Effectively Identifying the Inpatient With Hyperglycemia to Increase Patient Care and Lower Costs

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Abstract: Recent years have seen an increased focus on merging quality care and financial results. This focus not only extends to the inpatient setting but also is of major importance in assuring effective transitions of care from hospital to home. Inducements to meld the 2 factors include tying payment to quality standards, investing in patient safety, and offering new incentives for providers who deliver high-quality and coordinated care. Once seen as the purview of primary care or specific surgical screening programs, identification of patients with hyperglycemia or undiagnosed diabetes mellitus now presents providers with opportunities to improve care. Part of the new focus will need to address the length of stay for patients with diabetes mellitus. These patients are proven to require longer hospital stays regardless of the admission diagnosis. With reducing length of stay as a major objective, efficiency combined with improved quality is the desired outcome. Even with the mounting evidence supporting the benefits of improving glycemic control in the hospital setting, institutions continue to struggle with inpatient glycemic control. Multiple national groups have provided recommendations for blood glucose assessment and glycated hemoglobin testing. This article identifies the key benefits in identifying patients with hyperglycemia and reviews possible ways to identify, monitor, and treat this potential problem area and thereby increase the level of patient care and cost-effectiveness.

Keywords: patient care; hyperglycemia; diabetes mellitus; glycemic control

Introduction

Hospitals are facing demands for value-based purchasing, tying payment to quality standards, investing in patient safety, and offering new incentives for providers who deliver high-quality and coordinated care. To meet these demands, the need to improve the discovery, diagnosis, and management of chronic diseases such as diabetes mellitus (DM) is of major importance now more than ever. Combining quality care and financial results is not only significant for the inpatient setting but also critical for proper transitions of care from hospital to home, as evidenced by the introduction of the new Centers for Medicare and Medicaid Services (CMS) measures for 30-day risk-standardized readmission (2013) and mortality (2014) and the development of accountable care organizations (ACOs). Hospital leaders ranked engaging physicians in improving the culture of quality and redesigning care processes as the 2 top patient safety and quality initiatives in 2012.[1] Linking these 2 challenges is at the forefront of glycemic management in hospitalized patients.

Screening and identifying patients with hyperglycemia have typically been viewed as the responsibility of the primary care provider or of specific surgical screening

programs. Pay-for-performance and ACO models require that patients who present to the hospital with hyperglycemia or undiagnosed DM not be ignored, but should be viewed by providers as opportunities to improve patient care instead.

Hyperglycemia is a common occurrence in hospitalized patients.[2-4] Reports of hyperglycemia rates range from 12% to 57%, depending on the definition of hyperglycemia, patient characteristics, and history of DM.[2–6] Patients with hyperglycemia, particularly those who do not have DM, have higher mortality, morbidity, and readmission rates and longer hospital length of stay.[5,7-17] These factors can have adverse effects on publicly reported data, such as those on surgical site infections, Surgical Care Improvement Project measures, readmissions, and hospital-acquired conditions. Improving glycemic control is associated with reduced rates of infections, morbidity, and mortality, and decreased hospital length of stay in patients.[18-23] However, not all of the evidence regarding glycemic control is unequivocally positive. Several large studies targeting blood glucose control using intravenous insulin report increased mortality, particularly related to hypoglycemia.[24-27]

The Importance of Recognizing Hyperglycemia

Management of hyperglycemia in patients with previously known DM, undiagnosed DM, or stress-induced hyperglycemia takes a lower priority to the condition that prompted hospital admission. The CMS is now publicly reporting and has financial measures for 30-day readmission, in-hospital adverse events, and mortality for patients diagnosed with heart failure, acute myocardial infarction, and pneumonia. Hospitals are most financially impacted by these patients, and the rates of DM as a coexisting condition in these patients are 41.6%, 34.2%, and 25.1%, respectively.[28] Logically, it is financially imperative for hospitals to recognize and treat hyperglycemia regardless of the admitting diagnosis.

Reducing length of stay has long been an objective of both clinical and financial hospital leadership. Now more than ever, efficiency combined with improved quality is the outcome most desired. Patients with DM are known to have a longer length of stay and higher cost of care, regardless of the admission diagnoses.[5,29,30] The cardiac and vascular surgery population, more than any other, has been examined in various studies focusing on control of preoperative hyperglycemia, and has shown reductions in length of stay and cost savings of ≤ $3105 per patient.[31,32] Olson et al[33] and Newton and Young[34] also found reductions in length of stay of 0.36 to 1.8 days for the non-intensive care unit hyperglycemic population, which led to cost savings ≤ $2.2 million[34] through glycemic improvements. One of the most intriguing studies on length of stay was published by Umpierrez et al,[5] who found that patients with newly diagnosed hyperglycemia had a length of stay almost double that of patients with known DM (9.0 vs 5.5 days). The striking metric in that study was that the admission blood glucose level was only 189 mg/dL in patients with newly diagnosed hyperglycemia and no known history of DM versus 230 mg/dL in patients with known DM.

