

## In Brief

Inpatient diabetes programs have an opportunity to influence system-wide changes that can lead to improved quality and safety outcomes for patients. Data collection and analysis can lead to these improved outcomes through practice changes, development of protocols and order sets, and staff education. Tools and resources are available to assist diabetes professionals with their efforts toward continuous quality improvement.

# A Look at System-Wide Data Collection Processes to Improve Patient Outcomes

Joyce Malaskovitz, PhD, RN, CDE,  
and Charlotte Hodge, RN, NP, CDE

Diabetes now affects nearly 24 million people in the United States, and another 57 million people are estimated to have pre-diabetes.<sup>1</sup> With diabetes reaching epidemic proportions, this places an additional strain on our health care system. On a given day, 26% of all hospitalized patients meet the criteria for the diagnosis of diabetes.<sup>2</sup> It is imperative for diabetes clinicians to examine current processes to ensure that they are providing quality and safe care. Using a continuous quality improvement (CQI) process with a system-wide organizational approach will provide a comprehensive roadmap for improvement.

### Leadership Support is Crucial for Success

Hospital leaders, including administrative representatives, department directors, and medical staff, must make a commitment to providing high-quality and safe care for patients with diabetes and be willing to look at their practices and strive to improve them. Developing a formal CQI plan with specific performance measures lends itself to the ongoing evaluation of current processes and provides valuable insights and data to support the hospital in implementing new or revised initiatives, processes, policies, and procedures.

Datasets and analysis are necessary to form a consensus and to achieve buy-in for improved care. With data as a tool, hospitals are able to find areas for improvement and practical ways to accelerate and imple-

ment evidence-based interventions. For example, perhaps those who have not yet embraced a computerized approach to evaluating and analyzing data or computerized monitoring of patients' blood glucose levels will be inspired to use new tools that are now available and become an integral part of the consensus for change.

In years past, policies, procedures, and practice patterns were based on the latest scientific information. Today, with access to computerized data retrieval, tracking, and reporting, we are able to identify system-wide trends. Additionally, we are able to see the outcomes of our actions in a very powerful way while looking at system-wide feedback and challenges. We are able to share our data-driven outcomes with staff, professional colleagues, sister hospitals, and others to build consensus for practicing evidence-based medicine.<sup>3,4</sup>

A large percentage of every hospital census is made up of patients presenting with diabetes as a primary or—more often—secondary diagnosis. Today, hospitals are also recognizing the needs of the many patients who are hyperglycemic but do not have a diabetes diagnosis. Whether these patients' hyperglycemia is caused by undiagnosed diabetes or other factors, this group requires additional resources and time from hospitals. Inpatient hyperglycemia can negatively affect outcomes, both financial and clinical. The American Diabetes Association (ADA) recommends that all diabetic patients admitted to the hospital

have their diabetes clearly identified in the medical record.<sup>5</sup> Short- and long-term patient outcomes are often dramatically affected by the actions we take. It is important to note in one study, in-hospital mortality rates appeared to be even higher for patients with newly diagnosed hyperglycemia than for those with overt diabetes.<sup>2</sup> In critical care settings, we deal with the resolution of life-threatening diabetic ketoacidosis, hyperosmolar coma, and reversal of hospital-acquired hypoglycemia.

All patients with diabetes should have an order for glucose monitoring, and the results should be available to all health care team members.<sup>5</sup> More importantly, the hospital should establish goals for glucose targets, with subcategories for critical-care and noncritical-care patients, as recommended by the ADA and the American College of Endocrinology (Table 1).<sup>5,6</sup> Throughout the hospital, monitoring and improvement of blood glucose must become an ongoing and necessary task for every shift. Patients with diabetes are known to have lengths of stay 1–3 days longer than nondiabetic patients with the same admission diagnoses.<sup>6</sup> Glucose control with inherent hyperglycemia not only affects lengths of stay but also plays a significant role in decreasing morbidity and mortality associated with diabetes and its complications.<sup>6</sup>

The care of patients with diabetes is much improved when protocols exist for providing that care. These protocols should be based on system-wide data following patients from admission, through procedures and evaluations, to treatment and therapies, and eventually to discharge. Often, hospital administrators fail to look at diabetes as a separate product line and miss an opportunity to focus on improved care, which will result in improved outcomes and, ultimately,

reduce costs and enhance the bottom line.

### Where Opportunities Lie

Today's health care environment challenges us to develop high-quality, cost-effective care with a focus on continuous improvement. The process of performance improvement includes development of a plan, data collection, analysis, and ongoing monitoring, with identification of key issues. This process leads to establishing goals and implementing changes that will result in improvement. Performance improvement will ultimately lead to enhanced outcomes.

