

# JBDS-IP Joint British Diabetes Societies for inpatient care

Management of adults with diabetes  
undergoing surgery and elective  
procedures: Improving standards

Revised March 2016



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With special thanks to Christine Jones (Norwich) for her administrative work and help with these guidelines and with JBDS – IP

## Acknowledgement

Richard Grimsdell for the journey logo design

This is an update to the First Edition, published in 2011.

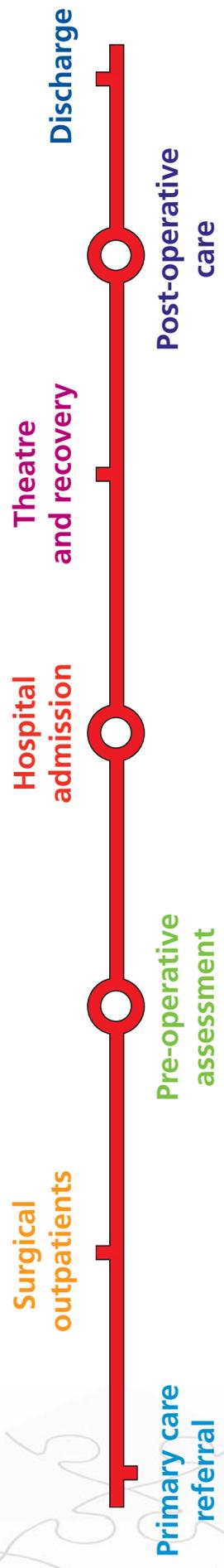
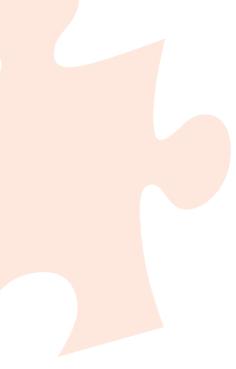
# Foreword

I am delighted to be asked to support this important document. As we are all aware, the number of people with diabetes continues to increase. With this increase in the general population, the numbers of people with diabetes requiring surgery is also on the rise. Since the last edition of this guideline was published there have been more data to show that poor glucose control in the peri-operative period is associated with an increased risk of all of the complications of surgery. Additionally, new data has shown that having diabetes remains a reason why many patients are inappropriately denied day case surgery.

The authors of this updated edition are to be congratulated on their efforts. The initial version they produced was well received and subsequently united all the professionals involved in the management of patients with diabetes undergoing surgical procedures. This edition has several updates; taking into account new published evidence; new drugs; and incorporates feedback from the first edition. It is hoped that this second edition will allow the guidelines to remain relevant and moreover, continue to promote improvements in the outcomes of the surgical patient with diabetes undergoing surgery.

**Professor Jonathan Valabhji**

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## Comprehensive care pathway for peri-operative management of diabetes



These guidelines cover all stages of the patient pathway from primary care referral to surgical outpatients, pre-operative assessment, hospital admission, surgery, post-operative care and discharge. The process should be seamless, with advance planning throughout.

The guidelines are primarily intended for the management of patients with diabetes referred for elective surgery. However, most of the recommendations can be applied to the patient presenting for emergency surgery with the proviso that many such patients are at high risk and are likely to require an intravenous insulin infusion and level 1 care (acute ward with input from critical care team) as a minimum.

# Main recommendations

## Organisation and planning of care

1. All institutions should have a clinical lead for the peri-operative management of patients with diabetes whose responsibility it is to ensure that the institution has up to date guidelines that are implemented. The clinical lead should also ensure that all patients with diabetes are optimally managed during their surgical admission.
2. Careful planning, taking into account the specific needs of the patient with diabetes, is required at all stages of the patient pathway from GP referral to post-operative discharge.
3. The patient should be involved at all stages of planning.
4. Hospitals should have a system in place to identify all patients with diabetes on the patient administration system to highlight the need to prioritise them on the operating list.
5. All letters of referral from primary care to a surgical speciality should identify patients with diabetes.
6. High-risk patients should be identified in surgical outpatients or at pre-operative assessment and plans should be put in place to manage the risk.
7. Early pre-operative assessment should be arranged to determine peri-operative diabetes management strategy and to identify and optimise other co-morbidities.
8. Day of surgery admission should be the 'default' position. Diabetes specific pre-admission should be avoided.
9. Minimise starvation time by prioritising on the list.
10. Surgical and anaesthetic principles of the Enhanced Recovery Partnership Programme should be implemented to promote earlier mobilisation with resumption of normal diet and return to usual diabetes management.
11. Multi-modal analgesia should be combined with appropriate anti-emetics to enable an early return to normal diet and usual diabetes regimen.

12. The patient should resume diabetes self-management as soon as possible where appropriate.
13. A policy which includes plans for diabetes management should be in place for safe discharge.
14. Outcomes should be audited regularly.

## Diabetes specialists

15. Clear guidelines should indicate when the diabetes specialist team should become involved.
16. All hospitals should implement a Diabetes Inpatient Specialist Nurse (DISN) service to support the elective pathway.

## Peri-operative use of intravenous insulin

17. The term 'variable rate intravenous insulin infusion' (VRIII) should replace the ambiguous term 'sliding scale'.
18. Patients with a planned short starvation period (no more than one missed meal in total) should be managed by modification of their usual diabetes medication, avoiding a VRIII wherever possible.
19. Patients expected to miss more than one meal should have a VRIII. However, patients on lifestyle alone or on once daily metformin, should only start a VRIII if their capillary blood glucose levels are greater than 12mmol/L on 2 consecutive occasions.
20. The recommended first choice substrate solution for a VRIII is 5% dextrose in 0.45% sodium chloride and either 0.15% potassium chloride (KCl) or 0.3% KCl.
21. Insulin should be prescribed according to National Patient Safety Agency (NPSA) recommendations for safe use of insulin, with the brand name and units written in full.

## Peri-operative blood glucose monitoring

22. Capillary blood glucose (CBG) levels should be monitored and recorded at least hourly during the procedure and in the immediate postoperative period.
23. Hospitals should have clear guidelines for the management of the blood glucose when it is outside the acceptable range. Trusts should consider prescribing insulin and / or hypoglycaemia treatments at the time of the pre-operative assessment clinic to enable peri-operative glucose control.
24. Training for blood glucose measurement and diabetes management should be introduced for clinical staff caring for patients with diabetes.
25. The WHO surgical safety checklist bundle should be implemented. The target blood glucose in the pre-operative, anaesthetised or sedated patient should be 6-10mmol/L (up to 12mmol/L may be acceptable). The target of 6-10mmol/L is for those who are treated with glucose lowering agents – i.e. insulin, (either subcutaneously, or via an insulin infusion) or sulphonylurea therapy. In the **awake** patient on agents that do not produce hypoglycaemia, provided they have not been given insulin, lower blood glucose values down to 3.5mmol/L are safe and do not require IV glucose or other rescue treatment.

# Introduction



Diabetes is the most common metabolic disorder, affecting at least 6-7% of people in the UK<sup>1</sup>. Over the next decade the exponential rise in obesity is predicted to increase the prevalence of diabetes by more than 50%. This has major implications for health services, with particular impact on inpatient care. The most recent data from the National Diabetes Inpatient Audit recent audit showed that in 2013 the prevalence of diabetes in the UK inpatient population ranged from 10-35%<sup>2</sup>. This figure is certain to rise in the future. Since diabetes-related co-morbidities increase the need for surgical and other operative procedures, it is not surprising that at least 10% of patients undergoing surgery have diabetes and this percentage is also likely to rise.

Diabetes leads to increased morbidity and increased length of stay, whatever the admission specialty, thereby increasing costs of inpatient care. This is a particular problem in surgical patients with diabetes where the excess bed days were recently estimated to be 45% greater than for people with diabetes admitted to medical wards<sup>3</sup>. Data have also shown that patients with diabetes are often inappropriately denied day case surgery<sup>4</sup>, leading to an overall rise in costs to the NHS<sup>5</sup>.

The peri-operative mortality rate for people with diabetes is reported to be up to 50% higher than that of the non-diabetic population<sup>6</sup>. The reasons for these adverse outcomes are multifactorial but include:

- Hypo- and hyperglycaemia
- Multiple co-morbidities including microvascular and macrovascular complications
- Complex polypharmacy, including misuse of insulin

- Inappropriate use of intravenous insulin infusion
- Management errors when converting from the intravenous insulin infusion to usual medication
- Peri-operative infection.

## The high-risk surgical patient and the impact of diabetes

The high-risk surgical population is made up of elderly patients with co-existing medical conditions undergoing complex or major surgery, often as an emergency. The most important co-morbid diseases include ischaemic heart disease, heart failure, respiratory disease, impaired renal function and diabetes mellitus. There is clear evidence that such diseases are strongly associated with poor outcomes after major surgery<sup>7-10</sup>. The primary aim of perioperative management of the surgical patient with diabetes is to decrease morbidity and hopefully reduce the duration of hospital stay.

## Diabetes related patient factors associated with worse outcomes

### Poor peri-operative glycaemia control

Previous work has suggested that glycaemic control has a significant impact on the risk of post-operative infection across a variety of surgical specialties<sup>6</sup>, although a recent systematic review has suggested that pre-operative HbA<sub>1c</sub> has little impact on outcomes<sup>11</sup>. However, the authors of the systematic review acknowledged that the studies to date have been of poor quality with small sample sizes and much heterogeneity.

Post-operative glycaemic control significantly influences the healing of deep sternal wound

infection after open heart surgery<sup>12</sup> and has been shown to have a similar impact on healing in other forms of surgery<sup>6</sup>. The 2013 National Inpatient Diabetes Survey found that 22% of patients on surgical wards experienced a hypoglycaemic event (9.3% having a severe episode – i.e. requiring the help of the third party) and inpatient hypoglycaemia is associated with increased mortality<sup>2</sup>. Diabetic ketoacidosis, though completely avoidable, still occurs on surgical wards and can result in post-operative death<sup>13</sup>.

### Complications of diabetes

Diabetes is associated with a two to four fold increase in cardiovascular disease including hypertension, coronary artery disease and stroke<sup>14</sup>. The majority of people with diabetes booked for surgery are likely to have one or more of these cardiovascular diseases and a significant number will have microvascular disease (nephropathy or neuropathy). Those with impaired cardiac function and/or nephropathy are at greater risk of fluid overload. Post-operative cardiac arrhythmias are more common in people with diabetes, particularly in those with autonomic dysfunction or a prolonged QTc interval<sup>15</sup>. The incidence of post-operative hypotension is increased, related to a combination of autonomic dysfunction, inadequate fluid replacement and inadequate monitoring of hypotensive therapies. This can precipitate acute kidney injury in those with nephropathy and hypotensive falls in the elderly.

Neuropathy affects between 30-50% of people with diabetes and places them at increased risk of heel ulceration, particularly if peripheral vascular disease is also present<sup>16</sup>.

Current evidence suggests that doctors often fail to identify high-risk patients before surgery and do not ensure that appropriate peri-operative interventions are provided<sup>7</sup>. For example, despite mortality rates in excess of 12%, less than one third of high-risk patients are admitted to critical care after surgery in the UK<sup>17,18</sup>. Since most post-operative deaths occur in the high-risk population, better identification and management of these patients might lead to substantial improvements in

outcome. Particular care should be paid to assessment of patients with diabetes to identify those at high risk of peri-operative complications.

### Excess costs

In 2009-10, it was estimated that just over 85,500 people with diabetes were denied day case surgery, with most of these being in the over 65 age group<sup>5</sup>. This same author used data from the NHS Institute to say that the excess cost of an ordinary admission where a day case admission was possible, was estimated at £277. This equates to an annual figure of almost £24m.

### The patient experience

Two recent reports by the Health Care Commission and Diabetes UK on patients' experiences of inpatient care make sober reading<sup>19,20</sup>.

The following quotes reflect patients' experiences of their hospital stay and provide graphic illustration of the problems they may face.

*"I received notification that I was to attend a pre-medical inspection where my diabetes was confirmed...the operation was scheduled for the following week. I was concerned about how my diabetes was going to be handled and we were reassured...that I was to be first on the list for operations that day, I was not to eat after 2 a.m. of the day of the operation and I would not be eating breakfast and obviously not taking my morning insulin as I normally would...When we turned up for the operation...the surgeon informed me that I was probably last on the day's list of operations...when I told him that I was insulin dependent and was told that I would be first on the list, he looked clearly shocked...He suggested that I have my breakfast and take my insulin and promptly disappeared..."*

*"Because I have type 2 diabetes, I was informed that I would need to be admitted the night before so that my diabetes "could be monitored by specialist staff". During my stay I saw no-one from the diabetes care team."*

*"I was hooked up to a machine to regulate my blood glucose... the nurses didn't seem to have a clue about how the machine worked... Both me and my family were left feeling very angry about the experience."*

*"I was put on a 'sliding scale' and after the operation. I asked to return to my usual regime. The request was refused... I was told that as it is a bank holiday weekend, if my levels were still high on Tuesday, they would call somebody in."*

*I discharged myself on the Saturday. Within 24 hours my levels were back to where they were before the operation."*

*"If the NHS wishes to save money, it perhaps should first look at diabetics who do not want to stay in hospital for yet another night, but who are unable to get out because their insulin is impounded, with nobody with sufficient authority to return diabetic control to the patient."*

*"...keep your wits about you as the ignorance of diabetes by a lot of staff is verging on criminal."*

Below are extracts from the Diabetes UK report<sup>19</sup>.

*"The sliding scales were mismanaged, in different ways... Several of the sliding scale arrangements were out of balance in that they led in practice to a steady reduction in blood glucose levels over several hours, leading towards hypoglycaemia. The mismanagement lay in the fact that suitable small adjustments were not made to moderate that rate of fall of blood sugar before hypoglycaemia."*

*"...nursing teams did not take effective steps to co-ordinate insulin administration, in timing and dose, with food intake... this neglect and mistreatment caused many episodes of avoidable hypoglycaemia and hyperglycaemia at levels liable to give rise to ketosis, and make the patient feel sicker in hospital!! That amounts to maltreatment."*

A number of common themes emerge from these anecdotal reports:

- Lack of a care plan
- Communication failure
- Inadequate experience and knowledge amongst clinical staff
- Failure to involve the diabetes specialist team.

# Factors leading to adverse outcomes

## Failure to identify patients with diabetes

If diabetes is not identified before admission, there will be no opportunity for pre-admission planning. This increases the risk of management errors during the admission<sup>21</sup>. The American Diabetes Association (ADA) and the UK NHS Institute for Innovation and Improvement (NHSII) both recommend an identifier in the medical record for all patients with diabetes admitted to hospital<sup>13,22</sup>.

## Lack of institutional guidelines for management of diabetes

Since the launch of the Joint British Diabetes Societies (JBDS) guidelines (all freely available at <http://www.diabetologists-abcd.org.uk/JBDS/JBDS.htm>) many hospitals have either adopted or adapted them. There is data emerging to show that by adopting these guidelines variations in practice are minimised and thus improve the standard of patient care.

However, not all hospitals have comprehensive guidelines for management of glycaemia in inpatients, and many lack a strategy for achieving good glycaemic control<sup>23</sup>. An analysis of 44 U.S. hospitals revealed shortcomings in diabetes management including persistent hyperglycaemia<sup>24</sup>. Poor glycaemic control increases morbidity with high risk of post-operative infection<sup>6</sup>.

## Poor knowledge of diabetes amongst staff delivering care

Understanding of diabetes and its management is poor amongst both medical and nursing staff. With the exception of blood glucose monitoring, training in diabetes management is not mandatory and nursing staff have limited learning opportunities. Undergraduate and postgraduate medical training often has little or no focus on the practical aspects of delivery of diabetes care. Although their own knowledge and experience is limited, ward staff are frequently reluctant to allow the patient to make their own decisions about the management of their diabetes. The problem is compounded by uncertainty about the legal aspects of inpatient self-medication.

## Complex polypharmacy and insulin prescribing errors

Patients with diabetes frequently require complex drug regimens with high potential for error

- Incorrect prescription
- Omitted in error or judiciously stopped and never restarted
- Continued inappropriately e.g. in presence of renal impairment
- Drug-drug interaction

Insulin treatment in hospital can be life-saving. It also has the potential to be life threatening given its narrow therapeutic index. Insulin is included in the list of top high alert medicines worldwide<sup>25</sup>.

# Standards of care for people with diabetes

In 2003 the National Service Framework for Diabetes set standards for the care of people with diabetes during hospital admission<sup>26</sup>. These are summarised in Box 1.

## BOX 1

### National Service Framework for Diabetes: Summary of recommendations for inpatients

- Diabetes must be recognised and managed effectively.
- People with diabetes should be supported to continue to manage their own diabetes (including self-testing and self-administration of medicines) wherever possible. Those requiring insulin should have access to the same formulation of insulin (analogue, human or animal) as before admission.
- People diagnosed with diabetes during an admission should be referred to the diabetes specialist team immediately for initial management of their diabetes.
- Information and education should be provided for management of diabetes, during the admission, recovery period and following discharge. This should take into account any lifestyle and dietary changes necessitated by the procedure.
- Ward staff should ensure that the timing and choice of food and snacks is appropriate. (Recent evidence suggests that meal choices for people with diabetes in hospital are poor, with up to 21% saying that they would never make the same food choices at home<sup>27</sup>).
- Ward staff should ensure that blood glucose levels are controlled when patients are either unconscious or less able to communicate with staff, for example, during the post-operative period.
- Hospital staff should have up-to-date knowledge and skills in diabetes care. There should be close liaison with the diabetes team, including arrangements for post-discharge diabetes-specific follow up.

Work has been undertaken to raise standards of diabetes care for patients undergoing surgical and investigative procedures. The NHSIII "Think Glucose" campaign highlights key areas for improvement in the care of inpatients with diabetes<sup>22</sup>.

- Focus on the patient
- Early identification of people with diabetes
- Comprehensive standardised assessment of patient needs
- Care Pathway: jointly agreed and implemented
- Involvement of Diabetes Inpatient Specialist Team
- Staff education

### Development of Joint British Diabetes Societies (JBDS) guidelines for peri-operative care of people with diabetes

In the face of the increasing anxiety and dissatisfaction from patient and evidence of actual harm<sup>6,28</sup>, there is an urgent need to improve peri-operative diabetes care across the UK. The first edition of guidelines was produced in 2011 as a result of collaboration between anaesthetists, surgeons and diabetes specialists who have based the recommendations on the best available evidence, best practice and patient experience. The document emphasised the importance of planning for all aspects of the patient pathway from initial referral by the GP through the inpatient period to discharge planning, involving the patient in the planning process at all stages. People with diabetes take responsibility for self-management on a day-to-day basis and are very experienced in the management of their own condition. Unfortunately, the NHS is often unable to cope with these individual needs during the hospital stay<sup>19,27</sup>. The guidelines emphasised the importance of allowing the person with diabetes to retain control of diabetes management during their admission unless their medical condition prevents them from doing so. There is also a JBDS

guideline on self-management of diabetes in hospital<sup>29</sup>.