Increased glucose exposure and admission glucose confirmed with an elevated glycated hemoglobin (HbA_{1c}) level are both associated with a higher risk of readmission for patients with heart failure.[16,18] Dungan et al[18] estimated that for every 1% increase in HbA_{1c} level, there was a 2-fold increase in the risk of readmission. Wei and colleagues[16] reported that patients admitted with an HbA_{1c} level ≥ 8% who received intensification of their DM medications had a significant decrease in risk for readmission of up to 33%. Furthermore, Robbins and Webb[17] showed that a DM diagnosis is associated with a 9.4% readmission rate, and that not recognizing DM as a diagnosis increased readmissions nearly 3-fold to 30.6%.

Thirty-day mortality is a new addition to the value-based purchasing measures but a long-time category in hyperglycemic outcome studies. Admission glucose levels were a predictor of mortality in patients presenting with pneumonia or acute myocardial infarction with or without preexisting DM.[15,35,36] Kosiborod et al[36] showed that patients without known DM admitted with acute myocardial infarction have a higher mortality rate but are less likely to be treated with insulin, even when glucose levels are distinctly elevated. Mortality rates have been seen to be as much as 5-fold higher in patients with newly discovered hyperglycemia compared with patients with known DM, which illustrates the need to screen all patients for hyperglycemia.[5]

Identifying the Patient With Hyperglycemia

Despite the financial implications and extensive literature on improving glycemic control in the hospital setting, institutions struggle with inpatient glycemic control. Perhaps one reason is the difficulty in identifying patients who are hyperglycemic.

The overall management of inpatient hyperglycemia can be broken down into 4 steps: 1) identifying patients who require insulin therapy; 2) starting an appropriate initial total daily dose of insulin; 3) titrating insulin doses on a daily basis

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to achieve the targeted glucose goals; and 4) developing a transition plan at discharge for patient care success.

Steps 2 and 3 have been thoroughly addressed in the literature. Choosing the appropriate initial total daily dose of insulin for each patient is critical to establishing glucose control quickly, because these patients have increasingly shorter lengths of stay. Similar to the titration of heparin, insulin doses must be adjusted on a day-to-day or more frequent basis to identify the proper dosing while avoiding unnecessary hypoglycemia or hyperglycemia. Significant literature exists on the actual management of inpatient hyperglycemia, the keys being initiation of scheduled insulin with elimination of the antiquated stand-alone "sliding scale," along with ongoing monitoring and titration of therapy.[21,22,37-47]

The American Diabetes Association (ADA) recommends blood glucose monitoring of patients receiving treatment linked to hyperglycemia, such as enteral or parenteral nutrition, high-dose steroids, immunosuppressive medications, and octreotide.[38] Additionally atypical antipsychotics, most β-blockers, protease inhibitors, and thiazide diuretics have been implicated in triggering hyperglycemia.[48] The Endocrine Society has recommended initial blood glucose assessment on admission, regardless of DM history, pointing out that "the risk-to-benefit of glucose testing and documenting a history of DM favors this approach despite the lack of randomized controlled trials."[45]

Testing for an elevated HbA_{1c} level may be another initial screening tool to evaluate for inpatient hyperglycemia. The ADA recommends measuring HbA_{1c} levels in at-risk patients with undiagnosed DM.[38] Greci et al[49] found that an HbA_{1c} level > 6% was 100% specific and 57% sensitive for diagnosing DM in hospitalized patients. An elevated HbA_{1c} level is valuable for identifying patients with preexisting but previously unrecognized DM.[50] However, patients with a recent onset of stress-induced hyperglycemia may not have an elevated HbA_{1c} level, and thereby this condition may be missed if a single screening value of HbA_{1c} level is used.

Kosiborod et al[51] found that mean glucose levels were a practical measure of hyperglycemia-associated risk in patients hospitalized with acute myocardial infarction, and concluded that elevated mean glucose levels may be used to initiate intensive glucose control. Additionally, they found that mortality rates in patients with hyperglycemia exceed those of patients with known DM, beginning with blood glucose levels ≥ 130 mg/dL. Inpatients with a known history of DM are more likely to undergo scheduled glucose monitoring and insulin. Patients with hyperglycemia without a known diagnosis of DM are the most challenging to identify. Centralized monitoring of plasma glucose may provide an initial place to identify these patients.

