

Reducing Surgical Complications: Risk-based Perioperative Screening for Diabetes and Glucose Management

**Oregon National Surgical Quality Improvement Program Consortium &
Oregon Patient Safety Commission
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Executive Summary

This white paper outlines a **Call to Action** for better perioperative care based on lessons learned by the National Surgical Quality Improvement Program (NSQIP) and other relevant studies.

These studies clearly indicate that surgical outcomes for patients with diabetes and prediabetes in Oregon can be better. Research and experience show that hyperglycemia in these patients can cause substantial morbidity and mortality and is frequently preventable. Hospitals and surgical teams can improve outcomes through better identification of patients with hyperglycemia and better management of their perioperative needs. Many best practices are not consistently implemented and yet stand to dramatically improve care and reduce costs.

The Oregon NSQIP Consortium (ONC) of eight hospitals represents over half of the acute care beds and annual discharges in the state. The ONC was formed in 2007 and meets regularly to share data, identify emerging best practices and develop strategies for improvement. The group is committed to presenting their findings and working to improve surgical care for all Oregonians.

Aggregate data from all NSQIP hospitals across the country has shown that surgical complications for patients with diabetes can be dramatically reduced. In similar fashion, in Oregon, results showed a 54% reduction in complications for patients with known diabetes. This is consistent with the increased efforts to improve glucose management during the perioperative period. Further studies also indicate that many more patients are at risk for hyperglycemia during surgery. Additional NSQIP findings demonstrate that complication rates for this group can also be reduced.

With initial indications from Oregon and national NSQIP and the strong evidence from the literature, the ONC calls on all Oregon surgeons to improve outcomes by:

1. Preoperatively screening surgical patients for poorly controlled diabetes and undiagnosed diabetes and prediabetes;
2. Measuring perioperative glucose in patients with diabetes or known risk-factors;
3. Treating perioperative hyperglycemia using safe and effective glycemic control strategies.

In the future the ONC will encourage member hospitals to collect more detailed glucose data to better understand the full impact of improved perioperative care. The ONC will also continue to publish their latest quality improvement results and above all, will offer encouragement to surgical teams across Oregon to provide the safest and best care possible.

The Oregon NSQIP Consortium

Eight Oregon hospitals currently participate in the [National Surgical Quality Improvement Program](#) (NSQIP). Participants agree to use a common data format to collect clinically-detailed, patient-specific data about surgical complications. These data are outcomes-based and risk adjusted using a well tested model. Findings are statistically valid, timely and actionable.

As a result, NSQIP hospitals can offer new ideas about **the next generation of surgical improvement initiatives**. To facilitate a conversation about these ideas, the eight Oregon NSQIP hospitals have joined together to create the Oregon NSQIP Consortium (ONC). Together, these eight represent about 50% of the acute care beds in Oregon and account for about 50% of the total discharges in the state. Within the consortium, NSQIP hospitals share the successes and challenges of surgical quality improvement in a systematic effort to learn what works and what doesn't work. In partnership with the Oregon Patient Safety Commission the ONC is dedicated to improving surgical care across the state by sharing clinical and quality improvement findings. This white paper and call to action are a result of the ONC's joint efforts.

A Call to Action for Oregon:

Surgical morbidity and mortality can be reduced by more widely implementing best practices. Recent findings from the National Surgical Quality Improvement Program suggest that hospital teams can improve outcomes through better identification of surgical patients with diabetes and prediabetes [1] and through better management of their perioperative needs. Some hospitals have done this rather dramatically. This white paper combines national and state NSQIP experience along with other current research to outline emerging strategies to improve care.

