Tight Glycemic Control in the Critical Care Environment

*An Integrative Review*

Recommendations & Summary of the Evidence

**Questions:** “What is the quality of the evidence concerning tight glycemic control in the critical care environment?”

- **Based on the reviewed evidence, the following recommendations are offered for consideration:**
  - **Staff Nurses**
    - Combine nursing judgment with glycemic protocols and interventions in order to individualize care for patients at risk for glycemic events (12).
    - Promote strategies for improving glucose control by becoming an active multidisciplinary team member (10).
    - Address concerns of hypoglycemia with inpatient clinical experts (6).
    - Participate in the development of accurate, practical, and easy-to-use glycemic tools (8).
    - Attend regular educational offerings concerning glycemic control (11).
  - **Nurse Educators**
    - Assist in protocols and algorithms development that incorporate concepts of glucose levels and rate of change, rather than dose changes based only on glucose levels (1).
    - Present comprehensive evidence-based glycemic control programs on a regular and ongoing basis to all staff nurses, with incorporation all modes of insulin administration, monitoring, and surveillance (10, 11, 15).
    - Consult with professional diabetes clinical experts in the development of glycemic control educational programs (10).
    - Provide additional education to staff nurses who take a longer time to do glycemic dosage calculations (10).
    - Assist in protocol and algorithm development that incorporate concepts of glucose levels and rate of change, rather than dose changes based only on glucose levels (1).
  - **Nurse Managers**
    - Reinforce staff nurse adherence to glycemic protocols and algorithms (12).
    - Promote patient safety by ensuring that glycemic tools, protocols, and algorithms are accurate, practical and easy for the staff nurse to use (8).
    - Provide adequate staffing in order to support all modes of insulin administration, monitoring, and surveillance (15).
    - Be attentive to and provide resources for staff nurses who take a longer time to do glycemic dosage calculations (10).
    - Evaluate the use of automated, continuous and/or noninvasive blood glucose monitoring to reduce nursing time and effort (2).
  - **Nurse Executives**
    - Current literature does not support continuous intensive insulin infusion outside the critical care environment to non-specialty patient-care areas, such as medical/surgical units (4, 9, 10, 11).
    - An entire hospital care system redesign, including mandatory glycemic algorithms and dedicated multidisciplinary support services, will be needed to safely to achieve target glucose levels while minimizing hypoglycemia (4, 10, 11).
    - Tight glycemic control programs need to reflect a multidisciplinary focus that incorporates expert nurses, such as Certified Clinical Nurse Specialists (10, 11).
    - Development and implementation of any tight glycemic control program should include resources to document and continuously monitor patient outcomes (9, 11).
    - Dedicated diabetes teams could deal more effectively with patients with undefined acute illness and uncontrolled glycemia (11).
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High blood glucose levels and its detrimental effects on patient outcomes are supported by many years of quality research. Current discussions surrounding blood glucose control now involve the specific methods needed to achieve tight glycemic control (blood glucose levels between 81 and 110 mg/dl) of the hospitalized patient. Patient census, resource allocation, and financial considerations have been cited as reasons for the movement of non-critical hyperglycemic patients receiving continuous intensive insulin infusion (CII) from the critical care area to the medical/surgical environment (1, 15). Current literature does not support CII outside the critical care environment to non-specialty patient-care areas, such as medical/surgical units (4, 9, 10, 11).

Recently, CII have been associated severe hypoglycemia, as well as patient deaths, in the intensive care setting (3, 4, 7). Some staff nurses are reluctant to maintain strict glycemic control in critically ill patients, due to fears of hypoglycemia (6). Although it is unclear as how CII contributes to hypoglycemia, a balance between CII therapy and glycemic targets must be maintained in order to avoid further glycemic complications and resulting negative patient outcomes (3, 4). Healthcare institutions using CII with consistent positive outcomes may share certain characteristics, such as adequate staffing and resources within a high-functioning multidisciplinary milieu (2, 4, 8, 9, 10, 11, 13, 14, 15). An entire hospital care system redesign, including mandatory glycemic algorithms and dedicated multidisciplinary support services, will be needed to safely achieve target glucose levels while minimizing hypoglycemia (4, 10, 11).

A 2006 evidence review concerning tight glycemic control examined the topics of insulin administration routes, insulin protocols, target glucose levels, and appropriate therapeutic environments. The integrative review yielded 154 total articles, with 15 deemed relevant for inclusion. A KP Care Management Institute Evidence Synopsis formed the basis of the 2006 review. An updated integrative review in 2008 on tight glycemic control in the critical care environment yielded 35 additional articles, with 11 articles examined in detail and 7 selected as relevant. 7 non-research items from the 2006 review were eliminated. The strength of the final 15 research articles ranged from insufficient to fair, with a final grade of fair. The remaining evidence is conflicting, demonstrating that the issues concerning tight glycemic control for the hospitalized patient via CII and other methods are complex. It is recommended that healthcare providers await answers resulting from future research studies, rather than adopting sweeping CII protocols for all patients in all patient care environments.

Key Summary of the Evidence

- Financial Considerations
  - Financial costs associated with glycemic control in critical care settings are substantial (2).
  - 2006 tight glycemic control cost: $182,488.00 for nurse salaries and $58,500.00 for supplies (2).
  - Cost improvement might be realized if patient outcomes are improved and LOS reduced by glycemic control (2).

