of caring for hospitalized patients with DM; (4) to increase the number of blood glucose test results within the AACE/ADA guideline; and (5) to decrease the number of hypoglycemia events.

Implementing this project has heightened staff awareness of the standards in diabetes care. Practice changes appear to be frozen in place and have become part of the normal workflow on all seven nursing units. The results demonstrate how much was accomplished so far and how much more needs to be done to ensure high quality care provision to patients with diabetes. For the best possible care for patients with DM at MMMC, the progression of the program should continue and produce positive results.
CHAPTER 5. DISCUSSION

Introduction

Kurt Lewin’s Change Theory was used to guide and facilitate improvements in glycemic control at MMMC. The unfreezing phase was accomplished by garnering support from stakeholders and hospital administrators on best practices of glycemic control to identify the problem. The moving phase was accomplished through revising policies, insulin orders, work flow, and continued education for nursing staff. Refreezing was carried out by collecting post implementation data, reporting results, on-going education, and monitoring of glycemic control on medical and surgical units. Results of post-implementation data show improvements in both hyper- and hypoglycemia and improvements in nursing knowledge regarding best practices for in-patient diabetes care. This section will examine these results, provide recommendations based on these findings, and describe plans for dissemination.

Interpretation of Findings

**Glucose within target.** After nine months of using the AACE/ADA recommendations, within target glucose levels rose 13% above baseline. To meet the project goal of 80% would have required a 30% increase. Although an improvement, this measure was less than expected. It is difficult to discern the cause of this less than desirable result. An informal chart review found that some orders were not changed from SSI to BBI. The AACE/ADA recommends clinical judgment and ongoing day-to-day assessment; therefore, it is possible physicians’ preferred delaying BBI therapy, or they may have forgotten to change the order. It is unknown, however, the extent to which the delay of changing to SSI orders could explain why target glucose levels only rose 13
percent. It is also unknown how other causes of hyperglycemia led to this result. Still, the improvement of glucose values within target acknowledges the positive effects of changes made. Monitoring insulin orders and timing of insulin administration would provide a better understanding of within target rates and help focus on areas for improvement.

**Glucose above target.** A 5% improvement in hyperglycemia was seen. In addition, the BBI order was positioned to be easily accessible. Although insulin orders were not monitored, during informal chart reviews there was a noticeable positive change in insulin ordering. The effectiveness of using BBI therapy and correct timing of insulin administration was reflected in this improvement.

**Glucose below target.** Improvement in blood glucose levels below 70 mg/dL was a major finding in the post-implementation analysis. Improvements were expected; however, the degree of change, from 9% to less than 1%, exceeded project goals. The main contributors for this success are the insulin administration work flow and removing corrective insulin at bedtime in the selection for insulin orders.

The trend in timing of hypoglycemia post-implementation shows fewer episodes of hypoglycemia occurring between 9:00 p.m. and 12:00 a.m., specifically, eight episodes within a six-month time frame, which is fewer than any other time of day. It is assumed that eliminating the routine use of corrective insulin at bedtime contributed to the improvement in hypoglycemia. There were 30 episodes of early morning hypoglycemia in six months, which is higher than the bedtime rate but still below other pre-meal hypoglycemia rates. This demonstrates hypoglycemia can be improved when giving boluses of insulin at meal times.
The post-project rates of hypoglycemia were found to be highest before breakfast. It can be reasoned that patients have the longest length of time without food during the pre-breakfast hours, so blood glucose would be lowest at this time. When examining the root cause for a few of the hypoglycemia events, it was discovered that 33 percent of hypoglycemia events that occurred before breakfast are among those who still had regular or rapid-acting insulin ordered at bedtime that preceded hypoglycemia before breakfast the following day. This was usually due to the patient having *nothing by mouth* orders (no food or fluids because of scheduled surgery or test), and insulin orders were not changed to BBI therapy when the patient resumed a regular diet.