To reduce surgical complications in Oregon, the ONC calls on all Oregon surgeons to:

1. Screen preoperatively

- **Screen preoperatively for poorly controlled diabetes:**
 - Any surgical patient with known diabetes should have an HbA1c done within 30 days before elective surgery as recommended by the American Diabetes Association (ADA). If glycemic control is poor, then consider delaying the surgery or modifying the diabetes regimen. Most patients with known diabetes and HbA1c > 9.0% should be considered poorly controlled. Another form of poorly controlled diabetes is represented by the patient with an HbA1c that is < 9% but with wide variation in blood glucose (< 70 or > 200 mg/dL);
 - In all cases, establishing preoperative diabetes control based on effective chronic care management is the goal. When this isn't possible and the surgery must go forward, it is even more imperative to diligently manage blood glucose and other care needs to avoid increased mortality and morbidity. The intent is to focus attention on effective care where it is needed, not to discourage care of the sickest and most difficult-to-care-for patients.

- **Screen preoperatively for undiagnosed diabetes and prediabetes:**

Preoperative Screening Recommendations

Not needed if patient already screened and normal within preceding three months

1. Age over 45
2. Or age 18 to 45 with BMI >25 and one other risk factor:
 - Inactive lifestyle
 - HTN (>140/90 or taking meds)
 - First degree relative with diabetes
 - Woman with polycystic ovarian syndrome
 - Woman with gestational diabetes and/or and infant >9lbs
 - High risk ethnic group –African American, Native American and Alaska Native, Asian/Pacific Islander, Hispanic/Latino
 - History of cerebrovascular disease

Screening should include fasting blood sugar (FBG) and HbA1c: If HbA1c > 6% or FBG > 126 mg/dL then confirm with repeated fasting glucose and/or glucose tolerance test.

If surgery occurs before confirmation then treat perioperatively as if they have diabetes.

- A simple cost-free questionnaire is available for providers and patients to determine their risk of undiagnosed diabetes and prediabetes [2].

2. Measure perioperative glucose to identify hyperglycemia

- All patients admitted urgently to a hospital who meet criteria (known diabetes, > 45 years old or over 18 years old with a BMI > 25) should have an HbA1c checked upon admission (unless previously done within past 30 days). An HbA1c of > 5.9% should be presumptive evidence of diabetes in this group. It should be measured before transfusion of blood products that can falsely lower it;
- All patients over 45 years old or over 18 years old with a BMI > 25 admitted to hospital should have their admission glucose checked and if not normal, rechecked during their hospitalization until demonstrated to be normal;
- Provide a glucometer for every operating room to facilitate detection and treatment of hyperglycemia. The patients meeting criteria (known diabetes, over 45 years old or over 18 years old with a BMI > 25 and one other risk factor) should have their capillary blood glucose checked and rechecked in the operating room and recovery room whether a preoperative HbA1c is available or not.

3. Treat hyperglycemia in the hospital using safe and effective glycemc control strategies and NOT predominantly by giving sliding scale insulin (SSI).

- Establish accepted glycemc control goals, Fig. 1. Note that new joint guidelines from the American Diabetes Association and the American Association for Clinical Endocrinology have been published online in *Diabetes Care* [3] in response to the recently published studies [4-8];

Figure 1: 2009 Glycemic Targets in Hospitalized Patients [3]

<p>Critically ill patients: For persistent hyperglycemia: initial goal of <180 mg/dL and maintenance goal of 140 – 180 mg/dL</p> <p>Non-critically ill patients: Fasting glucose <140 mg/dL Random glucose <180 mg/dL</p> <p>For stable patients in whom tight glycemic control was previously achieved, more rigorous targets may be appropriate.</p> <p>For terminally ill patients or those with severe comorbidities, less stringent targets may be appropriate.</p>