As a part of the CQI plan, it is important to select performance measures that include clinical and financial targets, as well as perceptions of care. Clinical measures are designed to evaluate the processes or outcomes associated with the delivery of clinical services (e.g., medication use, infection rates, patient safety, and hypo- and hyperglycemia). Administrative or financial measures address the organizational structure for coordinating and integrating services, including financial management (e.g., length-of-stay reduction, cost analysis, return on investment of product line, and evaluation of specific tools and expenses). Perception-of-care measures focus on the delivery of care or service from patients' and others' perspectives (e.g., a satisfaction questionnaire for patients, nurses, and physicians). Implementing educational programs and addressing patients' knowledge deficits can greatly enhance the satisfaction of patients and medical personnel.<sup>7</sup>

A sound system-wide design is integral to all approaches for the delivery of safe and evidence-based health care.

### Key Focus Initiatives for Data Collection

Both hypoglycemia and hyperglycemia are important patient safety issues that are appropriate for CQI analysis. Including both hypo- and hyperglycemia in hospital quality improvement initiatives has been linked to improved changes in practice patterns that result in optimal glycemic control and reduction in hospital costs.<sup>8</sup> Findings from data collection may suggest the need to create a glycemic control "champion" or team that assists with system-wide changes, including initiation of educational opportunities for physicians, nurses, and ancillary hospital staff members.

### Hyperglycemia

Hyperglycemia is common among hospitalized patients and may result from known diabetes, undiagnosed diabetes, stress, or some combination of these factors. Regardless of the underlying cause, all hyperglycemia should be treated. This is particularly important in critically ill patients because of the associations between hyperglycemia and increased mortality and morbidity, more frequent complications, longer lengths of stay, and higher costs.

The presence of hyperglycemia is associated with worse outcomes in various settings and patient populations, including the critically ill, those undergoing coronary artery bypass grafting (CABG), and those with other surgeries, myocardial infarctions, or acute ischemic stroke.<sup>9–13</sup> However, studies suggest that tight glycemic control programs can improve outcomes.<sup>14–16</sup>

**Data collection suggestions.** Some possible areas to consider as likely data collection points for addressing hyperglycemia would include, among others:

- Identifying and correcting unacceptable glucose levels
- Monitoring post-surgical CABG patients with diabetes to evaluate the percentage of blood glucose values that fall within and outside of established targets
- Ensuring that all patients with known diabetes are identified in the medical record
- Completing a time study focusing on the time from presentation of hyperglycemia to initiation of an insulin infusion

**Table 1. ADA and ACE Recommendations for Inpatient Glucose Targets<sup>5,6</sup>**

Patient Group	ACE	ADA
Critically Ill or Intensive Care Unit	110 mg/dl	As close to 110 mg/dl as possible and generally < 140 mg/dl
Noncritically Ill Medical/Surgical	110 mg/dl preprandial < 180 mg/dl maximum	< 126 mg/dl fasting < 180–200 mg/dl random

**Table 2. Intravenous Insulin Protocols<sup>22</sup>**

Protocol	Description	Population Type	Outcomes
Yale	Used a protocol to maintain blood glucose between 100 and 139 mg/dl	ICU	Once target blood glucose levels were achieved with IV insulin, 52% of subsequent hourly finger sticks were in the target range of 100–139 mg/dl, and 66% were in a “desirable” range of 80–139 mg/dl
Krinsley	Used intensive monitoring and continuous insulin infusion to maintain blood glucose < 140 mg/dl	ICU	Mortality was reduced by 30%, and mean glucose in the ICU went from 153 to 128 mg/dl
Portland	For perioperative use Used continuous insulin infusion	CABG	Mortality significantly reduced
van den Berghe	Maintains blood glucose between 80 and 110 mg/dl	Surgical ICU	Reduced ICU mortality by > 40% and in-hospital mortality by 34%
DIGAMI	Used a glucose-insulin infusion to keep blood glucose < 200 mg/dl followed by outpatient multi-dose subcutaneous insulin regimen	Myocardial infarction	Reduced mortality over 3.5 years

**Table 3. Computerized Insulin-Dosing Tools<sup>23–25</sup>**

Product	Description	Information
Medical Decisions Network GlucoStabilizer	Network-based tool that calculates the intravenous insulin drip adjustments necessary to adhere to tight glycemic control protocols	www.mdnoutcomes.net
Glucotec G+ System	Uses advanced dosing algorithms and a series of unique safety guard-rail alerts that promote achievement of normoglycemia quickly and safely	www.glucotec.com
MD Scientific Solutions EndoTool	Software algorithm that is designed to help caregivers in critical care settings calculate insulin dosage to control blood glucose	www.mdscientific.com