Admission and daily chemistries are collected for most inpatients. The laboratory values are usually assessed in the early morning hours when most patients have had nothing by mouth. In a prospective observational study of patients undergoing elective orthopedic procedures with insurance and access to primary care, preoperative screening using fasting blood glucose and HbA_{1c} levels indicated that 24% of all patients screened had unrecognized impaired fasting glucose levels or DM.[52] Additionally, 64% of patients with preoperative fasting blood glucose levels ≥ 100 mg/dL had persistently elevated blood glucose levels at 6- to 8-week follow-up visits. The rate of new-onset DM and hyperglycemia is certainly higher than the 16% identified by Umpierrez et al[5] in 2002. With such high rates of inpatient hyperglycemia and the potential for poor outcomes associated with hyperglycemia, the inpatient clinical team must find a way to identify these patients in real time so that effective treatment may be instituted.

Maintaining Glucose Control in the Hospital

Glucose control in the hospital setting has often been evaluated through retrospective analysis.[16,51,53-56] To actively target the patients for improving glycemic control while hospitalized, real-time glucose surveillance data are required. A daily review of plasma glucose levels on early-morning chemistries, identifying patients with a single glucose level > 180 mg/dL or 2 glucose levels > 130 mg/dL, may be the first step in diagnosing patients with unidentified hyperglycemia. The Endocrine Society recommends monitoring point-of-care (POC) glucose levels in patients with hyperglycemia (> 140 mg/dL) for ≥ 24 to 48 hours.[45]

Technology could assist in hyperglycemia surveillance. Cook et al[53] found almost a third of reported hospitals had no metric to track the quality of inpatient DM and hyperglycemia care. Additionally, 59% of all hospitals did not have an automatic system capable of extracting and analyzing glucose data.

Surveillance programs are commercially available today and come in a variety of end-user formatted platforms. The Society of Hospital Medicine has a retrospective internal achievement log through their Electronic Quality Improvement Programs (eQUIPS), allowing the institution to track its own performance and benchmark against comparison groups.[57] Electronic Quality Improvement Programs have many quality improvement–related reporting features,

allowing the hospital to track progress in glycemic control. Rals and Telcor produce POC software programs that can gather bedside glucose measurements directly from devices and provide reports of glycemic control, stratified according to inpatient unit, using user-defined targets for hypoglycemia and hyperglycemia. Electronic medical records make the task of identifying hyperglycemia easier through the various features and reports of the individual programs. Epic, for example, has an accordion report that can show patient glucose trends along with insulin administered and meal consumption.

Insulin dosing tools, such as the EndoTool Glucose Management System and Glucommander eGlycemic Management System, have analytic reports to improve identification of glycemic trends for hypoglycemia and hyperglycemia. Glucommander contains GlucoSurveillance (Glytec), a real-time glycemic tool that can identify patients with DM with out-of-target blood glucose or patients with hyperglycemia not known to have DM, and alerts the end user through the electronic medical record. For any of these tools to work effectively, especially for patients with new-onset hyperglycemia, follow-up POC testing must be ordered when an initial glucose is found to be out of range. All of these glucose tools require trained and dedicated staff to support the proper function, maximize the opportunity to identify patients who need treatment, and contribute to hyperglycemia improvement projects.

For hospitals that may be part of the 59% not having an automated glucose metric system, surveillance can still occur but will depend on frontline nurses and providers attentive to hyperglycemia. Patients requiring glucose intervention can be identified by having a daily report of glucose levels greater or less than institutional targets sent to designated team members to further investigate the need to implement glycemic measures.[35,58,59] Based on current guidelines, the blood glucose threshold is usually set at 180 mg/dL, and often a level exceeding this threshold detected at subsequent, consecutive check requires intervention by the clinical team.[38,43,45,46,59] Other measures include nurses notifying providers any time patients exceed defined targets. Actions could include ordering an HbA_{1c} test, administration of insulin therapy, dietitian consultation, and involvement of the DM nurse and/or team, if available.[59,60]

Discussion

Determining how inpatient glycemic management is addressed requires organizations to evaluate their current practice to identify strengths and opportunities to improve patient quality, safety, and financial metrics.[61] Identifying patients at risk for hyperglycemia begins with entry into the health system. Glucose testing at admission should trigger further monitoring and/or treatment through the use of protocols. It is essential to have protocols defining blood glucose values requiring further evaluation.