Although the main focus is on elective surgery and procedures much of the guidance applies equally to the management of surgical emergencies.

This second edition has some changes, in particular updating the evidence base for some of these recommendations, but also based on feedback from anaesthetists, diabetes teams and others who have used the document and felt that changes were necessary.

## **BOX 2**

### **Summary of problems facing healthcare providers in dealing with patients with diabetes undergoing surgery**

- The prevalence of diabetes in surgical inpatients is rising
- Patients with diabetes are often identified late in the admission process and the opportunity to improve glycaemic control in the pre-operative period is missed
- Knowledge of diabetes and its management amongst medical and nursing staff remains generally poor
- Patients with diabetes often have complex co-morbidities
- Diabetes is associated with a higher morbidity and mortality and a prolonged length of stay on surgical wards
- Post-operative infections are more common in patients with diabetes
- Patients with diabetes are vulnerable to pressure damage – in particular heel ulcers
- Polypharmacy and insulin misuse puts patients with diabetes at risk
- Not all hospitals have comprehensive guidelines in place for the management of diabetes, including life-threatening conditions such as hypo- and hyperglycaemia
- Patient groups are raising awareness of poor standards of inpatient care and are demanding improvement

# The metabolic response to surgery and the effect of diabetes

## Metabolic effects of starvation

Surgery is frequently accompanied by a period of starvation, which induces a catabolic state<sup>30</sup>. This can be attenuated in patients with diabetes by infusion of insulin and glucose (approximately 180g/day)<sup>31,32</sup>. If the starvation period is short (only one missed meal), the patient can usually be managed without an intravenous insulin infusion. However, care should be taken to avoid hypoglycaemia because this will stimulate secretion of counter-regulatory hormones and exacerbate the catabolic effect of surgery.

## Insulin should never be stopped in people with Type 1 diabetes because this will lead to ketoacidosis

If the starvation period is expected to require omission of more than one meal, a variable rate intravenous insulin infusion (VRIII) with concomitant glucose and electrolyte infusion will be required. Insulin requirements are increased by:

- Obesity
- Prolonged or major surgery
- Infection
- Glucocorticoid treatment

When a VRIII is used, insulin and substrate should be infused continuously. If the infusion is stopped, there will be no insulin present in the circulation after 3-5 minutes leading to immediate catabolism.

## Metabolic effects of major surgery

Major surgery leads to metabolic stress with an increase in catabolic hormone secretion and inhibition of anabolic hormones, particularly

insulin. In patients without diabetes this can lead to transient hyperglycaemia. The initial inhibition of insulin secretion is followed post-operatively by a period of insulin resistance so that major surgery results in a state of functional insulin insufficiency<sup>30</sup>. People with Type 1 diabetes undergoing surgery have no insulin secretory capacity and are unable to respond to the increased demand for insulin. People with Type 2 diabetes have pre-existing insulin resistance with limited insulin reserve, reducing their ability to respond to the increased demand.

## Interaction between hyperglycaemia and infection

Patients with diabetes are more susceptible to infection and poor peri-operative glycaemic control has a significant impact on the risk of post-operative infection across a variety of surgical specialities<sup>6,12</sup>.

## Emergency surgery, metabolic stress and infection

The main focus of these guidelines is elective surgery and procedures but patients with diabetes will also present with surgical emergencies.

The release of high levels of catabolic hormones in response to the crisis is certain to lead to hyperglycaemia, thus complicating the clinical situation. Many emergencies result from infection which will add further to the hyperglycaemia. Prompt action should be taken to control the blood glucose and an intravenous insulin infusion will almost always be required (Appendix 5).

# Guidelines for peri-operative diabetes care

These guidelines propose a pathway of care for patients undergoing elective surgery and procedures but are also relevant to emergency care. For this pathway of care to work effectively, complete and accurate information needs to be communicated by staff at each stage to staff at the next stage. Wherever possible the patient should be included in all communications and the management plan should be devised in agreement with the patient.

The team responsible for the patients' usual, ongoing diabetes care – i.e. primary or secondary care – should aim to optimise glycaemic control (an HbA1c of less than 69mmol/mol, 8.5%) prior to their surgical referral and it is felt that further optimisation is safely achievable. They should be able to postpone any elective procedure to facilitate this optimisation.

The Diabetes Specialist Team, and in particular the Diabetes Inpatient Specialist Nurse, can play a pivotal role through teaching, training and support, to ensure that other staff are able to facilitate the pathway.

## The Role of the Diabetes Inpatient Specialist Team

The Diabetes National Service Framework (NSF) stresses the importance of a good diabetes service for all inpatients with diabetes and the need to assess patient satisfaction with the service they receive.

It concludes that inpatient diabetes services could be improved by a Diabetes Inpatient Specialist Nurse (DISN) service, supported by diabetologists<sup>26</sup>.

A DISN service has been shown to reduce the length of stay for patients with diabetes, whatever the reason for admission<sup>33-36</sup>. A national survey conducted in 2007 of inpatient diabetes services in the United Kingdom has demonstrated that nearly 50% of acute hospitals do not have a DISN<sup>23</sup>.

There is also good evidence to show that the early involvement of the diabetes specialist team leads to shorter length of stay, with a significant increase in the proportion of day cases. In addition, there were increased patient satisfaction rates<sup>37</sup>.

These guidelines recommend that all trusts should implement such a DISN service. This will achieve compliance with the Diabetes NSF and will improve the care of surgical patients with diabetes. Local referral pathways need to be in place.

### BOX 3

#### Role of the diabetes inpatient specialist nurse (DISN)

- Structured and tailored patient education, including dietary advice
- Diabetes management advice to inpatients
- Advice to medical and nursing ward staff on the management of individual patients
- Diabetes education to medical and nursing staff and allied health professionals
- Involvement of other members of the diabetes specialist team where appropriate
- Review of ward protocols to ensure they reflect best practice and are consistent across wards
- Close and effective coordination with other specialist teams involved in caring for the patient
- Involvement in discharge planning

## The Enhanced Recovery Partnership Programme and diabetes

Enhanced recovery of patients undergoing surgery is a relatively new concept in the UK<sup>38,39</sup> and the Enhanced Recovery Partnership Programme has particular relevance for patients with diabetes<sup>40,41</sup>. The programme employs a selected number of evidence-based interventions which, when implemented as a pathway, demonstrate a greater impact on outcomes than when implemented as individual interventions. Enhanced recovery

ensures that the patient plays a vital role as a partner in their own care and the aim of the pathway is to maintain the patients in a state of as little metabolic stress as is possible.

## The principles

The underlying principle is to minimise length of stay after elective surgery through careful preparation, planning and co-ordination of all aspects of the patient pathway.

### 1. Preparation for surgery

Ensure the patient is in the best possible condition for surgery. Ideally this is undertaken by the GP prior to referral, or, at the latest, at pre-operative assessment.

- Optimise the diabetes management, in particular aiming for an HbA<sub>1c</sub> of less than 69mmol/mol (8.5%) prior to surgery, where it is appropriate to do so safely, and identification of other co-morbidities.
- Ensure that the patient is well informed, understands the treatment options and has realistic expectations about the risks and benefits of surgery and the processes involved. Having had the time and support to consider, the patient can then make an informed decision to proceed with surgery. Patients should be made aware of the increased risks of surgery with poorly controlled diabetes.

### 2. Intra-operative care

Use of appropriate anaesthetic, fluids, pain relief and minimally invasive operative techniques to reduce post-operative pain and gut dysfunction, promoting early return to normal eating.

### 3. Post-operative rehabilitation

Rehabilitation services available 7 days a week for 365 days a year, enabling rapid mobilisation and discharge and early return to normal activities.

## BOX 4

### The elements of the Enhanced Recovery Partnership Programme

- Optimise pre-operative health, commencing in primary care
- Anaesthetic pre-operative assessment with medical optimisation, risk stratification and discharge planning
- Informed decision making and managing of patient expectations
- Admission on the day of surgery
- Individualised goal directed fluid therapy
- Use of short acting anaesthetic agents and minimal access incisions when possible
- Minimal use of drains/tubes where no supporting evidence
- Avoidance of post-operative opioids when possible
- Planned early mobilisation
- Early post-operative oral hydration and nutrition
- Procedure-specific daily goals
- Discharge once predetermined criteria met and patient in agreement

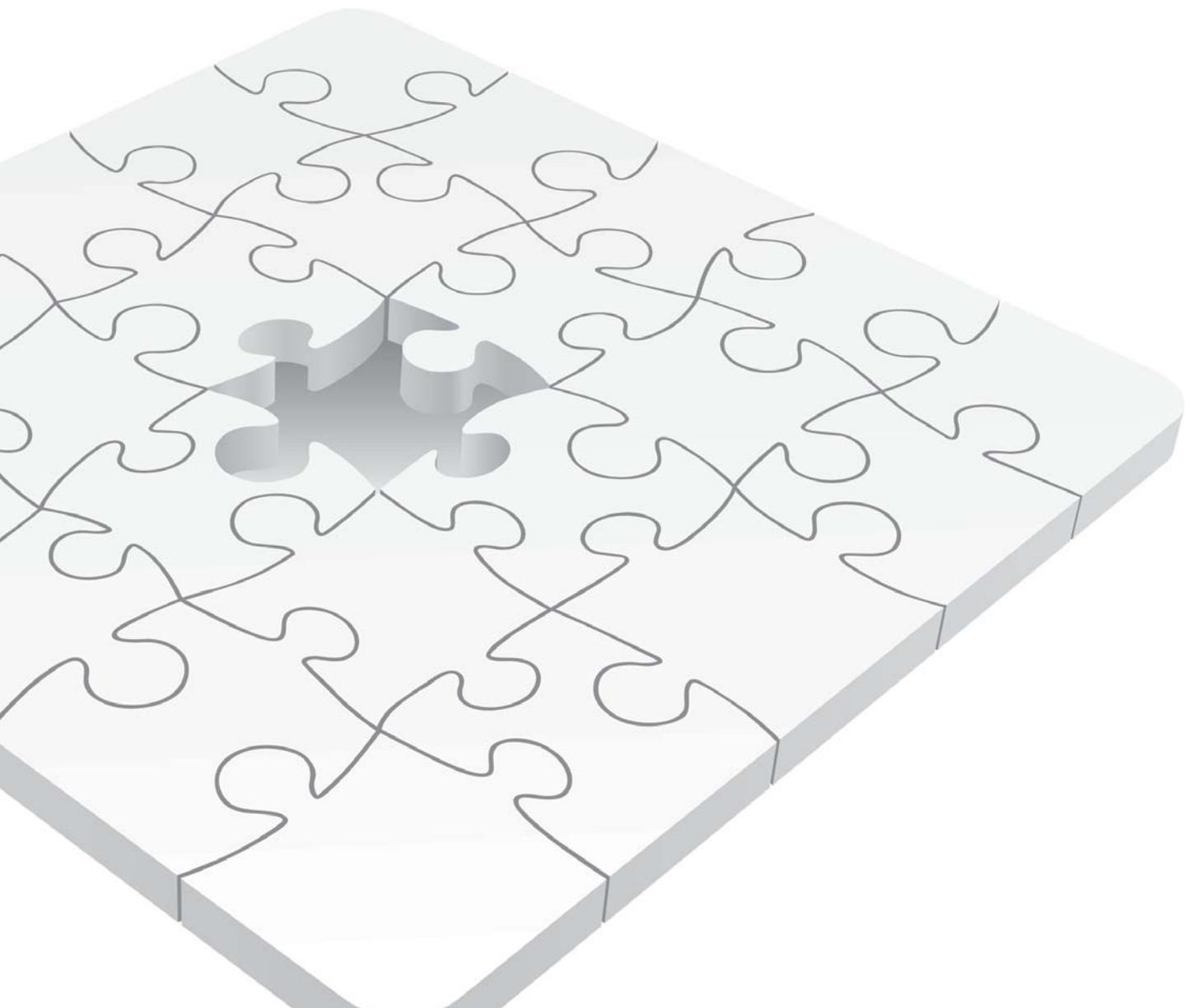
### Use of oral carbohydrate loading

The Enhanced Recovery Partnership Programme recommends the administration of complex carbohydrate drinks prior to surgery in order to reduce insulin resistance and to promote recovery. This may compromise blood glucose control and is not applicable for people with diabetes who are due to have their diabetes controlled perioperatively by manipulation of their medicines. If a VR8 is to be used in someone who has diabetes then an oral carbohydrate load may be beneficial<sup>42</sup>. The study showing these data may not be representative of the general population of people with diabetes because the mean HbA<sub>1c</sub> of the study cohort was  $44 \pm 1.7$ mmol/mol ( $6.2 \pm 0.2\%$ ). In summary, there are some data from small studies to suggest that carbohydrate loading preoperatively can be safe in patients with diabetes, but more work needs to be done<sup>43</sup>.





## Pathway of care for elective surgery



# Primary care



## Aims

- Ensure that the potential effects of diabetes and associated co-morbidities on the outcome of surgery are considered before referral for elective procedures
- Ensure that the relevant medical information is communicated fully at the time of referral
- Ensure that diabetes and co-morbidities are optimally managed before the procedure

## Recommendations

1. Provide the current HbA<sub>1c</sub>, blood pressure and weight measurements with details of relevant complications and medications in the referral letter (Appendix 12).
2. Optimise glycaemic control, aiming for an HbA<sub>1c</sub> of less than 69mmol/mol (8.5%) before referral if possible, and if it is safe to do so.
3. Consider referral to the diabetes specialist team for advice if the HbA<sub>1c</sub> is greater than 69mmol/mol (8.5%) and it is felt that further optimisation is safely achievable (see [Controversial areas page 38](#)).

A high HbA<sub>1c</sub> is an indication for intensive blood glucose control but it may not be realistic to delay referral until the HbA<sub>1c</sub> has been repeated. The referral letter should state if the GP considers that the glycaemic control is as good as they feel it could be, and that the patient is judged to be ready for the elective procedure.

4. Patients with hypoglycaemic unawareness should be referred to the diabetes specialist team irrespective of HbA<sub>1c</sub>.
5. Optimise other diabetes related co-morbidities.
6. Provide written advice to patients undergoing investigative procedures requiring a period of starvation (Appendices 8 and 9).

## BOX 5

### Minimum data required from GP when referring a patient for surgery/procedures (Appendix 12)

- Duration and type of diabetes
- Place of usual diabetes care (primary or secondary)
- Other co-morbidities
- Treatment
  - For diabetes oral agents/ insulin doses and frequency
  - For other co-morbidities
- Complications
  - At risk foot
  - Renal impairment
  - Cardiac disease
- Relevant measures (measured within the previous 3 months)
  - BMI
  - BP
  - HbA<sub>1c</sub>
  - eGFR

# Surgical outpatients



## Aims

- Arrange pre-operative assessment as soon as possible after the decision is taken to proceed with surgery to allow optimisation of care
- Day of surgery admission should be the 'default' position. Diabetes specific pre-admission should be avoided

## Recommendations

1. Systems should be in place to allow early pre-operative assessment to identify people with suboptimal diabetes control.
2. Clear institutional plans based on British Association of Day Surgery Directory of Procedures should be in place to facilitate day of surgery admission and prevent unnecessary overnight pre-operative admission<sup>44</sup>.
3. Hospital patient administration systems should be able to identify all patients with diabetes so they can be prioritised on the operating list.
4. Patients undergoing investigative procedures requiring a period of starvation should be identified and provided with written information about diabetes management (Appendices 8 and 9).
5. The surgeon in the outpatient clinic should ensure that patients with diabetes are not scheduled for an evening list. This avoids prolonged starvation times, the use of a VRIII and an unnecessary overnight stay. (See [Controversial areas page 44](#)).
6. Unless Diabetes Inpatient Specialist Nurses or other members of the Diabetes Inpatient Specialist Team are available for consultation 7 days per week, it may be prudent to avoid operating on patients with diabetes routinely at weekends. However, weekend operating may be acceptable if there is an adequate level of diabetes related specialist support available.

# Pre-operative assessment



## Aims

- Ensure that glycaemic control is optimised prior to surgery, aiming for an HbA<sub>1c</sub> of less than 69mmol/mol, if it safe to do so
  - Establish an individualised diabetes management plan, agreed with the patient, for the pre-admission and peri-operative period
  - Ensure that co-morbidities are recognised and optimised prior to admission
  - Ensure plans are in place to modify other treatments during the pre-admission and peri-operative period e.g. bridging therapy for warfarin, renal replacement therapy
  - Identify high-risk patients requiring critical care management (see page 9)
  - Ensure a management plan is in place to prevent peri-operative dysglycaemia, involving the diabetes specialist team if necessary
- c. Identify other co-morbidities with referral to the appropriate team for optimisation where necessary
  - d. Plan inpatient admission including
    - i. Timing of admission
    - ii. Location
    - iii. Timing of surgery
    - iv. Pre-admission management of medications (Appendices 1, 2, 8 & 9)
    - v. Availability of usual insulin (patient may need to bring if non formulary)
    - vi. Plans for Enhanced Recovery Partnership Programme in the context of diabetes (See Enhanced Recovery page 17)
  - e. Ensure the patient is fully consulted and engaged in the proposed plan of management
  - f. Give the patient written instructions with the changes they need to make to their medication prior to admission explicitly highlighted (Appendices 8 and 9)
  - g. Plan initial pre-operative management of diabetes
  - h. Ensure that Glucogel<sup>®</sup>, glucagon and rapid acting insulin is routinely prescribed to allow prompt treatment of hypo- or hyperglycaemia in the patient who is either unconscious or unable to cooperate. The target blood glucose in the pre-operative, anaesthetised or sedated patient should be 6-10mmol/L (up to 12mmol/L may be acceptable). The target of 6-10mmol/L is for those who are treated with glucose lowering agents – i.e. insulin, (either subcutaneously, or via an insulin infusion) or sulphonylurea therapy. In the **awake** patient on agents that do not produce hypoglycaemia,

## Recommendations

1. All patients with diabetes scheduled to undergo an elective procedure necessitating a period of starvation should attend a pre-operative assessment clinic as soon as possible
2. Pre-operative assessment clinic staff should:
  - a. Assess adequacy of glycaemic control. The risks of proceeding when control is suboptimal should be balanced against the urgency of the procedure
  - b. Consider referral to the diabetes specialist team according to local policy<sup>37</sup>. This should include all patients with hypoglycaemia unawareness and may include those with HbA<sub>1c</sub> greater than 69mmol/mol (8.5%) where it is felt that further optimisation is safely achievable (See Controversial areas page 38).

provided they have not been given insulin, lower blood glucose values down to 3.5mmol/L are safe and do not require IV glucose or other rescue treatment

- i. The patients' usual diabetes medication should also be written up on the drug chart with the appropriate adjustments made (see Appendices 1 and 2)
- j. Ensure that patients with diabetes are not placed on an evening list. This avoids prolonged starvation times, the use of a VRILL and potentially an unnecessary overnight stay. (See [Controversial areas page 44](#))
- k. During venous thromboembolism risk assessment ensure no contraindications to anti-embolism stockings e.g. patients with peripheral vascular disease or neuropathy<sup>45</sup>.
- l. Patients with 'at risk' feet should be identified and steps taken to document this clearly where it will be easily visible to theatre and ward teams
- m. Plan duration of stay and make preliminary discharge arrangements
- n. Ensure that admission ward staff are appraised of plans and able to activate them on the day of admission
- o. Consider the need for home support following discharge, and involve the primary care team in discharge planning.