Most hospitals are working to eliminate the sliding scale as the sole method of insulin delivery and are instead implementing a more physiological basal-bolus approach to treatment. Prescribing habits are sometimes hard to change; however, those who rationally examine the sliding-scale approach to treatment can quickly see that it allows, at best, only the means to correct hyperglycemia after the fact rather than to prevent its onset. Addressing hyperglycemia with a sliding-scale algorithm is known to be difficult, if not impossible, and is no longer recommended.<sup>17</sup> It is often

helpful to assess the impact of any practice change. This can be done simply by evaluating the levels of glycemic control before and after the practice change.

Intravenous insulin protocols, preprinted orders, and computerized insulin-dosing tools can be helpful in achieving glycemic targets (Tables 2 and 3). Computerized insulin-dosing tools eliminate the cumbersome paper process and minimize nurse errors. Upfront costs may be a barrier to implementation, but long-term savings can be realized from both the additional efficiency and elimination

of calculation errors, both of which can result in improved outcomes.

Most paper protocols for insulin delivery are lengthy and often difficult to follow. Many carry the burden of inherent errors associated with individual calculations and subjective interpretation of charts and arrows.

A recent study to evaluate the safety and effectiveness of using an intravenous insulin-dosing calculator with critically ill patients showed that using the calculator resulted in:

- 61% of blood glucose readings within the target range of 80–110 mg/dl

- 90.9% of blood glucose readings within the range of 60–150 mg/dl
- Average blood glucose of 106.5 mg/dl
- Frequency of hypoglycemia as defined by the study researchers (< 50 mg/dl) of 0.4%

The percentage of measurements < 110 mg/dl in the ICUs in the 3 months before introduction of the dose calculator program was 31.5%, compared to 51.5% in the following 3 months. Improvements in glycemic control were not accompanied by an increase in hypoglycemia. The frequency of hypoglycemia, defined as blood glucose < 50 mg/dl when using the dose calculator, was 0.4% compared to 0.5% during the 3 months before the introduction of the program.<sup>18</sup> This study demonstrated that use of the computerized calculator improved glycemic control compared to previous manually calculated protocols.

### Hypoglycemia

Hypoglycemia is the leading limiting factor in glycemic management.<sup>19</sup> Many episodes of hypoglycemia are preventable; however, institutions are more likely to have protocols for treatment rather than for prevention.

Multiple factors can contribute to hypoglycemic episodes, including but not limited to, lack of coordination between meals and insulin administration, interruption of enteral feeding, total parenteral nutrition or dextrose infusion, NPO (nothing-by-mouth) status, or inadequate oral intake. Identifying and tracking the root causes of hypoglycemic episodes may lead to a better understanding and further improvement, such as revising protocols, creating preprinted orders sets, and targeting educational opportunities for staff.

Treatment of hypoglycemia in the hospital should be immediate and standardized throughout the hospital. It is crucial to closely monitor glucose trends and to adjust insulin doses and make nutritional and other system changes accordingly to avoid further hypoglycemia. In 2007, the Joint Commission introduced a new disease-specific certification for advanced inpatient diabetes care that requires data collection regarding not only the incidence of hypoglycemia, but also the contributing causes. Identifying the etiology of hypoglycemia is extremely important because it can inform efforts

to implement staff education, develop or revise treatment protocols, and effect system-wide process changes.

**Data collection suggestions.** Confirmation that the protocol is being followed by all hospital staff is crucial for success and patient safety. Frequently, a problem associated with hypoglycemia treatment might go unnoticed unless it is specifically examined. For example, you might assume that rechecks after a hypoglycemic episode are being conducted only to find on closer inspection that this important element is frequently being omitted. Furthermore, it is suggested that hospitals have a data-tracking system in place for monitoring the percentage of low blood glucose values and their associated root causes, because this is a performance measure identified by the ADA and the Joint Commission's new advanced inpatient diabetes care certification.

Data collection can also provide evidence to support the need for establishing guidelines for hypoglycemia treatment in situations when patients are off the unit (e.g., during transit or when undergoing diagnostic testing). In addition, gathering data can help address the inevitable challenges that arise when patients are NPO. Each patient has unique circumstances and needs, and treatment plans must be individualized. Some hospitals may need to evaluate processes regarding when diabetes patients receive ancillary testing or educate staff members about hypoglycemia prevention measures specific to NPO status (Figure 1).