- Choose a protocol for glycemic control that matches existing resources for monitoring its safety and effectiveness;
- Develop multidisciplinary glycemic control efforts. Champions are essential. Surgeons should join, or if needed, start such an effort in their hospital [9];
- The Society of Hospital Medicine’s website has a particularly robust, free [resource on glucose control](#);
- Targeted institutional support has allowed some local hospitals to institute glycemic control teams. For example, Southwest Washington Medical Center has shown that a clinical pharmacist-led glycemia control team can better control hyper- and hypoglycemia;
- The safe administration of continuous intravenous insulin protocols may have value for surgical patients [6, 10]. In the meta-analysis of “tight glucose control” the relative risk of mortality appears lower in surgical intensive care units studied with tight control versus “conventional control”. Note, however, that “conventional control” arms in recent studies had much better average glucose control than older studies, i.e., now in the 140-160 mg/dL range versus historically over 200mg/dL [3];
- A recently published randomized prospective trial in vascular surgery patients at Beth Israel Hospital in Boston demonstrated that continuous intravenous insulin infusion for 48 hours starting with the beginning of surgery, led to a 71% reduction in the major cardiovascular events of myocardial infarction and heart failure compared to intermittent bolus insulin treatment. The length of hospital stay was also shortened [11];
- Basal-bolus insulin strategies that are modified daily should be the norm for care rather than sliding scale insulin (SSI). SSI leads to more hyperglycemia, more variability in glucose levels, often more hypoglycemia and more clinical inertia in the face of poor control [12]. It also increases the risk of diabetic ketoacidosis in hospitalized patients (a new uncompensated “never event” for CMS).

Background

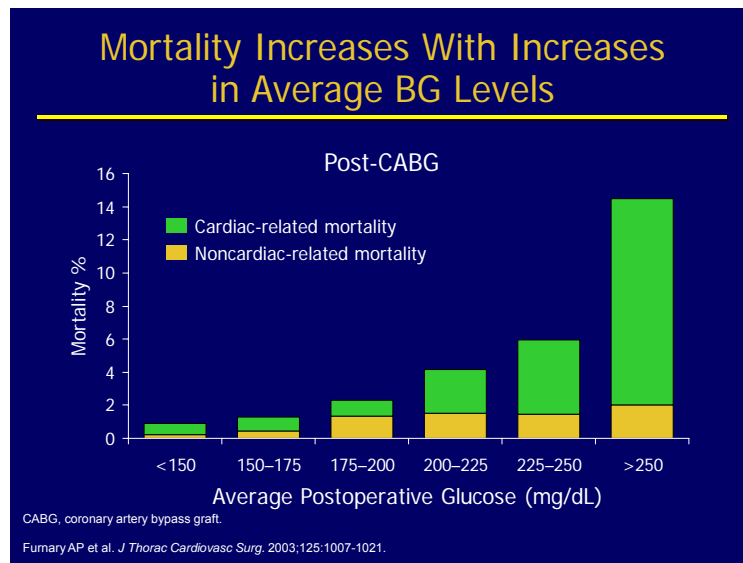
Almost 10% of U.S. adults currently have diabetes. A much larger and growing group (20-25%) have impaired fasting glucose or impaired glucose tolerance, often a step in the progression to full blown

diabetes. Patients with diabetes require hospitalization and surgical procedures more often than others with normal glucose tolerance. In 2007, up to 20% of the surgical patients in NSQIP hospitals were already diagnosed with diabetes and chronically on oral agents and/or insulin. They suffered all complications at much higher rates than patients without diabetes. We do not yet know how many more had undiagnosed diabetes or prediabetes. We do know that one quarter to one third of U.S. patients with these conditions are unaware of it and untreated [13].

Hyperglycemia is a manageable risk to the health of patients both inside and outside of the operating room. Based on a review of the literature, it is well documented that:

- Hyperglycemia can cause substantial mortality as has been shown in many studies. For example, cardiac patients in Portland, Oregon who were having coronary artery bypass graft (CABG) surgery experienced higher mortality with greater average postoperative glucose, Fig. 2 [14];

Figure 2: Hyperglycemia and Mortality [14] (In the years since this study was published, the general trend in the literature has been for the “control groups” of studies to have their average blood glucose around or below 140 to 150 in contrast to the historically uncontrolled higher levels that often occur with SSI treatment).



