

Insulin therapy within the intensive care unit

Claire Place and Anne Phillips

Introduction

This article is about the importance of a holistic approach to patients who are critically ill. It is important to understand how patients who are critically ill are affected by homeostasis and stress. During a critical illness all patients are under stress to a certain degree, with only a narrow limit that a patient can tolerate (Adam and Osborne, 1997). Consequently, the maintenance of homeostasis and blood glucose levels becomes one of the most important aspects of caring for those who are critically ill.

In 1999 the Department of Health (DoH) undertook a full review of critical care. This involved an expert group developing a framework aimed towards the delivery of critical care. This report highlighted the need for critical care to be planned and delivered systematically providing a National Health Service that works to common standards and protocols, taking full responsibility for the critically ill (DoH, 2000). A fresh approach to management of illnesses and problems associated with individual illnesses is one challenge for the DoH (2001a). It is important to recognise, act upon, and most effectively use medicines and treatments, ultimately developing strategies to deal with the physiological and psychological effects of illness (DoH, 2001a).

The reports clearly identify a need for consistent standards and protocols to aid the best possible outcome for the critically ill. According to Mallet and Dougherty (2000), clinical governance is a concept that can enable this. Nursing should be underpinned by evidence-based knowledge through research within the clinical setting.

Standards and the rationale for practice

Within intensive care, standards and protocols are clearly established to enable practitioners to provide the best possible care and are backed up with appropriate evidence as rationales. However, Viney

(1996) explains that in order to set certain standards an expert group needs to be established to instigate their initiation and implementation. It becomes essential to examine the beliefs and values underpinning these standards and to ask whether they cohere with clinical practice. Within our own clinical area, it is particularly pertinent that an agreed understanding is met regarding treatment. This has clearly been shown during the recent implementation of a new set of standards and protocols regarding the use of insulin therapy within the intensive care unit (ICU).

NICE guidelines

NICE guidelines stipulate that the primary aim of insulin therapy should be to replicate the body's natural secretion of insulin (DoH, 2001b). Therefore, the use of insulin within any environment is to regulate blood glucose within the body (Mallet and Dougherty, 2000). With high glucose levels being a moderately familiar condition among critically ill patients, insulin therapy is now more commonly being used (Rooney, 2003). This has presented itself as an issue for debate since the implementation of a new protocol and set of standards regarding insulin therapy within the ICU. There appears to be growing concern over the use of such therapy among staff, and the implications for both staff and patients.

ARTICLE POINTS

1 Hyperglycaemia is a risk factor for critically ill patients with and without diabetes.

2 Control of blood glucose can prevent problems in the short-term and disorders in the long-term.

3 Critical care nurses are often responsible for monitoring blood glucose and initiating intensive insulin therapy.

4 Intensive insulin therapy protocols need to be standardised as, from a nursing perspective, the benefits to patients outweigh the risks.

5 There is a need for further research into the effectiveness of insulin therapy. Treatment and protocols should be nationally or locally recognised.

KEY WORDS

- Intensive care unit
- Critically ill
- Insulin therapy
- Glucose monitoring
- Protocols

Claire Place is a Staff Nurse in ICU at York Hospital Trust and Anne Phillips is Programme Leader: Diabetes Education at the University of York

PAGE POINTS

1 Hyperglycaemia is a risk factor for critically ill patients – at least 12% without prior history of diabetes develop it.

2 Physical and psychological stress in ICU patients triggers a complex metabolic response leading the release of certain hormones and consequently increasing blood glucose levels.

3 Control of blood glucose can prevent complications and disorders; however, there is confusion over what levels aimed for should be.

4 In the ICU, the nurse is often given the responsibility for blood glucose monitoring and arranging infusions, such as insulin.

5 Well-proposed strategies and interdisciplinary strategies are necessary to enable full understanding of intensive glucose control.

Hyperglycaemia as a risk factor in ICU

Hyperglycaemia is a risk factor for critically ill patients (Dinardo et al, 2004). Research has shown that at least 12% of critically ill patients develop hyperglycaemia without having any prior history of diabetes, further emphasising that even a slight increase in blood sugars during critical illness is associated with adverse outcomes (Dinardo et al, 2004). For normal blood glucose levels to be maintained, insulin together with counter-regulatory hormones or stress hormones must all be in balance. If an imbalance occurs, such as a reduced utilisation of glucose, hyperglycaemia will develop (Oh et al, 2003). When caring for the critically ill patient, endocrine function should be seen as an important aspect (Jevon and Ewens, 2002) as, with disorders of the endocrine system being potentially life threatening, early detection of any problems becomes crucial.