**Nurses’ knowledge.** To obtain a baseline assessment of nurses’ knowledge, a multiple-choice quiz composed of ten questions on in-patient glycemic control was administered to a convenience sample of 40 nurses in October 2013. From the pre-test, an average score was calculated at 67%. An average score of 80% was set as the target after nursing education. The first question asked “what is the ADA target for pre-meal blood glucose for most hospitalized patients with diabetes?” The second question is “what are some lifestyle changes that can be taught to patients to prevent pre-diabetes?” The third question is “what is the ADA standard for fasting blood of hospitalized patients?” The fourth question asked is “what level of blood sugar can impair wound healing?” The fifth question asked for some of examples of prandial (meal-time) insulins. The sixth question asked which recommendations can lead to better diabetes care management. Question seven asked whether this statement is true or false: “Treatment for hypoglycemia (blood glucose of 70 or below) is 15 grams of carbohydrates, wait 15 minutes, retest, and retreat if needed.” Question eight asked “what are the ADA recommendations for an NPO
patient awaiting surgery?” Question nine asked “what is amylin and how it can affect glucose levels?” The last question again asked the participant to evaluate whether a statement is true or false: “The physician’s orders overrides ADA/AACE recommendations because ADA/AACE are guidelines to guide practice and serve as a resource for physicians and nurses.” In all of these questions, nine out of the ten questions showed improvement, which suggests evidence of knowledge gained in this area. Only the sixth question did not show improvement in nurses’ knowledge.

The in-patient diabetes quiz average score increased by 12% and is attributed to the diabetes in-services and the Diabetes Tip of the Week flyers created to increase nurses’ knowledge. The subject matter of each question was presented during in-service and the flyers addressed questions that were on the quiz as well. Comments about the flyers were always positive and often triggered questions from the nursing staff. This served as opportunities to reinforce information presented at the in-services.

Question one which asked “what percentage of hospitalized patients have diabetes?” resulted in the largest increase from pre quiz. Nurses scored 98% on the post-quiz versus 38% on the pre-quiz. This indicates that nurses now have a much better understanding of the rate of DM in hospitalized patients.

Question three had the lowest scores on both pre- and post-quiz results. The question asked “what is the ADA standard for fasting blood glucose of hospitalized patients?” The question attempted to ascertain whether the nurse understood the recommended blood glucose level targets for hospitalized patients with DM. It might indicate that some nurses seem to think a tighter blood glucose range is needed. More effort is needed to explain the appropriate blood glucose targets for hospitalized patients.
with DM. Question six is also noteworthy because there was a decline in the average score from 100% correct on the pre-quiz to 88% on the post-quiz. This question asked about the AACE/ADA recommendation to improve diabetes care management and required the nurse to choose an amount of time that insulin should be administered before meals. It is unclear why all 40 nurses were correct on this question before this practice change took place, yet only 32 of them scored correctly on the post-quiz. It could be speculated the cohort who took the first test may have been more knowledgeable regarding this question than the nurses who took the second quiz. Another consideration is that policy and workflow changes may have caused confusion about when to administer regular versus rapid acting insulin. Even though a decline was seen, 88% of nurses still answered the question correctly, which is above the desired 80% benchmark.

Questions four and eight showed marked improvement in the nurses’ knowledge, but did not reach the desired 80% benchmark. Twenty-four responses were incorrect for question four, relating to the level of blood glucose that may impair wound healing, suggesting that nurses at MMMC are still unfamiliar with target blood glucose levels for hospitalized patients with DM.

Overall, these finding demonstrate improvements in blood glucose within target, improvements in hypo- and hyperglycemia, and increased nurses’ knowledge of inpatient diabetes care. Implementing the AACE/ADA recommendations for glycemic control has made a positive impact on diabetes care at MMMC.

Implications and Recommendations

Scientific underpinnings for practice. In order to implement this project, the project coordinator examined nursing, biophysical, and social science literature to
ascertain best practices. In recent years, the biophysical knowledge guiding this project concerning glycemic control in hospitalized patients has received increased attention. This is likely related to the plethora of literature which shows that worsening hyperglycemia during medical or surgical illness may increase morbidity and mortality (Becker, Moldoveanu, Cukierman, & Gerstein, 2007; Gosmanov, Goorha, Stelts, Peng, & Umpierrez, 2013; Umpierrez et al., 2002).