### Order of lists

Many considerations determine the order of the operating lists. One of the most important goals in

the management of surgical patient with diabetes is to minimise the starvation time to promote early resumption of normal diet and normal medication at the normal time. Thus, it is recommended that the elective surgical patient with diabetes is prioritised on the theatre list, so that they may have lunch at the correct time after a morning procedure, or evening meal at the correct time after an afternoon procedure. For this reason, elective evening operating is not recommended for patients taking blood glucose lowering medication. (See [Controversial areas page 44](#)). However, prioritisation is not needed for patients who have diet-controlled diabetes.

### Responsibility for optimisation of glycaemic control (i.e. an HbA<sub>1c</sub> of less than 69mmol/mol, 8.5% if it is safe to do so)

Individual Trusts need to formulate guidelines for the management of patients who are not under secondary care follow up for their diabetes but are found to have sub-optimally controlled diabetes. Some Trusts may require these patients to be referred back to their primary care team with subsequent re-referral to secondary care. Others may allow the pre-operative assessment team ready access to the secondary care team as part of the pre-assessment process.

Local discussions will need to take place about the risks and benefits of delaying elective surgery to allow for glycaemic optimisation ("stopping the clock") and the risks of post-operative complications in those with poor peri-operative diabetes control.

# Hospital admission



## Aims

- Ensure that an agreed and documented individual patient plan is communicated to all involved in the care pathway including:
  - The patient
  - Relevant specialists (including anaesthetist, surgeon, diabetologist)
  - Staff in all relevant clinical areas
- Minimise the metabolic consequences of starvation and surgical stress
- Maintain optimal blood glucose control throughout the admission
- Prevent hospital acquired foot pathology
- Allow the patient to self-manage if they are able to do so

## Recommendations

1. Provide written guidelines for hospital staff and patients for the modification of commonly used diabetes treatment regimens on the day prior to and day of surgery (Appendices 1, 2, 8 & 9).
2. Identify high-risk patients (poor glycaemic control/complications of diabetes) and make arrangements for post-operative admission to critical care if indicated.
3. Base management on Enhanced Recovery Partnership Programme principles but omit the pre-operative high carbohydrate drink in people with insulin treated diabetes if a VRlll is not required. (See [Controversial areas page 17](#)).
4. Determine the treatment pathway in advance depending on the anticipated duration of starvation. Avoid a VRlll if the starvation period is short (only one missed meal).
5. Prioritise patients with diabetes on the list. This

reduces the starvation time and hence the likelihood of the patient requiring a VRlll.

6. Use 0.45% sodium chloride and 5% glucose with either 0.15% or 0.3% potassium chloride (as appropriate) as the substrate fluid of choice if a VRlll is required. It is recognised that this is not readily available at present but this guidance recommends that this becomes standard practice. (See [Controversial areas page 42](#)).
7. Ensure that Glucogel<sup>®</sup>, glucagon and rapid acting insulin is routinely prescribed to allow prompt treatment of hypo- or hyperglycaemia in the patient who is either unconscious or unable to cooperate. The target blood glucose in the pre-operative, anaesthetised or sedated patient should be 6-10mmol/L (up to 12mmol/L may be acceptable). The target of 6-10mmol/L is for those who are treated with glucose lowering agents – i.e. insulin, (either subcutaneously, or via an insulin infusion) or sulphonylurea therapy. In the **awake** patient on agents that do not produce hypoglycaemia, provided they have not been given insulin, lower blood glucose values down to 3.5mmol/L are safe and do not require IV glucose or other rescue treatment.
8. Capillary blood glucose (CBG) target ranges are controversial. Aim for CBG between 6-10mmol/L but 6-12mmol/L is acceptable. Avoid wide swings in CBG.
9. Monitor CBG regularly when the patient is under sedation. Hypoglycaemia sometimes manifests as drowsiness, which may be wrongly attributed to sedation.
10. For patients requiring a VRlll, the long-acting analogue (Glargine/Lantus<sup>®</sup>, Degludec/Tresiba<sup>®</sup>, Detemir/Levemir<sup>®</sup>) should be continued alongside the VRlll during the peri-operative period.

Evidence shows that this reduces the risk of rebound hyperglycaemia when the VRIII is discontinued<sup>46</sup>. **The dose of long acting insulin that the patient takes when they are well should be reduced by 20% whilst they are in hospital<sup>47</sup>.**

11. Ensure that the insulin is prescribed correctly – i.e. using the brand name, and ensuring the word ‘unit’ is written out (not using the abbreviation ‘u’).
12. Involve the diabetes specialist team if blood glucose targets are not achieved.
13. Identify high-risk feet and provide pressure relief where necessary. Avoid use of anti-embolism stockings where contraindicated.
14. Ensure that preparation for discharge is ongoing.

### Factors influencing the choice of peri-operative diabetes management

- Duration of starvation
- Timing of surgery /procedure (a.m. or p.m.)
- Usual treatment regimen (insulin, tablets, diet)
- Diabetes control prior to admission
- Other co-morbidities
- Likelihood that the patient will be capable of self-managing their diabetes during the immediate post-operative period.

### Anticipated short starvation period (only one missed meal)

Patients with good control (HbA<sub>1c</sub> less than 69mmol/mol, 8.5%) who are undergoing surgery with a short starvation period should be managed according to written guidelines. Examples are given in Appendices 1-4. The key elements required to manage the patient without pre-operative overnight admission are listed in Box 6.

### Anticipated long starvation period (more than one missed meal)

Most patients will require a VRIII. Written guidelines should be in place to ensure safe use<sup>23,48</sup> and should include the following:

- Indications for use of the VRIII and when to commence

- Remember to reduce the dose of long acting background insulin by 20%
- Drugs to be withheld whilst on the VRIII
- Drugs to be continued whilst on the VRIII
- Recommended frequency of bedside CBG monitoring
- Target CBG range
- Guidelines for adjustment of the insulin rate depending on the CBG result (insulin requirements vary between patients and may change)
- Recommended intravenous fluid providing the substrate (Appendix 6)
- How to set up the VRIII and substrate solution (Appendix 5)
- How and where to record glucose levels and rates of insulin infusion
- When and how to take down the VRIII (Appendix 7)
- When and how to recommence normal glucose lowering medication

#### BOX 6

#### Key elements required for managing the patient without overnight pre-operative admission

##### Patient factors

- Planned short starvation period (no more than one meal omitted)
- Good glycaemic control (HbA<sub>1c</sub> less than 69mmol/mol, 8.5%) - discuss with the diabetes team if the HbA<sub>1c</sub> is above this target, and it is felt that further optimisation is safely achievable
- Patient is expected to be fit and able to resume self-management of their diabetes before the anticipated time of discharge
- Explicit verbal and written instructions are provided concerning medication adjustment and (where appropriate) pre-admission and post-discharge blood glucose monitoring
- Patient understands and recognises the symptoms of hypoglycaemia and knows how to treat it. Advise that blood glucose levels below 4mmol/L should be treated as hypo irrespective of symptoms
- Information is provided about how to obtain advice in the event of problems with diabetes control
- Any significant co-morbidities are managed e.g. cardiovascular, renal, autonomic neuropathy.

### **Institutional factors**

- Agreement between the anaesthetist and the clinical team about the suitability of the proposed management plan
- Patient is scheduled early on the procedure list
- Adequate recovery time is available if the patient is on an afternoon list and is expected to go home the same day
- Anaesthetic technique should minimise fasting time and the risk of post-operative nausea and vomiting
- Capillary blood glucose should be monitored regularly to identify hypo or hyperglycaemia promptly
- Provision for a VRIII or a dose of subcutaneous insulin if CBG is above the target range
- Provision to admit the patient to hospital if a VRIII becomes necessary as an unplanned procedure. In such circumstances the patient should not be discharged until they are well enough to return to their normal regimen

# Fluid management for patients requiring a variable rate intravenous insulin infusion

## Aims of fluid management

- Provide glucose as substrate to prevent proteolysis, lipolysis and ketogenesis
- The target blood glucose in the pre-operative, anaesthetised or sedated patient should be 6-10mmol/L (up to 12mmol/L may be acceptable). The target of 6-10mmol/L is for those who are treated with glucose lowering agents – i.e. insulin, (either subcutaneously, or via an insulin infusion) or sulphonylurea therapy. In the **awake** patient on agents that do not produce hypoglycaemia, provided they have not been given insulin, lower blood glucose values down to 3.5mmol/L are safe and do not require IV glucose or other rescue treatment.
- Optimise intravascular volume status.
- Maintain serum electrolytes within the normal ranges.

## Recommendations

There is a limited evidence base for recommendation of optimal fluid and insulin management of the adult diabetic patient undergoing surgery and this is detailed separately (see [Controversial areas page 42](#) and [Appendix 6](#)). Until further data are available, we recommend the following:

- The substrate solution to be used alongside the VRIII should be based on serum electrolytes, measured daily and selected from:
  - 0.45% saline with 5% glucose and 0.15% potassium chloride (KCl)
  - 0.45% saline with 5% glucose and 0.3% KCl
- Very occasionally, the patient may develop hyponatraemia without signs of fluid or salt overload. In these rare circumstances it is acceptable to prescribe one of the following solutions as the substrate solution
  - 0.9% saline with 5% glucose and 0.15% KCl
  - 0.9% saline with 5% glucose and 0.3% KCl.

These additional solutions should be stocked by the hospital pharmacy. The recommended fluids are currently approximately three times as costly as 5% glucose but increased use should lead to a price reduction and establish best practice.

Guidelines for setting up a VRIII are provided in Appendix 5. The British Consensus Guidelines for Intravenous Fluid Therapy for the Adult Surgical Patient (GIFTASUP) provide further excellent detailed guidance<sup>50</sup>.



# Fluid management for patients not requiring a variable rate intravenous insulin infusion

## Aims of fluid management

- Provide intravenous fluid as required according to individual need until the patient has recommenced oral intake
- Maintain serum electrolytes within the normal ranges
- Avoid hyperchloraemic metabolic acidosis

## Recommendations

- Hartmann's solution should be used in preference to 0.9% saline<sup>50</sup>
- Glucose containing solutions should be avoided unless the blood glucose is low

See [Controversial areas page 42](#) for discussion of fluid options for patients not requiring an insulin infusion. Further detailed recommendations can be found in the British Consensus Guidelines on Intravenous Fluid Therapy for Adult Surgical Patients<sup>50</sup>.

# Special circumstances

## Continuous Subcutaneous Insulin Infusion (CSII) Pump

There are very few data on the use of continuous subcutaneous insulin infusions in the management of people with diabetes undergoing surgery.

If the starvation period is short, pump therapy should be continued and patients should remain on their basal rate until they are eating and drinking normally. Generally, patients on a CSII are very well educated and will be able to self-manage their diabetes appropriately if given the opportunity to do so. It is likely that they will be able to adjust their insulin rates to achieve glucose levels of between 6 and 10mmol/L. The anaesthetist should not give bolus insulin doses via the CSII. If hypoglycaemia occurs whilst on the CSII, then it should be treated as per the national hypoglycaemia guideline<sup>51</sup>. Regular CBG testing will be necessary, with electrolyte measurements if the pump is stopped for any length of time (significant hyperkalaemia may occur after discontinuation of an insulin pump<sup>52</sup>). If more than one meal is to be missed the pump should be removed and a VRIII should be used.

Peri-operative hypotension can decrease skin perfusion and reduce insulin absorption therefore normal hydration and blood pressure must be maintained. The stress of surgery and peri-operative complications such as infection are likely to change the insulin requirement and close liaison with the diabetes specialist team is advised. If the blood glucose cannot be maintained in the target range in the intra-operative or immediate post-operative period a VRIII should be initiated unless the patient is well enough to self-manage with bolus corrections. Advice should be sought from the diabetes specialist team.

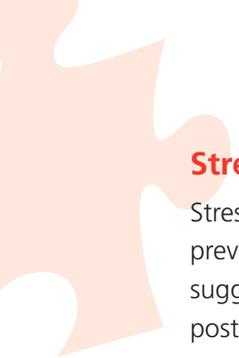
If a CSII has been continued throughout the peri-operative period, mealtime boluses should be recommenced once the patient is eating and drinking normally. The patient needs to be warned that their blood glucose may vary for a few days post-operatively and that corrections in their doses may need to be made. If the insulin pump has been discontinued and replaced with a VRIII, the CSII should be restarted (including the usual mealtime boluses) once the patient is eating and drinking and the VRIII should be discontinued 30 minutes after the first mealtime bolus.

## Emergency surgery

By definition there may be no opportunity for pre-admission planning. Generally, the emergency patient will require a VRIII. However, there are certain circumstances where patients may be suitable for manipulation of their normal diabetes medications, thus avoiding the need for a VRIII, e.g. those requiring an ERPC or peripheral minor orthopaedic procedures. The same principles outlined in Appendices 1 and 2 may be used for these cases – provided there is the opportunity for patient education.

The blood glucose should be closely monitored and if it rises above 10mmol/L a VRIII should be commenced and continued until the patient is eating and drinking. The HbA<sub>1c</sub> should be measured to assess the level of pre-admission blood glucose control as this may influence subsequent diabetes management.

Early involvement of the critical care and diabetes specialist teams is recommended in the management of any high-risk surgical patient (see page 9).



## Stress hyperglycaemia

Stress hyperglycaemia may occur in people not previously known to have diabetes. Recent data suggest that they are at particularly high risk of post-operative morbidity and mortality<sup>6,53</sup>.

Stress hyperglycaemia should be treated just as aggressively as known diabetes during the acute episode but after recovery re-assessment is required because untreated hyperglycaemia is associated with harm. For those individuals in whom blood glucose levels return to normal, a formal oral glucose tolerance test or fasting blood glucose should be carried out 6 weeks later to determine whether they have diabetes (as for hyperglycaemia and acute coronary syndrome or gestations diabetes). If the blood glucose remains elevated once the acute episode has resolved the diagnosis of diabetes can be made without a formal test.

# Theatre and recovery



Teamwork and the presence of a good local guideline are crucial. If the management plan has been communicated effectively from the pre-operative assessment clinic it should only be necessary to review, agree and implement the plan and react appropriately to blood glucose measurements.

## Aims

- Maintain intraoperative blood glucose level between 6-10mmol/L where possible. The target blood glucose in the pre-operative, anaesthetised or sedated patient should be 6-10mmol/L (up to 12mmol/L may be acceptable)
- Maintain normal electrolyte concentrations
- Optimise intra-operative cardiovascular and renal function
- Provide multi-modal analgesia with appropriate anti-emetics to enable an early return to a normal diet and usual diabetes regimen
- Avoid pressure damage to feet during surgery

## Recommendations

1. Implement the WHO surgical safety checklist bundle with maintenance of intraoperative blood glucose levels between 6-10mmol/L where possible. The target blood glucose in the pre-operative, anaesthetised or sedated patient should be 6-10mmol/L (up to 12mmol/L may be acceptable). The target of 6-10mmol/L is for those who are treated with glucose lowering agents – i.e. insulin, (either subcutaneously, or via an insulin infusion) or sulphonylurea therapy. In the **awake** patient on agents that do not produce hypoglycaemia, provided they have not been given insulin, lower blood glucose values down to 3.5mmol/L are safe and do not require IV glucose or other rescue treatment.

2. Implement the agreed care plan.

3. A patient with a VRIII needs at least 2 cannulae – one dedicated for insulin and glucose, and the others for anaesthetic drugs, and additional fluids

4. Check the CBG prior to induction of anaesthesia

5. Monitor the CBG regularly during the procedure (at least hourly – more frequently if readings outside the target range).

6. Avoid unnecessary use of VRIII, **but never stop an insulin infusion in someone with type 1 diabetes unless subcutaneous insulin has been given**

7. Correct a high blood glucose using additional subcutaneous insulin or by introducing a VRIII (Appendix 4).

8. Prescribe fluid regimen as required (Appendix 5).

9. Document the CBG, insulin infusion rate and substrate infusion on the anaesthetic record as recommended by the Royal College of Anaesthetists (RCOA) and the Association of Anaesthetists of Great Britain and Ireland (AAGBI)<sup>54,55</sup>.

10. Consider the use of individualised goal directed therapy<sup>50</sup>.

11. Ensure arrangements are in place to admit high-risk patients to critical care if necessary.

12. Implement surgical and anaesthetic principles of the Enhanced Recovery Partnership Programme to promote early return to normal diet and usual diabetes management.

13. Use anaesthetic techniques to reduce the incidence of post-operative nausea and vomiting (PONV) and promote early return to normal diet and usual diabetes management<sup>56-58</sup>.

## Intra-operative monitoring and documentation

The anaesthetic record should document blood glucose levels, fluids and drugs (including insulin) administered intra-operatively in line with the standards set by the RCoA<sup>54</sup>. The frequency of CBG monitoring should be determined by the clinical circumstances. NICE guidelines recommend that the blood glucose be monitored every 30 minutes during Caesarean section<sup>59</sup>. There are no recommendations for other procedures but hourly blood glucose measurement should suffice if the blood glucose is stable and in the target range.

Note: The 2010 Confidential Enquiry into Maternal and Child Health reported on the standards of anaesthetic record keeping in women with diabetes undergoing Caesarean section<sup>55</sup>. In the majority of cases standards of record keeping set by the RCoA and the AAGBI were not met. A key recommendation of the CEMACH report was therefore that Anaesthetists should adhere to the published standards for anaesthetic documentation<sup>54</sup>.

### BOX 7

#### Intra-operative care: key points

- Follow the plan made at the preoperative assessment
- Avoid using a VRIII for patients requiring short period of starvation (see Appendices 1 and 2 for medication management)
- Monitor the CBG at least hourly before surgery, at induction and hourly during surgery and in recovery
- More frequent measurements may be required if the blood glucose level is changing rapidly
- Consider changing to a VRIII if the blood glucose cannot be kept below 12mmol/L (Appendix 4)
- Use 0.45% sodium chloride with 5% glucose and 0.15% potassium chloride OR 0.45% sodium chloride and 5% glucose with 0.3% potassium chloride as the substrate fluid of choice if a VRIII is required (See Controversial areas and Appendix 6)
- Introduce an intravenous glucose infusion if the patient becomes hypoglycaemic (Appendix 4)
- If a VRIII is used it should be continued until the patient is ready to eat and drink (see Appendix 7 for transfer to usual medication)
- Regional and local anaesthesia techniques have the potential to reduce post-operative pain and nausea, however the incidence of complications (nerve damage and labile blood pressure) associated with their use appears to be greater in patients with diabetes<sup>60</sup>.

