



**THE PERI-OPERATIVE
MANAGEMENT OF THE ADULT
PATIENT WITH DIABETES**

May 2012

Association of Surgeons of Great Britain and Ireland

ISSUES IN PROFESSIONAL PRACTICE

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This document is an abridged and modified version of *Management of adults with diabetes undergoing surgery and elective procedures*. It has been edited specifically for the Association of Surgeons of Great Britain and Ireland with the full permission of NHS Diabetes.

The full and summary NHS Diabetes versions can be found on line at:

http://www.diabetes.nhs.uk/areas_of_care/emergency_and_inpatient/perioperative_management/

FOREWORD

Issues in Professional Practice (IIPP) is an occasional series of booklets published by the Association of Surgeons of Great Britain and Ireland to offer guidance on a wide range of areas which impact on the daily professional lives of surgeons. Some topics focus on clinical issues, some cover management and service delivery, whilst others feature broader aspects of surgical working life such as education, leadership and the law.

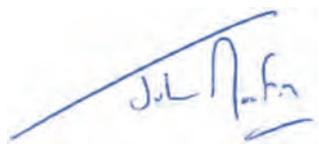
This IIPP focuses on **The peri-operative management of the adult patient with diabetes**. Diabetes affects at least 4% to 5% of people in the UK, with the prevalence in the UK in-patient population now ranging from 10% to 28%. Diabetes leads to increased morbidity and length of stay, thereby increasing in-patient costs, and the peri-operative mortality rate is reported to be up to 50% higher than that of the non-diabetic population.

Dileep Lobo and his team of subject-matter experts have produced recommendations for the peri-operative management of the adult patient with diabetes, covering all stages of the patient pathway from primary care referral to surgical outpatients, pre-operative assessment, hospital admission, surgery, post-operative care and discharge. Although these guidelines are primarily intended for the management of adult patients with diabetes referred for elective surgery, most of the recommendations can be applied to the patient presenting for emergency surgery with the proviso that many such patients are high risk and are likely to require an intravenous insulin infusion.

This document is an abridged and modified version of *Management of adults with diabetes undergoing surgery and elective procedures*. It has been edited specifically for the Association of Surgeons of Great Britain and Ireland with the full permission of NHS Diabetes, to whom we are most grateful.

The Association hopes that this publication, and others in the series (all accessible at: www.asgbi.org.uk/publications), will provide concise advice and guidance on major current issues, and grow into a helpful and accessible resource to support your professional practice.

Suggestions for any potential topics for future booklets in the *Issues in Professional Practice* series would be welcome.



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COMPREHENSIVE CARE PATHWAY FOR PERI-OPERATIVE MANAGEMENT OF THE ADULT PATIENT WITH 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 guidelines are primarily intended for the management of adult 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 high risk and are likely to require an intravenous insulin infusion.

MAIN RECOMMENDATIONS

Organisation and planning of care

1. 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.
2. The patient should be involved in planning for all stages.
3. Hospital patient administration systems should be able to identify all patients with diabetes so they can be prioritised on the operating list to allow for minimum starvation time.
4. High-risk patients (poor glycaemic control/complications of diabetes) should be identified in surgical outpatients or at pre-operative assessment, and plans should be put in place to manage their risk.
5. Early pre-operative assessment should be arranged to determine a peri-operative diabetes management strategy and to identify and optimize other co-morbidities.
6. Routine overnight admission for pre-operative management of diabetes should not be necessary.
7. 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.
8. The patient should resume diabetes self management as soon as possible where appropriate.
9. A policy which includes plans for diabetes management should be in place for safe discharge.
10. Processes and outcomes should be audited regularly.

Diabetes specialists

11. Clear guidelines should indicate when the diabetes specialist team should become involved.
12. All hospitals should implement a Diabetes Inpatient Specialist Nurse (DISN) service with 1.0 WTE per 300 beds.

Peri-operative use of intravenous insulin

13. The term 'variable rate intravenous insulin infusion' (VRIII) should replace the ambiguous term 'sliding scale'.
14. 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.
15. Patients expected to miss more than one meal should have a VRIII.
16. The recommended first choice substrate solution for a VRIII is 0.45% sodium chloride with 5% glucose and either 0.15% potassium chloride (KCl) or 0.3% KCl.
17. Insulin should be prescribed according to National Patient Safety Agency (NPSA) recommendations for safe use of insulin.