Patients within the ICU will have undergone varying degrees of physical and psychological stress due to either major surgery or acute illness (Sharp, 1993). These stressors and the disruption in homeostasis trigger a complex metabolic response, resulting in the release of certain hormones and consequently increasing the blood glucose levels. According to Sharp (1993), patients undergoing any kind of trauma require an increase in glucose so that normal and injured tissues can have their demands met. This would explain the requirement for insulin to ensure tissues have glucose they can utilise. This provides the basis and rationale for insulin therapy within our own clinical setting.

Blood glucose monitoring in ICU

Control of blood glucose levels in the short term can prevent complications and in the long term prevent disorders. However, Rooney (2003) emphasises a lack of certainty and increased confusion regarding the blood glucose levels that should be aimed for and in which conditions this will have a beneficial effect.

Within the ICU, the nurse is seen as competent and accurate in blood glucose

monitoring (Sharp, 1993) and is often given the responsibility of arranging infusions, such as insulin. Blood glucose samples are tested using either venous samples or arterial samples in conjunction with testing blood gases.

The extended role of a nurse has become more significant within the ICU, with expectations to fulfil the role. Dinardo et al (2004) have demonstrated that safe and accurate management of glycaemic levels in critically ill people is labour intensive. Well-proposed strategies and interdisciplinary support are therefore necessary to enable full understanding of intensive glucose control so that staff will be comfortable with clinical treatments they are providing. Strategies when in place should also ensure they have adequate and essential resources with which to provide the type of care required (Dinardo et al, 2004). This is seen as vital to critical care nursing. Strategies and interdisciplinary support would be of clear benefit within our own clinical area, and would better inform staff of the rationales for the implementation of intensive insulin therapy.

Critical care nurses within the ICU are firmly directed towards quality improvement and applying evidence to underpin their practice. Ultimately national guidance should support development in areas of practice that are actively contributing to the outcomes of patients' experiences, in addition to a reduction in risk of complications (DoH, 2001c). Coad and Haines (1999) concluded that close collaboration with staff results in increased confidence when implementing certain procedures and as a consequence has a positive impact on the delivery of care.

Critical illness and potential complications

According to Begany (2002), although the connection of hyperglycaemia with critical illness has been known for a while, it has only become clear of late that failure to normalise blood glucose levels will expose patients to further complications. These include severe infections, polyneuropathy, multiple organ failure and

ultimately death. Bradley (2002) highlights that as a result of these complications arising, the stress the body and organs are already under will release further adrenaline and noradrenaline into the blood stream, eventually suppressing the release of insulin, again the result being hyperglycaemia. The true cause of stress-induced hyperglycaemia is multi-focal (Rooney, 2003). Undurti (2002) has identified that the use of intensive insulin therapy substantially reduces mortality and morbidity, with recent studies providing more evidence suggesting that insulin therapy has a dramatic anti-inflammatory effect. Evidence also suggests that other advantages of intensive insulin therapy include a reduction in prolonged ventilation and the need for renal replacement therapy (Rooney, 2003) as well as a significant reduction in the requirement for prolonged antibiotic therapy and the number of red blood cell transfusions (Begany, 2002).

Tight glycaemic control

Preiser et al's study (2002) involved the comparison of conventional therapy (maintaining blood glucose levels between 10.0 and 11.1%) and intensive insulin therapy (controlled to keep blood glucose between 4.4 and 6.1%). The van den Berghe et al study (2001) concluded that glycaemic control should be seen as a preventative approach that should be fundamentally pertinent to all critically ill patients. As a result there was a reduction in mortality in the ICU of more than 40%. This was regardless of whether or not the patients had a history of diabetes. Begany (2002) explained that decreases in mortality are largely due to a reduction in deaths from sepsis related to multiple organ failure, highlighting that a history of diabetes or hyperglycaemia at the time of admission had no effect on mortality. However, intensive insulin therapy was found to have an effect on the duration of stay in the ICU but not the overall length of stay in hospital (Begany, 2002).