Key to implementation and sustainability is identifying a champion who not only understands the importance of addressing hyperglycemia but is also willing to be a change agent to overcome insulin resistance by the health care team and become a true champion for the cause.[61] The champion may be an endocrinologist, hospitalist, nurse practitioner, pharmacist, physician assistant, certified DM educator, or nurse with a passion for improving inpatient care of patients with hyperglycemia.[61-64] The champion alone will not be able to move the pendulum to improve patient outcomes; a focused team approach is required, along with administrative support.[43,65]

The team approach may differ depending on the setting, resources, expertise, and even culture of the organization. Large medical centers will usually have access to endocrinology services, additional resources, and infrastructure to perform surveillance and implementation of an effective plan by the focused team. A small community hospital may have a clinical provider champion, pharmacist, or certified DM educator to implement glycemic management methodology. The priority is for the champion to drive evidence-based practice requiring changes by all caring for the patients at risk. Provider-to-provider collaboration and education can foster further development of a heightened awareness to act when patients with hyperglycemia are discovered.[60,66]

Another important task of the champion and committee is to establish metrics with specific goals. Without these, the success of the program cannot be measured. Goal setting at the beginning of any project or process improvement is imperative for having a template against which to evaluate outcomes and to determine whether the goal of identifying inpatients with hyperglycemia was met. Examples of these metrics include percent of blood glucose readings within a predetermined target range, percent of blood glucoses resulting in hypoglycemia, length of stay, readmissions rates, and patient satisfaction. Adding hyperglycemic-specific goals and outcomes to hospital leadership's key performance indicators and having those metrics connect to medical director and hospitalist incentive programs may be a way to increase the success of hospital glycemic control.

Also important is the creation of service line- or provider group–based dashboards that provide transparency

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to all stakeholders regarding the level of glycemic control for specific groups of patients. Daily review of dashboards and/or glycemic reports and regular review of goals helps identify areas for ongoing improvement, whether the area is unit-based, individual provider–, or nurse-based, service line–based, or hospital- or health system–wide.

Once patients are identified as having hyperglycemia, order sets and protocols to manage blood glucose and changes should be initiated to promote glucose control. Patients must be provided with clear and concise education and information about insulin use. The education should focus on decreasing their anxiety and increasing their understanding of the importance of inpatient glucose control for improved outcomes. The clinical team must own the process of discussing the results of HbA_{1c} levels and preparing patients for discharge in the event that continuation of insulin may be required.

As practitioners try to limit readmissions and help patients achieve long-term glucose control, transitioning the patient out of the hospital is critical to the success of any inpatient glycemic control program. Admission HbA_{1c} levels can be used to assist in the transition home, because they can guide whether a change in therapy is warranted.[67] The other essential aspects of a successful transition are patient and caregiver education regarding DM "survival skills" and proper communication with outpatient providers. Education should be validated by allowing the patient to provide return demonstration of insulin administration and blood glucose monitoring, and being able to state the follow-up plan after discharge.

Important for larger-scale improvements are plans and pilot programs currently underway by CMS that focus on bundled payments, physician value-based purchasing, and the formation of ACOs.[68] Currently, insurance carriers are conducting incentive programs specific to glycemic outcomes. These programs place a financial value on improvement of hypoglycemic and hyperglycemic metrics.[68]

Conclusion

Identifying and treating inpatient hyperglycemia may have significant impact in improving patient outcomes, the culture of quality, and the financial bottom. The success of an inpatient glycemic control program requires significant collaboration among numerous departments. Progress can be made through diligent effort and commitment by all team members. Tools to assist clinicians with collecting data and setting standardized metrics can enable glycemic control teams to minimize practice variation and optimize glycemic control for patients with hyperglycemia, for those with known DM, and particularly those who are not admitted with a diagnosis of DM.[53]

Conlict of Interest Statement

Melanie E. Mabrey, DNP, ACNP-BC, BC-ADM, is a consultant for Glytec; she is a member of the speakers bureau and of the advisory committee for Sanofi. Raymie McFarland, PT, CSSGB, is employed by Glytec. Sandra L. Young, MSN, APRN, BC-ADM, is a consultant for Glytec. Andrew S. Rhinehart, MD, FACP, CDE, BC-ADM, CDTC, is employed by the Mountain States Health Alliance; is a consultant, member of the speakers bureau, and member of the advisory committee for Sanofi; is a member of the speakers bureau and the advisory committee for Amylin Pharmaceuticals, AstraZeneca, and Janssen; and is a member of the speakers bureau for Abbott Laboratories, Boehringer Ingelheim, Bristol-Myers Squibb, Forest Pharmaceuticals, Eli Lilly and Company, and Novo Nordisk. Penny L. Cooper, DNP, FNP-BC, ACNP-BC, CCRN, and Paul Chidester, MD, FACP, disclose no confl of interest.

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