As physician champion for the Glycemic Management Performance Improvement Team at Glendale Adventist Medical Center, I can attest that this protocol greatly improved the care provided to patients with diabetes. This new protocol can be replicated elsewhere and benefit patients with a comorbidity of diabetes contributing to a reduction in blood glucose levels, length of stay, and cost of care.

- Arby Nahapetian, MD,
  Vice President and Chief Medical Officer, Adventist Health Southern California Network
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2016 Vanguard Award Application – Hospital Quality Institute
Glycemic Management Protocol - Basal Bolus Insulin Protocol by Pharmacy

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EXECUTIVE SUMMARY

The Glycemic Management Improvement Project resulted in the sustainable implementation and on-going maintenance of a Basal Bolus Insulin Protocol (BBIP) beginning in September 2013. The BBIP Protocol in place promotes pharmacy and physician partnership in glycemic monitoring through use of insulin to mirror nutritional intake in order to prevent episodes of hyperglycemia, hypoglycemia, and associated complications. The team formed with the goal of reducing incidents of hyperglycemia and reducing the length of diabetic patient stays on telemetry and medical surgical units by deploying the BBIP protocol including pharmacist monitoring and physician and nursing education. Through this protocol, diabetic patients for whom their attending physician consents are placed on the BBIP protocol. Patients on the BBIP experienced a 26% reduction in their Pre-BBIP blood glucose levels. Average daily glucose levels were consistently under 180 after 3 days on protocol. The team also achieved a reduction of .55 days in the average length of stay in the diabetic population in 2013 through 2015 compared to pre-implementation timeframe (2012). The reduction in ALOS led to an annual estimated cost savings of $197,400. GAMC has continued to improve physician participation and realized sustained improvements in timely management of hyperglycemic episodes.
Glycemic Management Protocol- Basal Bolus Insulin Protocol by Pharmacy Glendale Adventist Medical Center APPLICATION NARRATIVE

Introduction:

The Glycemic Management Improvement Project began in late 2012 and resulted in the rollout of the Basal Bolus Insulin Protocol beginning in September 2013. The Basal Bolus Insulin Protocol (BBIP) promotes pharmacy and physician partnership in glycemic monitoring through the use of insulin to mirror nutritional intake in order to prevent episodes of hyperglycemia and hypoglycemia. The use of the BBIP protocol does this by:

- Mimicking the natural production of sugars
- Standardizing care for patients with diabetes
- Creating stability for patients with diabetes by preventing peaks & valleys in their sugars

Background and Relevance of the Problem being Addressed and Effort Undertaken:

Diabetes is becoming more common in the US with approximately 21 million Americans diagnosed in 2014 and over 8 million still may remain undiagnosed (CDC, 2012). In 2012, it was estimated that the total medical cost of diagnosed diabetes is $245 billion, with largest component (~43%) being cost for hospital inpatient care. Approximately 26% of GAMC’s adult inpatients have a co-morbidity of diabetes (diagnosis codes 250.0-250.9). Physicians may each manage blood glucose levels differently resulting in the potential for inconsistent follow-up. Without consistent glycemic management, patients are at an increased risk for complications. Uncontrolled hyperglycemia is associated with adverse outcomes and longer length of hospital stay. AHRQ Patient Safety Indicator # 10 is intended to flag cases of postoperative metabolic or physiologic complications in elective surgical patients for review and possible process improvement. This PSI rate has shown much variability. This measure includes uncontrolled diabetes and renal failure. This process improvement initiative focused on Glycemic Control for all patients at GAMC, not only post-operative patients.

The glycemic management of all inpatients at Glendale Adventist needed to be streamlined to reduce variability thus improving outcomes. The implementation of the Basal Bolus Insulin Protocol followed evidence based medicine, the ADA Guidelines, and had strong clinical and economic studies to support its implementation.
In addition to an overall desire to improve diabetic patient care, the following elements represent the motivating factors behind the creation of the Glycemic Management PI Team and the BBIP protocol:

- Patients with blood glucose values running too high across the entire hospital – within the acceptable range less than 50% of the time in many cases
- Desire to implement AACE/ADA guidelines & evidence-based care
- Opportunity for better diabetic education given patients do not manage their sugars with a sliding scale-only regimen at home

Performance Improvement Efforts:

The Glycemic Management Performance Improvement Team was created with the goal of reducing incidents of hyperglycemia and reducing the length of inpatient diabetic patient stays by deploying the basal bolus insulin protocol including pharmacist monitoring and physician and nursing education. Additional goals included (1) the deployment of the Basal Bolus Insulin Protocol (BBIP) program including pharmacy management of patient blood glucose levels, (2) improving glycemic management of patients thereby reducing the number of episodes of hyperglycemia, and (3) reducing the average length of stay of diabetic patients by a minimum of .345 days. In order to achieve these goals, Glendale Adventist Medical Center adopted and implemented a new Basal Bolus Insulin Protocol. Basal Bolus protocol includes the daily monitoring of blood glucose values by a dedicated pharmacist who reviews all elevated results and responds immediately to order the necessary medication and coordinate patient education and follow-up. Through this protocol all diabetic patients on telemetry and medical surgical units for whom their attending physician consented were placed on the basal bolus insulin protocol (BBIP) by pharmacy. The BBIP protocol involves the use of basal bolus insulin administration coupled with dosing and active monitoring of blood glucose levels by dedicated pharmacist resources.

Glycemic Protocol Workflow: Managing Blood Glucose Levels of Inpatients using the BBIP

Key intervention includes monitoring by pharmacy and appropriate adjustments to basal bolus insulin dosage
The pharmacy dedicated resources to daily monitoring of patients’ blood sugar levels and tailoring of insulin and medication through a pharmacy and physician partnership. In addition to developing the BBIP protocol as a multidisciplinary approach towards managing appropriate insulin dosing and timing, the project included enhancement patient education on diabetes and insulin therapy by pharmacy staff.

The Basal Bolus Monitoring Form was developed within Cerner to facilitate the pharmacy and physician partnership in glycemic monitoring. The pre-protocol baseline timeframe was from January 2012 to September 2013 and the post-protocol evaluation timeframe was from October 2013 to February 2015. The protocol has been implemented and the efforts are on-going. Forty-three physicians initially agreed to the BBIP auto-consult service and all of their medical-surgical unit patients with two POC readings >180mg/dl in 12 hours were automatically reviewed and enrolled in the BBIP program. Currently 115 physicians participate.

All non-medical surgical nursing units and hospital services outside the Medical Surgical and Telemetry units were excluded from this initial effort. This includes the exclusion of critical care areas, L&D, Rehab, Psych, ED, and Outpatient Services.

Implementation Efforts included the following initial steps:

1. Develop a performance improvement team to roll out recommendation
2. Develop and approve BBIP protocol and associated document
3. Test and Finalize processes
4. Promote use of BBIP with physicians
5. “Enroll” patients in BBIP program
6. Analyze patient blood glucose levels and adjust insulin per protocol
7. Analyze results and share with committee to increase uptake of BBIP amongst physicians
A detailed financial Impact of Care Model was developed and utilized to estimate expected decreased in length of stay (LOS) and cost savings. The impact of care model provides a conservative estimate of potential cost savings. Variation in insurance reimbursement is not included; however this information is included in reported cost savings. The model predicted a reduction of up to .345 in ALOS which was exceeded by the project results.

Results of the Effort: Impact on Patient Safety and Quality

During the timeframe the program has been active in either the planning and staff engagement or implementation phases there has been an improvement in glycemic management (values below 180) and a decrease in ALOS in the diabetic population by .55 days. The program resulted in a 26% reduction in the Pre-BBIP blood glucose levels for patients on the BBIP protocol.

<table>
<thead>
<tr>
<th>QUARTER/SEASON</th>
<th>ALOS DECREASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>-0.252</td>
</tr>
<tr>
<td>Q2</td>
<td>-1.116</td>
</tr>
<tr>
<td>Q3</td>
<td>-0.430</td>
</tr>
<tr>
<td>Q4</td>
<td>-0.307</td>
</tr>
<tr>
<td><strong>ANNUAL DIFFERENCE</strong></td>
<td><strong>0.55</strong></td>
</tr>
</tbody>
</table>

![Graph showing average Pre-BBIP vs. percent reduction by day 3](image)
Average daily glucose levels were consistently under 180 after 3 days on protocol. The team also achieved an average reduction of .55 days in the average length of stay (ALOS) in the diagnosed (coded) diabetic population compared to pre-implementation timeframe. This reduction in length of stay led to an estimated annual cost savings of $197,400 per year, $394,800 for two years. Overall, the annual impact of the decrease in ALOS was a cost reduction of just over $249,000; however revenue was also lost due to the decrease in length of stay on per diem contracts. Since the LOS decrease would actually impact reimbursement for a few insurance carriers, the net impact of realized cost savings was reduced to an annual estimate of $197,400. Patients with a length of stay greater than 14 were excluded. The cost savings were enough to cover the additional $150,000 in pharmacy staffing costs annually with a total net contribution of $47,400 in savings. Soft benefits have also included (1) the post-discharge benefits of medication education to diabetic patients, (2) the Introduction of collaborative glycemic monitoring has improved interdepartmental communication, and (3) Potential reductions in diabetic complications shown to be associated with the incidence of hyperglycemia. Unanticipated positive results included the decrease in workload of physicians, allowing them to focus more on other chronic conditions.

**Significance of the Results:**

Over the last year, several different methods were used to evaluate the statistical significance of the results of the first two years of project planning and implementation. Actual analysis of BBIP project success and tests for significance were done based on the strict implementation timeframes and does not include planning timeframes therefore ALOS values are different. A two sample T-test was conducted to evaluate if the difference between the pre-BBIP average length of stay (ALOS) of 6.16 days and post-BBIP ALOS of 5.86 was significant. All diabetic patients meeting BBIP criteria were included in the two sample T-test per criteria. **Comparison of the pre and post timeframe data showed a significant decrease in diabetic patient mean length of stay with a p value of 0.014.** In addition to reducing the mean length of stay, the overall spread also decreased post-BBIP implementation with the standard deviation in length of stay decreasing from 8.13 to 6.51.
The team also conducted an ALOS regression analysis which illustrated a direct relationship between the reduced blood glucose value and the reduced length of stay post-implementation.

A One-Way ANOVA (analysis of variance) was calculated post implementation in order to evaluate whether or not the reduction in the mean and standard deviation of our geometric length of stay was significant. A p-value of .017 was generated indicating the reduction in ALOS was in fact significant. A second One-way ANOVA was conducted to illustrate the relationship between blood glucose values and length of stay. These values appear to be closely related with a p-value of 0.018.

In order to evaluate the effectiveness of pharmacist monitoring as a major component of the BBIP effort, GAMC also performed a specific cohort study looking at a comparison of the outcome of physician only vs. pharmacist involved Glycemic Management. The team did a focused comparison study to evaluate whether or not pharmacists oversight was more effective at preventing episodes of hyperglycemia than physician monitoring alone. According to the data collected and analysis (Chi-square test) performed, using pharmacist monitoring as part
of the BBIP protocol, significantly (P value = 0.024) reduced the risk of having patients experience blood sugar swings resulting in episodes of hypoglycemia under 70 mg/dL. Also, a secondary Chi-Square test was performed that illustrated using pharmacist monitoring as part of the BBIP protocol, also significantly reduced the risk of having patients experience blood sugar swings resulting in episodes of hypoglycemia under 40 mg/dL (P value = 0.048).

From a six sigma perspective, the team also developed process capability reports and measured sigma values both of which experienced considerable improvement year over year. The process capability report generated for the post-BBIP implementation, revealed a centralization of reduced blood glucose values after BBIP treatment between 70-180 with 32.87% of values observed outside of the desired range. There is still a great deal of improvement to be made and the team continues to monitor progress.

**Project Sustainability and Scaling of Achievements:**

Glycemic Management Performance Improvement Team continues to promote the BBIP protocol and monitor progress on a monthly basis. As of July 2016, a total of 2,670 patients have participated in the Basal Bolus Insulin Protocol since its onset. Physician participation has increased greatly with currently 115 physicians consenting to glycemic management by pharmacy through BBIP. The project team and staff supporting this effort are completely sustainable. The pharmacy staff supporting the basal bolus insulin protocol are full time integrated staff including a full time pharmacist who has been dedicated solely to this effort since 2013.

Patient participation continues to increase over time with an average of 12.2 patients each day on the protocol since onset. An average of 14 patients per day were on the protocol in July 2016 making this last month one of our highest for BBIP participation. The total number of physician auto consults also hit an all-time high of 51 consults per month in June and July 2016. The BBIP protocol has now been utilized for thousands of GAMC patients and represents a best practice model that can potentially be deployed at similar scale organizations and health systems.

**Key Lessons Learned and Advice for Sharing:**

Several key lessons were learned during the planning and implementation phases of the glycemic management project. A dedicated physician champion was paramount to the project’s success, and the team recommends physician champions be engaged early on to craft and drive physician related initiatives. Another important lesson is the need to schedule additional time for information technology solutions, order set development, testing, and technical delays as these items often take longer and are more involved than anticipated. Our key lesson learned from an evaluation perspective is to ensure data collection both pre and
post-project is well-thought out and consistent. In the case of this project, data collection and documentation post-implementation was far more thorough and deliberate. Collecting different data elements pre and post implementation in an effort to improve the data collection process can result in limitations on the type of statistical analysis available and results that can be showcased. Lastly, implementing facility-wide change effectively requires a long term investment in staff engagement including a full scale roll-out of education to teach and adjust culture accordingly.

*Sections 2-8 Total Word Count: 2303 of 2400 Max*
APPENDIX A:
BIOGRAPHICAL INFORMATION OF TEAM LEADS
FULL NAME: Emery, Valena J
PREFERRED ADDRESS: Glendale Adventist Medical Center
1509 Wilson Terrace
Glendale, CA 91206

CONTACT INFO: (P) 818-409-8258
(F) 818-546-5616
(E-MAIL) emeryvj@ah.org

PRESENT POSITION: Director of Organizational Performance

Responsible for the following functions:
- Hospital-wide Quality Outcomes Program including Publicly Reported Quality Measures
- Hospital-wide Organizational Performance Improvement Program
- Medical Staff Peer Review Program
- Hospital wide Policies and Procedures

PROF. ASSOCIATIONS:
- California Association for Healthcare Quality – President for 2010-2011
  (President Elect 2009-2010 and Past-President 2011-2012)
- Hospital Association of Southern California (HASC) – Accreditation and Licensure Committee
- California Hospital Association (CHA) - Hospital Quality Committee

EDUCATION:
Loma Linda University, BS Degree, Health Information Management, 1994
Redlands University, Masters in Management Degree, Quality Management Emphasis, 1998
CPHQ (Certified Professional Healthcare Quality)
RHIA (Registered Health Information Administrator)
CTR (Certified Tumor Registrar)
HACP (Healthcare Accreditation Certified Professional)
CLSSBB (Certified Lean Six Sigma Black Belt)

Glendale Adventist Medical Center (GAMC): GAMC is a 515 bed facility. The hospital is a full service acute care and Heart and Vascular Institute, Orthopedics Institute, Women’s Center, Psychiatric and Substance Abuse Center, and Cancer Center. Ms. Emery leads the quality and performance improvement efforts at GAMC. GAMC has been a top performer as reflected in the following Quality Achievements for 2015:
1. Recognized by the Joint Commission as an Advanced Primary Stroke Center and has received Orthopedic Joint Replacement Disease Specific Certification.
2. Certified as a DNV Comprehensive Stroke Center, reflecting the highest levels of competence for treatment of serious stroke events.
3. Leapfrog Group hospital Safety Score- Letter Grade: A
4. U.S. News and World Report rates GAMC as High Performing in Heart Failure
5. 2015 Women’s Choice Award for patient safety, heart care, and orthopedics.

Professional Experience & Qualifications:
Ms. Emery is academically prepared in Quality Management and Health Information Management with extensive experience working with performance improvement initiatives, clinical quality, health information systems, and total quality management programs. Ms. Emery has been a guest speaker for HASC Seminars on Accreditation and Licensure topics, for CAHQ Annual Meeting addressing the AHRQ Measure “Failure to Rescue”, and for Lumetra for the ACM Collaborative on Core Measures. She has spoken at the 17th PreCALS / Medical Staff Leadership Conference sponsored by IMQ, and at the International Congress on Performance Measurement and Improvement in Health Care sponsored by the Joint Commission. Ms. Emery initiated the “Score 100” Campaign focusing on the reduction in failure rate for Core Measures at Glendale Adventist Medical Center.