- Perioperative hyperglycemia has emerged as one of the major risk factors contributing to substantial postoperative morbidity [15-18];
- Diabetes and prediabetes (defined as impaired fasting glucose or impaired glucose tolerance) pose a considerable risk for postoperative complications [14, 16, 19, 20];
- Hospitalized patients with hyperglycemia and previously unrecognized diabetes diagnosis have even higher mortality rates than patients with known diabetes [20];
- Twenty to thirty percent of hospitalized patients with hyperglycemia have undiagnosed diabetes and prediabetes [21];
- Hyperglycemia was present in 38% of patients admitted to the hospital and one-third of these patients had no history of diabetes prior to admission [20];
- Hospitalization is a golden opportunity for patients with newly identified hyperglycemia. They can receive initial diagnostics, education and treatment and referral to comprehensive ambulatory care [9].

Cost of Postoperative Complications

Although there is little direct evidence about the costs of surgical complications caused by hyperglycemia, many studies provide indirect indications of preventable harm and costs to care for patients with adverse outcomes. Here are a few examples:

- The total estimated cost of diabetes in 2007 was \$174 billion, with \$116 billion attributed to excess medical expenditures. Hospital inpatient care (50% of total cost) was the largest component of medical expenditures attributed to diabetes [22];
- Nationwide control of cardiovascular disease (which ultimately causes the death of most patients with diabetes) and of diabetes improved significantly between 1999 and 2006. In part this was due to improvements in glycemic control (lower HbA1c levels <7.0%) and mean HbA1c levels in patients with known treated diabetes [23];
- The median hospital costs of a NSQIP-detected infectious complication are over \$8,000: Many other complications are much more expensive, Fig. 3 (does not include additional costs incurred outside the hospital) [24];

Figure 3: Costs for Postoperative Complications [24]

Total Hospital Costs with and without Surgical Complications Results from NSQIP at University of Michigan			
Type of Surgical Complication	Complication present	Complication absent	Cost Difference
Infectious	\$13,083	\$5,044	\$8,039
Cardiovascular	\$18,496	\$5,236	\$13,260
Respiratory	\$62,704	\$5,015	\$57,689
Thromboembolic	\$33,589	\$5,233	\$28,356

- In addition to the moral imperative to provide the best care possible, there is a clear business case for preventing surgical adverse events (See Appendix 1 for list of cost studies).

Public Health Perspective

The ONC call to improve perioperative care has particular public health significance for Oregonians. In 2007 the Oregon Legislature passed and the Governor signed House Bill 3486 which declared an emergency related to diabetes and obesity. It directed the Oregon Department of Human Services to develop a [strategic plan](#) to slow the increasing rate of diabetes [25]. Approximately 262,000 Oregon adults have diabetes and an additional 592,000 individuals have prediabetes. In addition 60% of Oregonians are obese or overweight, conditions predisposing them to diabetes [26]. An additional 37,000 adults become obese each year. Oregonians with low income and those who are African American, Native American and Alaska Native, Asian/Pacific Islander and, Hispanic/Latino are at increased risk for diabetes, obesity and for poor access to health care. Public health supports a statewide, population-based, prevention approach to the burden of diabetes. If hospitals improve the perioperative screening for diabetes this will add support to Oregon's public health goals. (To read the strategic plan: go to www.healthoregon.org/diabetes)

ONC also agrees with a recent editorialist writing in *Anesthesia*: “The development of a prospective multi-institutional database evaluating the incidence and evidence-based management of hypoglycemia or hyperglycemia across the heterogeneous perioperative population would address some major public health concerns. This database would facilitate identification of previously undiagnosed surgical patients with diabetes, aid in determination of the incidence and natural history of SIH (Stress induced hyperglycemia) in perioperative patients, and provide data on the impact of glycemetic management and quality of long-term care of specific subsets of patients, including those undergoing primary neurological, cardiac or traumatic surgery.” [8]. The ONC thinks NSQIP can provide the basis of such a database.

Findings from NSQIP: Surgical care improvement for patients with hyperglycemia

Hospitals in Oregon and across the country are using NSQIP to identify areas for improvement and to reduce their postoperative complication rates. The program enables surgeons to do rigorous surgical outcomes assessment.