# Post-operative care



Any surgical procedure induces significant neuroendocrine stress. This results in increased insulin resistance and consequent hyperglycaemia. Nutrition may be delayed or interrupted by additional investigations or procedures. Glucose control during this period is unpredictable and difficult, requiring skill and experience on the part of the clinicians<sup>61</sup>.

During the pre-operative, operative and immediate post-operative recovery period patients are normally cared for by experienced anaesthetic staff, ensuring good glycaemic control. This is maintained if the patient is transferred to a critical care or HDU setting but the required expertise may not be available on a routine surgical ward. This is a potentially dangerous time for patients with diabetes and the diabetes specialist team should be involved promptly if good glycaemic control cannot be maintained<sup>37</sup>.

Patients undergoing emergency surgery are at particularly high risk in the post-operative period. Catabolic stress and infection predispose to hyperglycaemia and ketogenesis and it is crucial to maintain glycaemic control to optimise the outcome.

## Aims

- Ensure blood glucose levels are appropriately maintained. The acceptable post-operative range in the **awake** patient not on a VRIII is 4-12mmol/L, however if a VRIII is used, then the acceptable range remains 6-12mmol/L.
- Fluid and electrolyte balance should be maintained
- Optimise pain control
- Encourage an early return to normal eating and drinking, facilitating return to their usual diabetes regimen
- Follow the principles of the Enhanced Recovery Partnership Programme (see page 16)
- Avoid iatrogenic injury (drugs/diabetes management/infection/pressure damage)

## Recommendations

1. Staff skilled in diabetes management should supervise surgical wards routinely and regularly.
2. Allow patients to self-manage their diabetes as soon as possible, where appropriate.
3. Provide written guidelines for the use of intravenous fluids and insulin.
4. Prescribe and administer insulin in line with NPSA guidance, in consultation with the patient wherever possible<sup>25</sup>.
5. Ensure blood glucose levels are appropriately maintained. The acceptable post-operative range in the **awake** patient not on a VRIII is 4-12mmol/L, however if a VRIII is used, then the acceptable range remains 6-10mmol/L.
6. Monitor electrolytes and fluid balance daily and prescribe appropriate fluids.
7. Treat post-operative nausea and vomiting to promote normal feeding.
8. Maintain meticulous infection control.
9. Inspect foot and pressure areas regularly<sup>62</sup>.

# Safe use of insulin

Errors in insulin prescribing are very common and insulin has been identified as one of the top five high-risk medications in the in-patient environment<sup>63,64</sup>.

The wide range of preparations and devices available for insulin administration (currently more than 60) increases the potential for error. One third of all in-patient medical errors leading to death within 48 hours of the error involve insulin administration<sup>65</sup>.

Between November 2003 and August 2009 15,227 insulin incidents were reported in the NHS in England and Wales. Nine hundred and seventy two incidents resulted in moderate harm with severe or fatal outcomes in a further 18<sup>66</sup>.

- Ensure that insulin is prescribed using the brand name, written out in full
- Hand written abbreviations such as 'u' and 'iu' were a major cause of dose errors; misinterpretation has led some patients being given 10 times or 100 times the intended dose.
- Hypoglycaemia is common in hospitalised patients treated with insulin<sup>67</sup> and can incur significant costs<sup>68</sup>. Clinical protocols and guidelines are sometimes inadequate. Nursing staff may not be authorised to administer glucose without a prescription and intravenous glucose products are not always readily available in clinical areas.

The introduction of national guidelines for the management of hypoglycaemia has addressed this problem<sup>51</sup>.

- All staff prescribing or administering insulin should receive training in the safe use of insulin. Trusts should specify an appropriate training programme and it is recommended that this be mandatory.

## BOX 8

### Safe use of insulin

Iatrogenic complications from errors of insulin prescribing are common in both acute and elective situations. Insulin is included in the list of top ten high alert medicines worldwide<sup>28,69,70</sup>. The following errors account for 60% of all insulin-related incidents reported in the UK:

- wrong kind of insulin
- wrong dose (either wrong prescription or misread prescription)

- wrong time
- omitted dose

As a result of increased awareness of the harm associated with insulin errors, the Department of Health has added insulin maladministration to the list of 'Never Events' for 2011-12<sup>71</sup>.

## BOX 9

### Insulin never events

Death or severe harm as a result of maladministration of insulin by a health professional. Maladministration in this instance refers to when a health professional:

- uses any abbreviation for the words 'unit' or 'units' when prescribing insulin in writing
- issues an unclear or misinterpreted verbal instruction to a colleague
- fails to use a specific insulin administration device e.g. an insulin syringe or insulin pen to draw up or administer insulin, or
- fails to give insulin when correctly prescribed

In addition, the NPSA has made the following recommendations to promote safer use of insulin<sup>25,66</sup>.

- A training programme should be put in place for all healthcare staff (including medical staff) expected to prescribe, prepare and administer insulin.
- Policies and procedures for the preparation and administration of insulin and insulin infusions in clinical areas are reviewed to ensure compliance with the above.

### Safe use of variable rate intravenous insulin infusions (VRIII)

Prior to Alberti's seminal paper in 1979, the peri-operative management of the surgical patient with diabetes was haphazard, and was associated with an unacceptable level of morbidity and mortality<sup>31</sup>.

Alberti's Glucose, Insulin, Potassium (GIK) regimen was based on sound scientific principles and was shown to be superior to 2 other regimens, and thus by the mid 1980s was the most accepted method of

managing diabetes peri-operatively in the Oxford region<sup>72</sup>. It involved infusing a 500ml bag of 10% glucose at 125ml/hr, and to the bag 10 units of insulin and 1 g potassium chloride was added. However, if the patient's CBG fell out of the range of 5-10mmol/L, the whole bag of fluid was discarded and a different amount of insulin was added. Thus the Alberti regime is both intensive and wasteful, and had the potential for error with the number of additives to the fluid bag. Subsequently by 1993, the Alberti regime had become superseded by the regime in which the substrate and the insulin were separated into 2 separate infusions<sup>73</sup>. The glucose was administered at 125ml/hr and the insulin was administered at a rate appropriate to the serum glucose level. This regime became known as the "sliding scale" \*, and was subsequently almost universally adopted in the UK for the peri-operative management of the surgical patient. This was despite no studies either assessing the efficacy of it to maintain the CBG in the target range of 5-10mmol/L, or whether the regimen was safe.

We now have data from the National Diabetes Inpatient Audits, local audits, UK Collation of patient experiences and the NPSA that the VRIII/ "sliding scale" is associated with:

- Hypoglycaemia
- Hyperglycaemia
- Ketosis due to either delayed establishment or delayed administration of insulin on discontinuation.
- Hyponatraemia
- Prolonged length of stay

These data suggest that the VRIII does not reliably maintain the CBG in the target range and is also associated with harm. The use of a VRIII does not automatically guarantee that the blood glucose will remain in the target range. Assiduous monitoring and appropriate dose adjustment is essential.

Thus the aim of these guidelines is twofold:

1. To promote the use of alternative strategies to the VRIII if possible i.e. modification of the patient's usual medication.
2. To promote the safer use of the VRIII, when it not possible to manage the metabolic effect of starvation or surgery by modification of the patient's usual medication [Appendices 1 and 2].

For patients requiring a VRIII, the long-acting analogue (Glargine/Lantus®, Degludec/Tresiba®, Detemir/Levemir®) should be continued alongside the VRIII during the peri-operative period. Evidence shows that this reduces the risk of rebound hyperglycaemia when the VRIII is discontinued<sup>46</sup>.

**The dose of long acting insulin that the patient takes when they are well should be reduced by 20% whilst they are in hospital<sup>47</sup>, (see Controversial areas page 44).**

If the patient is normally treated with insulin the VRIII should not be discontinued until a short acting bolus has been given and background insulin is in place. Appendix 7 provides guidelines for transfer from a VRIII to subcutaneous insulin or oral therapy.

Treatment requirements may differ from what the patient usually takes when they are well in the immediate post-operative period with risk of both hypo and hyperglycaemia and clinical staff may need to take decisions about diabetes management. Training in blood glucose management is essential for all staff dealing with patients with diabetes<sup>74</sup>.

**The diabetes specialist team should be consulted if there is uncertainty about treatment selection or if the blood glucose targets are not achieved and maintained.**

# Discharge



Discharge planning should be built into the pre-operative assessment process in collaboration with the patient and should look beyond the inpatient episode of care. This is to ensure patient safety after discharge and reduce the risk of readmission<sup>75</sup>; the diabetes specialist team can play a pivotal role in this process. Ward staff should be provided with clearly defined discharge criteria to prevent unnecessary delays when the patient is ready to leave hospital. Multidisciplinary teamwork is required to manage all aspects of the discharge process<sup>76,77</sup>.

The diabetes specialist team should be involved at an early stage if the blood glucose is not well-controlled<sup>37</sup>. Delayed referral may lead to delays in discharge. Concerns can often be discussed with the diabetes specialist team by telephone.

## Aims

- Ensure early discharge determined by pre-agreed clinical and social criteria
- Ensure that factors likely to delay discharge are identified at the pre-operative assessment so that any necessary arrangements are in place when the patient is medically fit for discharge
- Ensure that plans are in place for safe management of diabetes post discharge

## Recommendations

1. In consultation with the patient, decide the clinical criteria that the patient must meet before discharge.
2. Set a date and/or time of discharge as early as possible. This should include weekends.
3. Identify whether the patient has simple or complex discharge planning needs and plan how they will be met.

4. Involve the diabetes specialist team if diabetes related delays in discharge are anticipated.
5. Provide patient education to ensure safe management of diabetes on discharge.
6. Discharge should not be delayed solely because of poor glucose control. The patient or carer's ability to manage the diabetes should be taken into consideration. Discuss with the diabetes specialist team if necessary.
7. Systems should be in place to ensure effective communication with community teams, particularly if changes to the patients' pre-operative diabetes treatment have been made during the hospital stay.
8. Diabetes expertise should be available to support safe discharge and the team that normally looks after the patient's diabetes should be contactable by telephone.

## Patient education

The Diabetes Inpatient Specialist Nurse, with the support of generalist nurses, can provide the patient education that is an essential part of discharge planning. Inpatient education can achieve earlier discharge and improved post-discharge outcomes<sup>78</sup>. Etzweiler<sup>79</sup> described three phases of patient education: "acute or survival education," "in depth education," and "continuing education." "Survival skills" are limited to topics essential in the short term for safe patient discharge. This needs to address the prevention of diabetes emergencies such as diabetic ketoacidosis (DKA), hyperosmolar hyperglycaemic states (HHS) and hypoglycaemia.

The metabolic and endocrine effects of surgery may last for several days and patients and/or carers should be advised about blood glucose management during this period.

Several factors influence glycaemic control in the post-operative period:

- Nutritional intake
- Blood glucose lowering medications
- Activity levels
- Stress hormones
- Infection
- Pain management
- Patient's psychological state.

Patients with sub-optimal pre-operative glycaemic control may be commenced on insulin during their inpatient stay and this may be continued on discharge. Education must be provided to ensure that the patient or carer has sufficient understanding to manage independently. Patients already established on insulin may experience variations in insulin requirements on discharge. Specialist advice on diabetes management should be available in the immediate post-discharge period.

### Self-monitoring of blood glucose

Patients who normally monitor their blood glucose may wish to increase the frequency of monitoring in the immediate post-operative period until glycaemic control and treatment are stable. Those who have been commenced on insulin or sulphonylureas during admission should be taught to self-monitor before discharge. Clear blood glucose targets should be documented as part of the discharge care plan and patients should be able to access specialist advice if they are concerned about their blood glucose level.

If patients are unable to self-monitor, and blood glucose monitoring is required, arrangements for monitoring in the community should be put in place before discharge.

### Sick day rules (Appendix 10)

Written guidance on management of blood glucose during illness should be provided at the pre-operative assessment clinic and should be reinforced on discharge.

### Medicines management on discharge

Care should be taken to ensure that there is no interaction between the patient's usual medication

and any new prescription. (See [pharmacological iatrogenic incidents - page 45](#)). The hospital pharmacist has a crucial role to play in ensuring that the discharge medication is safe and that the patient has the equipment and education required to manage safely at home.

Wherever possible the patient or carer should have resumed control of the diabetes prior to discharge.

#### BOX 10

##### Checklist for discharge planning

- Review the diabetes treatment and glycaemic control. Ensure that the diabetes specialist team is involved if necessary
- In partnership with the patient or their carer agree diabetes therapy on discharge depending on clinical status, social support and ability to self-manage
- Agree a blood glucose monitoring plan with self-monitoring where indicated for those who are able. Arrange community support for those who require blood glucose monitoring but are unable to self-care
- Agree blood glucose targets and provide a record book
- Revise principles of dose adjustment for patients on insulin therapy who are able to self-care
- Discuss any treatment changes with the individual and also ensure these are communicated to their usual provider of diabetes care
- Review advice for identification and treatment of hypoglycaemia
- Give verbal and written advice regarding 'Sick Day Rules'
- Check non-diabetes medications to reduce potential for drug-drug and drug-disease adverse effects
- Ensure all necessary equipment is available or supplied for home use e.g. glucose monitoring kit, diary, Sharpsguard®, insulin pen and insulin needles
- Update the patient-held diabetes record if one is in use
- Ensure that patient has a contact number and follow-up arrangements

# Controversial areas - glycaemic control

## What is the evidence that tight glycaemic control improves the outcome of surgery?

For many years the fear of undetected hypoglycaemia during general anaesthesia was the major influence in determining blood glucose concentrations. High glucose values were tolerated on the basis that "permissive hyperglycaemia" was safer than rigorous blood glucose control with the associated risk of hypoglycaemia. A number of studies have looked at the impact of tight blood glucose control on post-operative outcomes, with varying conclusions.

- Studies in patients undergoing cardiac surgery suggest that intra-operative and post-operative insulin therapy in people with and without diabetes improves morbidity, particularly the incidence of post-operative wound infections<sup>80,81</sup> although the methodology of these studies has been questioned<sup>82</sup>
- A randomised controlled trial with blinded assessment compared intra-operative "tight" glucose control (4.4-5.6mmol/L) with routine control (glucose less than 11.1mmol/L) in 400 cardiac surgical patients and concluded that outcome was not improved in patients with "tight" control regardless of diabetes status<sup>83</sup>
- A retrospective cohort study found that increased post-operative glucose values were an independent risk factor for infection in patients undergoing peripheral vascular surgery<sup>84</sup>
- A randomised pilot study compared conventional blood glucose treatment (< 12mmol/L) with insulin therapy (<6.6mmol/L) in neurosurgery and found a decreased infection rate but no difference in mortality and outcome<sup>85</sup>
- Trials in which "strict" glucose control was implemented, typically less than 6.1mmol/L, reported that hypoglycaemia occurred with an incidence of 9 to 17%<sup>83</sup>

For these reasons, the target blood glucose in the pre-operative anaesthetised or sedated patient has been advocated to be 6-10mmol/L, with up to 12mmol/L being acceptable<sup>86</sup>. In the **awake** post-

operative patient, not on a VRIII a range of 4-12mmol/L may be acceptable. This change has been made because of feedback from anaesthetists who feel that in the anaesthetised or sedated patient who is unable to make others aware if they are hypoglycaemic, aiming for close to 4mmol/L puts them at risk of developing hypoglycaemia. In addition, the NICE-SUGAR study of 6024 ITU patients (who aimed for 4.5-6.0mmol/L in the intensive treatment arm) found that 82.4% of all moderate hypoglycaemic episodes (that occurred in 45% of the entire cohort) occurred in the intensive treatment arm, and 93.3% of all severe hypoglycaemic episodes (that were experienced by 3.7% of the entire cohort) occurred in the intensive treatment arm<sup>87</sup>.

There is considerable *in vitro* work to show the deleterious effects of hyperglycaemia. High glucose concentrations have been shown to impair reactive endothelial nitrous oxide generation, increase expression of leukocyte and endothelial adhesion molecules, decrease complement function, impair neutrophil chemotaxis and phagocytosis, and enhance the synthesis of inflammatory cytokines<sup>88</sup>. The overall effect of these glucose-induced changes is to enhance inflammation and increase vulnerability to infection. The concentration of glucose at which these deleterious effects can be shown is surprisingly uniform, usually greater than 9 or 10mmol/L, which is similar to the values at which clinical infections become more common<sup>6</sup>.

In the virtual absence of clinical studies in general surgery, and considering the basic biological data on the harmful effects of hyperglycaemia, it is reasonable to recommend that in the anaesthetised or sedated patient blood glucose should be maintained in the range 6-10mmol/L<sup>89</sup> if this can be achieved safely. In the awake post-operative patient not on a VRIII, a range from 4-12mmol/L may be acceptable.

This recommendation is approximately concordant with the position statement of the American Association of Clinical Endocrinologists and American Diabetes Association and minimises the

risks of hyperglycaemia and hypoglycaemia<sup>3</sup>. It also reduces the risk of variability in blood glucose, which is more likely to occur if the target is less than 6.1mmol/L and has been associated with worse outcomes<sup>90</sup>.

### **Is an elevated pre-operative HbA<sub>1c</sub> associated with adverse outcomes following a range of surgical procedures?**

There is evidence that good control pre-operatively, as measured by the HbA<sub>1c</sub> level, is associated with improved outcomes after a range of non-cardiac surgical procedures<sup>6,91</sup>. In a recent study of patients undergoing hip and knee arthroplasty, patients with uncontrolled diabetes, assessed by HbA<sub>1c</sub>, had a significantly increased risk of surgical and systemic complications, higher mortality, and increased length of stay<sup>92</sup>. Elevated pre-operative HbA<sub>1c</sub> has been related to adverse outcomes following spinal surgery<sup>93</sup>, vascular surgery,<sup>94</sup> colorectal surgery<sup>95</sup>, and cardiac surgery<sup>96</sup>. However, this has been recently questioned<sup>11</sup>.

### **What is the upper limit of HbA<sub>1c</sub> acceptable for patients undergoing elective surgery?**

There is insufficient trial data to recommend an upper limit of HbA<sub>1c</sub> prior to elective surgery and the risks associated with poor glycaemic control should be balanced against the necessity for surgery. A recent retrospective analysis of post-operative outcomes found that a pre-operative HbA<sub>1c</sub> of 64mmol/mol or more (8%) was associated with poor outcomes<sup>97</sup>. For some patients, especially the frail elderly or those with multiple co-morbidities, an HbA<sub>1c</sub> of 64mmol/mol (8%) may be too low, thus we advocate that an upper limit between 64-75mmol/mol (8 and 9%) as being acceptable, depending on individual circumstances. For many patients a lower target HbA<sub>1c</sub> is achievable, but for those at high risk of hypoglycaemia a higher target may be appropriate. The healthcare team who normally care for the patient with diabetes, whether in primary or secondary care, should advise on the individual target at the time of referral and this will help to avoid unnecessary postponement of surgery.