Publications:
Published Article, “Hospital Acquired Conditions (HACs)”, in CAHQ Journal, Quarter 4, 2009
Published Article, “The Bottom Line: The Human Touch”, in CAHQ Journal, Quarter 4, 2009
Published Article, “Score 100”, in CAHQ Forum, Volume 29/#3, 3rd Quarter 2005
Published Article “Making the CPR a Reality”, CHIA Journal, November 1994
Published Article “DRG’s Are Not the Answer”, QRC Advisor, Aspen Publication, Volume 1/#10, August 1985
Published Annual "Cancer Program Report", for Parkview Community Hospital Medical Center and for physicians and residents of Riverside County, 1982-2001

Responsible for Publication of two audiovisual programs, “Watch What You Say” and “You and Your Medical Record”

Professional Recognitions:
- International Who’s Who of Professionals, 1996
- California Health Information Association (CHIA) Award for Outstanding Performance; June 7, 1995
- Registered Health Information Administrator, 1994; Placing at 98% of United States on examination
Romic Eskandarian, Pharm.D.  
Senior Director of Pharmacy Services at Glendale Adventist Medical Center  
Biographical Information

Romic Eskandarian, Pharm.D., is the senior director of pharmacy services at Glendale Adventist Medical Center. He has served in this position for the past eight years, where he is responsible for planning, implementing, managing and improving both inpatient and outpatient clinical pharmacy services.

As Senior Director of Pharmaceutical Services at Glendale Adventist Medical Center, Dr. Eskandarian also participates as a member of several committees including the Governing Board, Clinical Improvement Council, P&T, Antimicrobial Stewardship -Chair Committee and Medication Error Prevention Committee-Chair.

Before joining Glendale Adventist Medical Center in 2005, Dr. Eskandarian worked as a clinical pharmacist at White Memorial Medical Center. His first role at Glendale was clinical coordinator, where he took his practice experience and passion for education and began providing advanced elective clerkships in conjunction with local pharmacy schools. The following year, he expanded education efforts by starting a PGY1 pharmacy residency. He currently holds adjunct faculty positions at Western University, Loma Linda, USC, and Touro University.

Dr. Eskandarian’s interests focus on practice innovation, teaching effectiveness, medication safety, and management. He has published several articles in peer reviewed journals, and has presented at various local and national conferences. Dr. Eskandarian spearheaded the implementation of the Basal Bolus Insulin protocol at Glendale Adventist Medical Center.
APPENDIX B:
FULL SIX SIGMA PROJECT PRESENTATION
Six Sigma Project Report Presentation
Glycemic Management Protocol-
Basal Bolus Insulin Protocol
by Pharmacy

Black Belt Name: Valena Emery
Team Leader: Romic Eskandarian
Project Sponsor: Arby Nahapetian, MD
Glendale Adventist Medical Center
Define Phase – Glycemic Management Protocol Project Charter

Project Statement

Problem Statement
Approximately 26% of GAMC’s adult inpatients have a co-morbidity of diabetes. Physicians may each manage blood glucose levels differently resulting in the potential for inconsistent follow-up. Without consistent glycemic management, patients are at an increased risk for complications. AHRQ Patient Safety Indicator # 10 is intended to flag cases of postoperative metabolic or physiologic complications in elective surgical patients for review and possible process improvement. This PSI rate shows much variability. This measure includes uncontrolled diabetes and renal failure.

Project Scope
In Scope:
All diabetic patients on telemetry and medical surgical units for whom their attending physician consent to using the basal bolus insulin protocol (BBIP) by pharmacy.

Out of Scope:
All other nursing units and hospital services outside the Medical Surgical and Telemetry units. This exclusion includes all critical care and women’s services patients.

Roles & Responsibilities

Champion:  Arby Nahapetian, MD
Process Owner: Romic Eskandarian, PharmD
Project BB/GB: Valena Emery
Finance Contact: Deana Allington

Project Deliverables/Benefits

Project Goal
Deploy the Basal Bolus Insulin Protocol (BBIP) program including pharmacy management of patient blood glucose levels. Improve glycemic management of patients thereby reducing the number of episodes of hyperglycemia. Reduce the average length of stay of diabetic patients by a minimum of .345 days. Benefits will be evaluated quarterly following implementation.

Key Deliverables
Six Sigma project documentation, project plan and validated cost savings to meet project targets

Financial and Operational Benefits
Hard: Potential financial benefit of at least $150,000 per annum realized through decrease in average length of stay. This savings will cover additional pharmacy coverage and program cost.
Soft: Improved glycemic management and reduction in episodes of hyperglycemia for diabetic patients

Core team members:
Monica Ludwick, PharmD
Zarmen Israeli, MD – Endo
Terri Hansen
Judy Blair – CNO
Debra Balderama
Kathy Rodrigue
Wende Brookshire
Tamar Apelian
Terri VanHouten
Kimberly Groome

Pablo Bassuk, MD
Oliver Ong, MD – Endocrinology
Jhanna Nariyants, MD – Endo
Zarine Nacashian
Delia Duenas
Jocelyn Cajanap
John Deyell
Rebecca Paw
Punnoose Varghese
Yu-Wen Zoe Chen
Parastoo Rezai
Define Phase – Glycemic Management Protocol: Operational Definitions

Operational Definitions of Key Terms / Glossary

**Basal Bolus Insulin**: A basal-bolus routine involves taking a longer acting form of insulin to keep blood glucose levels stable through periods of fasting and separate injections of shorter acting insulin to prevent rises in blood glucose levels resulting from meals. A basal-bolus regimen, which includes an injection at each meal, attempts to roughly emulate how a non-diabetic person’s body delivers insulin.

**Hyperglycemia**: a medical term for blood sugar that is too high. High blood sugar is common for people with diabetes. Hospital-related hyperglycemia can occur in patients without diabetes.

**QI Macros & Microblog**: Additional software applications utilized to track data and perform statistics.

**QFD**: Quality Function Deployment

**RABBIT 2 Trial**: Randomized Study of Basal-Bolus Insulin Therapy in the Inpatient Management of Patients with Type 2 Diabetes

**SSI**: Sliding Scale Insulin

**SSRI**: Sliding Scale Regular Insulin
Define Phase – Financial Impact / COPQ (Cost of Poor Quality)

- The six sigma team utilized an algorithm for calculating a conservative cost of poor quality based on cost savings from decreasing length of stay by 10% (see detailed algorithm on following slides).
- The actual financial outcomes are included under the analyze and improve phases which account for the decrease in length of stay in 2013-2014 and reimbursement effects based on per diem and case rates.
- The COPQ is not limited to financial elements only.

<table>
<thead>
<tr>
<th>Cost</th>
<th>Cost</th>
<th>% of Total</th>
<th>Incidents</th>
<th>Annual Cost of Incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPQ Based on Elevated Length of Stay</td>
<td>$441 is based on a 10% reduction in the 6.3 day ALOS for diabetics with hyperglycemia.</td>
<td>30.0% of Inpatients are estimated to be diabetic (diagnosed and diagnosed).</td>
<td>480 Patients who could be on BBIP with better glycemic control</td>
<td>$ 212,688</td>
</tr>
<tr>
<td>Elevated Length of Stay for Patients with Hyperglycemia – Annualized Estimates</td>
<td>$441 ($700.00 per day * .63 days)</td>
<td>35% of diabetics are estimated to have a hyperglycemic episode while inpatient</td>
<td>304 Patient Days Avoided</td>
<td></td>
</tr>
<tr>
<td>Total Cost of Poor Quality:</td>
<td></td>
<td></td>
<td>$ 212,688 per year</td>
<td>$319,032 for first 18 months of BBIP</td>
</tr>
</tbody>
</table>
Define Phase – Financial Impact / COPQ (Cost of Poor Quality)

According to 2013 data, there is a 28.5% LOS reduction when POC-BG is well controlled. Our conservative estimates only include a 10% reduction.
Define Phase – Financial Impact / COPQ (Cost of Poor Quality)

Side by Side 2013 Trends Month by Month: There is a 28.5% LOS reduction when POC-BG is well controlled.

<table>
<thead>
<tr>
<th></th>
<th>Average LOS (BG&gt;180)</th>
<th>Average LOS (BG&lt;180)</th>
<th>LOS Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.40</td>
<td>4.57</td>
<td>28.5%</td>
</tr>
</tbody>
</table>

![Diagram showing LOS reduction comparison between BG>180 and BG<180 for each month of 2013]
Define Phase – Financial Impact / COPQ (Cost of Poor Quality)

The impact of care model shown here provides a conservative estimate of potential cost savings. Variation in insurance reimbursement is not included; however this information is included in reported cost savings (hard financial benefits).
## Define Phase – SIPOC

<table>
<thead>
<tr>
<th>Process Name</th>
<th>SUPPLIERS</th>
<th>INPUTS</th>
<th>PROCESS</th>
<th>OUTPUTS</th>
<th>CUSTOMERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Telemetry &amp; Medical Surgical Units</td>
<td>Diabetic Patient</td>
<td>Diabetic Patient Admitted to Tele or MS Unit</td>
<td>Inpatient with Diabetes assessed and admitted</td>
<td>Diabetic patients, Patient families, Physicians, Nursing staff</td>
</tr>
<tr>
<td>2</td>
<td>Laboratory Diabetic Patient</td>
<td>Inpatient with Diabetes assessed and admitted</td>
<td>Patient’s Blood Glucose Levels are monitored.</td>
<td>Elevated blood glucose results</td>
<td>Diabetic patients, Patient families, Physicians, Nursing staff</td>
</tr>
<tr>
<td>3</td>
<td>Diabetic patients, Physicians, Nursing staff</td>
<td>Elevated blood glucose levels</td>
<td>Patient insulin and other medications adjusted per physician order</td>
<td>Medication adjusted in response to blood glucose level</td>
<td>Diabetic patients, Patient families, Physicians, Nursing staff</td>
</tr>
<tr>
<td>4</td>
<td>Diabetic patients, Physicians, Nursing staff</td>
<td>Medication adjusted.</td>
<td>Patient education occurs.</td>
<td>Informed patient on new medication regimen.</td>
<td>Diabetic patients, Patient families, Physicians, Nursing staff</td>
</tr>
<tr>
<td>5</td>
<td>Diabetic patients, Physicians, Nursing staff</td>
<td>Informed patient on new medication regimen.</td>
<td>Patient’s Blood Glucose Levels continue to be monitored.</td>
<td>Blood glucose results</td>
<td>Diabetic patients, Patient families, Physicians, Nursing staff</td>
</tr>
<tr>
<td>6</td>
<td>Diabetic patients, Physicians, Nursing staff, Laboratory</td>
<td>Blood glucose results (potential hyper or hypoglycemia)</td>
<td>Patient insulin and other medications adjusted per physician order (repeat until discharge)</td>
<td>Informed patient on new medication regimen.</td>
<td>Diabetic patients, Patient families, Physicians, Nursing staff</td>
</tr>
<tr>
<td>7</td>
<td>Diabetic patients, Physicians, Nursing staff</td>
<td>Informed patient on new medication regimen.</td>
<td>Patient is discharged.</td>
<td>Patient is discharged home or to a SNF with or without effective glycemic control.</td>
<td>Diabetic patients, Patient families</td>
</tr>
</tbody>
</table>

### CTQ

**Critical to Quality (CTQ)**

- **CTQ 1** - Reduce the episodes of hyperglycemia in our diabetic patients
- **CTQ 2** - Reduce the average length of stay for the total population of diabetic patients on Medical Surgical and telemetry units by at least .345 days
### Define Phase: House of Quality (QFD)

**Customer Requirements**

<table>
<thead>
<tr>
<th>Customer Requirements</th>
<th>Priority Rating</th>
<th>Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Glycemic Management</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td>Service 24/7, 365</td>
<td>6</td>
<td>+</td>
</tr>
<tr>
<td>Effective Pharmacy &amp; Physician Communication</td>
<td>7</td>
<td>+</td>
</tr>
<tr>
<td>Patient/Family Education</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>Timely response /TAT</td>
<td>9</td>
<td>+</td>
</tr>
<tr>
<td>Physician engagement</td>
<td>8</td>
<td>+</td>
</tr>
<tr>
<td>Reduced Episodes of Hyperglycemia</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td>Reduced length of stay</td>
<td>5</td>
<td>+</td>
</tr>
<tr>
<td>Reduced Complications</td>
<td>4</td>
<td>+</td>
</tr>
<tr>
<td>Safe Discharge</td>
<td>3</td>
<td>+</td>
</tr>
</tbody>
</table>

**Technical Requirements**

- Average blood glucose
- Appropriate staffing
- Physician Timeliness
- Education Completed
- Pharmacy timeliness
- Physician Uptake rate
- Episodes outside range
- Length of stay (ALOS)
- Complications
- Readmissions

**Customer Assessment/Competitive Evaluation**

- Importance Rating: \[ \sum (\text{Priority} \times \text{Relationship}) \]

**Correlations:**

- **Strong Positive:** ☑
- **Positive:** +
- **Strong Negative:** ☐
- **Negative:** −

**Relationships:**

- **Strongest:** 10
- **Strong:** 7
- **Fair:** 4
- **Weak:** 1

**Targets:**

HQD illustrates a strong relationship between customer and technical requirements.
## Define Phase – VOC Translation

### Glycemic Management Protocol - Translate Table

<table>
<thead>
<tr>
<th>Voice of the Customer</th>
<th>Key Issue</th>
<th>CTQ</th>
<th>Goal</th>
<th>Y’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;We need to reduce the episodes of hyperglycemia in our diabetic patients&quot;</td>
<td>Clinical effectiveness</td>
<td>CTQ #1 - Reduce the episodes of hyperglycemia in our diabetic patients</td>
<td><strong>Goal #1</strong> - Reduce the number of hyperglycemic episodes following protocol initiation in target population by 30% compared to patients not on protocol</td>
<td>Y1 = the number of hyperglycemic episodes experienced by patients on the protocol</td>
</tr>
<tr>
<td>&quot;We need to reduce the length of stay, complications, and readmissions of our diabetic patients&quot;</td>
<td>Clinical effectiveness, $ / Efficiency</td>
<td>CTQ #2 - Timeliness of safe patient discharge</td>
<td><strong>Goal #2</strong> - Reduce the average length of stay for the total population of diabetic patients on Medical Surgical and telemetry units by at least .345 days</td>
<td>Y2 = the average length of stay of diabetic patients on the medical surgical and telemetry units</td>
</tr>
</tbody>
</table>
Define Phase

End of Phase Checklist

All items are to be ticked off before being able to move into next phase. Each phase must be signed off by Project Sponsor and MBB

<table>
<thead>
<tr>
<th>Define</th>
<th>Measure</th>
<th>Analyze</th>
<th>Improve</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Date: 09/01/2011</td>
<td>Start Date: Enter Date</td>
<td>Start Date: Enter Date</td>
<td>Start Date: Enter Date</td>
<td>Start Date: Enter Date</td>
</tr>
<tr>
<td>End Date: 12/15/2011</td>
<td>End Date: Enter Date</td>
<td>End Date: Enter Date</td>
<td>End Date: Enter Date</td>
<td>End Date: Enter Date</td>
</tr>
</tbody>
</table>

- Operational Definitions
- Project Charter
- Cost of Poor Quality (COPQ)
- Business Impact of project
- Project Plan
- Customer CTQ’s
- High Level Process Map (SIPOC)
- VOC
- House of Quality
- Formal Champion Approval

☐ Not Complete  
✔ Complete  
✧ Not Applicable  

Author: Valena Emery  
Date: 08/14/2014
Measure Phase – Project Variables/Project Y (or Ys)

Y1 = Number of hyperglycemic episodes experienced by inpatients in telemetry and medical surgical units (both before and after intervention as well as on and off the BBIP intervention).

Y2 = Average length of stay of diabetic patients on the medical surgical and telemetry units

Note: The majority of our analysis will be based on changes in ALOS due to improved diabetic care.
Measure Phase – Glycemic Management Protocol: Process Map

Glycemic Protocol Workflow: Management of Diabetic Patients Pre-BBIP

Nursing Unit

- Diabetic Patient Admitted/Transferred to Med-Surg or Telemetry
- Diabetic Patient experiences an episode of Hyperglycemia
- Patient’s Blood glucose levels are monitored
- Patient education occurs.