### Glucometrics

Glucometrics is a term used to describe the process associated with the systematic review of hospital-wide glucose data. Blood glucose data are downloaded into a database for analysis. Information can then be examined as a whole for hospital-wide evaluation for general reporting and trending, and also for unit-specific issues and physician-specific review of practice outcomes.<sup>20</sup>

Sharing timely and accurate metrics to frontline clinical teams, who can analyze the results and look for cause-and-effect relationships, will transform performance improvement into solid steps to achieve optimal outcomes. Tracking quality metrics should be a daily priority within the inpatient program.

### Additional Resources for Data Tracking

Two additional software resources from Medical Automation Systems, Inc., can assist in data collection and analysis:

- The Remote Automated Laboratory System (RALS) Plus is a software package that allows results from floor blood glucose monitors to be downloaded to a laboratory computer and then on to a hospital computer for viewing. The download contains all of the point-of-care glucose test results and allows customized reports to analyze hospital-wide or unit-specific glucometrics.
- The RALS Tight Glycemic Control Module is a data management system designed to provide a retrospective review of aggregate glucose data. It is intended to be used for quality improvement activities and is not intended for diagnosis, treatment, or therapy adjustments.

These additional resources can provide insight into a hospital's overall glucose control and assist in developing both general hospital-wide glycemic goals and more specific unit-level targets.

### Conclusions

Examination of individual tasks and specific locations within the hospital can provide useful information, but diabetes-focused initiatives must first target excellence across the entire spectrum of the organization and not focus on a single area. When looking at the performance of dedicated diabetes programs and their chosen initiatives, what seems to separate the best from the rest is their ability to continually collect and evaluate system-wide data, thoroughly analyze the variables, and implement timely and meaningful quality initiatives based on the data.

More important than implementing any specific quality improvement initiative is having the involvement of hospital administration. Without administrative support that purposefully places a greater emphasis on quality than on the bottom line, initiatives will not be successful. The commitment of administrative leadership to provide support, allocate appropriate resources, and demonstrate an unwavering dedication to quality is a key to ensuring the excellence of inpatient diabetes care, as



***HYPO OH NO NPO!!!***  
***Your Patient has Diabetes,***  
***is NPO,***  
***and has a***  
***Capillary Blood Glucose (CBG) less than***  
***70 mg/dl***

***Follow the Hypoglycemia Protocol!***  
***Consider These Options:***

- 1. Give 25 cc's D50 IV push over 30 seconds***  
***OR***
- 2. No IV Access—give 1 mg glucagon IM***  
***OR***
- 3. Give one tube of glucose gel***  
***AND***
- 4. Call MD for IV of D5W or D5½NS to run at***  
***appropriate rate for patient's condition***  
***(suggestion 75 cc/hr)***  
***THEN***
- 5. Recheck CBG every 15 minutes and treat until***  
***CBG is sustained above 70 mg/dl***

***Questions—CALL The Diabetes Treatment Center***  
***2-7560***

Figure 1. Sample educational tool to teach hospital staff how to respond to hypoglycemia in patients who are NPO.

well as patient safety and improved outcomes.<sup>21</sup>

Inpatient diabetes programs should focus on clinical outcomes, evidence-based medicine, patient education, patient safety, clinical and operational efficiency, financial stability, and patients' perceptions of care. Performance improvement initiatives are based on continuous data collection and analysis. Translating data into initiatives and coordinating support for improved patient care is the challenge.

Tracking selected quality metrics should be a daily part of inpatient program operations, with improved outcomes a priority. Hospitals having the best glycemic control score cards are those that are quickest to identify problem areas, develop methods to improve them, and eliminate the barriers to their successful implementation.

## Acknowledgments

The authors wish to thank Sam Kaufman, chief executive officer and managing director of Desert Springs Hospital in Las Vegas, Nev., for his ongoing dedication to and support of a quality diabetes program. His leadership provided the inspiration, resources, and commitment that led to the hospital's achievement in attaining the first Joint Commission Certificate of Distinction for Advanced Inpatient Diabetes Care.