Basic NSQIP parameters:

- Types of surgery studied: Initially limited to major general and vascular surgery, now can include up to 10 subspecialties of surgery by each participating hospital
- The 22 postoperative complications studied include: Post operative death, wound occurrences (infections, deep abscesses, etc.), respiratory occurrences (pneumonia, unexpected respiratory failure), urinary tract occurrences (kidney failure, urinary tract infection), CNS occurrences (stroke), cardiac occurrences (heart attack, cardiac arrest) and other (e.g., bleeding, thromboembolus, and systemic sepsis)
- Intervention strategies: Variation and experimentation among hospitals to improve surgical outcomes.

In 2006, unpublished results from a national NSQIP study revealed an aggregate rate of postoperative complications for patients with known diabetes of almost 40 unique postoperative complications for every 100 operations. The study included all hospitals enrolled in NSQIP nationally. Patients were tracked for 30 days post surgery.

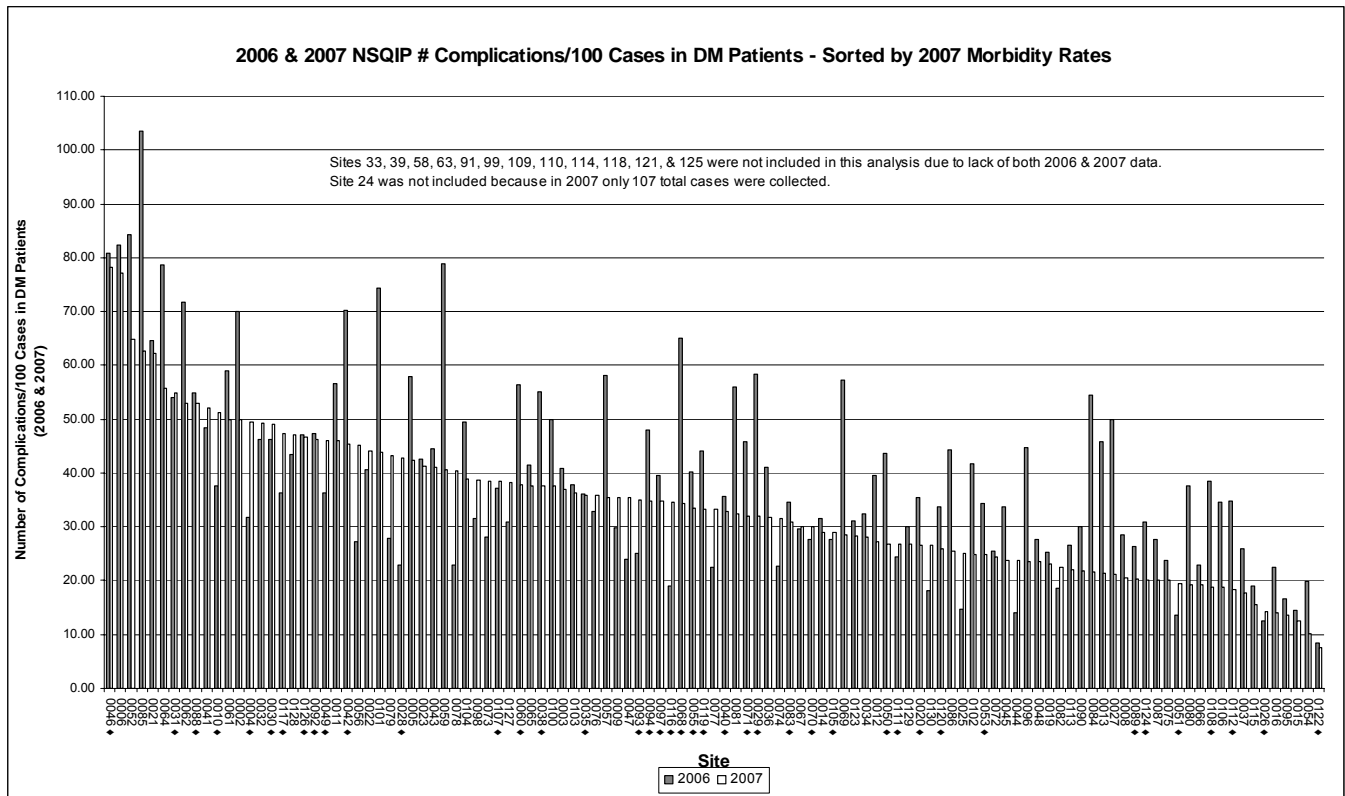
By 2007 the aggregate complication rate for these same NSQIP hospitals was lowered by 15% for patients with preoperatively diagnosed diabetes already on insulin and/or oral agents versus a 5% reduction in patients not known to have diabetes. Thus, total complications in patients with diabetes were decreasing three times faster than in other patients. It is not clear how much of this is due to better preoperative care, better diagnosis, or better perioperative management. The finding is consistent with a national trend toward lower chronic complication rates in treated patients with diabetes, i.e. lower amputation rates, lower rates of end-stage diabetes, cardiovascular disease and death from hyperglycemia [27].