Primary Care Physician/Endo

- Does physician change insulin dosage or related medications?
- Does patient experience another episode of hyperglycemia (or hypoglycemia)?
  - Yes: Pharmacy prepares and dispenses medication
  - No: Patient medication may be adjusted by physician

Pharmacy

- Low level of pharmacy involvement represents a missed opportunity.
Measure Phase – PO
Feeding Process Map

Potential opportunities:
- Heavy reliance on verbal communication around changes in condition, food intake, etc.
- Verbal communication between nurses and between nurses and physicians
- Not all food intake is documented
  - Some patients ordering and eating double meals
  - Food brought in by family
  - Unrestricted/multiple snacks on non-restricted diet
  - Food refused
  - Tray taken away before consumption documented
- "Diabetic diet" varies (clear fluids, etc.) vs. "non restricted diet" => snack at night versus throughout day
- Insulin dose based on premeal POC test and not carb intake
- 1+ hour gap between POC test and insulin administration and the actual meal eaten

RN, CAN, LVN
- Patient admitted who is PO feeding
- POC tests: before meals and before bed
- 6:30 am POC test and insulin administered as per physician's SSI order set
- 7:30 am shift change
- 7:30 am – 10 am? breakfast
- 11:30 am POC test and insulin given as per POC result
- 12 pm start with feeders, but if more needed, breakfast can be pushed back if # feeders short vs. # patients
- 12-12:30 pm Lunch served
- 4:30 pm POC test and insulin administered
- 12 pm start with feeders, but if more needed, lunch can be pushed back if # feeders short vs. # patients
- 5 pm start with feeders, but if more needed, dinner can be pushed back if # feeders short vs. # patients
- 5:53 pm dinner served
- 9 pm POC bedtime scheduled, 8-9 pm snacks

Physicians
- Physician orders: one of SSI, SSI++, Regular, or orals

Pharmacy

Dietary
- Dietary SHOULD receive either computerized meal order or direct order slip
- Dietary SHOULD receive either computerized meal order or direct order slip
- Dietary SHOULD receive either computerized meal order or direct order slip
Measure Phase - Data Collection

Process Measures Defined

Input Measures
- Number of days of pharmacy supervised glycemic monitoring per patient: *The number of days each patient has had their glucose results monitored by pharmacy.*
- Mean blood glucose BBIP: Average blood glucose of participating patients prior to beginning BBIP (basal bolus insulin protocol)

Process Measures
- Percent of Protocol Use: *Percentage of diabetic patients in Med-Surg or Telemetry placed on BBIP*

Output Measures
- Prevalence of Hyperglycemia: *The number of Hyperglycemia Episodes in the Med-Surg and Telemetry diabetic population following initiation of BBIP*
- Average Length of Stay (ALOS): *The average length of stay of diabetic patients before and after the implementation of the glycemic protocol*

CTQs and Specifications

CTQ #1 - Reduce the episodes of hyperglycemia in our diabetic patients

CTQ #2 - Timeliness of safe patient discharge - the average length of stay of diabetic patients on the medical surgical and telemetry units

Data Collection Plan

1. In general, will patients experience fewer episodes of Hyperglycemia when placed on BBIP?
2. What percentage of hyperglycemic patients can achieve a reduction to a blood glucose of 180 or below while on the BBIP?
3. How will the average length of stay of the entire diabetic patient population change following the introduction of the BBIP and related provider education activities.
4. Will the ALOS savings in the diabetic population result in real cost savings for the hospital?
Measure Phase - Data Collection Plan – Criteria

• **Time frame**
  – Pre-BBIP – January 2012 to September 2013 (where data is available)
  – Post-BBIP – October 2013 to December 2014

• **Inclusion criteria**
  – Auto-consult MDs (n=43)
  – Two POC readings >180mg/dl in 12 hours

• **Exclusion criteria**
  – Units excluded: Critical care areas, L&D, Rehab, Psych, ED, and Outpatient Services
## Measure Phase - Data Collection Plan 1 of 2

### Data Collection Plan

**Data Collection Objective:** To collect data on the incidence of hyperglycemia to evaluate and improve glycemic management at Glendale Adventist Medical Center.

<table>
<thead>
<tr>
<th>Measure Description</th>
<th>Measure Type</th>
<th>Operational Definition</th>
<th>Sampling Plan</th>
<th>Collection Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence of Hyperglycemia</td>
<td>Y1</td>
<td>Discrete</td>
<td>Did the patient have an incidence of hyperglycemia (BG &gt; 180)?</td>
<td>Blood glucose levels from routine finger sticks will be analyzed</td>
</tr>
<tr>
<td>Average Length of Stay</td>
<td>Y2</td>
<td>Continuous</td>
<td>The total amount of time the patient has spent in the hospital</td>
<td>Length of stay in the hospital</td>
</tr>
<tr>
<td>Participation in BBIP program</td>
<td>X1</td>
<td>Discrete</td>
<td>Did the physician place the patient on the BBIP or not?</td>
<td>BBIP order entered and patient added to pharmacy queue for monitoring</td>
</tr>
</tbody>
</table>
## Data Collection Plan

**Data Collection Objective:** To collect data on the incidence of hyperglycemia to evaluate and improve glycemic management at Glendale Adventist Medical Center.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Operational Definition</th>
<th>Sampling Plan</th>
<th>Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of days participation in BBIP</strong></td>
<td>For how many days was the patient on BBIP? BBIP order entered and patient added to pharmacy queue for monitoring</td>
<td>Internal tracking database managed by pharmacy</td>
<td>Pharmacy database internal tracking of BBIP patients</td>
</tr>
<tr>
<td><strong>Monitoring by whom</strong></td>
<td>Who monitors patient while on BBIP? (given limited likelihood of physician monitoring)</td>
<td>Internal tracking database managed by pharmacy</td>
<td>Pharmacy database internal tracking of BBIP patients</td>
</tr>
<tr>
<td><strong>Rate of PSI-10 (Metabolic Derangement)</strong></td>
<td>What is the rate of post-op metabolic derangement? PSI rate captured through coding submitted through Cerner and Premier</td>
<td>GAMC – all patients with diabetes on all units</td>
<td>Data pulled from Quality advisor for all diabetic patients.</td>
</tr>
</tbody>
</table>
Measure Phase - Measure Process Capability Pre-Implementation

Process Capability Report for Pre LOS Observed (using 95.0% confidence)

- Capability for percent: $C_{pk} = 0.43$
- Process is NOT CAPABLE

<table>
<thead>
<tr>
<th>Process Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LSL</td>
<td>*</td>
</tr>
<tr>
<td>Target</td>
<td>6</td>
</tr>
<tr>
<td>USL</td>
<td>13</td>
</tr>
<tr>
<td>Sample Mean</td>
<td>6.16482</td>
</tr>
<tr>
<td>Sample N</td>
<td>8112</td>
</tr>
<tr>
<td>StDev(Within)</td>
<td>5.24909</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential (Within) Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_p$</td>
</tr>
<tr>
<td>CI for $C_p$</td>
</tr>
<tr>
<td>$C_{PL}$</td>
</tr>
<tr>
<td>$C_{PU}$</td>
</tr>
<tr>
<td>$C_{pk}$</td>
</tr>
<tr>
<td>CI for $C_{pk}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Performance</th>
<th>Observed</th>
<th>Expected Within</th>
</tr>
</thead>
<tbody>
<tr>
<td>% &lt; LSL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% &gt; USL</td>
<td>11.00</td>
<td>9.64</td>
</tr>
<tr>
<td>% Total</td>
<td>11.00</td>
<td>9.64</td>
</tr>
</tbody>
</table>
Measure Phase - Baseline Performance of Ys

Collected Data
Data was successfully collected throughout 2013 – Spring 2015, including incidence of hyperglycemia, average length of stay, and the program uptake and success as seen in analysis section.

Baseline Process Measures
Baseline process measures include:
- The incidence of hyperglycemia in the diabetic population pre-BBIP
- The average length of stay for diabetic patients pre-BBIP

Graphical Overview
The graphics presented in the subsequent slides provides a summary of the incidence of hyperglycemia and elevate average length of stay in the diabetic patient population prior to program roll-out.

Baseline Process Sigma
A defect is defined as any incidence of hyperglycemia above the threshold of 180. Baseline Process Sigma: 1.3 (Based on a Cpk of 0.43)

Post-implementation, a defect will be defined as a patient who experiences an episode of hyperglycemia above 180 after 3 or more days of participation in the BBIP.
Measure Phase – Graphical Analysis - Baseline ALOS

The 2012 ALOS (pre BBIP protocol) in the inpatient diabetic population is 6.19 days representing a considerable need for improvement.

<table>
<thead>
<tr>
<th></th>
<th>TL Cases</th>
<th>TL Disch</th>
<th>IP%</th>
<th>Avg LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>1,137</td>
<td>3,730</td>
<td>30.48%</td>
<td>6.37</td>
</tr>
<tr>
<td>Q2</td>
<td>1,090</td>
<td>3,568</td>
<td>30.55%</td>
<td>6.66</td>
</tr>
<tr>
<td>Q3</td>
<td>1,110</td>
<td>3,596</td>
<td>30.87%</td>
<td>5.73</td>
</tr>
<tr>
<td>Q4</td>
<td>1,039</td>
<td>3,508</td>
<td>29.62%</td>
<td>5.97</td>
</tr>
<tr>
<td>2012 Grand TL</td>
<td>4,376</td>
<td>14,402</td>
<td>30.38%</td>
<td>6.19</td>
</tr>
</tbody>
</table>

NOTE: This analysis reflects all acute inpatients with diabetes. Criteria: Primary or Secondary Dx Range = 249.00-250.99; *Patient type = I (excludes Newborns, NICU, & Maternity); *Patient age >= 18
Measure Phase – Graphical Analysis – Pre-Implementation

ALOS

January 2012 through September 2013 Dotplot of ALOS

During the pre-implementation timeframe, there were more outliers and extended lengths of stay. The mean ALOS was 6.16 with a high StDev of 8.13.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>SE Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>8112</td>
<td>6.16</td>
<td>8.13</td>
<td>0.090</td>
</tr>
</tbody>
</table>

Each symbol represents up to 86 observations.
Results include rows where 'Pre or Post' = "Pre".
Measure Phase - RCA: Cause and Effect Diagram

Glycemic Protocol Six Sigma Project:
Root Cause Analysis for Inpatient Hyperglycemia

People

- Physician diligence in monitoring blood glucose values of patients
- Insulin related medication errors
- Patient diet and behavioral choices
- Physician responsiveness during on-call

Patient History of Type I or Type II Diabetes

Policies

- Nursing rounding and assessment policies
- Requirements for Education on Patient Medication
- Medication Reconciliation Policies

- Policies on pharmacy involvement with glycemic management

Procedures

- Frequency and accuracy of blood glucose testing
- Timeliness of insulin medication changes as required
- Insulin administration based on food consumption
- Type of Insulin or Other Diabetic Medications Administered

Technology

- Degree of difficulty for entering different insulin orders into Cerner
- Medication reminders and documentation in Cerner
- Reliability and accessibility of blood glucose monitors and equipment

Hyperglycemia in Inpatient Diabetic Patients

Red = Critical Root Causes
Measure Phase – Root Cause Analysis: Clinical Triggers of Hypoglycemia

• **Tube Feeding Changes**: Decrease in tube feed rate, or hold or discontinuation of tube feeds.
• **Insulin Hypersensitivity**: Patient is very sensitive to insulin dosing; small doses of insulin causing a large decrease in blood glucose.
• **Dietary Inconsistency**: Changes to diet where patient is taking in less food than usual.
• **Insulin Stacking**: Insulin dose is given later than scheduled, and multiple insulin doses are given very close to each other.
• **Declining Renal Function**: Poor renal function leads to insulin accumulation.
• **Other**: Includes but not limited to change in steroid administrations, unknown etiology, etc.
Measure Phase - Measure Baseline Performance

**CURRENT**

COPQ: $183,140.00 per year

Sigma Level: 1.3 (Based on Cpk of 0.43 from ALOS (Y2) data)

There is no baseline data for Y1 (blood glucose values) per the data collection plan. Following implementation, these values are collected for all patients participating in the BBIP protocol.

**GOAL**

COPQ: 0.00 (goal is to reduce the length of stay attributed to hyperglycemia in the algorithm shown prior)

Goal Sigma Level: 2.0

The hospital will reduce the cost of poor quality by reducing the length of stay enough to save a minimum of $183,140 per year in hospital costs.
## Measure Phase – Glycemic Protocol: FMEA

<table>
<thead>
<tr>
<th>Item #</th>
<th>Category Impacted Area</th>
<th>Potential Failure Mode (FM)</th>
<th>What can go wrong?</th>
<th>Potential Failure Effects: What is the impact of the failure? (Team determination or customer input)</th>
<th>Potential Causes: What is the requirement of the environment is not in place, or was not prescribed as needed?</th>
<th>Current Controls: What controls exist to prevent or detect the potential failure from occurring?</th>
<th>Actions Recommended</th>
<th>Risk Priority Number (RPN)</th>
<th>Prepared By/Team</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medication management to prevent prolonged or recurrent episodes of hyperglycemia.</td>
<td>Patients can experience multiple/recurrent episodes of hyperglycemia (elevated blood glucose above 180).</td>
<td>Patients can experience diabetic complications due to elevated glucose as well as an elevated length of stay.</td>
<td>Glycemic monitoring by physicians and pharmacy. Use of primarily basal bolus insulin as well as other insulin and diabetic management products based on physician preference.</td>
<td>4 40</td>
<td>Deployment and maintenance of full Basal Bolus Insuling Protocol (BBIP). Physician engagement in use of protocol and monitoring of blood glucose levels by pharmacists and physicians.</td>
<td>COMPLETE - BBIP Protocol deployed 9/14. Protocol maintained with physician engagement increasing month over month.</td>
<td>15 10 4 0</td>
<td>BBIP Protocol Team</td>
<td>Sept 2014 - Feb 2015 Final Edition 05/04/2016</td>
</tr>
<tr>
<td>2</td>
<td>Physician knowledge base regarding diabetic patient management.</td>
<td>Physicians can over or under administer insulin based on limited information provided regarding patient's history, food consumption, etc.</td>
<td>Patients can experience diabetic complications due to elevated glucose as well as an elevated length of stay.</td>
<td>Glycemic monitoring and education on staff, protocols in place to monitor feeding and insulin.</td>
<td>4 260</td>
<td>Physician education. Active use of endocrinologists to manage diabetic patients vs. family practice or internal medicine only. Deployment of BBIP protocol</td>
<td>COMPLETE - BBIP Protocol deployed 9/14. Including physician education. Team formed including physician champion and two endocrinologists to guide process.</td>
<td>15 10 4 0</td>
<td>BBIP Protocol Team</td>
<td>Sept 2014 - Feb 2015 Final Edition 05/04/2016</td>
</tr>
<tr>
<td>3</td>
<td>Nursing staff and knowledge base regarding diabetic patient management.</td>
<td>Nursing staff can over or under administer insulin based on limited information provided to nurses.</td>
<td>Patients can experience diabetic complications due to elevated glucose as well as an elevated length of stay.</td>
<td>Nurse education. Order sets and prescription details in EMR</td>
<td>4 40</td>
<td>Additional nurse education. Deployment and maintenance of full Basal Bolus Insuling Protocol (BBIP) including defined order sets and clear instructions for nursing. Monitoring of blood glucose levels and corresponding changes to insulin based on protocol.</td>
<td>COMPLETE - BBIP Protocol deployed 9/14. Including nursing education. Patient management dosage is being tightly overseen and updated based on pharmacy protocol.</td>
<td>15 10 4 0</td>
<td>BBIP Protocol Team</td>
<td>Sept 2014 - Feb 2015 Final Edition 05/04/2016</td>
</tr>
<tr>
<td>4</td>
<td>Financial risks and increased costs associated with patient care.</td>
<td>Patients may have elevated lengths of stay or experience Diabetic complications.</td>
<td>Increase in costs to the organization due to elevated lengths of stay. Decreased patient safety and patient satisfaction due to complications.</td>
<td>Glycemic monitoring by physicians and pharmacy. Use of primarily basal bolus insulin as well as other insulin and diabetic management products based on physician preference.</td>
<td>4 260</td>
<td>Deployment and maintenance of full Basal Bolus Insuling Protocol (BBIP). Physician engagement in use of protocol and monitoring of blood glucose levels by pharmacists and physicians.</td>
<td>COMPLETE - BBIP Protocol deployed 9/14. Including physician education. Team formed including physician champion and two endocrinologists to guide process.</td>
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<td>BBIP Protocol Team</td>
<td>Sept 2014 - Feb 2015 Final Edition 05/04/2016</td>
</tr>
</tbody>
</table>

**Key:**
- **Severity (SEV):** How severe is the effect on the customer? (1 = no impact, 10 = serious patient harm or death)
- **Probability (OCC):** How often does the failure occur? (1 = Never, 4 = Has happened once within past 5 years, 7 = happens 3-5 times per year, 10 = happens 6 or > times per year)
- **Detectability (DET):** How well can you discover/prevent the failure with current controls? (10 = Never, 7 = Less than 50% of the time, 4 = Over 50% of the time, 1 = Always)
- **Risk Priority Number (RPN):** What are the actions for reducing the SEV of the effect, the OCC of the cause or improving DET? What additional follow up is needed?