Peri-operative blood glucose monitoring

18. Capillary blood glucose (CBG) concentrations should be monitored and recorded at least hourly during the procedure and in the immediate postoperative period.
19. Hospitals should have clear guidelines for the management of blood glucose when it is outside the acceptable range.
20. The WHO surgical safety checklist bundle should be implemented. The target blood glucose should be 6-10 mmol/L (acceptable range 4-12 mmol/L).

INTRODUCTION

Diabetes affects at least 4-5% of people in the UK, with the prevalence in the UK in-patient population now ranging from 10-28%.

Diabetes leads to increased morbidity and length of stay, thereby increasing in-patient costs. The peri-operative mortality rate is reported to be up to 50% higher than that of the non-diabetic population [1]. The reasons for these adverse outcomes are multifactorial but include:

- hypo- and hyperglycaemia [1-3]
- multiple co-morbidities including microvascular (nephropathy and neuropathy) and macrovascular complications (stroke and myocardial infarction) [4-10]
- 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
- failure to appreciate that patients with diabetes need a higher level of care [4, 11, 12]

The patient experience

Two recent reports, by the Health Care Commission and Diabetes UK, on patients' experience of inpatient care have highlighted a number of issues [13, 14]:

- lack of care planning
- communication failures
- 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, thereby increasing the risk of management errors during the admission [15-17].

Lack of institutional guidelines for management of diabetes

Not all hospitals have comprehensive guidelines for management of glycaemia in inpatients, and many lack a strategy for achieving good glycaemic control [18, 19]. Poor glycaemic control increases morbidity with high risk of postoperative infection [1].

Poor knowledge of diabetes amongst staff delivering care

Despite the knowledge of diabetes and its management is poor amongst both medical and nursing staff, they are often 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 multiple and complex drug regimes with high potential for error. In particular, insulin therapy has a narrow margin of safety and is included in the list of top high alert medicines worldwide ^[20, 21].

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 ^[22]. 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 wherever possible. Those requiring insulin should have access to the same formulation of insulin 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.
- Ward staff should ensure that blood glucose concentrations 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 “**ThinkGlucose**” campaign of the NHS Institute for Innovation and Improvement highlights several key areas for improvement in the care of in-patients with diabetes ^[17]. Diabetes UK has also produced guidance for patients in the document *Diabetes care in hospital: What care to expect during your hospital stay* ^[23].

THE METABOLIC RESPONSE TO STARVATION AND SURGERY AND THE EFFECT OF DIABETES

Metabolic effects of starvation and surgery

Surgery is frequently accompanied by a period of starvation, both of which induce a catabolic state ^[24]. This can be attenuated in patients with diabetes by an infusion of insulin and glucose (approximately 180g/day) ^[25,26]. However, hypoglycaemia can also stimulate secretion of counter-regulatory hormones and exacerbate the catabolic response.

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 ^[24]. 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.

Insulin should never be stopped in people with Type 1 diabetes

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

When a VRIII is used, insulin and glucose should be infused continuously. If an intravenous insulin infusion is stopped, there is a serious risk of developing ketonaemia and ketoacidosis within a few minutes. This can be prevented by either continuing their long acting subcutaneous insulin whilst on their intravenous insulin, or administering subcutaneous insulin about 30 to 60 minutes prior to discontinuing the intravenous insulin infusion.

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 postoperative infection across a variety of surgical specialties ^[1,27].

GUIDELINES FOR PERI-OPERATIVE DIABETES CARE

For these guidelines to work effectively, complete and accurate information needs to be communicated by staff at each stage to staff at the next. Wherever possible, the patient should be included in all communications and the management plan should be devised in agreement with the patient.

The diabetes specialist team 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 in-patients with diabetes and the need to assess patient satisfaction with the service they receive. It concludes that in-patient diabetes services could be improved by a diabetes in-patient specialist nurse (DISN) service, supported by diabetologists [28].

A DISN service has been shown to reduce the length of stay for patients with diabetes, whatever the reason for admission [29-32]. 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 [33]. Diabetes UK recommends that all trusts should implement such a DISN service, at a level of 1.0 whole time equivalents per 300 beds.

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 [34,35]. 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 [36].