An elevated pre-operative HbA<sub>1c</sub> is associated with poorer outcomes whether diabetes has been diagnosed or not<sup>94,98</sup>. There may be a role for routine measurement of HbA<sub>1c</sub> at pre-operative

assessment in undiagnosed patients with risk factors for diabetes.

### **Can input from the diabetes specialist team improve outcomes?**

The Diabetes NSF concluded that the inpatient management of diabetes could be improved by a service model based on a diabetes in-patient specialist nurse (DISN) contributing to the care of all in-patients with diabetes<sup>99</sup>.

The role of the DISN should be to oversee the management of people with diabetes in hospital and to monitor their care through:

#### **General measures:**

- Diabetes education for medical and nursing staff and allied health professionals
- Review of ward protocols to ensure they are consistent across wards and reflect best practice

#### **Individual patient care:**

- Structured and tailored patient education, including dietary advice
- Diabetes management advice
- Advice to medical and nursing ward staff on the management of individual patients
- Involvement of other members of the diabetes specialist team (podiatrist, dietitian) where appropriate
- Close and effective coordination with other specialist teams involved in caring for the patient
- Involvement in discharge planning<sup>100</sup>

There is evidence that this model reduces excess bed occupancy<sup>34-36</sup>, but a UK survey conducted in 2007 of in-patient diabetes services found that nearly 50% of acute hospitals do not have a Diabetes Inpatient Specialist Nurse<sup>23</sup>.

### **Does optimisation of co-morbidities improve outcomes?**

Cardiac and renal dysfunction are common long-term complications of diabetes. Previous myocardial infarction, atrial fibrillation and a history of congestive cardiac failure all increase the risk of post-operative complications after non-cardiac surgery<sup>101</sup>. It is likely that the incidence of peri-operative morbidity and mortality among patients with diabetes could be reduced with better pre-operative assessment and optimisation of blood pressure, cardiovascular and renal reserve.

# Controversial areas - fluid and insulin

## Should a variable rate intravenous insulin infusion (VRIII) be recommended?

### Background

Since 1979, the gold standard for controlling the metabolic consequences of diabetes during surgery and starvation has been the simultaneous intravenous administration of glucose, insulin and potassium<sup>31</sup>. The recommended carbohydrate load of 180g glucose per day was designed to minimise catabolism associated with starvation and surgical stress. Alberti and Thomas described the use of other intravenous fluids in conjunction with the glucose-insulin-potassium regimen, but lactate-containing solutions (such as Hartmann's solution) were not recommended because they were thought to exacerbate the hyperglycaemia. The 'Alberti regime' with all 3 components administered from the same bag of intravenous fluid lacks flexibility and has consequently evolved into a regime in which the intravenous insulin is independently administered via a syringe driver while the glucose and potassium are administered via a volumetric pump<sup>73</sup>.

This regime, previously called a 'sliding scale', remains the most widely used and reliable method of controlling the metabolic consequences of starvation and surgery in the patient with diabetes<sup>73,102,103</sup>. The term 'variable rate intravenous insulin infusion' (VRIII) is now preferred as the term 'sliding scale' is ambiguous and may also be applied to variable intermittent boluses of subcutaneous insulin<sup>104</sup>.

### Advantages of VRIII

- Flexibility for independent adjustment of fluid and insulin
- Accurate delivery of insulin via syringe driver
- Allows tight blood glucose control in the intra-operative starvation period

### Disadvantages of VRIII

- Risk of adverse events leading to serious incidents (see BOX 11)
- Delays and difficulties in transferring back to the patient's normal regimen from an insulin infusion may prolong length of stay<sup>19,20</sup>.

Many surgical patients are now treated as day case or short stay and if the starvation period is short it may be possible to manage the diabetes without an insulin infusion<sup>105-108</sup>. To date the only published data available demonstrate that this approach is safe<sup>4</sup>.

### BOX 11

#### Adverse events associated with insulin/glucose infusions

- Hyponatraemia
- Hypoglycaemia
- Hyperglycaemia
- Delays in return to normal diabetes medication
- Prolonged hospital stay
- Ketoacidosis – potentially fatal which results from insulin omission in fasting patients, usually with type 1 diabetes
- Subcutaneous insulin administered by the patient just prior to or at the same time as the variable rate insulin protocol is commenced, leading to hypoglycaemia
- Up to tenfold insulin overdoses resulting from miscalculation or mispreparation of insulin containing infusions
- Use of the wrong insulin protocol; hospitals may have up to five variable rate insulin infusion protocols depending on the clinical situation
- Failure to monitor blood glucose regularly or to adjust the rate of insulin infusion, leading to hyper- or hypoglycaemic incidents
- Administration of either insulin and/or glucose containing solutions without using an electronic infusion control device
- Incorrect setting of infusion pumps and syringe drivers leading to over or under infusion of insulin and/or glucose
- Severe hypoglycaemia – sometimes fatal if glucose infusions or enteral feeds are discontinued but the insulin infusion is continued

# Controversial areas - Manipulation of diabetes drugs to facilitate day of surgery admission and potential avoidance of VRIII

With modern surgical and anaesthetic techniques many centres have now shown that it is safe to modify the patient's normal diabetes medication to facilitate day of surgery admission, day surgery, and avoidance of the VRIII if the starvation time is minimal. The avoidance of the VRIII in patients with good glycaemic control, who are expected to have short starvation period, and have received advice on pre-operative manipulation of their diabetes medication is now the cornerstone of the modern management of the surgical patient with diabetes. For those patients who do require a VRIII, pre-operative manipulation of the patient's diabetes medicines permits day of surgery admission. These are summarised in Appendices 1 and 2.

## Principles for the safe manipulation of diabetes medication

At present there is only one randomised study comparing the effect of manipulating the dose of diabetes medication preoperatively<sup>47</sup>. The perioperative manipulation of diabetes drugs is therefore based on experience, physiology and pharmacological principles. These principles include the following:

- Patients with type 1 diabetes will **always** require background insulin to prevent ketosis.
- Diabetes medication can be broadly subdivided into two categories.
  - Drugs that lower blood glucose levels. These include insulin and the sulphonylureas. These drugs are associated with hypoglycaemia in the fasted state, and will always require perioperative dose manipulation.

- Drugs that prevent blood glucose from rising e.g. metformin, GLP-1 analogues, DPP-IV inhibitors, SGLT2 inhibitors. These drugs will never/rarely cause hypoglycaemia in the fasted state, and will only require dose manipulation if there are other concerns.

- In basal – bolus insulin regimens and the continuous subcutaneous insulin infusion (CSII), the basal component provides the background insulin, whilst the bolus component provides the insulin to deal with the glucose load from meal times. Perioperative manipulation will always involve avoidance of the bolus dose associated with meals. Minor reduction of the basal dose is prudent to avoid hypoglycaemia that may be associated with lack of snacking/ lack of early morning breakfast.
- In patients on premixed insulin, halving the insulin dose with the omitted meal has been widely used.

Appendices 1 and 2 have been updated since the first edition of this guideline to better reflect the understanding of the physiology and pharmacology of newer agents. There are almost no data on the use of these drugs in the peri-operative period, and as such, these recommendations are pragmatic. Units are encouraged to audit their own data and publish them.

# Controversial areas - fluid management in patients requiring a VRIII

## Background

Fluid and electrolyte mismanagement is a recognised cause of morbidity and mortality in patients undergoing abdominal surgery<sup>73,102,109-115</sup>. A recent prospective study of 106 patients requiring laparotomy found that 54% suffered at least one iatrogenic complication as a result of post-operative fluid and electrolyte mismanagement<sup>113</sup>. Doctors in training are responsible for intravenous fluid prescriptions but may not be aware of daily fluid and electrolyte requirements or the composition of commonly prescribed intravenous fluids<sup>110,111</sup>. Accurate fluid and electrolyte management is essential for patients with diabetes for whom the focus of fluid administration has previously tended to be provision of a substrate for insulin and prevention of ketogenesis, rather than maintenance of fluid and electrolyte balance.

## Risk of hyponatraemia

Glucose/ insulin infusions can achieve good glycaemic control but may lead to hyponatraemia. This is clinically insignificant in many patients but hyponatraemia can lead to cerebral oedema with lethargy, headache, seizures, coma and even death<sup>116</sup>. The National Patient Safety Agency (NPSA) recommends that hypotonic fluids should be avoided in paediatric patients<sup>117</sup> and this advice should probably be extended to adults.

Many studies have shown that hypotonic intravenous solutions predispose to hyponatraemia<sup>116,118-122</sup>.

- In an audit of diabetic surgical patients there was a 25% incidence of hyponatraemia when a 5% glucose infusion and VRIII was used<sup>123</sup>.
- In sick hospital patients, the use of hypotonic fluids is a major risk factor for the development of hyponatraemia<sup>119</sup>.
- A review of women who developed severe post-operative hyponatraemic encephalopathy

concluded that the use of hypotonic fluids was the major contributing factor<sup>120</sup>.

Diabetic surgical patients are not only at risk of the inherent complications associated with standard fluid and electrolyte management, but are at higher risk of hyponatraemia through the use of hypotonic glucose solutions. A revised approach to peri-operative diabetic fluid management is needed to ensure glycaemic control and prevent excess catabolism.

## Aims of fluid therapy for the patient with diabetes

Major surgery or prolonged starvation (more than 1 missed meal) places the diabetic surgical patient at increased risk of catabolism. In this situation the aims of fluid therapy are:

- Prevention of gluconeogenesis, lipolysis, ketogenesis and proteolysis
- Maintenance of a blood glucose level between 6-10mmol/L (4-12mmol/L is acceptable). The target of 6-10mmol/L is for those who are treated with glucose lowering agents – i.e. insulin, (either subcutaneously, or via an insulin infusion) or sulphonylurea therapy. In the **awake** patient on agents that do not produce hypoglycaemia, provided they have not been given insulin, lower blood glucose values down to 3.5mmol/L are safe and do not require IV glucose or other rescue treatment.
- Maintenance of euvolaemia<sup>50</sup>
- Maintenance of serum electrolytes within the normal range.

The daily requirement of the healthy adult is 50-100mmol of sodium, 40-80mmol of potassium, and 1.5-2.5 litres of water<sup>124</sup>. In disease states these requirements may change and careful daily monitoring is needed, using clinical examination, fluid balance charts, daily measurement of serum electrolytes and regular weighing when possible<sup>50</sup>.

Patients with diabetes require 180g glucose per day, and additional potassium is required to prevent hypokalaemia when glucose and insulin are co-administered<sup>31</sup>. Supplements of magnesium, calcium and phosphate may also be necessary<sup>31</sup>.

### Choice of peri-operative fluid for patients requiring VRIII

None of the UK fluid protocols currently available for the management of the peri-operative adult diabetic patient can combine maintenance of glycaemic control with normal electrolyte balance. This failure contributes to the excess morbidity and increased length of stay of diabetic surgical patients. The advantages and disadvantages of the main options for peri-operative fluid are summarised in Appendix 6.

Since there are no randomised trials demonstrating the superiority of any specific fluid regimen, recommendations are based on the following criteria:

- Least likely to cause harm as a result of electrolyte and fluid imbalance
- Provision of adequate substrate to prevent gluconeogenesis, lipolysis and ketogenesis
- Ease of use (reduced risk of error)
- Compliance with NPSA alerts 1 and 22<sup>117,125</sup>
- Minimum cannulae and pumps required

Following the National Patient Safety Agency (NPSA) alert number 22<sup>117</sup>, paediatric units now use 0.45% saline with 5% glucose with additional potassium chloride as their 'default' fluid<sup>126,127</sup>. In the diabetic paediatric population undergoing surgery this fluid is run alongside a continuous variable intravenous insulin infusion.

Whilst isotonic in vitro, 0.45% saline/5% glucose is hypotonic in relation to plasma, and may predispose to hyponatraemia, some paediatric units prefer 0.9% saline/5% glucose/0.15% potassium chloride as their default fluid. Unfortunately, overload with 0.9% saline in adults is associated with morbidity<sup>112</sup>. Thus, 0.9% saline/5% dextrose cannot be recommended as first line intravenous fluid for adult patients with diabetes, although it may be useful when the serum sodium is low.

Until there are clinical studies to verify the safest solution for the patient with diabetes on a variable rate insulin infusion we advocate the use of 0.45% saline with 5% glucose and 0.15% KCl as the first choice solution.

There is a cost implication to this recommendation as this solution is approximately three times more expensive than 5% glucose. However, increased use is likely to reduce the price and this guideline gives priority to promotion of best practice.

#### BOX 12

##### Advantages of 0.45% saline with 5% glucose solution\*

- NPSA compliance
- Low incidence of electrolyte disturbances
- Constant supply of substrate (glucose) minimises starvation-induced ketogenesis
- Co-administration of a second type of fluid rarely required; reduced risk of fluid overload, errors in fluid balance calculation, multiple cannulae and pumps
- Suitable for intra-operative, pre and post-operative use

\*It is anticipated that this solution, in combination with potassium, will be commercially available in the near future

### Fluid management for patients not requiring a VRIII

A recent consensus paper has advocated that balanced salt solutions e.g. Ringer's lactate/acetate or Hartmann's solution should replace 0.9% sodium chloride to reduce the risk of inducing hyperchloraemic acidosis in routine surgical practice<sup>50</sup>. It has been suggested that administration of Hartmann's solution to patients with type 2 diabetes, may lead to hyperglycaemia<sup>128</sup>. However, 1 litre of Hartmann's solution would yield a maximum of 14.5mmol of glucose and even rapid infusion of a litre of Hartmann's solution would increase the plasma glucose by no more than 1mmol/L<sup>126</sup>. Thus Hartmann's solution is not contraindicated in the diabetic population.

# Controversial areas - long acting insulin analogues and evening lists

## Perioperative use of long acting insulin analogues

Many units advocate the continuation of long acting insulin analogues (Glargine/Lantus®, Degludec/Tresiba®, Detemir/Levemir®) alongside the VRIII. This has the advantage that no time is lost in re-establishing basal insulin once the VRIII is discontinued. This is particularly important in type 1 diabetes, where continuing the basal insulin can prevent rebound hyperglycaemia and even ketoacidosis when the VRIII is withdrawn<sup>46</sup>.

For patients not requiring a VRIII, the long-acting analogue (Glargine/Lantus®, Degludec/Tresiba®, Detemir/Levemir®) should be continued during the peri-operative period although **the dose the patient takes when they are well should be reduced by 20% whilst they are in hospital**. Reduction of the normal basal insulin risks undesirable hyperglycaemia but there is concern that some patients with type 2 diabetes may be taking very large doses of basal insulin which reflect regular food intake (grazing) rather than a true basal insulin requirement<sup>47</sup>. These patients may be at risk of severe hypoglycaemia if the full basal dose is continued during a period of starvation.

As a rough guide, if the patient reports that the blood glucose falls by more than 2mmol/L overnight it would be prudent to reduce the basal (long acting) insulin further. If the blood glucose remains stable overnight the normal basal insulin dose should be maintained.

## Elective evening and weekend operating lists

Many Trusts are introducing evening lists as a matter of routine. The associated risks for the patient with diabetes are:

- Excessively long starvation period (may extend from 1200 to 0800 hours the following day) with potential for poor glycaemic control
- No published data to demonstrate the safety of the practice
- No published data to indicate how to modify the normal diabetes medication to allow safe evening surgery
- Reduced access to diabetes specialist team advice
- Potential safety, staffing and clinical governance issues associated with the establishment and monitoring of an elective and potentially unnecessary VRIII at night

If a Trust insists that patients with medication-controlled diabetes are placed on elective evening lists, the Trust should develop its own treatment pathway and ensure that robust audit mechanisms are in place to demonstrate that their practice is safe.

Until Diabetes Inpatient Specialist Nurses or other members of the Diabetes Inpatient Specialist Team are available for consultation 7 days per week, we advise not operating on elective patients who will require a VRIII over the weekend or on an evening elective list.

# Prevention of pharmacological iatrogenic incidents

This section deals with medications other than insulin. (See [Safe use of insulin page 34](#)).

## Aims

- To reduce adverse drug interactions
- To reduce adverse drug-disease Interactions

## Recommendations

Regular review of prescriptions charts should be undertaken by medical and/or pharmacy staff to ensure there are no contra-indications to or interactions between prescribed medication.

## Rationale for recommendations

The majority of surgical patients with diabetes are middle aged or elderly and many have co-morbidities as a result of their diabetes or simply because of their age. Common problems include:

- Coronary disease, which may be silent, leading to increased risk of cardiovascular events and fluid overload. Patients with diabetes frequently take antihypertensive medication, drugs that modulate the renin-angiotensin-aldosterone system, beta blockers, statins and antiplatelet drugs. The effect of continuing these regular medications in the perioperative period needs to be considered.
- Renal impairment, which may worsen as a result of dehydration, hypotension or the use of contrast media. Dosing of renal excreted drugs may need review based on measurement of renal function.

## Drugs associated with iatrogenic incidents

### Metformin

Metformin is an effective drug used to treat type 2 diabetes, it primarily works by preventing gluconeogenesis, and therefore the risk of hypoglycaemia in the starved state is low. However, it is renally excreted and renal impairment may lead

to accumulation which is associated with an increased risk of lactic acidosis<sup>129</sup>.

A number of guidelines available for the use of metformin (see BOX 13) recommend withdrawing treatment peri-operatively. However, evidence for this approach is lacking and there is some evidence that perioperative continuation of metformin is safe<sup>130,131</sup>.

This guideline recommends that for patients undergoing procedures with a short starvation period (1 missed meal only) and have a low risk of acute kidney injury, metformin can be continued during the peri-operative period. In patients either at high risk of AKI or having a prolonged starvation period, the metformin should be stopped when the preoperative fast begins and restarted post-operatively once the patient is eating and drinking again and normal renal function has been assured.

Risk Factors for Peri-operative AKI (NICE CG169)<sup>132</sup>

- chronic kidney disease (adults with an estimated glomerular filtration rate [eGFR] less than 60ml/min/1.73m<sup>2</sup> are at particular risk)
- heart failure
- liver disease
- history of acute kidney injury
- neurological or cognitive impairment or disability, which may mean limited access to fluids because of reliance on a carer
- hypovolaemia
- hypotension
- use of drugs with nephrotoxic potential (such as non-steroidal anti-inflammatory drugs [NSAIDs], aminoglycosides, angiotensin-converting enzyme [ACE] inhibitors, angiotensin II receptor antagonists [ARBs] and diuretics) within the past week, especially if hypovolaemic
- use of iodinated contrast agents within the past week
- symptoms or history of urological obstruction, or conditions that may lead to obstruction

- haematological malignancy
- age 65 years or over

Anaesthetists and surgeons must however, be aware of the dangers of co-prescribing potentially nephrotoxic agents and patients discharged after surgical intervention need to know when to seek medical help should they become unwell (see Discharge page 36).

### Radio-opaque contrast and metformin

Contrast induced nephropathy is the development of renal impairment as a complication of radiological investigation using contrast media. Risk factors include advanced age, cardiac impairment, and pre-existing renal impairment, particularly in patients with diabetes.