---

**Legal/regulatory risks:** The risks associated with licensure, accreditation, and federal and state statutes, standards and regulations.

**Hospital marketing and reputation:** Risks associated with brand, reputation, business strategy, and market issues following a noticeable patient with severe complications.

**Financial risks:** Risks associated with increased costs associated with patient care.

**Potential Causes:**
- Ineffective dosage of insulin and diabetic medications.
- Lack of consistent monitoring if patient glucose blood levels.

**Current Controls:**
- Glycemic monitoring by physicians and pharmacy.
- Use of primarily basal bolus insulin as well as some other insulin and diabetic management products based on physician preference.

**Actions Recommended:**
- Deployment and maintenance of full Basal Bolus Insuling Protocol (BBIP).
- Physician engagement in use of protocol and monitoring of blood glucose levels by pharmacists and physicians.

---

**Glycemic Monitoring:**
- Glycemic monitoring by both pharmacy and physicians.
- Use of primarily basal bolus insulin as well as other insulin and diabetic management products based on physician preference.

---

**RPN Calculation:**
- RPN = SEV x OCC x DET

---

**Status:**
**Measure Phase – Prioritization Matrix**

- The following elements have the highest Risk Priority Number (RPN) indicating a need for action.

<table>
<thead>
<tr>
<th>Item #</th>
<th>Category /Impacted Area</th>
<th>Potential Failure Mode (FM)</th>
<th>RPN</th>
<th>pSEV</th>
<th>pOCC</th>
<th>pDET</th>
<th>pRPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medication management to prevent prolonged or recurrent episodes of hyperglycemia.</td>
<td>Insulin and other medications for diabetics can be used inappropriately/inadequately and fail to maintain patient blood glucose levels within normal ranges (70-180).</td>
<td>400</td>
<td>10</td>
<td>10</td>
<td>4</td>
<td>400</td>
</tr>
<tr>
<td>2</td>
<td>Physician knowledge base regarding diabetic patient management.</td>
<td>Physicians can over or under prescribe insulin based on limited information provided regarding patient's history, food consumption, etc.</td>
<td>280</td>
<td>10</td>
<td>7</td>
<td>4</td>
<td>280</td>
</tr>
<tr>
<td>3</td>
<td>Nursing skills and knowledge base regarding diabetic patient management.</td>
<td>Nursing staff can over or under administer insulin based on limited information. Nursing staff can fail to promote evidence based methods.</td>
<td>280</td>
<td>10</td>
<td>7</td>
<td>4</td>
<td>280</td>
</tr>
<tr>
<td>4</td>
<td>Financial risks and increased costs associated with patient care.</td>
<td>Patients may have elevated lengths of stay or experience diabetic complications.</td>
<td>280</td>
<td>10</td>
<td>7</td>
<td>4</td>
<td>280</td>
</tr>
</tbody>
</table>
# Measure Phase – Glycemic Management: Measure Baseline Performance and VOC Translation

**CURRENT**

COPQ: $**212,688.00** per year

**GOAL**

COPQ: $0 of $212,688.00 (goal is to reduce the length of stay attributed to hyperglycemia in the algorithm shown prior)

<table>
<thead>
<tr>
<th>Voice of the Customer</th>
<th>Key Issue</th>
<th>CTQ</th>
<th>Goal</th>
<th>Y’s</th>
<th>Potential X’s</th>
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<tbody>
<tr>
<td>&quot;We need to reduce the episodes of hyperglycemia in our diabetic patients&quot;</td>
<td>Clinical effectiveness</td>
<td>CTQ #1 - Reduce the episodes of hyperglycemia in our diabetic patients</td>
<td><strong>Goal #1</strong> - Reduce the number of hyperglycemic episodes following protocol initiation in target population by 30% compared to patients not on protocol</td>
<td>Y1 = the number of hyperglycemic episodes experienced by patients on the protocol</td>
<td>X1 = Participation in BBIP program&lt;br&gt;X2 = Number of days participation in BBIP&lt;br&gt;X3 = Monitoring by whom</td>
</tr>
<tr>
<td>&quot;We need to reduce the length of stay, complications, and readmissions of our diabetic patients&quot;</td>
<td>Clinical effectiveness, $/Efficiency</td>
<td>CTQ #2 - Timeliness of safe patient discharge</td>
<td><strong>Goal #2</strong> - Reduce the average length of stay for the total population of diabetic patients on Medical Surgical and telemetry units by at least .345 days</td>
<td>Y2 = the average length of stay of diabetic patients on the medical surgical and telemetry units</td>
<td>X1 = Participation in BBIP program&lt;br&gt;X2 = Number of days participation in BBIP&lt;br&gt;X3 = Monitoring by whom</td>
</tr>
</tbody>
</table>
### Measure Phase

#### End of Phase Checklist

All items are to be ticked off before being able to move into next phase. Each phase must be signed off by Project Sponsor and MBB

<table>
<thead>
<tr>
<th>Define</th>
<th>Measure</th>
<th>Analyze</th>
<th>Improve</th>
<th>Control</th>
</tr>
</thead>
</table>
| **Start Date:** 09/01/2011  
**End Date:** 12/15/2011 | **Start Date:** 12/16/2011  
**End Date:** 03/23/2012 | **Start Date:** Enter Date  
**End Date:** Enter Date | **Start Date:** Enter Date  
**End Date:** Enter Date | **Start Date:** Enter Date  
**End Date:** Enter Date |
| Operational Definitions  
Project Charter  
Cost of Poor Quality (COPQ)  
Business Impact of project  
Project Plan  
Customer CTQ’s  
High Level Process Map (SIPOC)  
VOC  
*House of Quality*  
Formal Champion Approval | Identify Project Y(s) and Xs \(Y = f(x_i)\)  
Current state process maps  
Data Collection Plan  
MSA  
Establish Baseline Performance (i.e. Process Capability, Pareto charts)  
Cause & Effect  
FMEA  
Priority Matrix  
Formal Champion Approval |  |

- [ ] Not Complete  
- ✓ Complete  
- ✿ Not Applicable

**Author:** Valena Emery  
**Date:** 08/14/2014
Analyze Phase : Theories (Xs) to be tested

Do the following elements contribute to increased lengths of stay for diabetic patients?
Y1 = Number of hyperglycemic episodes experienced by inpatients in telemetry and medical surgical units (both before and after intervention as well as on and off the BBIP intervention).
Y2 = Average length of stay of diabetic patients on the medical surgical and telemetry units
Note: The majority of our analysis will be based on changes in ALOS due to improved diabetic care.

Do the following reduce incidences of hyperglycemia and reduce length of stay?

• $X_4$: Patient participation in the BBIP program
• $X_5$: Number of days participation in BBIP (greater than three days predicted to have significant benefit)
• $X_6$: Monitoring by pharmacist vs. physician
### Analyze Phase - Data Collection Plan 1 of 2

#### Data Collection Plan

**Data Collection Objective:** To collect data on the incidence of hyperglycemia to evaluate and improve glycemic management at Glendale Adventist Medical Center.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Type Measure</th>
<th>Type Data</th>
<th>Stratification</th>
<th>Operational Definition</th>
<th>Sampling Plan</th>
<th>Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence of Hyperglycemia</td>
<td>Y1</td>
<td>Discrete</td>
<td>Yes or No (Yes can occur multiple times)</td>
<td>Did the patient have an incidence of hyperglycemia (BG&gt;180)?</td>
<td>Blood glucose levels from routine finger sticks will be analyzed</td>
<td>Data pulled from testing data for all GAMC Inpatient Areas</td>
</tr>
<tr>
<td>Average Length of Stay</td>
<td>Y2</td>
<td>Continuous</td>
<td>None - No grouping occurs</td>
<td>The average length of time diabetics stay in the hospital</td>
<td>The total amount of time the patient has spent in the hospital</td>
<td>GAMC – all patients with diabetes on all units</td>
</tr>
<tr>
<td>Participation in BBIP program</td>
<td>X1</td>
<td>Discrete</td>
<td>Yes or No</td>
<td>Did the physician place the patient on the BBIP or not?</td>
<td>BBIP order entered and patient added to pharmacy queue for monitoring</td>
<td>Patient included in BBIP list</td>
</tr>
</tbody>
</table>
### Data Collection Plan

**Data Collection Objective:** To collect data on the incidence of hyperglycemia to evaluate and improve glycemic management at Glendale Adventist Medical Center.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Type Measure</th>
<th>Type Data</th>
<th>Stratification</th>
<th>What</th>
<th>How</th>
<th>What</th>
<th>Where</th>
<th>When</th>
<th>How Many</th>
<th>Collection Method</th>
<th>Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of days participation in BBIP</td>
<td>X2</td>
<td>Discrete Daily Total (greater than three days is active participation)</td>
<td>For how many days was the patient on BBIP?</td>
<td>BBIP order entered and patient added to pharmacy queue for monitoring</td>
<td>Patient included in BBIP list</td>
<td>Internal tracking database managed by pharmacy</td>
<td>Sept 2013 - Ongoing</td>
<td>100% sample of all patients who participate in BBIP</td>
<td>Pharmacy database internal tracking of BBIP patients</td>
<td>Pharmacy</td>
<td></td>
</tr>
<tr>
<td>Monitoring by whom</td>
<td>X3</td>
<td>Discrete Pharmacist or Physician only</td>
<td>Who monitors patient while on BBIP? (given limited likelihood of physician monitoring)</td>
<td>Patient may be monitored by pharmacy or physician only per physician order</td>
<td>Track patients by who is monitoring per order</td>
<td>Internal tracking database managed by pharmacy</td>
<td>Sept 2013 - Ongoing</td>
<td>100% sample of all patients who participate in BBIP</td>
<td>Pharmacy database internal tracking of BBIP patients</td>
<td>Pharmacy</td>
<td></td>
</tr>
<tr>
<td>Rate of PSI-10 (Metabolic Derangement)</td>
<td>Y3 – Downstream</td>
<td>Discrete Yes or No</td>
<td>What is the rate of post-op metabolic derangement?</td>
<td>PSI rate captured through coding submitted through Cerner and Premier</td>
<td>Rate of patients with metabolic derangement (%)</td>
<td>GAMC – all patients with diabetes on all units</td>
<td>Jan 2012 – Ongoing</td>
<td>100% sample all inpatients</td>
<td>Data pulled from Quality advisor for all diabetic patients.</td>
<td>Org Performance</td>
<td></td>
</tr>
</tbody>
</table>
Analyze Phase - Summary of Testing Results

• Each of the following elements are contributing factors to extended lengths of stay for diabetic patients
  • $X_1$: Initial high blood glucose levels (above 180)
  • $X_2$: Prolonged elevated glucose levels
  • $X_3$: Diabetic complications due to prolonged elevated blood glucose levels.
Analyze Phase - Vital Few X’s for CTQ #2

Note: CTQ #1 is an input (X) for our ultimate CTQ #2

• Y = Diabetic Patient Length of Stay
  – Y = f (X₁, X₂, X₃, X₄, X₅, X₆)

Vital Few Xs are:
• X₁: Initial high blood glucose levels (above 180)
• X₂: Prolonged elevated glucose levels
• X₃: Diabetic complications due to prolonged elevated blood glucose levels.

Mitigated by our strategies:
• X₄: Patient participation in the BBIP program
  • **reductions illustrated in graphs on slides 55, 59, and 61**
• X₅: Number of days participation in BBIP (greater than three days predicted to have significant benefit)
  • **sizeable reductions after 3 days of BBIP illustrated in graphs on slides 53-54**
• X₆: Monitoring by pharmacist vs. physician
  • **see Chi square test on pages 66 and 67 illustrating better monitoring with less chance of hypoglycemic when monitored by pharmacist vs. physician only**
## Analyze Phase - VOC Translation

<table>
<thead>
<tr>
<th>Voice of the Customer</th>
<th>Key Issue</th>
<th>CTQ</th>
<th>Goal</th>
<th>Y’s</th>
<th>Potential X’s</th>
<th>Vital Few X’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;We need to reduce the episodes of hyperglycemia in our diabetic patients&quot;</td>
<td>Clinical effectiveness</td>
<td>CTQ #1 - Reduce the episodes of hyperglycemia in our diabetic patients</td>
<td><strong>Goal #1</strong> - Reduce the number of hyperglycemic episodes following protocol initiation in target population by 30% compared to patients not on protocol.</td>
<td>Y1 = the number of hyperglycemic episodes experienced by patients on the protocol</td>
<td>X4 = Participation in BBIP program</td>
<td>X4 = Participation in BBIP program</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X5 = Number of days participation in BBIP</td>
<td>X5 = Number of days participation in BBIP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X6 = Monitoring by whom</td>
<td>X6 = Monitoring by whom</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X7 = Dietary profile (food consumed)</td>
<td>X7 = Dietary profile (food consumed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X8 = Medication adherence</td>
<td>X8 = Medication adherence</td>
</tr>
<tr>
<td>&quot;We need to reduce the length of stay, complications, and readmissions of our diabetic patients&quot;</td>
<td>Clinical effectiveness, $ / Efficiency</td>
<td>CTQ #2 - Timeliness of safe patient discharge</td>
<td><strong>Goal #2</strong> - Reduce the average length of stay for the total population of diabetic patients on Medical Surgical and telemetry units by at least .345 days</td>
<td>Y2 = the average length of stay of diabetic patients on the medical surgical and telemetry units</td>
<td>X1 (also Y1): Initial high blood glucose levels (above 180)</td>
<td>X1 (also Y1): Initial high blood glucose levels (above 180)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X2 : Prolonged elevated glucose levels</td>
<td>X2 : Prolonged elevated glucose levels</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X3 : Diabetic complications due to prolonged elevated blood glucose levels.</td>
<td>X3 : Diabetic complications due to prolonged elevated blood glucose levels.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X4 : Patient participation in the BBIP program</td>
<td>X4 : Patient participation in the BBIP program</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X5 : Number of days participation in BBIP (greater than three days predicted to have significant benefit)</td>
<td>X5 : Number of days participation in BBIP (greater than three days predicted to have significant benefit)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X6 : Monitoring by pharmacist vs. physician</td>
<td>X6 : Monitoring by pharmacist vs. physician</td>
</tr>
</tbody>
</table>
## Analyze Phase

### End of Phase Checklist

All items are to be ticked off before being able to move into next phase. Each phase must be signed off by Project Sponsor and MBB.