Lewin’s Change Theory was found to be applicable for introducing a new process of glycemic control into MMMC. In this case, the changes introduced were revising insulin orders and work flow; and improving the staff nurse’s knowledge level of in-patient diabetes. Restraining forces related to work flow and insulin orders may still occur; therefore, empowered nurses will be added to the driving forces so that proper timing of insulin will remain integrated into an acceptable work flow. In addition, social science’s Change Theory and physiological science was bridged together, and as a result, two hospital polices had been revised.

The project did not use a research design, and outcomes were based on trends found in the data collected over time. The findings revealed that the practice changes made did promote improved healing and well-being among patients with DM, and showed that the recommendations by the AACE/ADA are an effective and physiological approach to glycemic management of hospitalized patients with diabetes.

Organizational & systems leadership for quality improvement and economics. The role of leadership cannot be emphasized enough regarding the success of this project. The project coordinator transitioned to an influential leadership position and served as a member of several committees, making diffusion of this practice change
easier and more successful. The DON was also very instrumental in the successful facilitation of this project. Her connection with the management of all departments enabled the gathering of necessary data and permission to accomplish project goals. Before she became involved in the project, the management was unstable. When the DON took on the role, she was able to offer stability and a renewed focus for completing the project goals.

Moreover, cost justification for this quality improvement (QI) project relies heavily on the hospital administration’s understanding of the benefits of glycemic control. These benefits were presented in the early stages and throughout the project. A significant cost savings can be achieved when quality of care and outcomes improve; however, benefits of an in-patient QI project might not actualize in the short term. The total fixed and variable costs involved in this project were minimal because the project required only a small amount of tangible resources, such as paper and ink. Much of the personnel time was provided at no cost to MMMC. Any correlations between improvements in hyperglycemia and clinical and financial outcomes was not seen immediately; however, focusing on improving blood glucose levels to within target may result in future cost savings from decreased re-admissions and complications.

**Evidence-based practice/translation science.** Transforming research evidence into practice is not an easy task, as it requires organizational support and knowledge-sharing and behavioral change. Transforming research findings regarding clinical and financial outcomes of the AACE/ADA recommendations into a QI project was accomplished based on evidence from literature and observations at MMMC. The potential for further changes as part of on-going glycemic control can be achieved with
on-going data collection and further research into new developments of in-patient diabetes care.

**Information system and technology.** Information technology is an important advancement in healthcare. The practice of healthcare is “inextricably entwined with the management of information” (Shortliffe & Cimino, 2014, p.12). MMC’s EMR system has yet to see its fullest potential. The EMR system selected for MMC had capabilities of producing daily census reports. However, it does not provide reporting of monthly or annual data. This made it difficult to obtain aggregated statistical information, such as monthly rates of hyper or hypoglycemia, or demographic information about patients. Moreover, the Abbot Data Base system was not able to trend or group blood glucose results so this was done manually. In order to monitor progress of a QI project, a system needs to be in place that provides useful and accurate trend data. Access to trend data would improve efficiencies in analyzing glucose results, timing of insulin, and decreasing incidence of hypoglycemia.

**Healthcare policy changes and ethics.** The project was designed to generate changes in the way that diabetes care is delivered at MMC. It was anticipated that with practice change, a greater improvement in blood glucose levels within the AACE/ADA recommendations would be seen. The actual improvement was less than expected but two new policies were generated by the project. In addition, the findings were striking enough to support the continuation of standard insulin order sets, workflow changes, and ongoing nursing education to improve knowledge of glycemic control in hospitalized patients with diabetes.
When it comes to standard insulin order sets, the three sets of basal insulin, bolus (mealtime) insulin, and corrective insulin were merged into one order set, with the basal and bolus insulin on top. This one order set, simplified work for providers ordering insulin for patients who are eating a regular diet. When it comes to nurse education, it was discovered through the project that *The Diabetes Tip of the Week* flyers were the best communication tool for educating nurses because they can reach a larger audience. When it comes to the workflow, the project was flexible allowing each unit to determine what worked best for them, which empowered the nurses. The practice changes that took place over the course of the project now appear to be frozen in place and have become part of the normal workflow on all seven nursing units of MMMC.

