

# Hyperglycemia in the Hospital: Changing the Way We Think

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A cardiac nurse, Jeanne Zerr, asked a question more than 10 years ago that has helped shape our current knowledge about hyperglycemia in the hospital setting. She wanted to know if high blood glucose levels were associated with increased thoracic wound infections. In 1997, Zerr and her colleagues in Portland, Ore., published an article with the findings that “the incidence of deep wound infection in diabetic patients was reduced after implementation of a protocol to maintain mean blood glucose levels < 200 mg/dl in the immediate postoperative care.”<sup>1</sup> Once the Portland group identified that hyperglycemia did affect wound healing, they developed a protocol to administer IV insulin to achieve tighter glucose control intraoperatively and postoperatively.<sup>2</sup> They have continued to study the impact of hyperglycemia on outcomes.

According to an article in the *Wall Street Journal*, nurses were initially resistant to the introduction of IV insulin protocols in the hospital.<sup>3</sup> I would guess that nurses were not the only ones resistant to the use of IV insulin protocols in the operating room and postoperatively. It appears that in our hospitals, not only are nurses resistant, but also surgeons, anesthesiologists, and other diabetes specialists are not convinced that glucose control matters during hospitalizations.

*It is time to change the way we think about hyperglycemia in the hospital.*

Positive steps are being taken to disseminate the results of the studies that have indicated that glucose control matters not only to those with diabetes, but also to anyone with hyperglycemia while in the hospital setting. The American Diabetes

Association (ADA), the American Association of Clinical Endocrinologists (AACE), and other interested organizations held a joint consensus conference on hyperglycemia in the hospital setting in December 2003. As a result of this conference, AACE produced a position statement that is available online at [www.aace.com](http://www.aace.com). The ADA asked a group of experts led by Stephen Clements, MD, CDE, to develop a technical review titled “Management of Diabetes and Hyperglycemia in Hospitals,” which was published in the February 2004 issue of *Diabetes Care*.<sup>4</sup> It is also available online at [www.diabetes.org](http://www.diabetes.org). An ADA position statement will be published in the near future.

Initially, I intended to reprint the technical review in these pages, because I believe the information it contains is crucial for those of us who care for people with diabetes and hyperglycemia. However, the review is extensive, spanning 37 pages and including 449 references, and therefore is too long to include here. However, it is my editorial intention to reprint the position statement when it becomes available.

For now, I urge you to take time to read the technical review. It is imperative that more providers and hospitals understand the importance of diabetes and hyperglycemia. The prevalence of diabetes in the hospital setting is conservatively estimated at 12.5–25%.<sup>4</sup> The evidence supports the contention that glucose control does indeed matter in the hospital setting.

Hyperglycemia has been linked to the immune system, mediators of inflammation, vascular response, and brain-cell response:

- It causes immunosuppression leading to infection.
- Acute hyperglycemia has been shown to increase viscosity, blood pressure, and natriuretic peptide levels.
- Hyperglycemia has numerous adverse effects on the cardiovascular system, including impairing preconditioning, a protective mechanism for cardiac insult. Infarct size increases in the presence of hyperglycemia.
- Hyperglycemia-induced platelet hyperactivity may explain the increased thrombotic events seen in hospitalized patients. The connection between acute hyperglycemia and vascular changes likely involve inflammatory changes.
- Acute hyperglycemia is associated with enhanced neuronal damage following induced brain ischemia.<sup>4</sup>

The recent technical review offers numerous outstanding and informative tables, including an evidence-based table associating blood glucose levels to clinical outcome (Table 1). Its Table 11 summarizes 11 evidence-based recommendations, including target blood glucose levels of < 110 mg/dl preprandially and < 180 mg/dl at peak postprandial, and the recommendation that intensive insulin therapy with intravenous insulin reduces mortality and morbidity among critically ill patients in surgical intensive care units. All 11 recommendations are shown here in Table 2.

The technical review also addresses the question, “How are target blood glucose levels best achieved in the hospital?” The role of oral agents is discussed, and extensive information on the use of insulin in diabetes and hyperglycemia is provided.

**Table 1. Partial Listing of Tables in the Technical Review “Management of Diabetes and Hyperglycemia in Hospitals”<sup>4</sup>**

Table Number	Table Title
Table 1	Evidence for Association of Blood Glucose Level With Clinical Outcomes
Table 3	Practical Guidelines for Hospital Use of Insulin
Table 4	Indications for Intravenous Insulin Among Non-Pregnant Adults With Established Diabetes or Hyperglycemia
Table 5	Components for Safe Diabetes Self-Management in the Hospital
Table 6	Conditions Creating High Risk for Hypoglycemia in Patients Receiving Scheduled Insulin
Table 7	Goals for Inpatient Diabetes Self Management Education (DSME)
Table 8	Conditions Causing Erroneous Bedside Blood Glucose Results
Table 10	Characteristics of an Effective Bedside Glucose Monitoring Quality Control Program
Table 11	Summary of Major Recommendations for Hospital Management of Hyperglycemia

The review also advises the elimination of the use of “sliding scale” terminology. Hallelujah! The term “scheduled insulin” or “programmed insulin” is recommended to refer to the insulin needed to cover the daily basal and nutritional needs, i.e., glucose infusions. When discrete meals are added,

then insulin doses should be written for “basal insulin,” “prandial insulin,” and “correctional insulin.”