### Define

- Start Date: 09/01/2011
- End Date: 12/15/2011
- Operational Definitions
- Project Charter
- Cost of Poor Quality (COPQ)
- Business Impact of project
- Project Plan
- Customer CTQ’s
- High Level Process Map (SIPOC)
- VOC
- *House of Quality*
- Formal Champion Approval

### Measure

- Start Date: 12/16/2011
- End Date: 03/23/2012
- Identify Project Y(s) and Xs (Y = f(xₙ))
- Current state process maps
- Data Collection Plan
- MSA
- Establish Baseline Performance (i.e. Process Capability, Pareto charts)
- Cause & Effect
- FMEA
- Priority Matrix
- Formal Champion Approval

### Analyze

- Start Date: 03/23/2012
- End Date: 12/31/2012
- List of theories to be tested
- Data collection plan
- Use Hypothesis testing to identify Vital Few root causes
- List of proven root causes
- Regression analysis
- 1-tail t test
- ANOVA, Chi Square
- Any one other Anal Tool
- *i.e. Process map analysis*
- Formal Champion Approval

### Improve

- Start Date: Enter Date
- End Date: Enter Date

### Control

- Start Date: Enter Date
- End Date: Enter Date

---

☑ Not Complete
✔ Complete
♦ Not Applicable

**Author:** Valena Emery  
**Date:** 08/14/2014
## Improve Phase: Improvement Strategies for Proven Xs for CTQ #2

*Note: CTQ #1 is an input (X) for our ultimate CTQ #2*

<table>
<thead>
<tr>
<th>Proven Xs (Causes)</th>
<th>Initial Solution Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1: Initial high blood glucose levels (above 180)</td>
<td>• Increase participation in the BBIP program with pharmacist monitoring.</td>
</tr>
<tr>
<td>X2: Prolonged elevated glucose levels</td>
<td>• Increase number of days participation in BBIP (greater than three days predicted to have significant benefit)</td>
</tr>
<tr>
<td>X3: Diabetic complications due to prolonged elevated blood glucose levels.</td>
<td>• Assure monitoring by both pharmacist and physician (shown to be more effective in smaller study).</td>
</tr>
</tbody>
</table>
Improve Phase - Potential Solutions

Solution Alternatives

• Basal Bolus Insulin Protocol - Using Insulin to mirror the meal so hyperglycemia and hypoglycemia become less of an issue & you maintain the sugar instead of chasing it
  • Standardizing care for patients with diabetes
  • Creating stability for patients with diabetes by preventing peaks & valleys in their sugars
• Physician and staff (nursing) education campaign on pro-active Glycemic Management

Selection Criteria

1. Likelihood of success in the reduction in episodes of hyperglycemia as shown in the literature
2. Potential annual cost and revenue impacts
3. Availability and need for long term and short term staffing

Selected Solution

The Basal Bolus Insulin Protocol (BBIP) was selected as the solution implemented in 2013. The solution included comprehensive training of physicians and staff on glycemic monitoring. In addition to implementing a new protocol and documentation, GAMC also committed a full time pharmacist to conduct glycemic monitoring.

Selection Process

Pugh Matrix, feasibility matrix, cost/benefit analysis, and risk analysis (PRA) were all used when selecting the BBIP protocol and accompanying education campaigns as a long term strategy for addressing episodes of Hyperglycemia.
**Improve Phase - Practicality / Feasibility matrix for BBIP**

**Implementation Elements**

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Cost / Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

- **High Benefit, Low Cost / Effort:**
  - Staff education on nutrition and hypoglycemia prevention
  - Full time dedicated pharmacist performing glycemic monitoring
  - Protocol implementation: Large scale physician education campaign and enlistment in glycemic protocol program

- **Low Benefit, High Cost / Effort:**
  - Staff education on BBIP
  - Develop glycemic monitoring forms
  - Team process and protocol development
  - Increased time, education, and focus for glycemic monitoring by only physicians
## Improve Phase – Glycemic Protocol Pugh Matrix

### Pugh Matrix

<table>
<thead>
<tr>
<th>Key Criteria</th>
<th>Importance Rating</th>
<th>Benchmark Option</th>
<th>BBIP Intervention</th>
<th>Staff Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTQ #1 - Reduce the episodes of hyperglycemia in our diabetic patients</td>
<td>6</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>CTQ #2 - Timeliness of safe patient discharge (ALOS)</td>
<td>5</td>
<td>+</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Likelihood of success in the reduction in episodes of hyperglycemia without causing frequent hypoglycemia</td>
<td>4</td>
<td>+</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Potential annual cost and revenue impacts</td>
<td>3</td>
<td>+</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Availability and need for long term staffing</td>
<td>2</td>
<td>-</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Availability and need for short term staffing</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

| Sum of Positives | 4 | 1 |
| Sum of Negatives | 2 | 1 |
| Sum of Sames     | 0 | 4 |
| Weighted Sum of Positives | 18 | 6 |
| Weighted Sum of Negatives | 3 | 1 |
| TOTALS           | 4 | 1 |
## Improve Phase - Possible Solution Matrix

<table>
<thead>
<tr>
<th>Solution</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
</tr>
</thead>
</table>
| • S1 – Basal Bolus Insulin Protocol - Using Insulin to mirror the meal so hyperglycemia and hypoglycemia become less of an issue & you maintain the sugar instead of chasing it  
  • Standardizing care for patients with diabetes  
  • Creating stability for patients with diabetes by preventing peaks & valleys in their sugars | ×  | ×  | ×  |
| • S2 – Physician and staff (nursing) education campaign on pro-active Glycemic Management |    |    | X  |
Improve Phase: Recommended Improvements

**Improvement #3: Basal Bolus Insulin Protocol with Pharmacy Monitoring**

Reduce the incidents of hyperglycemia and the length of inpatient diabetic patient stays by deploying the basal bolus insulin protocol including pharmacist monitoring and physician and nursing education.

**Scope:** All inpatients with diabetes present on med-surg and telemetry nursing units

**Phases:** Protocol Development, Promotion and Training, Roll-out, and Analysis

**Products:** Basal Bolus Insulin Protocol and related medications and testing

**High Level Implementation Steps**

1. Develop a performance improvement team to roll out recommendation
2. Develop and approve BBIP protocol and associated document
3. Test and Finalize processes
4. Promote use of BBIP with physicians
5. “Enroll” patients in BBIP program
6. Analyze patient blood glucose levels and adjust insulin per protocol
7. Analyze results and share with committee to increase uptake of BBIP amongst physicians

**Costs to Implement**

**Initial Costs:**
N/A – all staffing and project costs are ongoing.

**Ongoing Costs:**
1 additional pharmacist (for monitoring and medication adjustment during daytime hours) = $150,000

**Expected Benefits-Implementations**

- Reduction in episodes of hyperglycemia by a minimum of 5%.
- Minimum goal of $150,000 cost reductions in order to cover cost of pharmacist and **$212,688 cost reductions annually** based on an average decrease in ALOS
- Conservative goal of reduction in ALOS by .345.
Improve Phase: Selected Improvement – Basal Bolus Insulin Monitoring

The Basal Bolus Monitoring Form facilitates pharmacy and physician partnership in glycemic monitoring.
# Improve Phase: Selected Improvement – Basal Bolus Insulin Monitoring

## Insulin Pharmacokinetics

<table>
<thead>
<tr>
<th>Type</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rapid-Acting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspart</td>
<td>10-30 min</td>
<td>0.5-3 hours</td>
<td>3-5 hours</td>
</tr>
<tr>
<td>Glulisine</td>
<td>10-30 min</td>
<td>0.5-3 hours</td>
<td>3-5 hours</td>
</tr>
<tr>
<td>Lispro</td>
<td>10-30 min</td>
<td>0.5-3 hours</td>
<td>3-5 hours</td>
</tr>
<tr>
<td><strong>Short-Acting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>30 min</td>
<td>2-5 hours</td>
<td>4-12 hours</td>
</tr>
<tr>
<td><strong>Intermediate-Acting</strong></td>
<td>1-2 hours</td>
<td>4-12 hours</td>
<td>14-24 hours</td>
</tr>
<tr>
<td>NPH</td>
<td>1-2 hours</td>
<td>4-12 hours</td>
<td>14-24 hours</td>
</tr>
<tr>
<td><strong>Long-Acting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detemir</td>
<td>3-4 hours</td>
<td>Minimal</td>
<td>6-23 hours</td>
</tr>
<tr>
<td>Glargine</td>
<td>3-4 hours</td>
<td>Minimal</td>
<td>&gt;24 hours</td>
</tr>
</tbody>
</table>

* : Insulin used in pharmacy protocol at GAMC

The Basal Bolus Insulin Protocol uses evidence based medicine to monitor patients' blood glucose levels and dose patients appropriately.
Pre-implementation Workflow – Prior to Glycemic Management Protocol

Glycemic Protocol Workflow: Management of Diabetic Patients Pre-BBIP

Nursing Unit

- Diabetic Patient Admitted/Transferred to Med-Surg or Telemetry
- Diabetic Patient experiences an episode of Hyperglycemia
- Patient’s Blood glucose levels are monitored
- Patient education occurs.
- Patient does not receive benefits of active glycemic monitoring END

Primary Care Physician/Endo

- Does physician change insulin dosage or related medications?
  - Yes
  - No
  - Does patient experience another episode of hyperglycemia (or hypoglycemia)?
  - Yes
  - Patient medication may be adjusted by physician
  - No
  - Low level of pharmacy involvement represents a missed opportunity.

Pharmacy

- Pharmacy prepares and dispenses medication
Rob Bryant Proprietary and Confidential

Improve Phase – Glycemic Protocol – BBIP: Revised Process Maps

Glycemic Protocol Workflow: Managing Blood Glucose Levels of Inpatients using the BBIP

Key intervention includes monitoring by pharmacy and appropriate adjustments to basal bolus insulin dosage
The number of patient consults per month has increased greatly since the pharmacy portion of the program rollout in September 2013.
Patients can experience multiple/recurrent episodes of hyperglycemia (elevated blood glucose above 180). Patients can experience diabetic complications due to elevated glucose as well as an elevated length of stay.

Nursing staff can over or under administer insulin based on limited information. Nursing staff can fail to promote evidence based methods.

Physician education.

Active use of endocrinologists to manage diabetic patients vs. family practice or internal medicine only

Deployment of BBIP protocol

Physicians can over or under prescribe insulin based on limited information provided regarding patient's history, blood sugar levels, etc.

Nursing staff can over or under administer insulin based on limited information. Nursing staff can fail to promote evidence based methods.

Existing weak knowledge base regarding diabetic patient management.

Physicians can experience multiple/recurrent episodes of hyperglycemia (elevated blood glucose above 180). Patients can experience diabetic complications due to elevated glucose as well as an elevated length of stay.

Lack of knowledge regarding patient history, insulin, and diabetic medications.

Financial risks and increased costs associated with patient care.

Patients may have elevated lengths of stay or experience diabetic complications.

Increased in costs to the organization due to elevated lengths of stay. Decreased patient safety and patient satisfaction due to complications.

Lack of effective glycemic management by pharmacy and additional medical management and communication interactions.

Patients may have elevated lengths of stay or experience diabetic complications.

Increased in costs to the organization due to elevated lengths of stay. Decreased patient safety and patient satisfaction due to complications.

Lack of effective glycemic management by pharmacy and additional medical management and communication interactions.

Hospital marketing and reputation: Risks associated with brand, reputation, business strategy, and market issues following a noticeable patient with severe complications.

Patient could seek negative publicity for the hospital based on a negative treatment outcome.

Negative publicity should a patient experience complications or an extended length of stay based on ineffective glycemic management

Glycemic monitoring by physicians and pharmacy. Use of primarily basal bolus insulin as well as other insulin and diabetes management products based on physician preference.

BBIP protocol documentation. Pharmacy to maintain a separate external log with blood glucose values and patient details for daily monitoring.

Identify areas for improvement and develop a plan to address these issues.
## Improve Phase – Implementation Plan

<table>
<thead>
<tr>
<th>Item #</th>
<th>Category /Impacted Area</th>
<th>Actions Recommended</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Physician knowledge base regarding diabetic patient management.</td>
<td>Physician education. Active use of endocrinologists to manage diabetic patients vs. family practice or internal medicine only Deployment of BBIP protocol</td>
<td>COMPLETE - BBIP Protocol deployed 9/13 including physician education. Team formed including physician champion and two endocrinologists to guide process.</td>
</tr>
<tr>
<td>3</td>
<td>Nursing skills and knowledge base regarding diabetic patient management.</td>
<td>Additional nurse education. Deployment and maintenance of full Basal Bolus Insulin Protocol (BBIP) including defined order sets and clear instructions for nursing. Monitoring of blood glucose levels and corresponding changes to insulin based on protocol.</td>
<td>COMPLETE - BBIP Protocol deployed 9/13 including nursing education. Patient medication dosage is being tightly overseen and updated based on pharmacy protocol.</td>
</tr>
<tr>
<td>5</td>
<td>EMR Documentation</td>
<td>IT and pharmacy to partner to develop BBIP protocol documentation. Pharmacy to maintain a separate external log with blood glucose values and patient details for daily monitoring.</td>
<td>COMPLETE - Pharmacy monitoring form in place.</td>
</tr>
</tbody>
</table>
Improve Phase – Statistical Proof of Improvements Based on Decreased in ALOS (1 of 2)

The project team conducted an analysis of the average length of stay (ALOS) on a quarterly/seasonal basis comparing 2012 (pre-implementation) and 2013-2014 (post implementation) average length of stay for all patients with a primary or secondary diagnosis of diabetes. Results revealed sizeable decreases in length of stay when comparing similar seasons through this quarterly view. As a whole the post implementation timeframe (2013 and 2014) showed a decrease of 0.55 days in ALOS compared to 2012.

<table>
<thead>
<tr>
<th></th>
<th>ACUTE INPATIENT DIABETES PATIENT STATS</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TL Diab Discharges</td>
<td>TL Inpatient Disch</td>
<td>IP%</td>
<td>Avg LOS</td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td>1,181</td>
<td>3,764</td>
<td>31.38%</td>
<td>6.23</td>
</tr>
<tr>
<td>Q1</td>
<td></td>
<td>1,129</td>
<td>3,578</td>
<td>31.55%</td>
<td>5.24</td>
</tr>
<tr>
<td>Q2</td>
<td></td>
<td>1,134</td>
<td>3,707</td>
<td>30.59%</td>
<td>5.56</td>
</tr>
<tr>
<td>Q3</td>
<td></td>
<td>1,136</td>
<td>3,702</td>
<td>30.69%</td>
<td>5.70</td>
</tr>
<tr>
<td>Q4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014 Grand TL</td>
<td></td>
<td>4,580</td>
<td>14,751</td>
<td>31.05%</td>
<td>5.63</td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td>1,184</td>
<td>3,872</td>
<td>30.58%</td>
<td>6.02</td>
</tr>
<tr>
<td>Q1</td>
<td></td>
<td>1,117</td>
<td>3,655</td>
<td>30.56%</td>
<td>5.85</td>
</tr>
<tr>
<td>Q2</td>
<td></td>
<td>1,100</td>
<td>3,781</td>
<td>29.09%</td>
<td>5.04</td>
</tr>
<tr>
<td>Q3</td>
<td></td>
<td>1,086</td>
<td>3,631</td>
<td>29.91%</td>
<td>5.63</td>
</tr>
<tr>
<td>Q4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013 Grand TL</td>
<td></td>
<td>4,487</td>
<td>14,939</td>
<td>30.04%</td>
<td>5.64</td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td>1,137</td>
<td>3,730</td>
<td>30.48%</td>
<td>6.37</td>
</tr>
<tr>
<td>Q1</td>
<td></td>
<td>1,090</td>
<td>3,568</td>
<td>30.55%</td>
<td>6.66</td>
</tr>
<tr>
<td>Q2</td>
<td></td>
<td>1,110</td>
<td>3,596</td>
<td>30.87%</td>
<td>5.73</td>
</tr>
<tr>
<td>Q3</td>
<td></td>
<td>1,039</td>
<td>3,508</td>
<td>29.62%</td>
<td>5.97</td>
</tr>
<tr>
<td>Q4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012 Grand TL</td>
<td></td>
<td>4,376</td>
<td>14,402</td>
<td>30.38%</td>
<td>6.19</td>
</tr>
</tbody>
</table>

ALOS Improvements in 2013 and 2014 (2013 & 2014 combined compared to 2012)

Goal: Reduce ALOS by 0.345

<table>
<thead>
<tr>
<th>QUARTER/SEASON</th>
<th>ALOS DECREASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>-0.252</td>
</tr>
<tr>
<td>Q2</td>
<td>-1.116</td>
</tr>
<tr>
<td>Q3</td>
<td>-0.430</td>
</tr>
<tr>
<td>Q4</td>
<td>-0.307</td>
</tr>
<tr>
<td>ANNUAL DIFFERENCE</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Average LOS - Quarterly

- 2012
- 2013
- 2014
Improve Phase – Statistical Proof of Improvements Based on Decreased in ALOS (2 of 2)

- Overall, the annual impact of the decrease in variance was a cost reduction of just over $249,000.

- Since the LOS decrease would actually impact reimbursement for a few insurance carriers, the net impact of realized cost savings was reduced to $197,400.

- In summary, a comparison of average length of stay (ALOS) between 2012 (pre-intervention and planning) and 2013 & 2014 (planning and intervention timeframe) revealed an approximate cost savings of $197,400 a year due to a decrease in length of stay.

- Methods: Patients with LOS’s greater than 14 were excluded for financial analysis only. For the remaining patients, the team compared the variance of Actual LOS to GMLOS by insurance company for 2012 to the variance of Actual to GMLOS for 2013-2014 combined.
# Improve Phase – Statistical Proof of Improvements Based on Decreased in POC Glucose

The average POC glucose levels following BBIP gradually decreased below the threshold of 180.