Oregon NSQIP data offer good news and bad news. In less than two years, two Oregon NSQIP hospitals decreased complications in patients with diabetes by 54% from 65 to 30 per 100 operations. This success was attributed by those institutions to sustained efforts to improve glycemetic control during the perioperative period. However, the current Oregon NSQIP aggregated rate of 30-day complications of about 30 for every 100 cases in patients with known diabetes is still high. We do not yet know the rates of complications in undiagnosed patients with diabetes and prediabetes.

Both National NSQIP and Oregon NSQIP data show some institutions that have had rapid and large decreases in complications in patients with diabetes. Presumably, this is due to increased attention to

their care needs, which include control of their glucose and management of the other associated derangements such as cholesterol abnormalities, hyperinflammatory state, and hypertension.

Figure 4, NSQIP Variability of Surgical Complication Rates in Patients with Diabetes, 2006-2007*



While difficult to read in detail, Fig. 4 indicates the large variation in complication rates among NSQIP hospitals across the country. In fact, complication rates in patients with diabetes varied 12 fold -- from eight unique complications for 100 cases to over 100 complications per 100 cases. There is also variability in the individual hospital's ability to reduce complication rates as expressed in differences between the dark (2006) and light (2007) bars. Presumably, this degree of variability in outcomes exists in Oregon as well. The goal is to reduce variation by moving every Oregon hospital closer to lowest achievable complications.

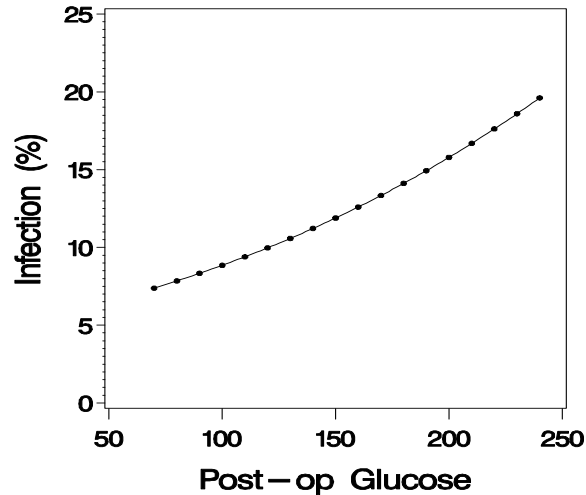
It is important to note that surgical complication rates adversely affect long-term survival. A longer-term study of Veterans Administration NSQIP patients found that the occurrence of a 30-day complication reduced median patient survival by 69%. This was the case independent of preoperative patient risk and even when patients who did not survive for 30 days were excluded from the analysis [28].