The insulin protocol initiated within our clinical area is deemed applicable to all patients admitted into ICU. Critical care

patients are ventilated. Regardless of whether they suffer from any type of diabetes, the treatment remains the same.

According to Bassett and Makin (2000), insulin therapy should be used for all critically ill patients suffering from a form of diabetes and no reference has been made to adaptations in treatment. However, if a patient's primary reason for admission is uncontrollable diabetes the protocol would not apply and another course of action depending on their condition would be taken. Within our clinical area, guidelines state that every patient is commenced along the same course of treatment regarding blood glucose control, with exceptions made to diabetes-related emergencies.

A randomised control trial conducted in Belgium in 2001 (van den Berghe et al, 2001) was undertaken looking at the implementation of an insulin infusion protocol within a medical intensive care unit based upon the findings from the DIGAMI (Diabetes and Insulin-Glucose infusion in Acute Myocardial Infarction) study (Malmberg et al, 1999). Goldberg et al (2004) suggest that, based upon prevailing clinical evidence, there appears to be an increased attempt worldwide to maintain strict glycaemic control in critically ill patients with the use of insulin therapy. Although the Goldberg et al study concluded a successful implementation of a safe intensive insulin therapy protocol within the medical ICU, no evidence is available to show how successful tight glycaemic control was and what the clinical benefits were. The study does state, however, that clearly more work needs to be done to assess this. Interestingly, Goldberg et al (2004) explain that it remains unclear as to whether hyperglycaemia is a causal factor in poor clinical outcome or simply an indication of critical illness.

Protocols in ICU

Goldberg et al (2004) highlight that barriers exist when it comes to implementation of intensive insulin protocols, identifying the impact upon the busy ICU staff as adding considerably to their workload. As a result such implementations may not be readily

PAGE POINTS

1 As a result of complications, stress on the body and organs leads to further release of adrenaline and noradrenaline into the blood stream, eventually suppressing insulin release and resulting in hyperglycaemia.

2 Insulin therapy has a dramatic anti-inflammatory effect.

3 Insulin therapy also reduces the need for renal replacement therapy, prolonged ventilation, prolonged antibiotic therapy and reduces the number of red blood cell transfusions needed.

4 Studies show a reduction in mortality with tight glycaemic control.

5 The workload associated with implementation of intensive insulin protocols mean they may not be readily accepted.

PAGE POINTS

1 The Intensive Care Society has initiated guidelines for standards, and recommends a consistent approach should be adopted with regular six-monthly updates or review.

2 A distinct advantage of intensive insulin therapy is the reduced time patients spend in ICU.

3 Disadvantages of intensive insulin therapy are: increase in hypoglycaemia risk, sedation can mask hypoglycaemia and differences in opinions of when to introduce insulin and in which patients to apply the protocol.

4 Disadvantages highlight the need for education and support for staff.

5 Work still needs to be done to determine the full benefits of insulin therapy within the ICU.

accepted. Lewis et al (2004) have identified a clear need for the use of an insulin protocol in the treatment of critically ill patients. However, before the publication of the van den Berghe et al (2003) study in Belgium an effective and validated protocol was indefinable. Goldberg et al (2004) have noted that many existing intensive insulin protocols are disadvantaged due to excessive blood glucose targets or directions dictating a need for supervision or frequent divergence from the protocol. Through general consensus and staff opinion many nurses in ICU have found it difficult to apply the insulin therapy protocol to all patients, resulting in deviation and more frequent requests for physician input.

The Intensive Care Society (2004) has initiated guidelines for standards of intensive care. One such guideline is that of therapeutic policies, stating that a consistent approach to common therapeutic procedures should be adopted within the ICU with regular six-monthly updates or review. This is also part of the clinical governance agenda of the National Health Service.

Current protocols in ICU could be up for debate due to the level of disruption observed within our current clinical setting. Kanji et al (2004) emphasise that although there is a requirement for tighter glycaemic control in critically ill patients, no universally accepted tool or protocol has been suggested to smooth the progress of intensive insulin therapy. As a result, standardising protocols is deemed the most appropriate strategy to get the maximum gain from such therapy while guaranteeing patient safety at all times.