<table>
<thead>
<tr>
<th></th>
<th>Pre-BBIP</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov</td>
<td>210</td>
<td>216</td>
<td>191</td>
<td>187</td>
<td>175</td>
<td>157</td>
</tr>
<tr>
<td>Dec</td>
<td>231</td>
<td>222</td>
<td>192</td>
<td>193</td>
<td>183</td>
<td>182</td>
</tr>
<tr>
<td>Jan</td>
<td>208</td>
<td>198</td>
<td>183</td>
<td>183</td>
<td>166</td>
<td>156</td>
</tr>
<tr>
<td>Feb</td>
<td>208</td>
<td>197</td>
<td>182</td>
<td>164</td>
<td>156</td>
<td>172</td>
</tr>
<tr>
<td>Mar</td>
<td>203</td>
<td>200</td>
<td>186</td>
<td>164</td>
<td>162</td>
<td>164</td>
</tr>
<tr>
<td>Overall</td>
<td>214</td>
<td>206</td>
<td>187</td>
<td>181</td>
<td>175</td>
<td>169</td>
</tr>
</tbody>
</table>
Improve Phase – Statistical Proof of Improvements Based on Decreased in POC Glucose

Percent of Blood Glucose Results above 180

- % of total POC >=181
- % of total POC 181-300
- HOSPITAL MEAN

Average Pre-BBIP vs. Percent Reduction by Day 3
(Patients with BG>180)

Average Pre-BBIP vs. Percent Reduction by Day 3
(ALL Patients)
Improve Phase – Statistical Proof of Improvements Based on Decrease in Diabetic Patient Length of Stay

Welcome to Minitab, press F1 for help.
Executing from file: C:\Program Files (x86)\Minitab\Minitab 17\English\Macros\Startup.mac

Two-Sample T-Test and CI: Geo LOS Observed, Pre or Post

Two-sample T for Geo LOS Observed

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>SE Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post</td>
<td>5889</td>
<td>5.86</td>
<td>6.51</td>
<td>0.085</td>
</tr>
<tr>
<td>Pre</td>
<td>8112</td>
<td>6.16</td>
<td>8.13</td>
<td>0.090</td>
</tr>
</tbody>
</table>

Difference = μ (Post) − μ (Pre)
Estimate for difference:  -0.305
95% CI for difference:  (-0.548, -0.063)
T-Test of difference = 0 (vs ≠): T-Value = -2.47  P-Value = 0.014  DF = 13864

For the above two sample T test, all diabetic patients were included per criteria below and when comparing the pre and post timeframe data showed a significant decrease in diabetic patient LOS (p= 0.014).

Time frame: Pre-BBIP – January 2012 to September 2013, Post-BBIP – October 2013 to December 2014
Inclusion criteria: All diabetic patients on Medical Surgical Units
Exclusion criteria: Units excluded: L&D, Rehab, Psych, ED, and Outpatient Services

*****Note: While all of 2013 was used for financial analysis as “post” due to the amount of planning and education occurring early in 2013, the actual analysis of BBIP success was done based on the strict implementation timeframe.
Improve Phase – Statistical Proof of Improvements Based on Decrease in Diabetic Patient Length of Stay

Post implementation data illustrates a lower mean as well as a tighter spread (StDev of 6.51) and elimination of outlier cases.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>SE Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post</td>
<td>5889</td>
<td>5.86</td>
<td>6.51</td>
<td>0.085</td>
</tr>
<tr>
<td>Pre</td>
<td>8112</td>
<td>6.16</td>
<td>8.13</td>
<td>0.090</td>
</tr>
</tbody>
</table>

**Time frame**
- Pre-BBIP – January 2012 to September 2013
- Post-BBIP – October 2013 to December 2014
During the post-implementation timeframe, there were fewer outliers and a tighter spread for length of stay (hence the graph’s scale is much smaller). The mean ALOS is now 5.86 with a lower StDev of 6.51.

Each symbol represents up to 47 observations.
Results include rows where 'Pre or Post' = "Post".
Regression Analysis: Geo LOS Observed versus Year

The regression equation is
Geo LOS Observed = 543.9 - 0.2672 Year
S = 7.48803   R-Sq = 0.1%   R-Sq(adj) = 0.1%

Analysis of Variance
Source      DF    SS      MS    F     P
Regression   1   665  665.289  11.87  0.001
Error        1399  784933   56.071
Total        1400  785598

The fitted line plot shows an improvement in 2013 and 2014 compared to the higher variance and high number of outliers seen in 2012 prior to implementation.
**Improve Phase – Graphical Analysis – Post-Implementation**

**BBIP Regression Analysis**

**Regression Analysis: BBIP Min versus LOS to Use**

The regression equation is

BBIP Min = 174.0 - 1.597 LOS to Use

S = 54.8630    R-Sq = 3.4%    R-Sq(adj) = 3.3%

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1</td>
<td>83675</td>
<td>83675.0</td>
<td>27.80</td>
<td>0.000</td>
</tr>
<tr>
<td>Error</td>
<td>789</td>
<td>2374848</td>
<td>3009.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>790</td>
<td>2458523</td>
<td>3002001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normal Probability Plot below illustrates the direct relationship between the reduced BBIP value and the reduced length of stay.

![Normal Probability Plot](image)
Improve Phase – Graphical Analysis – Post -Implementation

ALOS ANOVA

One-way ANOVA: Geo LOS Observed versus Pre or Post

Method
Null hypothesis All means are equal
Alternative hypothesis At least one mean is different
Significance level $\alpha = 0.05$
Rows unused 53

Equal variances were assumed for the analysis.

Factor Information

<table>
<thead>
<tr>
<th>Factor</th>
<th>Levels</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre or Post</td>
<td>2</td>
<td>Post, Pre</td>
</tr>
</tbody>
</table>

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre or Post</td>
<td>1</td>
<td>318</td>
<td>318.27</td>
<td>5.67</td>
<td>0.017</td>
</tr>
<tr>
<td>Error</td>
<td>1399</td>
<td>785280</td>
<td>56.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>14000</td>
<td>785598</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Model Summary

<table>
<thead>
<tr>
<th>S</th>
<th>R-sq</th>
<th>R-sq(adj)</th>
<th>R-sq(pred)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.48969</td>
<td>0.04%</td>
<td>0.03%</td>
<td>0.01%</td>
</tr>
</tbody>
</table>

Means

<table>
<thead>
<tr>
<th>Pre or Post</th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post</td>
<td>5889</td>
<td>5.8594</td>
<td>6.5113</td>
<td>(5.6681, 6.0507)</td>
</tr>
<tr>
<td>Pre</td>
<td>8112</td>
<td>6.1648</td>
<td>8.1265</td>
<td>(6.0018, 6.3278)</td>
</tr>
</tbody>
</table>

Pooled StDev = 7.48969

The post-implementation One-way ANOVA illustrates the reduction in mean and standard deviation following the implementation of the BBIP protocol with a P Value of 0.017.
Improve Phase – Graphical Analysis – Post-Implementation

BBIP ANOVA

Interval Plot of Geo LOS Observed vs Pre or Post
95% CI for the Mean

Decrease in Geo LOS following Implementation

The pooled standard deviation is used to calculate the intervals.
One-way ANOVA: BBIP Min versus LOS to Use

Null hypothesis: All means are equal
Alternative hypothesis: At least one mean is different
Significance level: $\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

<table>
<thead>
<tr>
<th>Factor</th>
<th>Levels</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS to Use</td>
<td>40</td>
<td>0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 37, 38, 39, 47</td>
</tr>
</tbody>
</table>

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS to Use</td>
<td>39</td>
<td>183837</td>
<td>4714</td>
<td>1.56</td>
<td>0.018</td>
</tr>
<tr>
<td>Error</td>
<td>751</td>
<td>2274686</td>
<td>3029</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>790</td>
<td>2458523</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Model Summary

- $S = 55.0352$
- $R-sq = 7.48\%$
- $R-sq(adj) = 2.67\%$
- $R-sq(pred) = *$

Pooled StDev = 55.0352

This One-way ANOVA illustrates the relationship between blood glucose values and length of stay. $p = 0.018$
Interval Plot of BBIP Min vs LOS to Use
95% CI for the Mean

Figure illustrates the relationship between the BBIP values and patient length of stay.

Higher BBIP values are associated with higher lengths of stay and more variation.

The pooled standard deviation is used to calculate the intervals.
PharmD vs. MD Glycemic Management Focused Study

• Retrospective cohort study
  – Study Duration: October 2013 to February 2014
  – Treatment group n=164
    • PharmD managed patients on BBIP
  – Control group n=444
    • MD managed patients on insulin
• Inclusion criteria:
  – Patients ≥18 years of age
  – Non-critically ill patients
  – Two point-of-care BG readings >180 mg/dL within a 12-hour time frame or patients with a physician order for a BBIP pharmacy consult
• Exclusion criteria:
  – Patients managed with insulin pumps, and patients residing in ICU, Maternity, Labor and Delivery, NICU, Rehab, and Behavioral Health
  – Patients with less than 3 days of insulin therapy
• Primary & Secondary Outcomes
  – Percentage decrease in average BG by day 3 of BBIP therapy
  – Time to reach goal average BG level <180 mg/dL
  – Number of hypoglycemic events, defined as BG level <70mg/dL
• Statistical Analysis
  – Chi-square, t-test

GAMC also performed a specific cohort study looking at the success of MD vs. PharmD Glycemic Management. Below are the demographics illustrating the two samples were similar:

<table>
<thead>
<tr>
<th></th>
<th>BBIP (n=164)</th>
<th>Non-BBIP (n=444)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>71</td>
<td>70</td>
<td>0.37</td>
</tr>
<tr>
<td>Hgb-A1c</td>
<td>7.82</td>
<td>7.87</td>
<td>0.80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Male</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBIP (n=164)</td>
<td>88 (54%)</td>
<td>76 (46%)</td>
<td>0.35</td>
</tr>
<tr>
<td>Non-BBIP (n=444)</td>
<td>252 (57%)</td>
<td>192 (43%)</td>
<td>0.004</td>
</tr>
</tbody>
</table>
Research Results - Chi-squared & T-test

Chi-Square Test for Association: Worksheet rows, Worksheet columns

Chi-Square test for those under 70 mg/dL revealed that BBIP protocol significantly reduced the risk of a low blood glucose level.

<table>
<thead>
<tr>
<th></th>
<th>BBIP – Pharmacist Monitoring (n=164)</th>
<th>Non-BBIP (MD Monitoring (n=444)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Date BG Average (mg/dL)</td>
<td>225</td>
<td>220</td>
<td>0.39</td>
</tr>
<tr>
<td>Day 3 BG Average (mg/dL)</td>
<td>179 (↓20%)</td>
<td>182 (↓17%)</td>
<td>0.10</td>
</tr>
<tr>
<td>Patients with BG&lt;70mg/dL</td>
<td>11 (6.7%)</td>
<td>59 (13.3%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Patients with BG&lt;40mg/dL</td>
<td>4 (2.4%)</td>
<td>29 (6.5%)</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Research Results - Chi-squared & T-test

Chi-Square Test for Association: Worksheet rows, Worksheet columns

Rows: Worksheet rows   Columns: Worksheet columns
Pharm      MD   All
1  160  415  575
   155.10  419.90
2  4  29  33
   8.90  24.10
All  164  444  608

Cell Contents:   Count, Expected count

Chi-Square test for those under 40 mg/dL revealed that BBIP protocol significantly reduced the risk of a very low blood glucose level.

<table>
<thead>
<tr>
<th></th>
<th>BBIP – Pharmacist Monitoring (n=164)</th>
<th>Non-BBIP (MD Monitoring (n=444)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Date BG Average (mg/dL)</td>
<td>225</td>
<td>220</td>
<td>0.39</td>
</tr>
<tr>
<td>Day 3 BG Average (mg/dL)</td>
<td>179 (↓20%)</td>
<td>182 (↓17%)</td>
<td>0.10</td>
</tr>
<tr>
<td>Patients with BG&lt;70mg/dL</td>
<td>11 (6.7%)</td>
<td>59 (13.3%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Patients with BG&lt;40mg/dL</td>
<td>4 (2.4%)</td>
<td>29 (6.5%)</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Research Results - Conclusion

A pharmacist managed BBIP significantly reduced BG levels to below 180mg/dL by day 3 after initial hyperglycemic alert.

Glycemic control at GAMC has improved after implementation of the BBIP, with a 6% lower number of POC Glucose values >180mg/dL.

*** The incidence of hypoglycemic events were significantly lower in the pharmacist managed population compared with the physician managed population.

Therefore a pharmacist managed basal bolus insulin service is as effective and may be safer than physician managed glycemic control.
Improve Phase – Statistical Proof of Improvements

**Current State:**
Sigma Level: 1.3 (Based on Cpk of 0.43 from ALOS (Y2) data)

**Future State:**
Sigma Level: 1.5 (Based on Cpk of .5 from length of stay (Y2) data)
Sigma Level: 1.9 (Based on Blood Glucose (Y1) values post-implementation)
Estimated DPO: 32.87%
Estimated DPMO: 328,690
The Process Capability Report shows a centralization of reduced blood glucose values after BBIP treatment between 70-180 with 32.87% of values observed outside of the desired range. There is still a great deal of improvement to be made.
## Improve Phase - VOC Translation

<table>
<thead>
<tr>
<th>Voice of the Customer</th>
<th>Key Issue</th>
<th>CTQ</th>
<th>Goal</th>
<th>Y’s</th>
<th>Potential X’s</th>
<th>Vital Few X’s</th>
<th>Solutions</th>
</tr>
</thead>
</table>
| "We need to reduce the episodes of hyperglycemia in our diabetic patients" | Clinical effectiveness | CTQ #1 - Reduce the episodes of hyperglycemia in our diabetic patients | **Goal #1** - Reduce the number of hyperglycemic episodes following protocol initiation in target population by 30% compared to patients not on protocol | Y1 = the number of hyperglycemic episodes experienced by patients on the protocol | X1 = Participation in BBIP program | X1 = Participation in BBIP program | S1 – Implement BBIP
S2 – Conduct nursing and physician education on glycemic management |
| "We need to reduce the length of stay, complications, and readmissions of our diabetic patients" | Clinical effectiveness, $ / Efficiency | CTQ #2 - Timeliness of safe patient discharge | **Goal #2** - Reduce the average length of stay for the total population of diabetic patients on Medical Surgical and telemetry units by at least .345 days | Y2 = the average length of stay of diabetic patients on the medical surgical and telemetry units | X1 = Participation in BBIP program | X2 = Number of days participation in BBIP | X2 = Number of days participation in BBIP | S1 – Implement BBIP
S2 – Conduct nursing and physician education on glycemic management |
Improve Phase – Glycemic Protocol: Fishbone of a Solution

Glycemic Protocol Six Sigma Project:
Solution - Initiate the Basal Bolus Insulin Protocol (BBIP)

People/Manpower
- Pharmacists monitor the blood glucose level of patients through an automated system
- Patient’s medication change based on episodes of hyperglycemia
- Pharmacy staff work with physicians to provide more proactive monitoring
- Physicians can rely on pharmacy to manage insulin dosage

Methods
- Pharmacists adjust medication appropriately through BBIP
- Nursing rounding and assessment policies
- Requirements for Education on Patient Medication
- Medication Reconciliation Policies
- Policies on increased pharmacy involvement with glycemic management
- Institution of Basal Bolus Insulin Protocol amongst majority of physicians

Tools
- Establish reporting mechanism for monitoring of blood glucose values
- Evaluation of Length of Stay and financial implications of BBIP
- Trending of insulin values and diabetes outcome data

Documentation
- Reduce degree of difficulty required for entering different insulin orders into Cerner
- Implement medication reminders and documentation in Cerner
- Automated review and flagging of blood glucose level

Initiate Basal Bolus Insulin Protocol (BBIP)
## Improve Phase – Glycemic Management: Mistake Proof Table

<table>
<thead>
<tr>
<th>Solution</th>
<th>Mistake Proofing Opportunities</th>
<th>SCALE</th>
<th>Maintenance</th>
<th>Effectiveness</th>
<th>Time to Develop</th>
<th>Training</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Increase Physician Participation in BBIP to reduce patients &quot;falling through&quot; the cracks</td>
<td>9: Strong relationship</td>
<td>5%</td>
<td>40%</td>
<td>15%</td>
<td>5%</td>
<td>30%</td>
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<tr>
<td>2</td>
<td>Electronic Medical Record Controls including Dosage Monitoring and Flags</td>
<td>4: Moderate relationship</td>
<td>9</td>
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<td>4</td>
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<td>3</td>
<td>Pharmacist Review of Dosage</td>
<td>1: Weak relationship</td>
<td>9</td>
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<tr>
<td>4</td>
<td>Pharmacist Daily Review of Blood Glucose Values</td>
<td>0: No relationship</td>
<td>9</td>
<td>9</td>
<td>1</td>
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<td>5</td>
<td>Nursing Monitoring of Clinical Triggers for Hyperglycemia</td>
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<td>9</td>
<td>9</td>
<td>4</td>
<td>9</td>
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<td>6</td>
<td>Patient Education and Discharge Home with Basal Bolus Insulin</td>
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<td>9</td>
<td>9</td>
<td>1</td>
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### Improve Phase

#### End of Phase Checklist

All items are to be ticked off before being able to move into next phase. Each phase must be signed off by Project Sponsor and MBB.

