

# Management of inpatients with diabetes undergoing surgery using pre-printed variable rate intravenous insulin infusion prescriptions

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## Article points

1. Achieving good glycaemic control during the perioperative period for people with diabetes is a way of reducing complications. Variable rate insulin infusion (VRIII) is suggested as a way of doing so.
2. The use of VRIII can be challenging, often due to staffing shortages or poor staff knowledge. The East Sussex Health Care NHS Trust carried out an audit to assess the use of VRIII in people undergoing surgery.
3. The results demonstrate that VRIII is effective at improving glycaemic control during pre-, peri- and post-operative period. When implemented correctly, it is a useful tool to enable healthcare professionals to deliver safe and effective care.

## Key words

- Diabetes
- Surgery
- Variable rate intravenous insulin infusions

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**It is widely documented that people with diabetes who are admitted to hospital for surgery are far more likely to have increased length of stays, and are more prone to surgical site infections and delayed wound healing than people without diabetes. The use of variable rate intravenous insulin infusions (VRIII) is suggested as a way of improving glycaemic control during the perioperative period to aid a reduction in any potential complications. This article will highlight the outcomes of the audit conducted at the East Sussex Healthcare NHS Trust on the use of pre-printed VRIII prescriptions for people with diabetes undergoing surgery and give an overview of the challenges facing the service that we provide for this cohort, as well as the proposed solutions.**

According to the Health Survey for England in 2014, the number of individuals being diagnosed with diabetes significantly increased from 2.9% to 7.1% in men and from 1.9% to 5.3% in women between the period of 1994 and 2014 (Health & Social Care Information Centre, 2015). On a global scale, it is estimated that up to 415 million people between the ages of 20 and 70 years are affected by diabetes (Diabetes UK, 2015). It is predicted that by 2040, up to one in ten will have diabetes, an estimated 642 million people worldwide (Diabetes UK, 2015).

Within the UK, someone is diagnosed with diabetes every 2 minutes and there are currently 4 million people living with the condition. However, caution should be used with these figures, as it is estimated that many more people may have diabetes without knowing it (Diabetes UK, 2015).

It is widely documented that people with diabetes who are admitted to hospital for surgery are far more likely to have increased length of stays, and are more prone to surgical site infections and delayed wound healing than those without diabetes (Dhinsa et al, 2010).

Diabetes UK published a report in 2014 that estimated that the NHS spends in excess of £10 billion a year on diabetes care, with up to £2 billion being spent on avoidable complications that result in increased length of stay in hospital (Diabetes UK, 2014). This is, on average, 2.6 days longer than people without diabetes (Hex et al, 2012).

With NHS expenditure increasing every year, it is imperative that savings are made. Achieving good glycaemic control during the perioperative period for people with diabetes is a way of reducing complications and improves standards of care, which ultimately reduces NHS expenditure.

The use of variable rate insulin infusion (VRIII) is suggested as a way of improving glycaemic control during the perioperative period to aid a reduction in any potential complications (Hui et al, 2012). This systematic review focused on people having cardiac surgery, where catecholamines and steroids are used, and blood glucose levels are expected to be high as a result. In this case, VRIII is definitely recommended. With regard to other surgeries, VRIII is recommended if the individual is missing more than one meal, or if diabetes control is suboptimal.

Alberti and Thomas (1979) published a seminal paper advocating the use of a pre-mixed infusion containing glucose, potassium and insulin for people undergoing surgery. This is known as the Alberti Regimen. They advocated the need to establish a set of guidelines that were straightforward to assist in the care of people with diabetes undergoing surgery (Hall, 2009). While the regimen appeared to offer a simple solution in the management of glycaemic control for people with diabetes, it did not offer any flexibility in the needs of different individuals. Due to the multitude of additions to the fluid bag, it was also argued that there was an increased risk of errors. Therefore its safety was often questioned and, as such, is no longer recommended for use today (George et al, 2015).

The Joint British Diabetes Society for Inpatient Care (JBDS-IP) published updated guidelines in 2015 surrounding the use of VRIII for people undergoing surgery. They recommended that those with diabetes who were predicted to miss more than one meal should be commenced on a VRIII (JBDS-IP, 2015). They recommend an HbA<sub>1c</sub> of <69 mmol/mol prior to surgery and the acceptable target for capillary blood glucose (CBG) levels to be 6–12 mmol/L, while trying to avoid wide-ranging variations. Compared to subcutaneous insulin, VRIII provides a more controlled delivery of insulin, which can be adjusted quickly without the risk of dose stacking, due to its short half-life (Ead, 2009). However, data collected from audits within the UK found that the use of VRIII remains a contentious issue, with many reports of adverse events, such as hypoglycaemia, hyperglycaemia, ketosis and prolonged length of stay (National Patient Safety Agency [NPSA], 2010). Despite these issues, VRIII is arguably a useful solution to achieve good glycaemic control for some people undergoing surgery.