## References

- Centers for Disease Control and Prevention: National diabetes fact sheet: general information and national estimates on diabetes in the United States, 2008 [article online]. Available online from <http://www.cdc.gov/Features/DiabetesFactSheet/>. Accessed 26 September 2008
- Umpierrez GE, Isaacs SD, Bazargan N, You X, Thaler LM, Kitabchi AE: Hyperglycemia: an independent marker of in-hospital mortality in patients with undiagnosed diabetes. *J Clin Endocrinol Metab* 87:978–982, 2002
- The Joint Commission: *Disease Specific Care Certification Manual*. The Joint Commission, Oakbrook Terrace, Ill., 2008
- American College of Endocrinology Task Force on Inpatient Diabetes and Glycemic Control: American College of Endocrinology and American Diabetes Association consensus statement on inpatient diabetes and glycemic control: a call to action. *Diabetes Care* 29:1955–1962, 2006
- American Diabetes Association: Standards of medical care in diabetes [Position Statement]. *Diabetes Care* 31 (Suppl. 1):S37–S45, 2008
- American College of Endocrinology Task Force on Inpatient Diabetes and Glycemic Control: American College of Endocrinology position statement on inpatient diabetes and metabolic control [article online]. Available online from <http://www.aace.com/pub/pdf/guidelines/InpatientDiabetesPositionStatement.pdf>. Accessed 3 October 2008
- Krinsley JS, Jones RL: Cost analysis of intensive glycemic control in critically ill adult patients. *Chest* 129:644–650, 2007
- Brown H: Diabetes nurse reduces hospital stays, errors. *Clin Endocrinol News* 2:5, 2007
- Clement S, Braithwaite SS, Magee MF, Ahmann A, Smith E, Schafer R, Hirsch I: Management of diabetes and hyperglycemia in hospitals. *Diabetes Care* 27:553–591, 2004
- Capes SE, Hunt D, Malmberg K, Gerstein HC: Stress hyperglycemia and increased risk of death after myocardial infarction in patients with and without diabetes: a systemic overview. *Lancet* 355:773–778, 2000
- Estrada CA, Young JA, Nifong LW, Chitwood WR Jr: Outcomes and perioperative hyperglycemia in patients with or without diabetes mellitus undergoing coronary artery bypass grafting. *Ann Thorac Surg* 75:1392–1399, 2003
- Krinsley JS: Association between hyperglycemia and increased hospital mortality in a heterogeneous population of critically ill patients. *Mayo Clin Proc* 78:1471–1478, 2003
- Pomposelli JJ, Baxter JK 3rd, Babineau TJ, Pomfret EA, Driscoll DF, Forse RA, Bistrian BR: Early postoperative glucose control predicts nosocomial infection rate in diabetic patients. *J Parenteral Enteral Nutr* 22:77–81, 1998
- Williams LS, Rotich J, Qi R, Fineberg N, Espay A, Bruno A, Fineberg SE, Tierney WR: Effects of admission hyperglycemia on mortality and costs in acute ischemic stroke. *Neurology* 59:67–71, 2002
- Vanhorebeek I, Langouche L, Van den Berghe G: Tight blood glucose control with insulin in the ICU: facts and controversies. *Chest* 132:268–278, 2007
- Krinsley JS: Effect of an intensive glucose management protocol on the mortality of critically ill adult patients. *Mayo Clin Proc* 79:992–1000, 2004
- Bode BW, Braithwaite SS, Steed RD, Davidson PC: Intravenous insulin infusion therapy: indications, methods, and transition to subcutaneous insulin therapy. *Endocr Pract* 10 (Suppl. 2):71–80, 2004
- Rattan J, Roudebush C, Kumar N, Macy A, Golas A, Wall D, Wolverton C, Nelson D, Carroll J, Flanders S: Utilization of a computerized intravenous insulin infusion program to control blood glucose in the intensive care unit. *Diabetes Technol Ther* 9:232–240, 2007
- Cryer PE: Hypoglycaemia: the limiting factor in the glycaemic management of type 1 and type II diabetes. *Diabetologia* 45:937–948, 2002
- Goldberg PA, Bozzo JE, Thomas PG: "Glucometrics": assessing the quality of inpatient glucose management. *Diabetes Technol Ther* 5:560–569, 2006
- DerGurahian J: The way to the top: high marks coincide with quality patient-safety measures. *Modern Healthcare* (Suppl.):22–26, 2008
- College of American Pathologists website: <http://www.cap.org/apps/cap.portal>. Accessed 26 September 2008
- Medical Decision Network: GlucoStabilizer website. [http://www.mdnoutcomes.net/GlucoStabilizer\\_Results.htm](http://www.mdnoutcomes.net/GlucoStabilizer_Results.htm). Accessed 26 September 2008
- GlucoTek website: [http://www.glucootec.com/glucommander/safe\\_insulin\\_administration.asp](http://www.glucootec.com/glucommander/safe_insulin_administration.asp). Accessed 26 September 2008
- MD Scientific website: <http://www.mdscientific.com/solutions.php>. Accessed 26 September 2008

Joyce Malaskovitz, PhD, RN, CDE, is director of the diabetes treatment center at Desert Springs Hospital and director of account management for Healthways, Inc., in Las Vegas, Nev. Charlotte Hodge, RN, NP, CDE, is president and founder of Diabetes Solutions in Riverside, Calif.