NSQIP data also suggest that there is no safe level of hyperglycemia. A recent study done in one NSQIP hospital demonstrated an almost linear increase in infectious complications with rising glucose in all patients who underwent general and vascular surgery, Fig. 5 [15]. This is currently the only published study that has directly tied patient's in-hospital peak postoperative blood glucose levels to their outcomes as measured by NSQIP. In addition, all other complications taken together as measured in NSQIP were elevated if the glucose was elevated, whether the patient had diabetes or not. In another

* Explanation: hospitals with a tall dark bar next to the 2007 lower light bar trend line improved complication rates in patients with diabetes compared to their "taller" 2006 rate

recent study of average blood glucoses for the first 48 hours after carotid endarterectomy in 10,546 Veteran's Hospital patients' postoperative hyperglycemia above 120 mg/dL was associated with increased complications as measured in the separate Veteran's Hospital NSQIP audit. The magnitude of increased risk was directly proportional to the level of hyperglycemia. by the time average glucose was in the 160 to 200 mg/dL range the relative risk of 2 or more complications was increased 4.67 fold [18].

Figure 5, Relationship between Postoperative Hyperglycemia and Risk of Postoperative Infection [15]



A recent informal survey of NSQIP hospitals indicates that few (eight out of 120 respondents) preoperatively screen for diabetes and prediabetes or have teams in the hospital who consider themselves “glycemia control teams” charged with the systematic improvement of glycemic control. The current lack of individual glucometric data in the NSQIP data set prevents inference about what exact levels of acute glucose control have been most effective and safest.

Continued Controversy:

Recent research about the management of hyperglycemia has clarified some questions while raising new ones [4-7]. Some evidence is directly related to perioperative care [4, 5] and other studies address glycemic control in critically ill populations [6, 7]. Researchers and clinical experts are still trying to understand which insulin protocols and blood glucose targets work best to reduce complications for specific patient populations.

Hypoglycemia, whether spontaneous or iatrogenic, can cause morbidity and is associated with increased mortality. Most patients with diabetes will die of cardiovascular events. In a recent study of patients hospitalized with acute myocardial infarction, however, this risk was confined to patients who developed hypoglycemia spontaneously. In contrast, iatrogenic hypoglycemia after insulin therapy was not associated with a higher mortality risk [29]. This confirmed an earlier result in acute myocardial infarction that episodic brief hypoglycemia that occurred as a result of insulin therapy in patients with diabetes and heart attack was not associated with increased deaths [30]. Brief episodes of hypoglycemia that occur during insulin-based glucose control in hospitalized patients should be avoided. They should not, however, discourage attempts at glucose control. The situation is different in the outpatient setting but in general, even there, glucose control is “still worthwhile and worth pursuing” [31].

There is still much to be understood but in the midst of all this information there are a few things that are very clear:

- Hyperglycemia can cause substantial morbidity and mortality;
- Current care of a large proportion of hospitalized patients could be better;
- Clinicians should continue to pursue optimal glucose management, even though the target glucose levels we should seek are in a state of flux;
- Change is local and dependent on leadership and resources;
- NSQIP is a program that enables hospitals to do robust quality improvement at the institutional level;
- The ONC leverages learning at all of the member hospitals and is a safe table for quality and patient safety champions.

Conclusion:

The next steps for ONC are to identify **all patients** at risk for postoperative hyper- and hypoglycemia, and to minimize the extremes of glucose during perioperative care. The ONC will encourage hospitals collecting NSQIP data to add as much glucose control data as is practicable to the NSQIP validated risk adjustment and outcomes data. This step will clarify the impact of hospital glycemia control on reducing surgical complications. Because there is still much to learn, the ONC pledges to regularly share aggregated results of these efforts with to the public in Oregon to make the problem (and the solutions) more visible.

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Oregon NSQIP Hospitals

- Kaiser Sunnyside Medical Center
- Legacy Emanuel Medical Center
- Oregon Health & Science University Hospital
- Providence Portland Medical Center
- Providence St. Vincent Medical Center
- Sacred Heart Medical Center at RiverBend
- Salem Hospital
- Legacy Good Samaritan Hospital

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Appendix 1

Cost Studies

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