Guidance produced by the Royal College of Radiologists in 2015 states that “there is no need to stop metformin after contrast in patients with serum creatinine within the normal reference range and/or 60ml/min/1.73m<sup>2</sup>. If the serum creatinine is above the reference range or the eGFR is below 60, any decision to stop the metformin for 48 hours following contrast medium administration should be made in consultation with the referring clinician”<sup>133</sup>.

### Non-steroidal anti-inflammatory drugs (NSAIDs)

Regular NSAIDs provide excellent analgesia for many post-operative patients, and can have useful opioid-sparing effect, particularly in those undergoing day case and other minor surgery. However, there are several additional considerations in patients with diabetes:

- **Gastro-intestinal:**

- Patients already taking regular aspirin to prevent coronary thrombosis, have an increased risk of gastrointestinal haemorrhage

- NSAID-induced gastritis and diarrhoea may predispose to dehydration

- **Renal:**

- NSAIDs impair the redistribution of renal blood flow in the presence of hypovolaemia and may worsen renal function. This is especially important if prescribed concurrently with drugs that modulate the Renin-Angiotensin-Aldosterone system

- **Oedema:**

- NSAIDs may increase the risk of oedema, especially if given concurrently with glitazones

### Dexamethasone

All glucocorticoids have the potential to increase blood glucose levels, but the size of the effect depends on the dose, route of administration and patient characteristics. The use of dexamethasone for the treatment of post-operative nausea and vomiting is controversial in people with diabetes because its advantages of allowing earlier resumption of normal diet may be outweighed by the complication of prolonged hyperglycaemia<sup>44,56</sup>. The diabetes specialist team should be consulted for management of steroid-induced hyperglycaemia. Specific guidance on the management of steroid induced hyperglycaemia has been produced by JBDS and is available at <http://www.diabetologists-abcd.org.uk/JBDS/JBDS.htm>

### BOX 13

#### Guidelines for the use of metformin in the peri-operative period

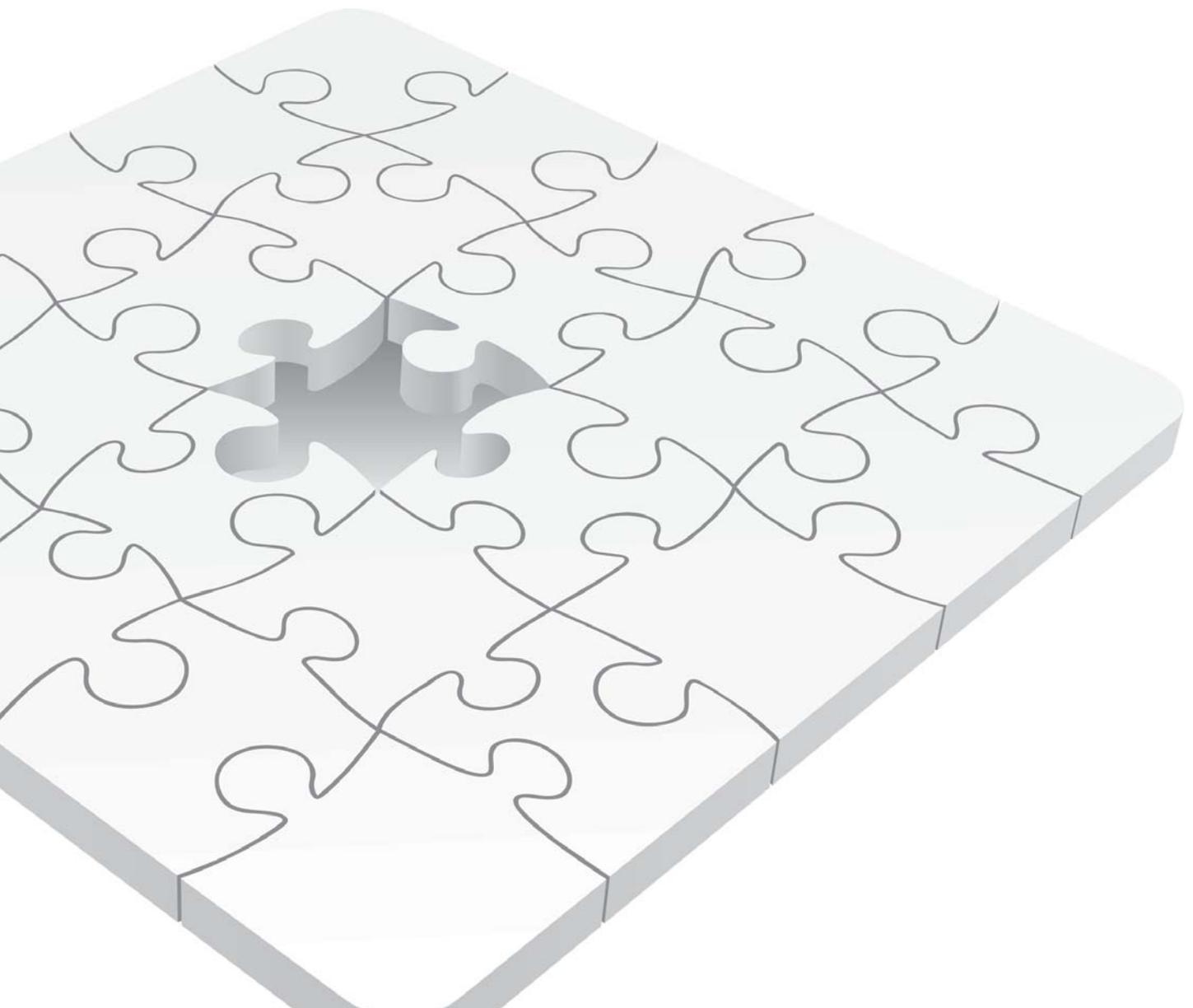
- **NICE CG66 Type 2 diabetes, May 2008<sup>134</sup>**
  - Review the dose of metformin if the serum creatinine exceeds  $130\mu\text{mol/l}$  or the eGFR is below  $45\text{ml/min}/1.73\text{m}^2$
  - Stop the metformin if the serum creatinine exceeds  $150\mu\text{mol/l}$  or the eGFR is below  $30\text{ml/min}/1.73\text{m}^2$
  - Prescribe metformin with caution for those at risk of a sudden deterioration in kidney function and those at risk of eGFR falling below  $45\text{ml/min}/1.73\text{m}^2$
- **BNF 68 March 2015<sup>135</sup>**

Contains NICE guidance as above and also adds the use of general anaesthesia as a contra indication to metformin, recommending 'suspend metformin on the morning of surgery and restart when renal function returns to baseline'
- Royal College of Radiologists states that "there is no need to stop metformin after contrast in patients with serum creatinine within the normal reference range and/or eGFR  $>60\text{ml/min}/1.73\text{m}^2$ "<sup>133</sup>
- The Summary of Product Characteristics for generic metformin 500mg and 850mg film coated tablets<sup>129</sup> states: "Metformin hydrochloride must be discontinued 48 hours before elective surgery under general, spinal or peridural anaesthesia. Therapy may be restarted no earlier than 48 hours following surgery or resumption of oral nutrition and only if normal renal function has been established." In addition, it goes on to say: "As the intravascular administration of iodinated contrast materials in radiologic studies can lead to renal failure, metformin hydrochloride must be discontinued prior to, or at the time of the test and not be reinstated until 48 hours afterwards, and only after renal function has been re-evaluated and found to be normal"





## Audit standards



### Institutional Standards:

Indicator	Standard
<b>Access:</b>	
Has the Trust either adopted these National Guidelines <i>or</i> has their own alternative, evidence based and audited internal guidelines for the perioperative care of patients with diabetes?	Yes
Does the Trust collect data about the outcomes for patients with diabetes undergoing surgery or procedures?	Yes
Does the Trust have the services of a dedicated Diabetes Inpatient Specialist Nurse (DISN) at staffing levels most recently recommended by Diabetes UK and TREND-UK (1.0 WTE per 300 beds)?	Yes
<b>Institutional Accountability and Integrity:</b>	
Does the Trust have a 'clinical lead' for peri-operative care for people with diabetes with responsibility for implementation of peri-operative guidelines?	Yes
Does the Trust take part in the National Inpatient Diabetes Audit (NaDIA)?	Yes

### NPSA Standards<sup>25,66</sup>:

Indicator	Standard
All regular and single insulin (bolus) doses are measured and administered using an insulin syringe or commercial insulin pen device. Intravenous syringes must never be used for insulin administration	100%
The term 'units' is used in all contexts. Abbreviations, such as 'U' or 'IU', are never used	100%
Insulin must always be prescribed by brand name, written out in full	100%
All clinical areas and community staff treating patients with insulin have adequate supplies of insulin syringes and subcutaneous needles, which staff can obtain at all times	100%
An insulin syringe must always be used to measure and prepare insulin for an intravenous infusion	100%
A training programme should be put in place for all healthcare staff (including medical staff) expected to prescribe, prepare and administer insulin	100%
Policies and procedures for the preparation and administration of insulin and insulin infusions in clinical areas are reviewed to ensure compliance with the above	100%

### Department of Health 'Never Event' Standard<sup>71</sup>:

Indicator	Standard
Death or severe harm as a result of maladministration of insulin by a health professional	Never

### Local Standards:

Indicator	Standards
<b>Access:</b>	
Percentage of staff involved in the care of people with diabetes undergoing surgery or procedures who have received training in blood glucose measurement	100%
Percentage of staff involved in the care of people with diabetes undergoing surgery or procedures receiving appropriate education from the Diabetes Inpatient Specialist Team	75%
<b>Safety, Quality, and Effectiveness During the Patient Journey:</b>	
Percentage of primary care referrals containing all suggested information (Appendix 12)	80%. Where necessary, education programmes should be instituted to engage with primary care colleagues to raise the standard of referral letters
Percentage of patients with diabetes referred from surgical outpatients for pre-operative assessment	100%
Percentage of patients for whom a perioperative diabetes management plan is created at the pre-operative assessment clinic	100%
Percentage of people with diabetes who are listed for elective surgery who are admitted on the day of the procedure	90%. An exclusion for this is where other significant co-morbidity needs pre-operative optimisation
Percentage of people with diabetes who are listed for elective surgery who are admitted on the day of the procedure	100%. An exclusion for this is where other significant co-morbidity needs pre-operative optimisation
Percentage of people with diabetes who have a surgical condition that would normally be managed as a day case who have no other day surgery contraindications who are listed for day case surgery	100%. An exclusion for this is where other significant factors necessitate an inpatient stay
Percentage of people with diabetes who are listed on the first third of the operating list (morning or afternoon lists)	95%
Percentage of people in whom a VRILL is established with correct configuration of the one-way and anti-siphon valves	100%
Length of stay for patients with diabetes undergoing surgery or procedures	No longer than 10% greater than for people without diabetes

Percentage of people with diabetes and a condition not usually requiring a post-operative overnight stay who are operated on electively during an evening list	0%
Percentage of patients with diabetes who receive hourly monitoring of blood glucose during their procedure, and in recovery	100%
Percentage of time that people with diabetes have their pre-operative and intraoperative blood glucose levels kept between 6 to 12mmol/L	100%
Percentage of patients with evidence of poor peri-operative glycaemic control: <ul style="list-style-type: none"> <li>- Diabetic ketoacidosis</li> <li>- Hyperosmolar hyperglycaemic state</li> <li>- Hypoglycaemia requiring 3rd party assistance</li> </ul>	0%
Percentage of patients where their discharge is delayed because of diabetes related problems	0%
<b>Institutional Accountability and Integrity:</b>	
Percentage of patients with diabetes identified as such on hospital patient administration system	95%
Percentage of clinical coding that identifies people with diabetes correctly	100%
<b>Patient and Staff Satisfaction:</b>	
Percentage of staff who feel that they have sufficient levels of appropriate and timely support from the Diabetes Inpatient Specialist Team	100%
Percentage of patients who express satisfaction with their patient journey, using validated tools such as the Diabetes Treatment Satisfaction Questionnaire (DTSQ) and the Diabetes Treatment Satisfaction Questionnaire for Inpatients (DTSQ-IP)	80%

Appendices 1 and 2 have been updated since the first edition of this guideline to better reflect the understanding of the physiology and pharmacology of newer agents. There are almost no data on the use of these drugs in the peri-operative period, and as such, these recommendations are pragmatic. Units are encouraged to audit their own data and publish them.

# Appendix 1:

## Guideline for peri-operative adjustment of insulin

Insulins	Day prior to admission	Day of surgery / whilst on a VRIII		
		Patient for a.m. surgery	Patient for p.m. surgery	If a VRIII is being used*
<b>Once daily (evening)</b> (e.g. Lantus® or Levemir® Tresiba® Insulatard® Humulin I®) Insuman Basal®)	Reduce dose by 20%	Check blood glucose on admission	Check blood glucose on admission	Continue at 80% of the usual dose
<b>Once daily (morning)</b> Once daily (morning) (Lantus® or Levemir® Tresiba® Insulatard® Humulin I®) Insuman Basal®)	Reduce dose by 20%	Reduce dose by 20% Check blood glucose on admission	Reduce dose by 20% Check blood glucose on admission	Continue at 80% of the usual dose
<b>Twice daily</b> (e.g. Novomix 30®, Humulin M3®, Humalog Mix 25®, Humalog Mix 50®, Insuman® Comb 25, Insuman® Comb 50 twice daily Levemir® or Lantus®)	No dose change	Halve the usual morning dose. Check blood glucose on admission Leave the evening meal dose unchanged	Halve the usual morning dose. Check blood glucose on admission Leave the evening meal dose unchanged	Stop until eating and drinking normally
<b>Twice daily - separate injections of short acting and intermediate acting</b> (e.g. animal neutral, NovoRapid® Humulin S®) Apidra® <b>and intermediate acting</b> (e.g. animal isophane Insulatard® Humulin I® Insuman®)	No dose change	Calculate the total dose of both morning insulins and give half as intermediate acting only in the morning. Check blood glucose on admission Leave the evening meal dose unchanged	Calculate the total dose of both morning insulins and give half as intermediate acting only in the morning. Check blood glucose on admission Leave the evening meal dose unchanged	Stop until eating and drinking normally

Insulins	Day prior to admission	Day of surgery / whilst on a VRIII		
		Patient for a.m. surgery	Patient for p.m. surgery	If a VRIII is being used*
<b>3, 4 or 5 injections daily</b> (e.g. an injection of mixed insulin 3 times a day or 3 meal time injections of short acting insulin and once or twice daily background)	No dose change	<b>Basal bolus regimens:</b> omit the morning and lunchtime short acting insulins.  If the dose of long acting basal insulin is usually taken in the morning then the dose should be reduced by 20%*  <b>Premixed a.m. insulin:</b> halve the morning dose and omit lunchtime dose Check blood glucose on admission	Take usual morning insulin dose(s). Omit lunchtime dose. Check blood glucose on admission	Stop until eating and drinking normally

\*If the patient requires and ongoing VRIII then the long acting background insulin should be continued but at 80% of the dose the patient usually takes when they are well. Normal insulin doses should be recommenced when the patient is eating and drinking normally.

At the pre-operative assessment clinic, all patients should have emergency treatment for hypoglycaemia written on their drug chart – i.e. Glucogel®, and 20% dextrose. Rapid acting insulin should also be prescribed.

**The management of perioperative hyperglycaemia and hypoglycaemia is outlined in Appendix 4.**

**Warn the patient that their blood glucose control may be erratic for a few days after the procedure.**

# Appendix 2:

## Guideline for peri-operative adjustment of non-insulin medication

Tablets	Day prior to admission	Day of surgery / whilst on a VRIII		
		Patient for a.m. surgery	Patient for p.m. surgery	If a VRIII is being used*
<b>Acarbose</b>	Take as normal	Omit morning dose if NBM	Give morning dose if eating	Stop once VRIII commenced, do not recommence until eating and drinking normally
<b>Meglitinide</b> (repaglinide or nateglinide)	Take as normal	Omit morning dose if NBM	Give morning dose if eating	Stop once VRIII commenced, do not recommence until eating and drinking normally
<b>Metformin</b> (eGFR is greater than 60 ml/min/1.73m <sup>2</sup> and procedure not requiring use of contrast media**)	Take as normal	If taken once or twice a day – take as normal If taken three times per day, omit lunchtime dose	If taken once or twice a day – take as normal If taken three times per day, omit lunchtime dose	Stop once VRIII commenced, do not recommence until eating and drinking normally
<b>Sulphonylurea</b> (e.g. glibenclamide, gliclazide, glipizide, glimeperide)	Take as normal	If taken once daily in the morning – omit the dose that day If taken twice daily – omit the morning dose that day	If taken once daily in the morning – omit the dose that day If taken twice daily – omit both doses that day	Stop once VRIII commenced, do not recommence until eating and drinking normally
<b>Pioglitazone</b>	Take as normal	Take as normal	Take as normal	Stop once VRIII commenced, do not recommence until eating and drinking normally
<b>DPP IV inhibitor</b> (e.g. sitagliptin, vildagliptin, saxagliptin, alogliptin, linagliptin)	Take as normal	Take as normal	Take as normal	Stop once VRIII commenced, do not recommence until eating and drinking normally

Tablets	Day prior to admission	Day of surgery / whilst on a VRIII		
		Patient for a.m. surgery	Patient for p.m. surgery	If a VRIII is being used*
<b>GLP-1 analogue</b> (e.g. exenatide, liraglutide, lixisenatide, dulaglutide)	Take as normal	Take as normal	Take as normal	Take as normal
<b>SGLT-2 inhibitors</b> (e.g. dapagliflozin, canagliflozin, empagliflozin)	Take as normal	Omit on day of surgery	Omit on day of surgery	Omit until eating and drinking normally

\*If the patient requires and ongoing VRIII then the long acting background insulin should be continued but at 80% of the dose the patient usually takes when they are well. Normal insulin doses should be recommenced when the patient is eating and drinking normally.

At the pre-operative assessment clinic, all patients should have emergency treatment for hypoglycaemia written on their drug chart – i.e. Glucogel®, and 20% dextrose. Rapid acting Insulin should also be prescribed.

**The management of perioperative hyperglycaemia and hypoglycaemia is outlined in Appendix 4.**

**Warn the patient that their blood glucose control may be erratic for a few days after the procedure.**

NBM – Nil By Mouth, OD – Once Daily, BD – Twice Daily, TDS – Three times Daily, a.m. – morning, p.m. – afternoon

\*\* If contrast medium is to be used and eGFR less than 60ml/min/1.73m<sup>2</sup>, metformin should be omitted on the day of the procedure and for the following 48 hours.

# Appendix 3:

## How to identify which patients with diabetes are suitable for day surgery

Patients with diet-controlled diabetes are all suitable for day case surgery if the procedure itself is suitable for day surgery and all other criteria are fulfilled.