**Inter-professional collaboration.** This project depended on contributions from multiple MMMC departments. Collaboration between administration, pharmacy, physicians, education staff, registered dietician, nursing staff, and the hospital’s informaticists made the project a success. Pharmacy managers worked with the project coordinator to revise medication administration policies and EMR orders. Education was coordinated with the Clinical Education Department to incorporate the project coordinators educational session into the RN updates. Therefore, the coordinator needed to use effective communication and collaborative skills in the development and implementation of practice models, peer review, practice guidelines, health policy, standards of care, and/or other scholarly products. The coordinator led the administration, pharmacy, physicians, education staff, registered dietician, nursing staff, and the hospital’s informaticists in the analysis of complex practice and organizational issues. In addition, the coordinator used consultative and leadership skills with the administration,
pharmacy, physicians, education staff, registered dietician, nursing staff, and the hospital’s informaticists to create change in health care and complex healthcare delivery systems. Meetings proved to be an effective marketing strategy. The involvement of people in this project continues to enhance communication throughout the hospital and allows for immediate feedback. Communication is vital to marketing this quality improvement project.

Because the project coordinator was not employed at MMMC for most of the project implementation, it was not possible to form an official diabetes team. The coordinator served as the change agent that connected individuals from multiple professions throughout the hospital. In addition, being a member of several teams has provided the venue to present project activities and findings. Evidence for this practice change and progression of changes was presented during several Infection Control, POC and QI meetings.

**Prevention and population health.** Prior to starting the project, a review of the literature was conducted to determine the evidence supportive of glycemic control practice changes in hospitalized patients with diabetes. The evidence-based recommendations for administering insulin and the results of subsequent chart reviews were presented to the MMMC Director of Nursing (DON), the pharmacy manager, and the quality director. All were in favor of moving forward with the practice change and agreed that nursing and physician education would be needed. For patients with DM who are hospitalized, DM is usually a secondary diagnosis (Baldwin, Villanueva, McNutt, & Bhatnagar, 2005). Yet it can cause coronary artery disease, dehydration, falls, and foot wounds (Hodge & Malaskovitz, 2014; Lansang & Umpierrez, 2008; Magaji & Johnston,
2011). More education is needed to teach patients and health care physicians that the underlying cause of hospitalization is from uncontrolled DM and that controlling blood glucose can decrease the risk of these co-morbidities (Baldwin et al., 2005; Hodge & Malaskovitz, 2014). The root cause of hospitalization is best addressed with population management in the out-patient setting as a means of preventive health care. Community health nurses, ambulatory care facilities, and home health nurses are examples of professionals in a good position to provide preventive care for diabetic patients.

While patients are hospitalized, physicians, nurses and ancillary staff can take advantage of the recovery time to provide information on health promotion and prevention. Controlling blood glucose levels in the hospital can set a good example for patients. Sending this message of good glycemic control in the in-patient setting helps educate patients to carry this over to the home setting.

**Advanced nursing practice and education.** The results of the project revealed that many nurses are unaware of the importance of their contributions to practice changes. The improvements that took place after the implementation of the project led to the recommendation that more nurses should be involved in QI projects. For example, two night shift nurses explained during pre-project implementation that they delayed giving the morning insulin until the very end of their shift because they knew giving this insulin too early would cause hypoglycemia. Yet they felt uncomfortable passing on the task to day shift nurses as it was not scheduled to be given by the day shift staff. These nurses provided strong support for this practice change; hence, their contribution for this advancement in practice was recognized. This project has provided understanding that one does not need to work around hospital polices, but can change policies when
appropriate. In general, carrying out this project has heightened staff awareness of the standards in diabetes care. Practice changes eventually became part of the normal workflow on all seven nursing units. The results showed that there are still some improvements necessary to ensure high quality care provision to patients with diabetes, but the project set the hospital on the right course to accomplish quality diabetes care. For the best possible care for patients with DM at MMMC, the progression of the program should continue and produce positive results.