Iatrogenic complications from errors of insulin prescribing are common [37-39]. As a result of these issues, and the 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 (see **Box 2**) [40], as well as the NPSA issuing Rapid Response Reports on the safe prescribing of insulin [20,41].

NHS Diabetes has developed e-learning packages for the safe use of insulin. And for the safe use of intravenous insulin. These modules have become mandatory in some UK hospitals. They can be accessed at: http://www.diabetes.nhs.uk/safe_use_of_insulin/

BOX 2

Insulin Never Events

A 'Never Event' with respect to insulin is death or severe harm as a result of maladministration of insulin by 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, eg. an insulin syringe or insulin pen, to draw up or administer insulin, or
- Fails to give insulin when correctly prescribed.

Strategies to maintain glycaemic control

Classically, glycaemic control has been achieved with concurrent administration of intravenous infusions of insulin and glucose. During the 1980s this was using the 'GIK' (Alberti) regimen ^[26], but more recently, the insulin has been delivered independently using a VRIII, however, this is not without its complications (see **Box 3**). These include:

BOX 3

Adverse events associated with insulin/glucose infusions

- Hyponatraemia.
- Ketoacidosis – potentially fatal – resulting 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 overdosage resulting from miscalculation or mis-preparation 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.
- Delayed establishment of the VRIII.
- Delays and difficulties in transferring back to the patient's normal regimen from an insulin infusion may prolong length of stay ^[13, 14].

Due to these and other issues, many units are now successfully managing the peri-operative glucose control in the elective surgical patient by manipulating patients' usual diabetes medication. Provided the starvation period is short and other criteria are fulfilled ^[42-46] (see **Box 4**). However the VRIII does have the following advantages:

- Flexibility for independent adjustment of fluid and insulin.
- Accurate delivery of insulin via syringe driver.
- Allows tight blood glucose control in the intraoperative starvation period when used appropriately.

BOX 4**Factors influencing the choice of peri-operative diabetes management**

- Duration of starvation.
- Timing of surgery /procedure (am or pm).
- 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.

Safe use of variable rate intravenous insulin infusions (VRIII)

VRIIIs are over-used in the peri-operative setting. Patients often return to surgical wards from theatre with an intravenous insulin infusion in place, but no directions for its withdrawal. Written guidelines for conversion from the VRIII to the usual diabetes treatment may not be available. Doctors are often unaware of how to do this, and infusions are continued or discontinued inappropriately. Continuing a VRIII while a patient is eating often results in poor glycaemic control and the VRIII should be withdrawn once the patient is able to eat and drink normally. 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 6* provides guidelines for transfer from a VRIII to subcutaneous insulin or oral therapy. Treatment requirements may differ from usual in the immediate post-operative period, where there is a risk of both hypo and hyperglycaemia, and clinical staff may need to take decisions about diabetes management. **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.**

Diabetes and the Enhanced Recovery Partnership Programme

Enhanced recovery of patients undergoing surgery is a relatively new concept in the UK ^{147, 481} and the Enhanced Recovery Partnership Programme has particular relevance for patients with diabetes ^{149, 501}. 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 (see *Box 5*).

BOX 5

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.

Footnote to box 5

Use of oral carbohydrate loading

The Enhanced Recovery Partnership Programme recommends the administration of high carbohydrate drinks prior to surgery. This may compromise blood glucose control and is not recommended for people with insulin treated diabetes.

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.

Action plan

1. Provide the current HbA1c, blood pressure and weight measurements with details of relevant complications and medications in the referral letter (see **Box 6**).
2. Optimise glycaemic control before referral if possible.
3. Consider referral to the diabetes specialist team for advice if HbA1c is greater than 69 mmol/mol (8.5%) (see **Controversial areas**, page 22). A high HbA1c is an indication for intensive blood glucose control, but it may not be realistic to delay referral until the HbA1c has been repeated.
4. Patients with hypoglycaemic unawareness should be referred to the diabetes specialist team irrespective of HbA1c.
5. Optimise other diabetes related co-morbidities.

BOX 6

Minimum data required from GP when referring a patient for surgery/procedures

- 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:
 - BMI
 - BP
 - HbA1c
 - 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.
- Avoid overnight pre-operative admission to hospital wherever possible.