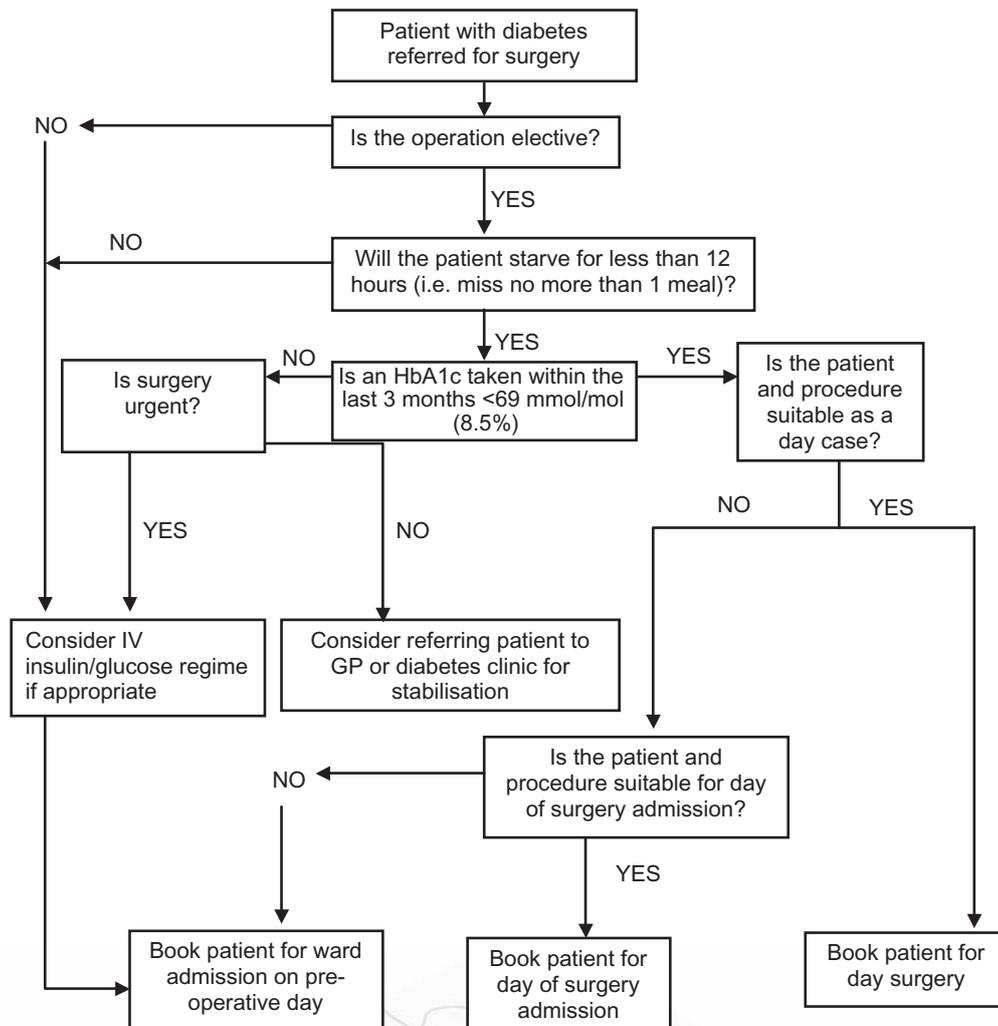
See the algorithm below for guidance.

Give patients instructions for adjusting their dose of tablets or insulin (patient instruction leaflet).

Patients with diabetes controlled by oral or injected medication are suitable for day case surgery if:

- they fulfil all day case criteria
- they can be early on a morning or afternoon list (ensures adequate recovery time.)

### Suitability of patients with diabetes for day surgery



# Appendix 4:

## Guideline for peri-operative monitoring of diabetes and management of hyperglycaemia and hypoglycaemia in patients undergoing surgery with a short starvation period (one missed meal)

- These guidelines are for the management of well-controlled patients ( $HbA_{1c} < 69\text{mmol/mol}$ , 8.5%) undergoing surgery with a short starvation period.
- Medication should be managed as in Appendix 1 or 2, depending on usual treatment.
- Patients who are not well controlled but in whom surgery cannot be postponed should have a VRIII.
- Monitor capillary blood glucose on admission and hourly during the day of surgery. The target blood glucose in the pre-operative, anaesthetised or sedated patient should be 6-10mmol/L (up to 12mmol/L may be acceptable). The target of 6-10mmol/L is for those who are treated with glucose lowering agents – i.e. insulin, (either subcutaneously, or via an insulin infusion) or sulphonylurea therapy. In the **awake** patient on agents that do not produce hypoglycaemia, provided they have not been given insulin, lower blood glucose values down to 3.5mmol/L are safe and do not require IV glucose or other rescue treatment.
- At the pre-operative assessment clinic, all patients should have emergency treatment for hypoglycaemia written on their drug chart – i.e. Glucogel®, and 20% dextrose. Rapid acting insulin should also be prescribed.
- **Pre-operative hyperglycaemia:** (blood glucose greater than 12mmol/L with blood ketones less than 3mmol/L or urine ketones less than +++)
  - **Type 1 diabetes:** give subcutaneous rapid acting analogue insulin (i.e. Novorapid®, Humalog® or Apidra®). Assume that 1 unit will drop the blood glucose by 3mmol/L. Recheck blood glucose 1 hour later to ensure it is falling. If surgery cannot be delayed commence a VRIII.
  - **Type 2 diabetes:** give 0.1 units/kg of subcutaneous rapid acting analogue insulin, and recheck blood glucose 1 hour later to ensure it is falling. If surgery cannot be delayed or the response is inadequate, commence a VRIII.
- **Post-operative hyperglycaemia:** (blood glucose greater than 12mmol/L with blood ketones less than 3mmol/L or urine ketones less than +++)
  - **Type 1 diabetes:** give subcutaneous rapid acting analogue insulin. Assume that 1 unit will drop blood glucose by 3mmol/L BUT wherever possible take advice from the patient about the amount of insulin normally required to correct a high blood glucose. Recheck the blood glucose 1 hour later to ensure it is falling. Repeat the subcutaneous insulin dose after 2 hours if the blood glucose is still above 12mmol/L. In this situation the insulin dose selected should take into account the response to the initial dose – consider increasing the dose if the response is inadequate. Recheck the blood glucose after 1 hour. If it is not falling consider introducing VRIII.
  - **Type 2 diabetes:** give 0.1 units/kg of subcutaneous rapid acting analogue insulin, and recheck blood glucose 1 hour

### Management of hyperglycaemia

It is advocated that the following information be on the drug chart:

- **Blood glucose greater than 12mmol/L either pre- or post- surgery**
  - Check capillary ketone levels using an appropriate bedside monitor if available
  - If capillary blood ketones are greater than 3mmol/L or urinary ketones greater than +++ or greater cancel surgery, follow DKA guidelines and contact the diabetes specialist team or the on call medical team for advice

later to ensure it is falling. Repeat the subcutaneous insulin after 2 hours if the blood glucose is still above 12mmol/L. In this situation the insulin dose selected should take into account the response to the initial dose – consider doubling the dose if the response is inadequate. Repeat the blood glucose after another hour. If it is not falling consider introducing VRIII.

### Management of hypoglycaemia and hypoglycaemia risk

- Admission or peri-operative hypoglycaemia (capillary blood glucose less than 6mmol/L). N.B. patients on diet alone are not at risk of hypoglycaemia and are excluded from the guideline below:
  - If CBG is 4-6mmol/L and the patient has symptoms of hypoglycaemia: Consider giving 50-100ml of 10% dextrose as a stat iv bolus and repeat the CBG after 10 minutes.

- If CBG is less than 4mmol/L; give 75-100ml of 20% glucose (i.e. 300-400ml/hr using an infusion pump) and repeat the capillary blood glucose after 10 minutes.
- Try to avoid stopping the VRIII in type 1 diabetic patients. If it is stopped recommence as soon as the blood glucose rises above 5mmol/L.
- Persistent hypoglycaemia should be referred urgently to the diabetic specialist team or the on-call medical team.
- Increase frequency of blood glucose monitoring until normoglycaemia achieved and then revert to monitoring blood glucose hourly until the patient is eating and drinking.

These recommendations are at slight variance with the National Guideline for the Management of Hypoglycaemia in Adults with Diabetes<sup>51</sup>, but are designed to promote individualised care during the highly monitored peri-operative period.

# Appendix 5:

## Guideline for the use of a variable rate intravenous insulin infusion (VRIII)

### Aim

The aim of the VRIII is to achieve and maintain glucose levels within the target range of 6-10mmol/L, although up to 12mmol/L may be acceptable. This is done by infusing a constant rate of glucose-containing fluid as substrate while infusing insulin at a variable rate. In particular it should be used in those patients who cannot be safely managed by the manipulation of their usual diabetes medications as outlined in Appendices 1 and 2.

### Principles

- There is no one fit for all.
- The VRIII is the preferred method of controlling the surgical patient's serum glucose in the following circumstances:
  - Patient with Type 1 diabetes undergoing surgery with a starvation period greater than 1 missed meal
  - Patient with Type 1 diabetes undergoing surgery who has not received background insulin
  - Patient with Type 2 diabetes undergoing surgery with a starvation period greater than 1 missed meal and develops hyperglycaemia (CBG >12mmol/L)
  - Patients with poorly controlled diabetes as defined as an HbA<sub>1c</sub> >69mmol/mol (>8.5%)
  - Most patients with diabetes requiring emergency surgery
- If the patient is already on a long acting insulin analogue (e.g. Levemir®, Lantus® or Tresiba®) these should be continued at 80% of the usual dose
- Heavier patients often require more insulin per hour
- Initial insulin infusion rate should be determined by the bedside capillary blood glucose (CBG) measurement

- Hourly bedside CBG measurement should be taken to ensure that the intravenous insulin infusion rate is correct - initially for the first 12 hours or as locally agreed
- If the blood glucose remains over 12mmol/L for 3 consecutive readings and is not dropping by 3mmol/L/hr or more the result should be rechecked and if the result is confirmed, scale should be changed as shown in the table below
- If the blood glucose is less than 4.0mmol/L, the insulin infusion rate should be reduced to 0.5 or 0.2 units per hour (depending on which scale is being used), and the low blood glucose should be treated as per the National Guideline for the Management of Hypoglycaemia in Adults with Diabetes<sup>51</sup> irrespective of whether the patient has symptoms. However, if the patient has continued on their long acting background insulin, then their VRIII can be switched off, but the regular CBG measurements need to continue

### Indication for VRIII

- Patients anticipated to have a long starvation period (i.e. 2 or more missed meals)
- Decompensated diabetes

### Administration

- Some institutions use prefilled syringes and where available, these should be used according to local policies
- Make up a 50ml syringe with 50 units of Soluble Human Insulin (e.g. Human Actrapid®) with 49.5ml of 0.9% sodium chloride solution

### Fluids to run alongside the VRIII

- To ensure a steady supply of substrate and to ensure the RDA for sodium is met, it is recommended that 5% glucose in 0.45% saline and 0.15%/0.3% potassium chloride should always be run alongside the VRIII at a rate to meet the patient's fluid maintenance requirements

- It is acknowledged that not all surgical wards and theatres will have access to this solution. In these circumstances 4% glucose in 0.18% saline and 0.15%/0.3% potassium chloride can be used instead. However, daily assessment of serum electrolytes is mandatory and resultant hyponatraemia must be treated appropriately
- The practice of alternating 5% glucose with 0.9% saline according to serum glucose is not recommended
- To prevent hypoglycaemia, the substrate solution containing glucose must never be discontinued inadvertently, especially during transfers
- The rate of fluid replacement must be set to deliver the hourly fluid requirements of the individual patient and should not be altered thereafter without senior advice

- Some patients will require additional concurrent crystalloid (via a second infusion line)

#### Cautions:

- 1) Do not infuse insulin without substrate unless in ITU/HDU/CCU setting.
- 2) Measure CBG hourly to avoid hypoglycaemia and hyperglycaemia
- 3) Ensure the administration of background insulin to prevent hyperglycaemia and ketosis on cessation (See Appendix 7)
- 4) In patients with type 1 DM, the VR88 must never be taken down until alternative subcutaneous insulin has been administered in the previous 30 minutes
- 5) Ensure RDA of sodium is met to prevent hyponatraemia and measure electrolytes daily

### Rate of insulin infusion

This is modified from the JBDS document: The use of variable rate intravenous insulin infusion (VR88) in medical inpatients. Available at <http://www.diabetologists-abcd.org.uk/JBDS/JBDS.htm>

Glucose mmol/L	Insulin Rates (ml/hr)						Customised scale
	Standard Rate (Start on standard rate unless indicated)		Reduced rate (for use in insulin sensitive patients i.e. needing less than 24 units/day)		Increased rate (for use in insulin resistant patients i.e. needing more than 100 units/day)		
	if no basal insulin	if basal insulin continued	if no basal insulin	if basal insulin continued	if no basal insulin	if basal continued	
<4	0.5ml/hr and administer 100ml iv 20% glucose	0 ml/hr and administer 100ml iv 20% glucose	0.2ml/hr and administer 100ml iv 20% glucose	0ml/hr and administer 100ml iv 20% glucose	0.5ml/hr and administer 100ml iv 20% glucose	0 ml/hr and administer 100ml iv 20% glucose	
4.1-6	0.5ml/hr and consider 50ml iv 20% glucose*	0ml/hr and consider 50ml iv 20% glucose*	0.2ml/hr and consider 50ml iv 20% glucose*	0ml/hr and consider 50ml iv 20% glucose*	0.5ml/hr and consider 50ml iv 20% glucose*	0ml/hr and consider 50ml iv 20% glucose*	
6.1-8	1	1	0.5	0.5	2	2	
8.1-12	2	2	1	1	4	4	
12.1-16	4	4	2	2	6	6	
16.1-20	5	5	3	3	7	7	
20.1-24	6	6	4	4	8	8	
>24.1	8	8	6	6	10	10	
>24.1	Ensure insulin is running, and not measuring an artefact						

\* if the patient is pre-operative, sedated or anaesthetised, or there has been a rapid fall to a CBG between 4.1 and 6.0mmol/L: give 50ml of 20% glucose IV to prevent the CBG falling to below 4.0mmol/L

#### **Treatment of CBG <4mmol/L whilst on VRIII**

- Administer 100ml of 20% glucose
- Recheck glucose every 15 minutes until CBG >6.0mmol/L, and then revert to hourly

#### **Management of CBG 4.1-6mmol/L**

- If the patient is pre-operative, sedated or anaesthetised, or there has been a rapid fall to a CBG between 4.1 and 6.0mmol/L: give 50ml of 20% glucose IV to prevent the CBG falling to below 4.0mmol/L
- Fastidiously recheck glucose every hour to ensure CBG does not fall below 4.0mmol/L

#### **Guidelines for setting up a variable rate intravenous insulin infusion**

- Intravenous fluid must be administered using a volumetric infusion pump and an infusion/IV fluid stand must always be available
- Delivery of the substrate solution and the VRIII must be via a single cannula **with appropriate one-way and anti-siphon valves**
- Set the fluid replacement rate to deliver the hourly fluid requirements of the individual patient. The rate must not be altered thereafter without senior advice

- Insulin must be administered via a syringe pump alongside the substrate infusion
- Insulin should not be administered without substrate except on senior advice in an ITU/HDU setting
- Insulin must be infused at a variable rate to keep the blood glucose levels between 6-10mmol/L, but up to 12mmol/L is acceptable
- Continue the substrate solution and VRIII intra-operatively and post-operatively until the patient is eating and drinking and back on their usual glucose lowering medication
- Additional fluid therapy may be required according to the specific needs of the patient for a given surgical procedure. Hartmann's solution is acceptable. Ideally the post-operative sodium intake should not exceed 200mmol/day
- If the insulin and substrate solution are disconnected from the patient, new solutions and new giving sets should be used to reduce the risk of nosocomial infection

The British Consensus Guidelines for Intravenous Fluid Therapy for the Adult Surgical Patient (GIFTASUP) provide further detailed guidance<sup>50</sup>.

# Appendix 6:

## Advantages and disadvantages of intravenous solutions

	Advantages	Disadvantages
5% glucose in 0.45% saline with 0.15% KCl at 83-125ml/hr with a continuous VRIII	<ul style="list-style-type: none"> <li>• Constant supply of substrate</li> <li>• Meets daily sodium and potassium requirements</li> <li>• Safety profile of regimen demonstrated in the paediatric diabetic population</li> </ul>	<ul style="list-style-type: none"> <li>• Not widely available</li> <li>• Hypotonic solution in vivo with reference to plasma and may still predispose to hyponatraemia</li> <li>• May exceed daily requirements of sodium</li> </ul>
5% glucose in 0.9% saline with 0.15% KCl at 83 - 125ml/hr with a continuous VRIII	<ul style="list-style-type: none"> <li>• Constant supply of substrate</li> <li>• Meets potassium requirements</li> <li>• Safety profile of regimen demonstrated in the paediatric diabetic population</li> </ul>	<ul style="list-style-type: none"> <li>• Not widely available</li> <li>• Will exceed daily sodium chloride requirement and predispose to oedema and hyperchloraemic metabolic acidosis</li> </ul>
0.18% saline with 4% glucose with 0.15% KCl at 83-125ml/hr with a continuous VRIII	<ul style="list-style-type: none"> <li>• Constant supply of substrate</li> <li>• Meets potassium requirements</li> <li>• Widely available</li> </ul>	<ul style="list-style-type: none"> <li>• Does not meet daily sodium requirement</li> <li>• Associated with hyponatraemia. Use in children has been curtailed by the NPSA</li> <li>• Hypotonic solution in vivo with reference to plasma</li> </ul>
Either 5% or 10% glucose with 0.15% KCl at 125ml/hr with a continuous VRIII	<ul style="list-style-type: none"> <li>• Constant supply of substrate</li> <li>• Widely available</li> </ul>	<ul style="list-style-type: none"> <li>• Does not provide any sodium</li> <li>• Associated with hyponatraemia</li> </ul>
5-10% glucose with 0.15% KCl at 125ml/hr with additional 0.9% saline at a variable rate to correct the hyponatraemia and a continuous VRIII	<ul style="list-style-type: none"> <li>• Constant supply of substrate</li> <li>• Widely available</li> </ul>	<ul style="list-style-type: none"> <li>• Requires 3 infusion pumps (1 for the glucose, 1 for the saline and 1 for the insulin)</li> <li>• May need multiple venous access leading to difficulties in obtaining blood samples and venous access</li> <li>• May lead to fluid overload</li> </ul>
10% glucose with 0.15% KCl at 60 ml/hr with additional 0.9% saline at 60ml/hr with a continuous VRIII	<ul style="list-style-type: none"> <li>• Constant supply of substrate</li> <li>• Widely available</li> </ul>	<ul style="list-style-type: none"> <li>• Needs 3 infusion pumps (1 for the glucose, 1 for the saline and 1 for the insulin)</li> <li>• May need multiple venous access leading to difficulties obtaining blood samples and venous access</li> </ul>

	Advantages	Disadvantages
<p>10% glucose with 0.15% KCl at 100ml/hr if CBG less than 15mmol/L with a continuous VRIII</p> <p>0.9% saline with 0.15% KCl at 100ml/hr if CBG more than 15mmol/L with a continuous VRIII</p>		<ul style="list-style-type: none"> <li>• Erratic supply of substrate</li> <li>• Unpredictable administration of sodium</li> <li>• Increased nursing workload and difficulties in maintaining accurate fluid balance charts with constant changes of fluid bags according to CBG</li> <li>• Difficulty in monitoring fluid balance</li> <li>• Cannot be recommended</li> </ul>
<p>500ml 10% glucose and 0.15% KCl with 5 units insulin if CBG less than 6mmol/L.</p> <p>500ml 10% glucose and 0.15% KCl with 10 units insulin if CBG 6-10mmol/L.</p> <p>500ml 10% glucose and 0.15% KCl with 15 units insulin if CBG 10-20 mmol/L.</p> <p>500ml 10% glucose and 0.15% KCl with 20 units insulin if CBG more than 20mmol/L.</p> <p>All administered at 100-125 ml/hr and with additional 0.9% saline to treat established hyponatraemia</p>	<ul style="list-style-type: none"> <li>• Intrinsically safe as substrate and insulin are co-administered</li> <li>• Evidence to support its use</li> </ul>	<ul style="list-style-type: none"> <li>• Increased nursing workload and difficulties in maintaining accurate fluid balance charts with constant changes of fluid bags according to CBG</li> <li>• Hyponatraemia is a recognised complication.</li> <li>• May lead to fluid overload with the co-administration of additional 0.9% saline.</li> </ul>
Hartmann's Solution, Ringer's lactate and Plasma-Lyte 148®	<ul style="list-style-type: none"> <li>• Causes minimal metabolic and electrolyte disturbance</li> <li>• Provided the blood sugars are controlled and stable without the use of a VRIII, Hartmann's solution can be safely used as the sole fluid in all patients with diabetes</li> </ul>	<ul style="list-style-type: none"> <li>• Probably has insufficient calories to provide a safe substrate solution when given with a continuous infusion of insulin</li> <li>• Has insufficient potassium to run alongside a continuous insulin infusion</li> <li>• Continuous use over several days will lead to salt retention as well as hypokalaemia</li> </ul>

# Appendix 7:

## Transferring from a VRIII to subcutaneous insulin or oral treatment

### Restarting oral hypoglycaemic medication

- Recommence oral hypoglycaemic agents at pre-operative doses once the patient is ready to eat and drink.
- Be prepared to withhold or reduce sulphonylureas if the food intake is likely to be reduced.
- Metformin should only be recommended if the eGFR is greater than 60ml/min/1.73m<sup>2</sup>.