An ICU nursing perspective

A distinct advantage to intensive insulin therapy is the reduced time in ICU, as reported by Dyer (1995) who explored the psychological stresses specific to or accentuated by the ICU. According to Waldman et al (1993) the variety of problems – for example prolonged ventilation, slower healing times, increased infection risk, increased risk of pressure sore formation, etc – are vast and can be seen post-ICU, emphasising the

requirement to implement procedures that aid quick recovery thus reducing further complications.

One of the disadvantages from the nursing perspective is the increase in hypoglycaemia from intensive insulin therapy. Van den Berghe et al (2003) reported that episodes of hypoglycaemia occurred more often in people being treated with insulin than in those without. It was highlighted that hypoglycaemic events were avoidable as the nursing teams' experience and awareness increased. As nurses became more 'diabetes aware', detection of adverse events, i.e. hypoglycaemia, especially for patients under sedation, would be clearer. However, despite the risk of hypoglycaemia the use of intensive insulin therapy clearly outweighed the lack of team experience. This emphasises the clear need for education of staff.

Staff appear to be interested in the long-term effects intensive insulin therapy may have. A sliding scale protocol for the control of blood glucose outside the ICU for an individual with diabetes or not has been implemented within our Trust. It has been highlighted within the ICU protocol that, upon discharge from ICU to the wards, if the blood glucose levels are still not stabilised a sliding scale protocol should be initiated. Groeneveld et al (2002) state that multiple pathways exist where insulin treatment will decrease mortality and morbidity within a variety of critical conditions, for example acute myocardial infarction, acute infection, trauma or post surgery. They have stipulated that hyperinsulinaemia may have adverse effects if a large amount of insulin is required to keep tight glucose control.

Another limitation of intensive insulin therapy within the critically ill is that sedation can mask hypoglycaemia. It has been reiterated by the Royal College of General Practitioners (2001) that with insulin therapy comes an associated and increased risk of hypoglycaemia. There is, therefore, a need for blood glucose to be checked frequently and for appropriate equipment to be readily available (Woodrow, 2003).

Within our clinical area, confusion

remains amongst staff as to which protocol to follow to maintain normoglycaemia in non-ventilated patients, and when to introduce a sliding scale. Differences in opinion also pose a problem when categorising whether or not the protocol applies to patients. There is a clear need for education and a supportive programme to ensure effective use of therapy and realisation of maximum benefit amongst staff. This is vital to the development of critical care in the future.

Conclusion

There is still work to be done to determine the full benefits of intensive insulin therapy within the ICU. In general, insulin therapy appears to be effective in places that have utilised it and taken it forward and studies have clearly revealed the impact in reducing mortality. There is a need for further research into the true effectiveness of such therapy upon a different and a wide variety of patient groups. There is a randomised controlled trial currently underway within a general ICU in two centres (Rooney, 2003).

Although no universally accepted tool appears to have been adopted on a national level, it is recognised that each trust is developing and implementing protocols in accordance with their patients' needs. Overall, intensive insulin therapy should be seen as a multidisciplinary approach towards critical illness and it is essential that standards implemented be nationally or at least locally agreed. ■