Action plan

1. Systems should be in place to allow early preoperative 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 ^[51] (see *Appendix 1*).
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 (examples can be found in the full monograph at http://www.diabetes.nhs.uk/areas_of_care/emergency_and_inpatient/perioperative_management/)
5. The surgeon in the outpatient clinic should avoid scheduling patients with diabetes for an evening list.
6. Plan duration of stay and make preliminary discharge arrangements considering individual needs. This may need to involve the primary care team.

Order and times of lists

Many considerations determine the order of the operating lists. One of the most important goals in the management of the surgical patient with diabetes is to minimise the starvation time to promote early resumption of normal diet and normal medication at the normal time. Therefore, it is recommended that elective surgical patients with diabetes are 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 22).

Pre-operative assessment

Aims

- Ensure that glycaemic control is optimised prior to surgery.
- 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 perioperative period e.g. bridging therapy for warfarin, renal replacement therapy.
- Establish whether the patient can be safely managed with manipulation of their usual diabetes medication or if they need a VRIII.
- Identify high-risk patients requiring critical care management.
- Ensure that the patients know how to manage their diabetes prior to admission.

Action plan

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 ¹³³. This should include all patients with hypoglycaemia unawareness and those on a continuous subcutaneous insulin infusion (CSII), and may also include those with HbA1c greater than 69 mmol/mol (8.5%) (see *Controversial areas*, page 22).
 - c. Identify other co-morbidities with referral to the appropriate team for optimisation where necessary.
 - d. Plan in-patient admission including:
 - i. timing of admission
 - ii. location
 - iii. timing of surgery
 - iv. pre-admission management of medications
 - v. availability of usual insulin (patient may need to bring their own if it is non formulary)
 - vi. plans for Enhanced Recovery Partnership Programme in the context of diabetes
 - 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.
 - g. Plan initial pre-operative management of diabetes.
 - h. Ensure that admission ward staff are appraised of plans and able to activate them on the day of admission.

3. Ensure that the patient is given appropriate written instructions on how to manipulate their diabetes medications prior to admission and other instructions related to diabetes related precautions. Examples of these can be found in Appendices 8 and 9 the on line main document at:

http://www.diabetes.nhs.uk/areas_of_care/emergency_and_inpatient/perioperative_management/

Responsibility for optimisation of glycaemic control

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. Local policies should be followed.

Anticipated short starvation period (only one missed meal)

Patients with good control (HbA1c less than 69 mmol/mol, 8.5%) who are undergoing surgery with a short starvation period should be managed according to these guidelines, with modification of their usual diabetes medications (see *Appendices 1 and 2*).

Anticipated starvation period more than one missed meal

Most of these patients will require a VRIII. Written guidelines should be in place to ensure safe use ^[18, 21] (see *Appendix 5*).

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 (HbA1c less than 69 mmol/mol, 8.5%) – discuss with the diabetes team if the HbA1c is above this target.
- 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 concentrations below 4 mmol/L should be treated as hypoglycaemia 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.
- 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.

Hospital admission

Aims

- Minimise the metabolic consequences of starvation and surgical stress.
- Maintain optimal blood glucose control throughout the admission.
- Prevent hospital acquired foot pathology.

Action plan

1. Base management on Enhanced Recovery Partnership Programme principles but omit the pre-operative high carbohydrate drink in people with insulin treated diabetes.
2. Institute the pre-agreed diabetes treatment pathway.
3. 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 VRIII is required.
4. Monitor CBG concentrations 1 – 2 hourly.
5. CBG target ranges are controversial. Aim for CBG between 6-10 mmol/L but 4-12 mmol/L is acceptable, avoiding wide swings.
6. Consider continuation of long-acting analogues (Glargine/Lantus®, Detemir/Levemir®) alongside the VRIII during the peri-operative period. This is generally recommended but local policies should be adhered to (see *Controversial areas*, page 22).

7. Prescribe and administer insulin according to NPSA guidance [20,41].
8. Involve the diabetes specialist team if blood glucose targets are not achieved.
9. Identify high risk feet and provide pressure relief where necessary. Avoid use of anti-embolism stockings where contraindicated.
10. Ensure that preparation for discharge is ongoing.

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.
- Maintain blood glucose concentrations between 6-10 mmol/L where possible (acceptable range 4-12 mmol/L).
- Optimise intravascular volume status.
- Maintain serum electrolytes within the normal ranges.