### Restarting subcutaneous insulin for patients already established on insulin

- Conversion to subcutaneous insulin should be delayed until the patient is able to eat and drink without nausea or vomiting.
- Restart the normal pre-surgical regimen. Be prepared to adjust the doses because the insulin requirement may change as a result of post-operative stress, infection or altered food intake.
- Consult the diabetes specialist team if the blood glucose levels are outside the acceptable range (4-12mmol/L) or if a change in diabetes management is required.

The transition from intravenous to subcutaneous insulin should take place when the next meal-related subcutaneous insulin dose is due e.g. with breakfast or lunch.

### For the patient on basal bolus insulin

There should be an overlap between the VRIII and the first injection of fast acting insulin. The fast acting insulin should be injected subcutaneously with the meal and the intravenous insulin and fluids discontinued 30 to 60 minutes later.

If the patient was previously on a long acting insulin analogue such as Lantus®, Tresiba®, or Levemir®, this should have been continued and thus the only action should be to restart their normal short acting insulin at the next meal as outlined above.

**If the basal insulin was stopped in error, the insulin infusion should be continued until the patient's usual background insulin has been given. If the basal insulin is normally taken once daily in the evening and the intention is to convert to subcutaneous insulin in the morning, give half the usual daily dose of basal insulin as isophane (e.g. Insulatard®, Humulin I®) in the morning; this will provide essential background insulin until the long acting analogue can be recommenced. Check for blood or urine ketones and glucose levels regularly (e.g. every 4 to 6 hours) during this transition phase.**

Contact the diabetes team for advice.

### For the patient on a twice daily fixed-mix regimen

The insulin should be re-introduced before breakfast or before the evening meal. Do not change to subcutaneous insulin at any other time. The VRIII should be maintained for 30 to 60 minutes after the subcutaneous insulin has been given.

### For the patient on a continuous subcutaneous insulin infusion (CSII, 'pump')

The 'pump team' should be informed at the time of the admission or routinely referred at pre-assessment.

The subcutaneous insulin infusion should be recommenced at their normal basal rate. The VRIII should be continued until the next meal bolus has been given. Do not recommence the CSII at bedtime.

### Calculating subcutaneous insulin dose in insulin-naïve patients

(N.B. these are guidelines only and advice should be sought from the diabetes specialist team).

**Estimated Total Daily Dose (TDD) of insulin** - this estimate is based on several factors, including the patient's sensitivity to insulin, degree of glycaemic control, insulin resistance, weight, and age.

Calculate the average hourly insulin dose by totalling the last 6 hours doses on the chart and dividing by 6 e.g. 12 units divide by 6 = 2 units/hour.

This should then be multiplied by a factor of 20 (not 24 because of the risk of hypoglycaemia with the first dose) to get the total daily dose (TDD) insulin e.g. ~40 units.

### Calculating a basal bolus (QDS) regimen

Give approximately 50% of the TDD with the evening meal in the form of long acting insulin and divide the remaining dose to be given as rapid acting equally between pre-breakfast, pre-lunch and pre-evening meal.

The first dose of fast acting subcutaneous insulin should preferably be administered prior to breakfast or lunch. It should only be administered before the evening meal if monitoring can be guaranteed. Do not convert to a subcutaneous regimen at bedtime.

**It is important that basal insulin is given before the insulin infusion is taken down.**

**See guidance on previous page for transfer from the VRIII to basal bolus insulin.**

	Pre-breakfast	Pre-lunch	Pre-evening meal	Bedtime
Rapid acting insulin, e.g. Apidra® / Humalog®/ NovoRapid®	6 units	6 units	6 units	
Long acting insulin, e.g. Lantus®/Levemir®/ Tresiba®				18 units

### Calculating a twice daily (BD) regimen

If a twice-daily pre-mixed insulin regimen is to be used, two thirds of the total daily dose should be given at breakfast, with the remaining third given with the evening meal.

# Appendix 8:

## Examples of patient information leaflets for patients undergoing surgery or procedures requiring a period of starvation

### Patient instruction leaflet for people with diabetes controlled with tablets or by injections of GLP-1 agonists - Byetta® (exenatide), Bydureon® (long acting exenatide), Victoza® (liraglutide), or Lyxumia (lixisenatide)

Before your operation or procedure:

**Please follow the instruction in the table below marked "What to do with your medication before surgery"**

If your operation is in the morning.

- Do not eat any food after midnight.
- Drink clear fluids such as black tea or coffee, sugar-free squash or water up to 5 a.m.

If your operation is in the afternoon:

- Eat breakfast before 7 a.m. and take no food after this time.
- Drink clear fluids such as black tea or coffee, sugar-free squash or water up to 10 a.m.
- When you travel to and from the hospital for your operation carry some glucose tablets or a sugary drink.

If you have any symptoms of a low blood sugar such as sweating, dizziness, blurred vision or shaking please test your blood sugar if you are able to do so.

If it is less than 6mmol/L take 4 glucose tablets or 150ml of the sugary drink (this is the same as half a standard sized can of non-diet cola). Please tell staff at the hospital that you have done this because it is possible that your surgery may have to be rearranged for another day.

- After your operation you will be offered food and drink when you feel able to eat. If you are eating and drinking normally you should resume taking your normal tablets the morning after surgery. However, your blood glucose levels may be higher than usual for a day or so.
- When you get home, if you feel nauseated or vomit and are unable to eat, please refer to the sick day rules leaflet.
- If you do not improve quickly and usually attend the hospital for diabetes care please telephone the Diabetes Team on (telephone number) during office hours Monday – Friday. Outside these hours please contact your GP practice or out of hours service.
- If you usually see your GP about your diabetes please phone your GP practice.

### Remember to bring with you to hospital

- Glucose tablets or a sugary drink.
- Blood glucose testing equipment (if you usually monitor your blood glucose).
- The tablets you usually take for your diabetes.

Instructions for taking your diabetes medication before your operation (assessing nurse to complete).

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## What to do with your medication before the surgery

Tablets	Day prior to admission	Day of surgery	
		Patient for a.m. surgery	Patient for p.m. surgery
<b>Acarbose</b>	Take as normal	Omit morning dose if you have been told to fast from midnight	Take your morning dose if eating breakfast. Do not take your lunchtime dose
<b>Meglitinide</b> (repaglinide or nateglinide)	Take as normal	Omit morning dose if you have been told to fast from midnight	Take your morning dose if eating breakfast. Do not take your lunchtime dose
<b>Metformin / Glucophage MR</b> If you are due to have contrast media this <b>may</b> need to be stopped on the day of the procedure and not taken for a further 48 hours (your doctor should tell you this in advance)	Take as normal	If taken once a day – do not stop. If taken twice a day – do not stop. If taken three times a day omit your lunchtime dose only	If taken once a day – do not stop. If taken twice a day – do not stop. If taken three times a day omit your lunchtime dose only
<b>Sulphonylureas</b> (glibenclamide, glipizide, gliclazide/ gliclazide MR, glimepiride, gliquidone)	Take as normal	If taken once a day in the morning – omit this dose. If taken twice a day, omit the morning dose	If taken once a day in the morning – omit this dose. If taken twice a day, omit both doses
<b>Thiazolidinediones</b> (Pioglitazone)	Take as normal	Take as normal	Take as normal
<b>DPP-IV inhibitors</b> (sitagliptin, saxagliptin, vildagliptin, alogliptin, linagliptin)	Take as normal	Take as normal	Take as normal
<b>GLP-1 analogue</b> (e.g. exenatide, liraglutide, lixisenatide)	Take as normal	Take as normal	Take as normal
<b>SGLT-2 inhibitors</b> (e.g. dapagliflozin, canagliflozin)	Take as normal	Omit your morning dose	Omit your morning dose

**You should resume taking your normal tablets the morning after surgery. However, your blood glucose may be higher than usual for a day or so.**

## Patient instruction leaflet for people with insulin (or insulin and tablet) controlled diabetes undergoing surgery or a procedure requiring a period of starvation

[To be adapted depending on the procedure]

Before your operation or procedure:

**Please follow the instruction in the table below marked "What to do with your insulin before surgery (or procedure)."**

If your operation (procedure) is in the morning

- Do not eat any food after midnight.
- Drink clear fluids such as black tea or coffee, sugar-free squash or water up to 5 a.m.

If your operation (procedure) is in the afternoon

- Eat breakfast before 7 a.m. and take no more food after this time.
- Drink clear fluids such as black tea or coffee, sugar-free squash or water up to 10 a.m.
- When you travel to and from the hospital for your operation carry some glucose tablets or a sugary drink.

If you have any symptoms of a low blood sugar such as sweating, dizziness, blurred vision or shaking please test your blood sugar if you are able to do so. If it is less than 6mmol/L take 4 glucose tablets or 150ml of the sugary drink (this is the same as half a standard sized can of non-diet cola). Please tell staff at the hospital that you have done this because it is possible that your surgery may have to be rearranged for another day.

- After your operation (procedure) your blood sugar will be checked and additional insulin given if necessary.

- After your operation (procedure) you will be offered food and drink when you feel able to eat. If you are eating and drinking normally you should resume taking your normal insulin (and tablets) the next morning. However, your blood glucose levels may be higher than usual for a day or so.
- When you get home, if you feel nauseated or vomit and are unable to eat, please refer to the sick day rules leaflet.
- If you do not improve quickly and usually attend the hospital for diabetes care please telephone the Diabetes Team on (telephone number) during office hours Monday – Friday. Outside these hours please contact your GP practice or out of hours service.
- If you usually see your GP about your diabetes please phone your GP practice.

### Remember to bring with you to hospital

- Glucose tablets or sugary drink.
- Blood glucose testing equipment you usually use.
- Insulin (and tablets) you usually take for your diabetes.

Instructions for taking insulin before your operation [to be completed by assessing nurse].

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## What to do with your insulin before surgery (procedure)

Insulins	Day prior to admission	Patient for a.m. surgery	Patient for p.m. surgery
<b>Once daily (evening)</b> (Lantus®/Glargine or Levemir®/Detemir® or Degludec/Tresiba® or Insulatard® or Humulin I®)	Your dose will need to be reduced by 20%	No dose adjustment necessary*	No dose adjustment necessary*
<b>Once daily (morning)</b> (Lantus®/Glargine or Levemir®/Detemir® or Degludec/Tresiba® or Insulatard® or Humulin I®)	Your dose will need to be reduced by 20%	Your dose will need to be reduced by 20% and your blood glucose will be checked on admission	Your dose will need to be reduced by 20% and your blood glucose will be checked on admission
<b>Twice daily</b> (Novomix 30®, Humulin M3®, Insuman comb 15®, Insuman comb 25®, Insuman comb 50®, Humalog Mix 25®, Humalog Mix 50®)	No dose change	Halve your usual dose. Your blood glucose will be checked on admission Resume your normal insulin with your evening meal	Halve your usual dose. Your blood glucose will be checked on admission Resume your normal insulin with your evening meal
<b>3, 4, or 5 injections daily</b> (e.g. an injection of mixed insulin 3 times a day or 3 meal time injections of short acting insulin and once or twice daily background)	No dose change	Omit your morning dose of short acting insulin if no breakfast is eaten. If you normally take a long acting basal insulin in the morning you should take 80% of your normal dose. If you normally take a pre-mixed insulin the dose should be halved. Omit your lunchtime dose. Resume your normal insulin with your evening meal	Take usual morning insulin dose(s). Omit lunchtime dose. Your blood glucose will be checked on admission Resume your normal insulin with your evening meal

**You should resume taking your normal insulin the morning after surgery (procedure).  
However, your blood glucose may be higher than usual for a day or so.**

# Appendix 9:

Example of instructions for non-operative procedures requiring a period of starvation (no more than one missed meal)

Advice should be sought from your normal diabetes care provider

## Gastroscopy / Bronchoscopy

- Follow guidelines for surgery as in leaflets above

## Colonoscopy

### Day before procedure: insulin-treated patients

- Follow the advice provided about low residue food.
- Take the bowel preparation as instructed.
- Take additional clear fluid, and sugary drinks such as Lucozade® or clear fruit juice to maintain the blood glucose levels.
- Test your blood glucose levels before administering insulin.
- Take half the usual dose of short acting (NovoRapid®/Humalog®/Actrapid®/Humulin S®) or mixed insulin (Novomix 30®/Humulin M3®/Humalog Mix 25®).
- Take the usual dose of long acting insulin (Lantus®/Levemir®/Tresiba®).

### Day before procedure: non insulin treated patients

- Omit any diabetes tablets.

### Day of procedure: insulin treated or non insulin treated patients

Follow the guidelines for the day of surgery (procedure) (Appendix 8).

# Appendix 10:

## Sick Day Rules for People with Diabetes

These are a guide only, local practice may vary

### What should I do if I am unwell?

- **NEVER** stop taking your insulin or tablets – illness usually increases your body's need for insulin.
- **TEST** your blood glucose level every 2 hours, day and night.
- **TEST** your urine for ketones every time you go to the toilet or your blood ketones every 2 hours if have the equipment to do this.
- **DRINK** at least 100ml water/sugar free fluid every hour – you must drink at least 2.5 litres per day during illness (approx. 5 pints!).
- **REST** and avoid strenuous exercise as this may increase your blood glucose level during illness.
- **EAT** as normally as you can. If you cannot eat or if you have a smaller appetite than normal, replace solid food during illness, with one of the following:
  - 400ml milk
  - 200ml carton fruit juice
  - 150-200ml non-diet fizzy drink
  - 1 scoop ice cream

### When should I call the Diabetes Specialist Nurses or my GP?

- **CONTINUOUS** diarrhoea and vomiting, and/or high fever.
- **UNABLE** to keep down food for 4 hours or more.
- **HIGH** blood glucose levels with symptoms of illness (above 15mmol/L - you may need more insulin).
- **KETONES** at ++2 or +++3 in your urine or 1.5mmol/L blood ketones or more. (You may need more insulin). In this case, contact the person who normally looks after your diabetes immediately.

**OUTSIDE NORMAL WORKING HOURS consult the local out of hours service or go to your local hospital A&E department.**

# Appendix 11:

## Discharge letter: Advice for patients with diabetes who are discharged following a surgical procedure

- Take your insulin or other medication as advised in the information leaflet.
- Monitor your blood glucose if you have the equipment to do so – 4 times per day if possible. You should test more frequently if you are unwell, nauseated or vomiting.
- Your blood glucose may be higher than usual. This is not a concern if you are feeling well.
- If you are feeling unwell (particularly if vomiting and unable to take food or medication) contact your usual diabetes team/GP surgery.  
Tel: .....
- If outside normal working hours contact the out of hours service  
Tel: .....

# Appendix 12:

## GP letter with recommendations for referral of patients for surgery

Dear Local GP

You may be aware of the recent publication from NHS Diabetes, '**Management of adults with diabetes undergoing surgery and elective procedures: improving standards**'.

The recommendations contained within this document aim to streamline the management of the surgical patient with diabetes. There is emphasis on optimising the patient's condition before referral for surgery, promoting day surgery where possible, avoiding the unnecessary use of intravenous insulin, and encouraging a rapid return to the patient's usual diet and diabetes management.

**We are writing to ask for your help in implementing these recommendations at a local level.**

We request that you provide the following information when referring a patient with diabetes for a surgical opinion:

### Up-to-date current diabetes care

- Duration and type of diabetes
- Place of usual diabetes care (primary or secondary care)
- Other co-morbidities
- Treatment
  - For diabetes - oral agents/ insulin doses and frequency
  - For other co-morbidities

### Specific complications of diabetes

- At risk foot
- Renal impairment
- Cardiac disease

### Recent values for

- BMI
- BP
- HbA<sub>1c</sub>
- eGFR

### Importance of good glycaemic control prior to surgery

There is evidence that poor pre-operative glycaemic control is associated with greater post-operative mortality and morbidity after elective surgery. **In view of this we recommend that every effort be made to achieve an HbA<sub>1c</sub> below 69mmol/mol (8.5%) prior to surgery and it is felt that further optimisation is safely achievable.** To avoid the risk of postponement or cancellation, please review the treatment of any patient with an HbA<sub>1c</sub> above this target to improve diabetes control. You may wish to consider referral to the local diabetes team. If there is a reason why control cannot be improved, please make this clear so that the risks and benefits of surgery can be assessed.

We will start to use this approach to assess patients pre-operatively from .....(date).

For further information please contact the Diabetes Specialist Nurse Team on .....(tel no.).

We look forward to working together with you to improve surgical outcomes for patients with diabetes.

Yours sincerely

Medical Director

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