## Rationale

A systematic review of existing literature conducted by Hui et al (2012) was carried out to determine whether the use of protocol-directed insulin infusions was not only safe, but also effective in achieving target CBG levels in people with diabetes. Of the studies included in the review, clear links were made between the association of suboptimal glycaemic control (blood glucose readings outside of the specified target range) and adverse effects on individuals' recoveries.

One of the studies conducted by Furnary (2009) identified that when a person's CBG levels rose above 10 mmol/L, they were twice as likely to develop wound infections, with the risk increasing as CBG level increased. These findings correlate to an earlier study conducted by Fish et al (2003), who reported that those with CBG levels >14 mmol/L were ten times more likely to experience complications following their cardiac surgery. Marchant et al (2009) retrospectively reviewed over a million people who had undergone surgery. They reviewed the glycaemic control before and after the surgery to identify whether suboptimal CBG levels were a contributing factor to adverse effects after surgery. They went on to conclude that when CBG levels were suboptimal, it greatly increased the risk of complications, regardless of the type of diabetes.

## Challenges

In a busy hospital environment, the use of VRIII can prove challenging at times. Ead (2009) found that people on VRIII can greatly add to a nurse's workload. This is due to the frequency of CBG testing required and any insulin titrations needed based on the CBG reading. In 2006, Aragon calculated that direct nursing time required for people on VRIII can be as much as two hours per day, which in a busy, short-staffed environment can be a tall order. The same study also identified that nursing staff often feared causing the individual to become hypoglycaemic, which made them anxious about using VRIII (Aragon, 2006).

Akhtar et al (2010) found that healthcare professionals' fears surrounding insulin or VRIII were not unfounded. They identified that insulin was in the top five most common drugs to be involved in medication errors. They also identified that insulin has the highest rate of administration errors and the harm caused tends to be significant clinically. Data published by the JBDS-IP (2015) revealed that up to a third of deaths occurring in hospital that were as a result of medical error were linked to insulin administration. These documented dangers surrounding the use of insulin could be one of the reasons why healthcare professional are fearful of using VRIII. Perhaps the fear of insulin use could be attributed to a lack of knowledge on the part of the healthcare professionals?

Grout and Phillips (2012) carried out an audit

## Page points

1. The Joint British Diabetes Society for Inpatient Care recommended that those with diabetes who were predicted to miss more than one meal should be commenced on a variable rate intravenous insulin infusion (VRIII).
2. They recommend an HbA<sub>1c</sub> of <69 mmol/mol prior to surgery and the acceptable target for capillary blood glucose (CBG) levels to be 6–12mmol/L, while trying to avoid wide-ranging variations.
3. In a busy ward environment, the use of VRIII can greatly add to a nurse's workload. This is due to the frequency of CBG testing required and any insulin titrations needed based on the CBG reading.



professionals' knowledge. All foundation year one and two doctors, as well as Core Medical Training doctors receive induction training from the diabetes inpatient specialist nurses. This training covers the management of people with diabetes, as well as a focus on prescribing, particularly, insulin. Guidance on the use of the VRIII, especially during the perioperative period, is also covered.

Three years ago, the Trust introduced pre-printed prescriptions for intravenous insulin management in certain circumstances, including surgery and nil by mouth (*Figure 1* and *Figure 2*), diabetic ketoacidosis, hyperosmolar hyperglycaemic state, acute coronary syndrome and obstetrics. These were developed with the aim of reducing prescribing errors and the feedback received from the staff using it has been very positive. The advantage of the pre-printed prescriptions is the clarity of information around:

- Algorithm selection.
- Criteria on which group of people it should be used for.
- Frequency of CBG monitoring.
- Targets.
- Intravenous (IV) fluid management.
- Potassium replacement.
- Continuation of basal insulin.
- Guidance on when to discontinue.

The charts were entered into the JDDBS 2014 competition to find the safest and most effective insulin prescription chart. All of the charts that were entered into the competition were judged against UK NPSA criteria for the safe prescription of insulin guidelines. Nottingham University Hospital was the overall winner, with ESHT as the runner up (Dashora et al, 2015). Within the ESHT, the implementation of the VRIII pre-printed prescription chart has seen a reduction in management errors from 25% to 6.5%.