Recommendations

There is limited evidence on which to base recommendations for optimal fluid and insulin management in the adult diabetic patient undergoing surgery. 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.

Guidelines for setting up a VRIII are provided in *Appendix 5*. The recent **British Consensus Guidelines for Intravenous Fluid Therapy for the Adult Surgical Patient (GIFTASUP)** provides further excellent detailed guidance [52].

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 ^[52].
- Glucose containing solutions should be avoided unless the blood glucose is low.

Emergency surgery

By definition, there will be no opportunity for pre-admission planning. The blood glucose concentration should be closely monitored and if it rises above 10 mmol/L a VRIII should be commenced and continued until the patient is eating and drinking. It is recommended that if the patient is taking long acting insulin analogues (e.g. levemir or glargine), then these need to be continued along with the VRIII.

The HbA1c should be measured to assess the level of preadmission 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.

Theatre and recovery

Aims

- Maintain good glycaemic control throughout.
- 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.

Action plan

1. Implement the WHO surgical safety checklist bundle with target blood glucose 6-10 mmol/L (acceptable range 4-12 mmol/L).
2. Check the CBG prior to induction of anaesthesia/sedation and at least hourly thereafter. Hypoglycaemia sometimes manifests as drowsiness, which may be wrongly attributed to sedation.
3. Maintain the blood glucose in the target range.
4. Consider the use of individualised goal directed therapy ^[52].
5. Ensure arrangements are in place to admit high risk patients to critical care if necessary.
6. Implement the Enhanced Recovery Partnership Programme, including the use of regional and local anaesthesia where appropriate.

Post-operative care

Aims

- Ensure glycaemic control and fluid and electrolyte balance are maintained.
- Optimise pain control.
- Encourage an early return to normal eating and drinking, facilitating return to the usual diabetes regimen.
- Follow the principles of the Enhanced Recovery Partnership Programme.
- Avoid iatrogenic injury.

Action plan

1. Staff skilled in diabetes management should be available for timely input and advice.
2. Allow patients to self-manage their diabetes as soon as possible, where appropriate.
3. Monitor electrolytes and fluid balance daily and prescribe appropriate fluids.
4. Maintain CBG in the acceptable range.
5. Treat post-operative nausea and vomiting to promote normal feeding.
6. Maintain meticulous infection control.
7. Inspect foot and pressure areas regularly ^[53].

Discharge

Aims

- Ensure early discharge determined by pre-agreed clinical and social criteria.
- Ensure that factors likely to delay discharge are identified at surgical outpatients or 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.

Action plan

1. Identify whether the patient has simple or complex discharge planning needs and plan how they will be met.
2. Involve the diabetes specialist team if diabetes related delays in discharge are anticipated.
3. Discharge should not be delayed solely because of poor glucose control.

4. Systems should be in place to ensure effective communication with community teams, particularly if changes to the patients' preoperative diabetes treatment have been made during the hospital stay.
5. 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.
6. Ensure that patients are given a copy of the 'Sick Day Rules' (see *Appendix 7*)

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 ¹⁵⁴. 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.

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. However, several studies have shown that permissive hyperglycaemia may be detrimental ^{155 - 60}.

In the virtual absence of clinical studies in general surgery, and considering the basic biological data on the harmful effects of hyperglycaemia ¹⁶¹, it is reasonable to recommend that blood glucose should be maintained in the range 6 to 10 mmol/L¹⁶² if this can be achieved safely. A range from 4-12 mmol/L is acceptable. These targets also reduce the risk of variability in blood glucose, which is more likely to occur if the target is less than 6.1 mmol/L and has been associated with worse outcomes ¹⁶³.

Is an elevated pre-operative HbA1c associated with adverse outcomes following a range of surgical procedures?

There is evidence that good control pre-operatively, as measured by the HbA1c level is associated with improved outcomes after a range of non-cardiac surgical procedures ^{11, 64}. In a recent study of patients undergoing hip and knee arthroplasty, patients with uncontrolled diabetes assessed by HbA1c had a significantly increased risk of

surgical and systemic complications, higher mortality, and increased length of stay ¹⁶⁵. Elevated pre-operative HbA1c has been related to adverse outcomes following spinal surgery ¹⁶⁶, vascular surgery ¹⁶⁷, colorectal surgery ¹⁶⁸, and cardiac surgery ¹⁶⁹.