The results of the study reveal nursing practice has advanced through the initial questioning of hyperglycemia, through theory, research and conducting this practice change. The work flow is now in-line with current best practices to improve glycemic control of hospitalized patients with diabetes.

**Plans for Dissemination**

Hospital administrators, staff nurses, and physicians need to know the efforts and results of this quality project. Plans for disseminating this project include completing this paper by July 2015 and conducting the final presentation the following week. Thereafter, a presentation for MMMC staff nurses on evidence based practice and the concepts of Lewin’s Change Theory will be conducted utilizing this project as an exemplar. Online modules regarding in-patient diabetes care will be developed and added to the nurses’ annual competencies at MMMC. These steps are imperative in order to prevent unfreezing. As was done before the project was carried out, the results of this project will be presented to the Director of Nursing (DON), the pharmacy manager, and the quality director. Once their appreciation and validation of the results are given, the findings will
also be presented to the physicians, who have the capacity to ensure support for insulin order changes.

Summary

This was a quality improvement project using Lewin’s Change Theory to improve glycemic control of hospitalized patients with diabetes at MMMC. Refreezing was successful because there was sustainable change in nursing work flow, insulin orders, and glycemic control. Continued use of the evidence based order sets and current nursing work flow should aid in sustaining this trend. As a result of this project, RN updates in diabetes care is ongoing, so it is less likely that the change will be undone. Further monitoring of the insulin administration process, insulin orders, and nursing knowledge of in-patient diabetes care is needed to monitor compliance with these changes.
APPENDIX A. IN-PATIENT DIABETES QUIZ

1) Approximately what percent of hospitalized patients in the U.S. have diabetes?
   a) 1%
   b) 30%
   c) 10%
   d) 50%

2) What are some lifestyle changes that can be taught to patients to prevent pre-diabetes?
   a) Eat what you want but in moderate proportions; walk daily; frequently diet to maintain weight
   b) Exercise 30 minutes a day; eat high fat, high fiber and high sugar
   c) Exercise 150 minutes a week; lose 7% of body fat; eat healthy
   d) Maintain BMI of 35 or greater; Exercise 5 days a week

3) The ADA recommendations for blood glucose reading for hospitalized patients are:
   a) 70-220
   b) 70-110
   c) 80-130
   d) 70-180

4) According to research a blood sugar level over ___ impairs wound healing?
   a) 300
   b) 280
   c) 250
   d) 220

5) What are examples of prandial (mealtime) insulins?
   a) Regular insulin, insulin aspart, insulin lispro and insulin glulisine
   b) NPH, ultralente insulin, regular insulin
   c) Insulin lispro, insulin aspart, insulin glargine, ultralente insulin
   d) Regular insulin, insulin aspart, NPH, insulin glulisine

6) Recommendations to improve diabetes care management are:
   a) Blood glucose within 1 1/2 hours of meal, regular insulin 1 hours before meals
   b) Blood glucose within 1 hour of meal, regular insulin 30-60 minutes before meals, rapid acting insulin right before meals
   c) Blood glucose within 1 hour before meal, regular or rapid acting insulin 1 hour before meal
   d) Blood glucose within 2 hours before meal, regular insulin right before eating

7) Treatment for hypoglycemia (blood glucose of 70 or below) at Maui Memorial Medical Center on a conscious person includes:
a) 15 grams of carbohydrates, wait 15 minutes, retest, and retreat if needed.
b) 6-8 Glucose tabs, re-test after 15 minutes
c) 1 cup water or 1 can diet coke, as long as patient is conscious
d) 1 cup juice with 2 packets sugar and 4 glucose tab

8) What are the ADA general recommendations for an NPO patient awaiting surgery?
a) Morning of surgery give all diabetes oral medications
b) Pre-op hold all diabetes oral medications; give 100% of usual basal dose to patients with DM II and 100% of usual am basal dose to patients with DM I.
c) Pre-op hold all diabetes oral medications; give 50% of usual am basal dose to patients with DM II, and 100% of usual am basal dose to patients with DM I.
d) Pre-op hold all diabetes oral medications; give 100% of usual am basal and bolus insulin to patients with DM II and 50% of usual am basal insulin to patients with DM I.