<table>
<thead>
<tr>
<th>Define</th>
<th>Measure</th>
<th>Analyze</th>
<th>Improve</th>
<th>Control</th>
</tr>
</thead>
</table>
| Start Date: 09/01/2011  
End Date: 12/15/2011 | Start Date: 12/16/2011  
End Date: 03/23/2012 | Start Date: 03/23/2012  
End Date: 12/31/2012 | Start Date: 01/01/2013  
End Date: 06/30/2014 | Start Date: 07/01/2014  
End Date: 03/30/2015 |
| ☑ Operational Definitions  
Project Charter  
Cost of Poor Quality (COPQ)  
Business Impact of project  
Project Plan  
Customer CTQ’s  
High Level Process Map (SIPOC)  
VOC  
House of Quality  
Formal Champion Approval | ☑ Identify Project Y(s) and Xs (Y = f(x,n))  
Current state process maps  
Data Collection Plan  
MSA  
Establish Baseline Performance (i.e. Process Capability, Pareto charts)  
Cause & Effect  
FMEA  
Priority Matrix  
Formal Champion Approval | ☑ List of theories to be tested  
Data collection plan  
Use Hypothesis testing to identify Vital Few root causes  
List of proven root causes  
Regression analysis  
1-tail t test  
ANOVA, Chi Square  
Any one other Anal Tool ie. Process map analysis  
Formal Champion Approval | ☑ Apply Lean  
Generate Solutions  
Prioritize Solutions  
Assess Risks  
DOE / Test Solutions  
Cost Benefit Analysis  
Pugh Matrices  
Fish bone of a Solution  
Two Tail T-Test  
Go No Go or Mistake Proof Table  
Implement Plan  
Formal Champion Approval | □ Implement sustainable process controls – validate:  
Control System  
Monitoring Plan  
Response Plan  
☑ $ Benefits validated  
☑ Graphical/ statistical summary of improvement |

Author: Valena Emery  
Date: 08/14/2014

- □ Not Complete  
- ✓ Complete  
- ✗ Not Applicable
Control Phase: Control Plan

The glycemic management program and basal bolus insulin protocol includes daily monitoring of blood glucose levels by pharmacy and monthly reporting of results to performance improvement team members.

<table>
<thead>
<tr>
<th>Control Subject</th>
<th>Subject Goals</th>
<th>Unit of Measure</th>
<th>Sensor</th>
<th>Frequency of Measurement</th>
<th>Sample Size</th>
<th>Criteria/Action</th>
<th>Who Decides</th>
<th>Who Acts</th>
<th>Reactions to Out of Control</th>
<th>Analysis Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood Glucose Levels (individually)</td>
<td>Below 180 mg/dL</td>
<td>mg/dL</td>
<td>Automatic alert</td>
<td>Daily/Multiple Times a day</td>
<td>100%</td>
<td>Above 180, consider medication adjustment</td>
<td>Pharmacist/Physician</td>
<td>Pharmacist</td>
<td>Medication adjustment</td>
<td>Internal pharmacy database</td>
</tr>
<tr>
<td>Average Blood Glucose Levels</td>
<td>Below 166 mg/dL</td>
<td>mg/dL</td>
<td>Monthly reporting</td>
<td>Monthly</td>
<td>100%</td>
<td>Above 170, conduct RCA</td>
<td>Director of Pharmacy</td>
<td>Director of Pharmacy</td>
<td>Follow-up on education and conduct RCA</td>
<td>Internal pharmacy database</td>
</tr>
<tr>
<td>Average Length of Stay</td>
<td>Below 5.64</td>
<td>Days</td>
<td>Cerner/Premier</td>
<td>Monthly</td>
<td>100%</td>
<td>Above 6.2, conduct RCA/case review</td>
<td>Director of Pharmacy</td>
<td>Director of Org Performance</td>
<td>Follow-up on education and conduct RCA</td>
<td>Quality Advisor Reporting</td>
</tr>
</tbody>
</table>
Control Phase – Procedures which effect Glycemic Management

• The other side of the dilemma – Procedures put in place to deal with the following causes of hypoglycemia during BBIP:

  – **Tube Feeding Changes**: Decrease in tube feed rate, or hold or discontinuation of tube feeds.

  – **Insulin Hypersensitivity**: Patient is very sensitive to insulin dosing; small doses of insulin causing a large decrease in blood glucose.

  – **Dietary Inconsistency**: Changes to diet where patient is taking in less food than usual.

  – **Insulin Stacking**: Insulin dose is given later than scheduled, and multiple insulin doses are given very close to each other.

  – **Declining Renal Function**: Poor renal function leads to insulin accumulation.

  – **Other**: Includes but not limited to change in steroid administrations, unknown etiology, etc.
Control Phase – Monitoring of Hypoglycemic Events post-BBIP

BBIP Patient Hypoglycemic Events
Grouped by Month (N=249)
Sep 2013 - May 2016
## Control Phase – Glycemic Protocol Communication Plan

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Level of communication - Storyboard, paragraph update, tollgate summary</th>
<th>How information is communicated – 1:1, meeting, email, newsletter</th>
<th>Where information is communicated – e.g. if during a standing meeting, which is the most appropriate forum?</th>
<th>Frequency of communication – every other week, at tollgate, at end of project</th>
<th>Who is responsible for doing the communication?</th>
<th>Dates for communication to occur</th>
<th>On Agenda Meeting set on individuals calendar (Mark when established)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VP, Quality &amp; Medical Affairs (Physician Champion)</td>
<td>Monthly meeting updates X 2</td>
<td>1:1 Meeting and Monthly project team meetings</td>
<td>1:1 meetings with Dir of Org Perf and Pharmacy Dir</td>
<td>Monthly in two separate forums</td>
<td>Dir. of Pharmacy and Dir. Of Org Perf</td>
<td>Sept 2012-Present</td>
<td>Routine schedule ongoing</td>
</tr>
<tr>
<td>Pharmacists</td>
<td>Coordinated trainings</td>
<td>Group training setting</td>
<td>Group training and dept. meetings</td>
<td>Monthly initially and as needed</td>
<td>Dir. of Pharmacy</td>
<td>Sept 2012-Present</td>
<td>Routine schedule ongoing</td>
</tr>
<tr>
<td>Pharmacy Staff</td>
<td>Coordinated trainings</td>
<td>Group training setting</td>
<td>Group training and dept. meetings</td>
<td>Monthly initially and as needed</td>
<td>Dir. of Pharmacy</td>
<td>Sept 2012-Present</td>
<td>Routine schedule ongoing</td>
</tr>
<tr>
<td>Physicians</td>
<td>Coordinated trainings and newsletter</td>
<td>Trainings and newsletter</td>
<td>Dedicated trainings for physicians</td>
<td>Multiple trainings available (10+)</td>
<td>Dir. of Pharmacy and Phys Champion</td>
<td>June 2013 – Sept 2013</td>
<td>Scheduled Multiple trainings (10+)</td>
</tr>
<tr>
<td>Nursing Staff</td>
<td>Coordinated trainings and newsletter</td>
<td>Trainings and newsletter</td>
<td>Dedicated trainings for physicians</td>
<td>Multiple trainings available (10+)</td>
<td>Dir. of Pharmacy and Phys Champion</td>
<td>June 2013 – Sept 2013</td>
<td>Scheduled Multiple trainings (10+)</td>
</tr>
<tr>
<td>Steering Committee</td>
<td>Monthly meeting updates</td>
<td>Monthly project team meetings</td>
<td>Glycemic PI Team meetings</td>
<td>Monthly</td>
<td>Physician Champion</td>
<td>Sept 2012-Present</td>
<td>Routine schedule ongoing</td>
</tr>
<tr>
<td>Finance Department</td>
<td>Meetings and data exchange</td>
<td>Meetings and Email</td>
<td>Scheduled data review meetings</td>
<td>Quarterly</td>
<td>Dir. Org Performance</td>
<td>Quarterly 2013-present</td>
<td>Scheduled meetings when fin data available</td>
</tr>
</tbody>
</table>
Control Phase - Process Control Charts: Pre and Post Samples

**Xbar-S Chart of Geo LOS Observed**

- **Sample Mean**
  - Pre: 6.0364
  - Sample: 6.0364
  - Post: 6.0364
  - UCL = 6.3275
  - LCL = 5.7452

- **Sample StDev**
  - Pre: 7.447
  - Sample: 7.447
  - Post: 7.447
  - UCL = 7.653
  - LCL = 7.241

Tests are performed with unequal sample sizes.

BBIP Protocol Implemented
Blood glucose values for protocol participants are only available as a post measure and were only collected starting in October 2013. Data above represents the trend in blood glucose levels from October 2013- December 2014. Note that acceptable values are between 70 and 180. Red marks indicate individual outliers.

Blood glucose values improved after BBIP treatment (values included are final values of participants following BBIP protocol prior to discharge). These values have become more centralized over time.
Control Phase - Project Results/Benefits

<table>
<thead>
<tr>
<th>Financial (Hard) Benefits</th>
<th>Soft Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reduce average length of stay (ALOS) by .55 days</strong> in diagnosed (coded) diabetic population in 2013 and 2014 compared to pre-implementation timeframe (2012).</td>
<td>Post-discharge benefits of medication education to diabetic patients.</td>
</tr>
<tr>
<td><strong>Estimated annual cost savings of $197,400 per year, $394,800 for two years.</strong> Cost savings are enough to cover the additional $150,000 in pharmacy staffing costs annually with a total net contribution of $47,400.</td>
<td>Introduction of collaborative glycemic monitoring has improved interdepartmental communication</td>
</tr>
<tr>
<td><strong>26% reduction in the Pre-BBIP blood glucose levels for patients on BBIP.</strong> Average daily glucose levels are consistently under 180 after 3 days on protocol.</td>
<td>Potential reductions in diabetic complications shown to be associated with the incidence of hyperglycemia.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Baseline</th>
<th>Project Target</th>
<th>Project Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPQ = -$212,688.00 per year</td>
<td>COPQ = $0.00</td>
<td>COPQ = $212,688.00- $197,400.00 = +$15,288.00 per year</td>
</tr>
<tr>
<td>ALOS (2012): 6.19 days</td>
<td>ALOS= 6.19-.345 = 5.845 days</td>
<td>ALOS = 5.64 days in 2013 &amp; 2014 (5.86 Sept 2013-Dec 2014 only) Note: $150,000 of $197,400 in cost savings is needed to offset pharmacy staffing costs</td>
</tr>
<tr>
<td>(all diagnosed diabetic patients included in ALOS)</td>
<td></td>
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</tbody>
</table>
Control Phase – Glycemic Protocol (BBIP Project) Lessons Learned

• A dedicated physician champion is paramount to project success.

• Schedule additional time for information technology solutions, order set development, testing, and technical delays.

• Ensure data collection both pre and post-project is well-thought out and consistent vs. collecting different data elements pre and post project in an effort to improve the data collection process as you go.

• Implementing facility-wide change effectively requires a full scale roll-out of education to teach and adjust culture.
# Control Phase

## End of Phase Checklist

All items are to be ticked off before being able to move into next phase. Each phase must be signed off by Project Sponsor and MBB.

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</thead>
<tbody>
<tr>
<td><img src="image" alt="Checklist" /></td>
<td><img src="image" alt="Checklist" /></td>
<td><img src="image" alt="Checklist" /></td>
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<td><img src="image" alt="Checklist" /></td>
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<tr>
<td>Start Date: 09/01/2011&lt;br&gt;End Date: 12/15/2011</td>
<td>Start Date: 12/16/2011&lt;br&gt;End Date: 03/23/2012</td>
<td>Start Date: 03/23/2012&lt;br&gt;End Date: 12/31/2012</td>
<td>Start Date: 01/01/2013&lt;br&gt;End Date: 06/30/2014</td>
<td>Start Date: 07/01/2014&lt;br&gt;End Date: 03/30/2015</td>
</tr>
<tr>
<td>Operational Definitions&lt;br&gt;Project Charter&lt;br&gt;Cost of Poor Quality (COPQ)&lt;br&gt;Business Impact of project&lt;br&gt;Project Plan&lt;br&gt;Customer CTQ’s&lt;br&gt;High Level Process Map (SIPOC)&lt;br&gt;VOC&lt;br&gt;House of Quality&lt;br&gt;Formal Champion Approval</td>
<td>Identify Project Y(s) and Xs (Y = f(x_n))&lt;br&gt;Current state process maps&lt;br&gt;Data Collection Plan&lt;br&gt;MSA&lt;br&gt;Establish Baseline Performance (i.e. Process Capability, Pareto charts)&lt;br&gt;Cause &amp; Effect&lt;br&gt;FMEA&lt;br&gt;Priority Matrix&lt;br&gt;Formal Champion Approval</td>
<td>List of theories to be tested&lt;br&gt;Data collection plan&lt;br&gt;Use Hypothesis testing to identify Vital Few root causes&lt;br&gt;List of proven root causes&lt;br&gt;Regression analysis&lt;br&gt;1-tail t test&lt;br&gt;ANOVA, Chi Square&lt;br&gt;Any one other Anal Tool e.g. Process map analysis&lt;br&gt;Formal Champion Approval</td>
<td>Apply Lean&lt;br&gt;Generate Solutions&lt;br&gt;Prioritize Solutions&lt;br&gt;Assess Risks&lt;br&gt;DOE / Test Solutions&lt;br&gt;Cost Benefit Analysis&lt;br&gt;Pugh Matrixes&lt;br&gt;Fish bone of a Solution&lt;br&gt;Tail T-Test&lt;br&gt;Go No Go or Mistake Proof Table&lt;br&gt;Implement Plan&lt;br&gt;Formal Champion Approval</td>
<td>Implement sustainable process controls – validate:&lt;br&gt;Control System&lt;br&gt;Monitoring Plan&lt;br&gt;Response Plan&lt;br&gt;Standardize and translate&lt;br&gt;$ Benefits validated&lt;br&gt;Graphical/ statistical summary of improvement&lt;br&gt;Formal Champion Approval</td>
</tr>
</tbody>
</table>
### Next Steps

- Continued Recruitment and engagement of physicians in the enrollment and use of BBIP protocol
- Continued daily monitoring of patients on BBIP protocol and quarterly monitoring of success of reducing glucose levels and diabetic LOS
- Publication and application for Vanguard Quality Award

### Project Plan

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<td>Transfer to Business</td>
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<td>Monitor Results</td>
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</table>
THANK YOU

Thank you very much for taking the time to hear about our work on the Glycemic Management Protocol.
Approximately 26% of GAMC’s adult inpatients have a co-morbidity of diabetes. Physicians may each manage blood glucose levels differently resulting in the potential for inconsistent follow-up. Without consistent glycemic management, patients are at an increased risk for complications.

Project Scope:
In Scope: All diabetic patients on telemetry and medical surgical units for whom their attending physician consent to using the basal bolus insulin protocol (BBIP) by pharmacy.
Out of Scope: All other nursing units and hospital services outside the Medical, Surgical, and Telemetry units. This exclusion includes all critical care and women’s services patients.

Project Goal:
Deploy the BBIP program including pharmacy management of blood glucose levels. Improve glycemic management of patients thereby reducing the number of diabetic patients by a minimum of .345 days. Benefits will be evaluated quarterly following implementation.

Financial and Operational Benefits:
Hard: Potential financial benefit of at least $150,000 per annum realized through decrease in average length of stay. This savings will cover additional pharmacy coverage and program cost.
Soft: Improved glycemic management and reduction in episodes of hyperglycemia for diabetic patients.