What is the acceptable upper limit of HbA1c for patients undergoing elective surgery?

There is insufficient evidence to recommend an upper limit of HbA1c prior to elective surgery and the risks associated with poor glycaemic control should be balanced against the necessity for surgery. An upper limit between 64-75 mmol/mol (8 and 9%) is acceptable, depending on individual circumstances. For many patients a lower target HbA1c 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.

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 ¹⁷⁰⁻⁷⁸¹. 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 ¹⁷⁹.

Aims of fluid therapy for the patient with diabetes

Major surgery or prolonged starvation (more than one 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 concentration between 6-10 mmol/L (4-12 mmol/L is acceptable),
- maintenance of euvolaemia ¹⁵²,
- maintenance of serum electrolytes within the normal range.

The daily requirement of the *healthy* adult is 60-100 mmol of sodium, 40-80 mmol of potassium, and 1.5-2.5 litres of water ¹⁸⁰. 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 ¹⁵². Patients with diabetes require 180g glucose per day, and additional potassium is required to prevent hypokalaemia when glucose and insulin are co-administered. Supplements of magnesium, calcium and phosphate may also be necessary ¹²⁵.

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.

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 ^{181, 82},
- minimum cannulae and pumps required.

Following the recent National Patient Safety Agency (NPSA) alert number 22 ¹⁸¹, many paediatric units now use 0.45% saline with 5% glucose with additional potassium chloride as their 'default' fluid ^{174, 83}. In the diabetic paediatric population undergoing surgery this fluid is run alongside a continuous variable intravenous insulin infusion.

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.

BOX 7

Advantages of 0.45% saline with 5% glucose solution

- Low incidence of electrolyte disturbances.
- Constant supply of substrate (glucose) minimizes 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.

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 ¹⁵². It has been suggested that administration of Hartmann's solution to patients with Type 2 diabetes, may lead to hyperglycaemia ¹⁸⁴. However, one litre of Hartmann's solution would yield a maximum of 14.5 mmol of glucose and even rapid infusion of a litre of Hartmann's solution would increase the plasma glucose by no more than 1 mmol/L⁸⁵. Thus, Hartmann's solution is not contraindicated in people with diabetes.

Long acting insulin analogues

Perioperative use of long acting insulin analogues

Many units advocate the continuation of long acting insulin analogues (glargine/Lantus® or 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 lack of basal insulin can lead to hyperglycaemia and even ketoacidosis when the VRIII is withdrawn.

There is debate amongst diabetes teams as to whether the dose of long acting insulin analogues should be reduced by one third or maintained at the usual level. Local advice should be sought.

Prevention of pharmacological iatrogenic incidents

This section deals with medications other than insulin (see *Safe use of insulin*, page 12).

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 contraindications to or interactions between prescribed medication.

Drugs associated with iatrogenic incidents

Metformin

Metformin is renally excreted. Renal failure may lead to high plasma concentrations which, if greater than 5 mcg/ml, are associated with an increased risk of lactic acidosis ¹⁸⁶.

This guideline recommends that, for patients undergoing a short starvation period (one missed meal only), metformin can be continued unless patient is on a three-times-per-day regimen, when the middle dose should be omitted. In renal impairment metformin should be

stopped when the preoperative fast begins and restarted post-operatively once the patient is eating again.

Prescribers must, however, be aware of the dangers of co-administration of potentially nephrotoxic agents, and patients discharged early after surgical intervention need to know when to seek medical help should they become unwell.

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 has recently been produced by the Royal College of Radiologists ¹⁸⁷¹ recommending that there is no need to stop metformin after contrast has been administered in patients with a normal serum creatinine and/or eGFR of >50ml/min/1.73m². If the serum creatinine is above the reference range, or the eGFR is below 50ml/min/1.73m², the need to stop the metformin should be discussed with the referring clinician.