- Adam SK, Osbourne S (1997) *Critical Care Nursing: Sciences and Practice*. University Press, Oxford
- Bassett C, Makin L (2000) *Caring for the Seriously Ill Patient*. Edward Arnold, London
- Begany T (2002) Intensive insulin reduces ICU morbidity and mortality. *Pulmonary Reviews* **7**(1) (available at <http://www.pulmonaryreviews.com/jan02/intens.html>, accessed 6.1.05)
- Bradley C (2002) Intensive insulin therapy in critically ill patients. *Intensive and Critical Care Nursing* **18**: 128–29
- Coad S, Haines S (1999) Supporting staff caring for critically ill patients in acute care areas. *Nursing in Critical Care* **4**(5): 245–48
- Department of Health (2000) *Comprehensive Critical Care: a review of adult critical care services*. DoH, London
- Department of Health (2001a) *The Expert Patient: a new approach to chronic disease management for the 21st century*. DoH, London
- Department of Health (2001b) *New NICE Work Programme Goes Out for Consultation*. DoH, London
- Department of Health (2001c) *The Nursing Contribution to the Provision of Comprehensive Critical Care: a strategic programme of action*. DoH, London (PDF available at <http://www.dh.gov.uk/assetRoot/04/01/47/50/04014750.pdf>, accessed 6.1.05)
- DiNardo M, Korytkowski M, Siminerio L (2004) The importance of normoglycaemia in critically ill patients. *Critical Care Nursing Quarterly* **27**(2): 126–34
- Dyer I (1995) Preventing ITU syndrome, or how not to torture an ITU patient. *Intensive and Critical Care Nursing* **11**(3): 130–39; **11**(4): 223–32
- Goldberg P, Siegel M, Sherwin R et al (2004) Implementation of a safe and effective insulin infusion protocol in a medical intensive care unit. *Diabetes Care* **27**: 461–67
- Groeneveld JAB, Beishuizen A, Visser FC (2002) Insulin: a wonder drug in the critically ill. *Critical Care* **6**(2): 102–05
- Intensive Care Society (2004) *Standards for Intensive Care* (available at <http://www.ics.ac.uk/>, accessed 6.1.05)
- Jevon P, Ewens B (2002) *Monitoring the Critically Ill Patient*. Blackwell Science, Oxford
- Kanji S, Singh A, Tierney M, Meggison H, McIntyre L, Herbert P (2004) Standardization of intravenous insulin therapy improves the efficiency and safety of blood glucose control in critically ill adults. *Intensive Care Medicine* **30**: 804–10
- Lewis KS, Kane-Gill SL, Bobek MB, Dasta JF (2004) Intensive insulin therapy for critically ill patients. *Annals of Pharmacotherapy* **38**(7): 1243–51
- Mallet J, Dougherty L. Oh TE Editor (2000) *The Royal Marsden Hospital Manual of Clinical Nursing Procedures*. 5th ed. Blackwell Science, Oxford
- Malmberg K, Norhammar A, Wedel H, Ryden L (1999) Glycometabolic state at admission: important risk marker of mortality in conventionally treated patients with diabetes mellitus and acute myocardial infarction: long-term results from the Diabetes and Insulin-Glucose Infusion in Acute Myocardial Infarction (DIGAMI) study. *Circulation* **99**: 2626–32
- Oh T, Bersten A, Soni N, Editors (2003) *Oh's Intensive Care Manual*. 5th ed. Butterworth Heinemann, London
- Preiser J, Devos P, van den Berghe G (2002) Tight control of glycaemia in critically ill patients. *Current Opinion in Clinical Nutrition and Metabolic Care* **5**: 533–37
- Rooney K (2003) *Tight Glycaemic Control in ICU*. (available at <http://www.sicsebm.org.uk/Insulin/Insulin.summary.htm>, accessed 6.1.05)
- Sharp S (1993) Blood glucose monitoring in the intensive care unit. *British Journal of Nursing* **2**(4): 209–14
- McIntosh A, Hutchinson A, Home PD, et al on behalf of the Royal College of General Practitioners (2001) *Clinical guidelines and evidence review for type 2 diabetes: management of blood glucose*. ScHARR, University of Sheffield, Sheffield
- Undurti N (2002) Insulin and the critically ill. *Critical Care* **6**(3): 262–63
- van den Berghe G (2003) Insulin therapy for the critically ill patient. *Clinical Cornerstone* **5**(2): 56–63
- van den Berghe G, Wouters P, Weekers F et al (2001) Intensive insulin therapy in critically ill patients. *New England Journal of Medicine* **345**(19): 1359–67
- van den Berghe G, Wouters P, Weekers F et al (2003) Outcome benefit of intensive insulin therapy in the critically ill: insulin dose versus glycaemic control. *Critical Care Medicine* **31**(2): 359–66
- Viney C, Editor (1996) *Nursing the Critically Ill*. Bailliere Tindall, London
- Waldmann C, Tseng P, Meulman P, Whittet H (1993) Aromatherapy in the intensive care unit. *Care of the Critically Ill* **9**: 170–74
- Woodrow P (2000) *Intensive Care Nursing – A Framework for Practice*. Routledge, London

PAGE POINTS

1 Insulin therapy appears to be effective in places that have used it and taken it forward.

2 There is a need for further research into the true effectiveness of insulin therapy.

3 Intensive insulin therapy should be seen as a multidisciplinary approach towards critical illness and it is essential that standards implemented be nationally or at least locally agreed.