- Insulin Protocols
  - Inpatient guidelines and protocols should be evidence-based, carefully developed, and validated (10).
  - Insulin protocols for the hospitalized hyperglycemic patient have not been compared for safety and effectiveness (1).
  - Algorithms should incorporate concepts of glucose levels, rate of change, and insulin sensitivity, rather than dose changes based only on glucose levels (1, 15).
  - Staff nurse efficacy for total protocol implementation time has been poor (12).
  - Protocols to maintain BG levels between 81 and 110mg/dl in critically ill patients may not be recommended, due to the frequency of hypoglycemia (12).
  - Patients with sepsis may benefit from other less strict insulin protocols than the Leuven protocol (3)
  - Bath Insulin Protocol proved to be an effective tool for implementing intensive insulin therapy and maintain the blood glucose of patients within the target range (14).
  - Basal/bolus and intravenous insulin administration therapies are superior to sliding scale insulin regimes (1).
**Blood Glucose (BG) Control**
- Target BG level of less than 145 mg/dl would provide the most benefit with less risk of inadvertent hypoglycemia (7, 12).
- Intensive insulin treatment (via Leuven protocol) has no measurable, consistent beneficial effect in critically ill patients with severe sepsis; such therapy increases the risk of hypoglycemic episodes (3).
- Occurrence of hypoglycemia has been shown to be an independent risk factor for death from any cause, while intensive insulin therapy was not an independent risk factor for death (3).
- Control of glucose levels, rather than absolute levels of exogenous insulin, appear to account for the mortality benefit associated with intensive insulin therapy demonstrated by others (4, 7).
  - Hyperglycemia is relevant outcome variable determining, rather than absolute hypoinsulinemia (7).
- Intensive insulin therapy reduced morbidity and mortality, as compared to conventional therapy, among mechanically ventilated critically ill patients who remained in a surgical intensive care unit for more than five days (5).
  - Further studies are needed to determine what degree of glucose control is required to achieve similar benefits in non-critical care patient group (4).
- Factors independently associated with adequate daily BG control (12):
  - Protocol adherence
  - High bilirubin level: unclear reasons
  - Low daily insulin dose: association between BG control and insulin resistance
  - Low C-reactive protein level: decreased incidence of hyperinflammation

**Critical Care**
- Current literature does not recommend the use of CII outside the critical care environment to non-specialty patient-care areas, such as medical/surgical units (4, 9, 10, 11).
- A variable-rate insulin infusion protocol aimed at controlling hyperglycemia did not reduce short-term mortality following AMI using an intention-to-treat analysis (6).
- Conflicts with earlier studies in which a survival advantages was demonstrated in insulin-treated patients (6).
- Strict control of BG in AMI patients is difficult to obtain (6).
- There was a reluctance of CCU nursing staff to aggressively lower BG levels re: fear of hypoglycemia (6).
- Increased insulin administration is positively associated with death in the ICU regardless of the prevailing blood glucose level (7).

**Nurse Workload**
- Additional workload created by intensive insulin therapy is burdensome, costly, and should not be underestimated (2, 14)
  - Up to 2 hours of nursing time is required for glycemic control for a single patient in a 24 hr period (2).
  - Must be considered prior to commencing this therapy, with appropriate means of staff support identified (2, 14).
- Evaluate automated, continuous and/or noninvasive BG monitoring to reduce ICU nursing time and effort (2, 13).
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Recommendations & Summary of the Evidence

➢ **Education**
  - Adequate staffing and in-service training is necessary to support all modes of insulin administration, monitoring, and surveillance (15).
  - Nurse educators are encouraged to:
    - Consult with professional diabetes clinical experts in the development of glycemic control educational programs (10).
    - Provide additional education to staff nurses who take a longer time to do glycemic dosage calculations (10).
    - Consider intensive insulin therapy dosage calculation in yearly skills lists.

➢ **Surgical Environment**
  - Aggressive control of perioperative glucose reduces the incidence of surgical site infections (4).
  - Considered promising but not proven to be causally associated with improved outcomes (4).
## Appendix A
### Quality of the Evidence

| Key Search Terms (1996-2006) | Search Results |  |  |  |  |  |  |  |
|-----------------------------|----------------|---|---|---|---|---|---|
|  | Cochrane Central Register of Controlled Trials | CINAHL Journals | Ovid Journals | Ovid Medline | EBM Reviews ACP Journal Club | Total | Relevant Articles |
| Insulin protocol, continuous insulin infusion, intravenous insulin, medical surgical, medical patients | 5 | 7 | 118 | 16 | 1 | 147 | 8 |
| Intensive insulin therapy, tight glycemic control | 24 | 7 | 147 | 8 |
| Total | 31 | 14 | 118 | 16 | 1 | 178 | 11 |

### Key Web Search Terms (2000-2007)

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<th>Search Terms</th>
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<td>Insulin drips AND medical surgical patients</td>
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2006 Additional relevant articles & materials located through context links: 6
2008 Additional relevant articles & materials located through context links: 4

2006 articles eliminated from 2008 review (Anecdotal Sources): 7

### SCORE LEVELS OF STUDIES RELEVANT ARTICLES ARTICLE NUMBER

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Total 15

(* Clinical Expert Commentary & Analysis)
2008 References


2008 References


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