9) What is amylin and how does it affect glucose levels?
a) Amylin is a hormone secreted with insulin from beta cells that slows gastric emptying and promotes satiety, thereby preventing post-prandial spikes in blood glucose levels
b) Amylin is a hormone that is made by the liver and has no effect on blood glucose
c) Amylin is a hormone secreted by kidneys that inhibits the release of glucagon.
d) Amylin is a hormone secreted by the pancreas and raises blood sugar levels when they fall too low,

10) The physician’s orders overrides ADA/AACE recommendations because ADA/AACE serves to guide practice and is a resource for physicians and nurses. Additionally, these guidelines do not fit every patient.

a) True
b) False
# APPENDIX B. TIMELINE

<table>
<thead>
<tr>
<th>TASK</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J</td>
<td>A</td>
</tr>
<tr>
<td>Unfreezing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successful Proposal Defense</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brief Key Leaders &amp; Staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop Marketing Products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare Instruments and data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>collection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop In-Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educate Staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Progress Review</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop Database</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implement Practice Change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Re-Freezing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Re-enforce education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collect Post Chart and Quiz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enter/Analyze Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpret Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare &amp; Submit Dissemination Products</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C. INSTITUTE FOR HEALTHCARE IMPROVEMENT

MEASUREMENT TOOL

Percent of blood sugars in the 70 to 180 mg/dL range

- Type of measure: Outcome
- Aim: Increase
- Measure calculation: Numerator/denominator * 100

  Numerator: Number of glucose values within 70 to 180 mg/dL in the 30 chart sample
  Denominator: Total number of glucose tests done in the chart sample

- Goal: 80 percent or more blood sugars are in the 70 to 180 mg/dL range

Percent of blood sugars in the 0 to 69 mg/dL range

- Type of measure: Balancing
- Aim: Decrease
- Measure calculation: Numerator/denominator * 100

  Numerator: Number of glucose values within 0 to 69 mg/dL in the 30 chart sample
  Denominator: Total number of glucose tests done in 30 chart sample

- Goal: Less than 2 percent of blood sugars are in the 0 to 69 mg/dL range

Percent of blood sugars greater than 180 mg/dL

- Type of measure: Balancing
- Aim: Decrease
- Measure calculation: Numerator/denominator * 100

  Numerator: Number of glucose values 180 mg/dL or above in the 30 chart sample
  Denominator: Total number of glucose tests done in the in the 30 chart sample

- Goal: Less than 20 percent of blood sugars are in the greater than 180 mg/dL range
# APPENDIX D. DATA COLLECTION TOOL

<table>
<thead>
<tr>
<th>ACCT #</th>
<th># of BG Test Done</th>
<th># of BG less than 70</th>
<th># in 70-180 Range</th>
<th># of BG greater than 200</th>
<th># of BG greater than 250</th>
<th># of BG greater than 300</th>
<th>Names of Diabetes Meds.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX E. REVISED INSULIN ORDERS
REFERENCES


Mendez, C. E., Mok, K. T., Ata, A., Tanenberg, R. J., Calles-Escandon, J., & Umpierrez, G. E. (2013). Increased glycemic variability is independently associated with
length of stay and mortality in noncritically ill hospitalized patients. *Diabetes Care, 36*(12), 4091-4097. doi: 10.2337/dc12-2430


control. *Quality Management in Health Care, 16*(3), 239-249. doi: 10.1097/01.qmh.0000281060.37979.83