While the issue of staffing is one that is not isolated to our trust, it remains a difficult issue to overcome. Recruiting and retaining staff is challenging at times, and while every effort is made to fill the gaps in staffing, there is no quick fix. For every new nursing recruit, ESHT has a mandatory "safe intravenous (IV) administration study day". The DSNs are currently working with learning and development colleagues to include use of IV insulin on the study day. This will hopefully address the issue that many newly qualified nurses raise about having no formal training on how to administer VRIII when they start with the Trust.

This would also enable them to disseminate what they have learnt to other healthcare professionals in their clinical area, therefore widening the educational net. By reducing the barriers surrounding VRIII, it can help make its use more beneficial and safe for the people receiving it.

### Discussion: The audit

The diabetes team at ESHT carried out an audit to review the use of the pre-printed VRIII chart developed by the Trust, with a focus on the surgical/nil-by-mouth protocol (*Figure 1*). The audit covered the period between April and September 2015. The people included were from the Surgical Admission Unit (SAU) and two general surgical wards. The individuals were selected randomly and were known to have received VRIII during the pre-operative period. A total of eight individuals were included in the audit. These included both males and females and their ages varied. The audit aimed to identify how well the pre-printed prescription chart was followed. The individuals' notes were reviewed and checked against various criteria, including:

#### Prescribing aspects

- Starting algorithm.
- Algorithm chosen.
- Algorithm signed.
- Algorithm dated.
- IV insulin infusion signed.
- IV insulin infusion dated.
- Algorithm changed.

#### Management aspects

- CBG checked hourly.
- IV insulin rate changed appropriately.
- CBG within target range (6–12 mmol/L).
- Number of hypoglycaemic episodes during infusion.
- Duration of infusion.
- Evidence of infusion continuation in theatre and recovery.
- Appropriate discontinuation.

Of the eight patients identified, it was shown that three demonstrated an improvement in CBG readings within a couple of hours. Their CBG came within the target range (6–12 mmol/L) while they received the VRIII. Seven people had no episodes of hypoglycaemia during the infusion. The final individual had ten recorded episodes of

### Page points

1. The diabetes team at East Sussex Health Care NHS Trust carried out an audit to review the use of the pre-printed VRIII chart developed by the Trust, with a focus on the surgical/nil-by-mouth protocol.
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**“The results from the audit demonstrate that the Trust’s VRIII is effective at improving glycaemic control during pre-, peri- and post-operative periods.”**

hypoglycaemia, but on close scrutiny it was identified that the individual spent a total of 122 hours on VRIII, while awaiting decisions of further treatment and investigations. All but one of the cases had their CBG checked hourly, as stated in the protocol. All eight of the cases demonstrated that the VRIII was discontinued at the appropriate time, mainly when the person resumed their normal eating and drinking patterns.

From a prescribing view point, the audit demonstrated that prescribing errors were very low. Any errors were attributed to an algorithm not being selected, signed or dated. This was particularly relevant in one person. This individual showed very different results compared to the other seven. The person was the only one with type 1 diabetes and was admitted for emergency incision and drainage of a left perianal abscess. During the infusion the CBG remained >14 mmol/L. This can be explained by the patient being commenced on the VRIII with very high CBG (>19 mmol/L) and only for a short duration (4 hours). However, it is important to note that, although the CBG remained out of the acceptable range, it did help reduce the CBG for the duration of the infusion. This individual also had very poor glycaemic control, with their last HbA<sub>1c</sub> value reading 131 mmol/mol (14.1%).

One of the biggest challenges identified was that six out of the eight people assessed had no evidence in their notes that the VRIII was continued in theatre and recovery. Of the two that did, documentation relating to CBG readings or VRIII was done in the recovery room, but no notes were found for the period when they were in theatre. This goes against the guidelines from the JBDS-IP (2015) and the Royal College of Anaesthetists (Royal College of Anaesthetists, 2006). The guidelines recommend that CBG, insulin and substrate infusion rates should be recorded while the patient is sedated and undergoing their operation in order to correct any rising CBG.

There needs to be a collaborative approach, involving the anaesthetists, to raise awareness about the importance of an agreed protocol in managing these individuals with diabetes during surgery.

### Conclusion

The results from the audit demonstrate that the Trust’s VRIII is effective at improving glycaemic control during pre-, peri- and post-operative periods.

When implemented correctly, it is a useful tool to enable healthcare professionals to deliver safe and effective care. This article highlighted the importance of education and collaborative working among healthcare professionals in the management of people with diabetes undergoing surgery. ■

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