Statistical proof of improvements based on decrease in POC glucose:
The Basal Bolus Monitoring Form facilitates Pharmacy and physician partnership in glycemic monitoring.

A comparison of average length of stay revealed an estimate annual cost savings of $197,400 due to a decrease in length of stay of 0.55 days. These results have been sustainable.

Glendale Adventist Medical Center (GAMC) is a 515-bed, fully accredited, acute care hospital serving Glendale and Los Angeles communities. GAMC is committed to offering services that position us as one of the leading medical institutions in Southern California.

At GAMC, you will find a true center of medical science, which includes state-of-the-art diagnostic technologies, innovative surgical techniques, among other services.

emeryvj@ah.org
Eskandrm@ah.org
APPENDIX D:
CURRENT ONGOING BBIP MONITORING RESULTS
Basal Bolus Insulin Protocol (BBIP)

Romic Eskandarian, Pharm.D.
Director of Pharmacy
Glendale Adventist Medical Center
Background

• Diabetes is becoming more common in the US with approximately 21 million Americans diagnosed in 2014 and over 8 million still undiagnosed
• In 2012, it was estimated that the total medical cost of diagnosed diabetes is $245 billion, with largest component (~43%) being cost for hospital inpatient care.
• Uncontrolled hyperglycemia is associated with adverse outcomes and longer length of hospital stay

Management of Hyperglycemia

Background

• **Hyperglycemia:**
  - Common and costly problem in hospitalized patients
  - Treatment Complexity: sliding scale; oral diabetic agents
  - Patients fear of insulin therapy

• **Incidence of diabetes in the U.S.**
  - 2011: 25.8 million patients with diabetes
  - 2014: 29.1 million patients with diabetes
    - 21 million diagnosed
    - 8.1 million undiagnosed

Management of Hyperglycemia

**Background**

- *The American Association of Clinical Endocrinologists (AACE)* recommends

  - **Blood Glucose (BG) Targets**
    - **ICU:** 140-180mg/dL
    - **Non-ICU**:
      - Pre-meal: <140mg/dL
      - Random: <180mg/dL

  - **Choice of Therapy**
    - **ICU:** IV insulin infusion
    - **Non-ICU:** SQ basal, bolus, and correctional insulin

  - **Hgb-A1c goal** \( \leq 6.5\% \) for most non-pregnant adults
Management of Hyperglycemia

Background

• *The American Diabetes Association (ADA) recommends*

  • **Blood Glucose (BG) Targets**
    • **ICU:** 140-180mg/dL
    • **Non-ICU:** 140-180mg/dL
      • More stringent goal (110-140mg/dL) for certain ICU patients

  • **Choice of Therapy**
    • **ICU:** IV insulin infusion
    • **Non-ICU:** SQ basal, bolus, and correctional insulin

  • **Hgb-A1c goal** <7% for most non-pregnant adults, <6.5% for “healthy”
# Management of Hyperglycemia

## Background

<table>
<thead>
<tr>
<th>Patient Characteristic/Health Status</th>
<th>Rationale</th>
<th>Fasting or pre-prandial glucose (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy (few co-existing chronic illnesses)</td>
<td>Longer remaining life expectancy</td>
<td>90-130</td>
</tr>
<tr>
<td>Complex/intermediate (multiple co-existing chronic illness)</td>
<td>Intermediate remaining life expectancy</td>
<td>90-150</td>
</tr>
<tr>
<td>Very Complex/Poor Health (long term care or end-stage chronic illnesses)</td>
<td>Limited remaining life expectancy</td>
<td>100-180</td>
</tr>
</tbody>
</table>

Standards of Medical Care in Diabetes-2014. American Diabetes Association. *Diabetes Care* 2014; vol 37 no supplement 1 S14-S80
Management of Hyperglycemia

Purpose

1. Stringent blood glucose control
2. Reduction in episodes of hyper- and hypo-glycemia
3. Enhanced patient education of disease and insulin therapy
4. Multi-disciplinary approach towards inpatient diabetes management
5. Reduction in length of stay among patients with financial benefit
# Hyperglycemia vs Rest of Patient Population (2013 Patients Length of Stay Comparison)

<table>
<thead>
<tr>
<th></th>
<th>Average LOS (BG&gt;180)</th>
<th>Average LOS (BG&lt;180)</th>
<th>LOS Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.40</td>
<td>4.57</td>
<td>28.5%</td>
</tr>
</tbody>
</table>

![Graph showing comparison between average LOS for patients with BG>180 and BG<180 for each month in 2013.](image)
# Insulin Pharmacokinetics

<table>
<thead>
<tr>
<th>Type</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rapid-Acting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspart</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glulisine</td>
<td>10-30 min</td>
<td>0.5-3 hours</td>
<td>3-5 hours</td>
</tr>
<tr>
<td>Lispro</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Short-Acting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>30 min</td>
<td>2-5 hours</td>
<td>4-12 hours</td>
</tr>
<tr>
<td><strong>Intermediate-Acting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPH</td>
<td>1-2 hours</td>
<td>4-12 hours</td>
<td>14-24 hours</td>
</tr>
<tr>
<td><strong>Long-Acting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detemir</td>
<td>3-4 hours</td>
<td>Minimal</td>
<td>6-23 hours</td>
</tr>
<tr>
<td>Glargine</td>
<td></td>
<td>Minimal</td>
<td>&gt;24 hours</td>
</tr>
</tbody>
</table>

☆: Insulin used in pharmacy protocol at GAMC
Insulin Pharmacokinetics

![Graph showing insulin pharmacokinetics for Aspart, lispro, glulisine, Regular, NPH, Detemir, and Glargine]
Outcomes Analysis

Sep 2013 to July 2016
Total Patients Since Go-Live: 2,670
*RETROSPECTIVE*

Initiation of BBIP MD or PharmD (N=984)
Initiation of BBIP MD or PharmD (N=629)

- 64%
- 36%
Number Patient Days of Therapy
Sep 13 - Jul 16
Total Consult Days (N=12615), Total Patients Consulted (N=2445)
Number of Patient Consults
Sep 13 - July 16
Total Consult Days (N=12615), Total Patients Consulted (N=2670)
Average Days of Therapy
Sep 13 - Jul 16

Overall Average Length of Therapy (4.9 days), Total Patient Consults (N=2670)
Average Days of Therapy (Quarterly)
Sep 13 - Jun 16
Overall Average Length of Therapy (4.9 days), Total Patient Consults (N=2597)
**BASAL-BOLUS INSULIN MONITORING FORM**

**Patient Information**

- Patient Name: ___________________________
- Age: _____ Sex: Male □ Female □ Room: ________
- FIN#: __________________________ MR#: ________
- Admit Date: __/__/____ Requesting M.D.: ____________
- Pre-Admission Insulin Regimen: ________________
- Estimated Therapy Duration: __/__/____
- Height (cm): ________ Actual Weight (kg): ________
- Ideal Weight (kg): ________ Hgb A1c: ________ Date: ________
- Allergies: NKA / Other: ________________

**Initial Assessment Checklist**

- DM diagnosis or Steroid induced hyperglycemia
- Weight and renal function verified
- Verify Hypoglycemia risk (N/V, frail, elderly, critically ill, cardiac, hepatic, renal failure, and septic)
- Current MAR reviewed for steroids, diabetes related meds or dextrose containing IVFs
- Current TDD and BG average reviewed
- Glucose POC levels & Hgb A1c ordered
- Enter initial Progress Note in PowerChart
- Discontinue all diabetes meds (including TNF)

**Follow-Up Patient Review**

- Check for PharmD Progress Note entries
- Check for endocrine consults, if any
- Weight and renal function verified
- Current MAR review-steroids, DFW, etc.
- Current TDD and BG average reviewed
- Enter Progress Note in PowerChart

**Nutritional status:**
- □ NPO □ Clear Liquids □ Tube Feedings—Bolus / Continuous □ Regular

**Type of DM:**
- □ Type I □ Type II □ Home DM Meds:

---

**Date:**

| Date: | / | / | / | / | / | / | / | / | / |
---|---|---|---|---|---|---|---|---|---|
**POC-BG Avg** | / | / | / | / | / | / | / | / | / |
**TDD<sub>actual</sub>** | / | / | / | / | / | / | / | / | / |
**Basal** | / | / | / | / | / | / | / | / | / |
**Nutritional Status** | / | / | / | / | / | / | / | / | / |
**Prandial (TID AC)** | / | / | / | / | / | / | / | / | / |
**Correction** | / | / | / | / | / | / | / | / | / |
**Insulin Bolus Given?** | / | / | / | / | / | / | / | / | / |
**Scr / CrCl** | / | / | / | / | / | / | / | / | / |
**Steroids** | / | / | / | / | / | / | / | / | / |
**Dextrose IVF** | / | / | / | / | / | / | / | / | / |

**Recalculating TDD<sub>new</sub> based upon Insulin Use Past 24 Hours and Special Situation**

| TDD<sub>new</sub> | / | / | / | / | / | / | / | / | / |
---|---|---|---|---|---|---|---|---|---|
**Basal<sub>new</sub>** | / | / | / | / | / | / | / | / | / |
**Prandial<sub>new</sub> (TID AC)** | / | / | / | / | / | / | / | / | / |
Average Length of Therapy (Sep 2013 - Jul 2016)
Overall Average Length of Therapy (N=5)
Total Patient Consults (N=2670)

Total Days of Therapy = 12615 Patient Days

Extended period of BBIP management was resulted from patients transferring from one medical floor to Rehab

<table>
<thead>
<tr>
<th>Total Days of Therapy (ALL pts)</th>
<th>Total Days of Therapy (managed at least 3 days)</th>
<th>Patients managed on BBIP (managed at least 3 days)</th>
<th>Average Length of Therapy (managed at least 3 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12615</td>
<td>8425</td>
<td>1127</td>
<td>8425/1127 = 7.5</td>
</tr>
</tbody>
</table>
Average Number of Patients Per Day
2014 vs 2015 vs 2016

Daily average number of patients = 12.2
### BBIP Daily Average POC-Glucose

**Sep 13 - Jul 16**

**Total Patients Since Go-Live = 2670**

<table>
<thead>
<tr>
<th></th>
<th>Pre-BBIP</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb</td>
<td>227</td>
<td>195</td>
<td>177</td>
<td>166</td>
<td>194</td>
<td>166</td>
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<tr>
<td>Mar</td>
<td>232</td>
<td>233</td>
<td>212</td>
<td>182</td>
<td>187</td>
<td>172</td>
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<tr>
<td>Apr</td>
<td>227</td>
<td>206</td>
<td>190</td>
<td>187</td>
<td>167</td>
<td>175</td>
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<tr>
<td>Jun</td>
<td>225</td>
<td>225</td>
<td>194</td>
<td>184</td>
<td>178</td>
<td>169</td>
</tr>
<tr>
<td>Jul</td>
<td>231</td>
<td>204</td>
<td>180</td>
<td>186</td>
<td>184</td>
<td>185</td>
</tr>
<tr>
<td>Overall Since Go-Live</td>
<td>212</td>
<td>205</td>
<td>187</td>
<td>181</td>
<td>176</td>
<td>172</td>
</tr>
</tbody>
</table>
Average Pre-BBIP vs. Percent Reduction by Day 3
(Patients with BG>180)
Average Pre-BBIP BG vs. Day 3 BG
(ALL patients vs. BG>180)
Outcome Analysis

GAMC Data
Sep 2013 to Jul 2016
## Value

<table>
<thead>
<tr>
<th>Clinical Outcomes</th>
<th>Patient Satisfaction</th>
<th>Physician and Nursing Satisfaction</th>
<th>ADE Prevention</th>
<th>Financial Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Instantaneous response to uncontrolled BG</td>
<td>• Improved glycemic control vs home</td>
<td>• Decreasing workload of physicians, allowing more time to focus on other conditions</td>
<td>• Reduced incidence of Hyper- and Hypo-glycemia</td>
<td>• Potential decrease in hospital length of stay and hospital complications, resulting in significant cost savings</td>
</tr>
<tr>
<td>• Daily PharmD Monitoring of BG</td>
<td>• Improved understanding disease state and insulin therapy via face to face PharmD &amp; patient interaction</td>
<td></td>
<td>• Reduced incidence of potential DDIs with oral agents</td>
<td></td>
</tr>
<tr>
<td>• Stringent BG control → ↓ risk of infections → ↓ length of stay and ↓ mortality</td>
<td></td>
<td>• Collaborative and interdisciplinary care with nursing for inpatients with diabetes</td>
<td>• Tighter glucose control in steroid induced hyperglycemia</td>
<td></td>
</tr>
</tbody>
</table>

- Instantaneous response to uncontrolled BG
- Daily PharmD Monitoring of BG
- Stringent BG control → ↓ risk of infections → ↓ length of stay and ↓ mortality
- Improved glycemic control vs home
- Improved understanding disease state and insulin therapy via face to face PharmD & patient interaction
- Decreasing workload of physicians, allowing more time to focus on other conditions
- Collaborative and interdisciplinary care with nursing for inpatients with diabetes
- Reduced incidence of Hyper- and Hypo-glycemia
- Reduced incidence of potential DDIs with oral agents
- Tighter glucose control in steroid induced hyperglycemia
Acute Inpatient Average LOS 2012-2014

<table>
<thead>
<tr>
<th></th>
<th>Q1</th>
<th>Q2</th>
<th>Overall</th>
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<tbody>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>6.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>6.23</td>
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<tr>
<td>Q3</td>
<td>6.02</td>
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</tr>
<tr>
<td>Q4</td>
<td>6.02</td>
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<tr>
<td>2013</td>
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</tr>
<tr>
<td>Q1</td>
<td>6.66</td>
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<tr>
<td>Q2</td>
<td>5.85</td>
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<tr>
<td>Q3</td>
<td>5.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q4</td>
<td>5.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>5.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>5.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q3</td>
<td>5.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q4</td>
<td>5.04</td>
<td></td>
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</tbody>
</table>

ALOS Diff (2013-2014)

- Q1: 0.210
- Q2: -0.603
- Overall: -0.393
Conclusion

• Significant Reduction in BG levels to below 180mg/dL by day 3 after initial hyperglycemic alert

• Improvement of overall glycemic control in GAMC with a 6% lower number of POC Glucose values >180mg/dL

• Reduction in length of stay among patients with diabetes by 0.55 days vs 0.395 targeted

• Estimated annual reduction in costs was known to be $197,400
BBIP Patient Hypoglycemic Events
Grouped by Trigger (N=268)
Sep 2013 - Jul 2016
BBIP Patient Hypoglycemic Events
Grouped by Month (N=268)
Sep 2013 - Jul 2016
Triggers of Hypoglycemia

- **Tube Feeding Changes**: Decrease in tube feed rate, or hold or discontinuation of tube feeds.
- **Insulin Hypersensitivity**: Patient is very sensitive to insulin dosing; small doses of insulin causing a large decrease in blood glucose.
- **Dietary Inconsistency**: Changes to diet where patient is taking in less food than usual.
- **Insulin Stacking**: Insulin dose is given later than scheduled, and multiple insulin doses are given very close to each other.

**Declining Renal Function**: Poor renal function leads to insulin accumulation.

- **Other**: Includes but not limited to change in steroid administrations, unknown etiology, etc.
A comprehensive article search was performed to investigate the rate of insulin-induced hypoglycemia. One meta-analysis of 19 studies was included; seven out of 19 used basal-bolus as intervention. Hypoglycemia Rate is calculated as (Number of Pt with Hypoglycemia / Number of Pt in Treatment Group).

<table>
<thead>
<tr>
<th>Publication</th>
<th>Intensive Control (Basal-Bolus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elinav, 2007</td>
<td>2 / 102</td>
</tr>
<tr>
<td>Malmberg, 2005</td>
<td>60 / 474</td>
</tr>
<tr>
<td>Maynard, 2009</td>
<td>191 / 6810</td>
</tr>
<tr>
<td>Patel, 2009</td>
<td>4 / 210</td>
</tr>
<tr>
<td>Umpierrez, 2007</td>
<td>2 / 65</td>
</tr>
<tr>
<td>Umpierrez, 2009</td>
<td>22 / 67</td>
</tr>
<tr>
<td>Umpierrez 2011</td>
<td>24 / 104</td>
</tr>
<tr>
<td>Overall Average</td>
<td></td>
</tr>
<tr>
<td>GAMC (2015 YTD)</td>
<td>268/2670</td>
</tr>
</tbody>
</table>

Glycemic Control at GAMC

Percentage of POC Glucose values >180mg/dL

31%


33%  28%