The review also included information on special situations, including total parenteral nutrition, glucocorticoid therapy, and enteral feedings. The roles of self-management educa-

tion, medical nutrition therapy, and bedside glucose monitoring are also addressed.

Implementing these extensive guidelines will require a change in the way we think. Until now, patients in the hospital have been expected to have hyperglycemia, with or without a diagnosis of diabetes, and that has been accepted. Today, data support the contention that glucose control and insulin administration does make a difference in the hospital setting. Elsewhere in this issue (p. 112), we have included an article by *Diabetes Spectrum* associate editor Geralyn Spollett, MSN, C-ANP, CDE, that focuses on clinical considerations for hospitalized patients and highlights the importance of changing the way we view hyperglycemia in the hospital.

Beyond just changing the way we think, however, we must also change the way we practice. Implementing the aggressive, but achievable, standards laid out in the technical review will require a multidisciplinary approach and effort. Administrator

**Table 2. Summary of Major Recommendations for Hospital Management of Hyperglycemia**

Recommendation	Level of Evidence
• Good metabolic control is associated with improved hospital outcomes. Target plasma glucose levels are: <110 mg/dl preprandial and <180 mg/dl peak postprandial.	B
• Intensive insulin therapy with intravenous insulin, with the goal of maintaining blood glucose 80–110 mg/dl, reduces morbidity and mortality among critically ill patients in the surgical ICU.	A
• Intravenous insulin infusion is safe and effective for achieving metabolic control during major surgery, hemodynamic instability, and NPO status.	B
• Intravenous insulin infusion is safe and effective for patients who have poorly controlled diabetes and widely fluctuating blood glucose levels or who are insulin deficient or severely insulin resistant.	B
• Intravenous insulin infusion, followed by multidose subcutaneous insulin therapy, improves survival in diabetic patients after myocardial infarction.	A
• For insulin-deficient patients, despite reductions or the absence of caloric intake, basal insulin must be provided to prevent diabetic ketoacidosis.	B
• Use of scheduled insulin improves blood glucose control compared with orders based on sliding scale insulin coverage alone.	B
• For patients who are alert and demonstrate accurate insulin self-administration and glucose monitoring, insulin self-management should be allowed as an adjunct to standard nurse-delivered diabetes management.	E
• Patients with no prior history of diabetes who are found to have hyperglycemia (random blood glucose >125 mg/dl or 6.9 mmol/l) during hospitalization should have follow-up testing for diabetes within 1 month of hospital discharge.	E
• Establishing a multidisciplinary team that sets and implements institutional guidelines, protocols, and standardized order sets for the hospital results in reduced hypoglycemic and hyperglycemic events.	B
• Diabetes education, medical nutrition therapy, and timely diabetes-specific discharge planning are essential components of hospital-based diabetes care.	C

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and third party payers will need to see the cost benefits that can accrue from shorter hospital stays and fewer complications when hyperglycemia is reduced. Physicians, nurses, and quality improvement coordinators will need to step up to make hyperglycemia management a priority for their own hospitals. Protocols for glucose management and staff education will be a necessity to improve the way hyperglycemia is treated. Additional clinical trials will be necessary to discern the best approaches for glucose management and to provide further evidence related to the importance of glucose control, the role of insulin therapy, and other influences on mortality and morbidity.

Changing the way we think (let alone the way we practice) can seem a daunting task. But I encourage you to take your cue from Jeanne Zerr and be an instigator in your own institution. Ask questions. Spread your knowledge throughout the hospital system. Develop and implement protocols. Share your findings with others.

## References

- <sup>1</sup>Zerr KJ, Furnary AP, Grunkemeir GL, Bookin S, Kanhere V, Starr A: Glucose control lowers the risk of wound infection in diabetics after open heart surgery. *Ann Thorac Surg* 63:356–361, 1997
- <sup>2</sup>Furnay AP, Zerr KJ, Grunkemeir GL, Starr A: Continuous intravenous infusion reduces the

incidence of deep sternal wound infection in diabetic patients after cardiac surgical procedures. *Ann Thorac Surg* 63:352–360, 1999

<sup>3</sup><http://webprints.djreprints.com/912731093120.html>. Accessed 15 February 2004.

<sup>4</sup>Clements S, Braithwaite SS, Magee MF, Ammann A, Smith EP, Schaffer RA, Hirsch IB, on behalf of the Diabetes in Hospitals Writing Committee: Management of diabetes and hyperglycemia in hospitals (Technical Review). *Diabetes Care* 27:553–589, 2004

*Note of disclosure: Ms. Childs has received honoraria for speaking engagements from Novo Nordisk Pharmaceuticals and Aventis Pharmaceuticals, both manufacturers of insulin products for the treatment of hyperglycemia.*