Audit standards

Institutional Standards:	
Indicator	Standard
Access:	
Has the Trust either adopted these national guidelines or 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 the National DISN group (1.0 WTE per 300 beds)?	Yes

Institutional accountability and integrity:	
Does the Trust have a clinical lead for peri-operative care for people with diabetes with responsibility for implementation of peri-operative guidelines?	Yes

NPSA standards	
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%
All clinical areas and community staff treating patients with insulin have adequate supplies of insulin syringes and subcutaneous needles, which they can obtain at all times.	100%
An insulin pen is always used to measure and prepare insulin for an intravenous infusion.	100%
A training programme is 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	
Indicator	Standard
Death or severe harm as a result of maladministration of insulin by a health professional.	Never

Local standards:	
Indicator	Standards
Access:	
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%
Safety, Quality, and effectiveness during the patient journey:	
Percentage of primary care referrals containing all suggested information (<i>Appendix 12</i> in the main NHS Diabetes document).	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 peri-operative 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 that are listed on the first third of the operating list (morning or afternoon lists).	95%
Percentage of people in whom a VRIII is established with correct configuration of the one-way and antisiphon 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 that 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 blood glucose concentrations kept between 6 to 10 mmol/L (although 4 to 12 is acceptable) during their admission.	100%
Percentage of patients with evidence of poor peri-operative glycaemic control: <ul style="list-style-type: none"> • Diabetic ketoacidosis • Hyperosmolar hyperglycaemic state • Hypoglycaemia requiring 3rd party assistance 	0%

Percentage of patients where their discharge is delayed because of diabetes related problems.	0%
Institutional accountability and integrity:	
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%
Patient and Staff Satisfaction:	
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%

APPENDIX 1:

Guideline for peri-operative adjustment of insulin (short starvation period – no more than ONE missed meal)

Insulins	Day prior to admission	Day of Surgery	
		Patient for AM surgery	Patient for PM surgery
Once daily (evening) (e.g. Lantus® or Levemir®. Insulatard® Humulin I®) Insuman®)	No dose change*	Check blood glucose on admission	Check blood glucose on admission
Once daily (morning) (Lantus® or Levemir® Insulatard® Humulin I®) Insuman®)	No dose change	No dose change* Check blood glucose on admission	No dose change* Check blood glucose on admission
Twice daily (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
Twice daily - separate injections of short acting (e.g. animal neutral, Novorapid® Humulin S®) Apidra® and intermediate acting (e.g. animal isophane Insulatard® HumulinI® 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

<p>3, 4 or 5 injections daily</p>	<p>No dose change</p>	<p>Basal bolus regimens: omit the morning and lunchtime short acting insulins. Keep the basal unchanged.*</p> <p>Premixed AM insulin: halve the morning dose and omit lunchtime dose. Check blood glucose on admission</p>	<p>Take usual morning insulin dose(s). Omit lunchtime dose. Check blood glucose on admission</p>
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* Some units would advocate reduction of usual dose of long acting analogue by one third. This reduction should be considered for any patient who ‘grazes’ during the day (see *Controversial areas*, page 22).

Perioperative hyperglycaemia and hypoglycaemia: follow guidelines 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 (short starvation period – no more than ONE missed meal)

Tablets	Day prior to admission	Day of Surgery	
		Patient for AM surgery	Patient for PM surgery
Acarbose	Take as normal	Omit morning dose if NBM	Give morning dose if eating
Meglitinide (repaglinide or nateglinide)	Take as normal	Omit morning dose if NBM	Give morning dose if eating
Metformin (procedure not requiring use of contrast media*)	Take as normal	Take as normal	Take as normal
Sulphonylurea (e.g. Glibenclamide, Gliclazide, Glipizide, etc.)	Take as normal	Once daily am omit. Twice daily omit am	Once daily am omit. Twice daily omit am
Pioglitazone	Take as normal	Take as normal	Take as normal
DPP IV inhibitor (e.g. Sitagliptin, Vildagliptin, Saxagliptin, Linagliptin)	Take as normal	Omit on day of surgery	Omit on day of surgery
GLP-1 analogue (e.g. Exenatide, Liraglutide)	Take as normal	Omit on day of surgery	Omit on day of surgery

NBM nil by mouth
 OD once daily
 BD twice daily
 TDS three times daily
 AM morning
 PM afternoon

* If contrast medium is to be used and eGFR less than 50 ml/min/1.73m², metformin should be omitted on the day of the procedure and for the following 48 hours.

APPENDIX 3:

Guidelines for suitability of patients with diabetes for day case surgery.

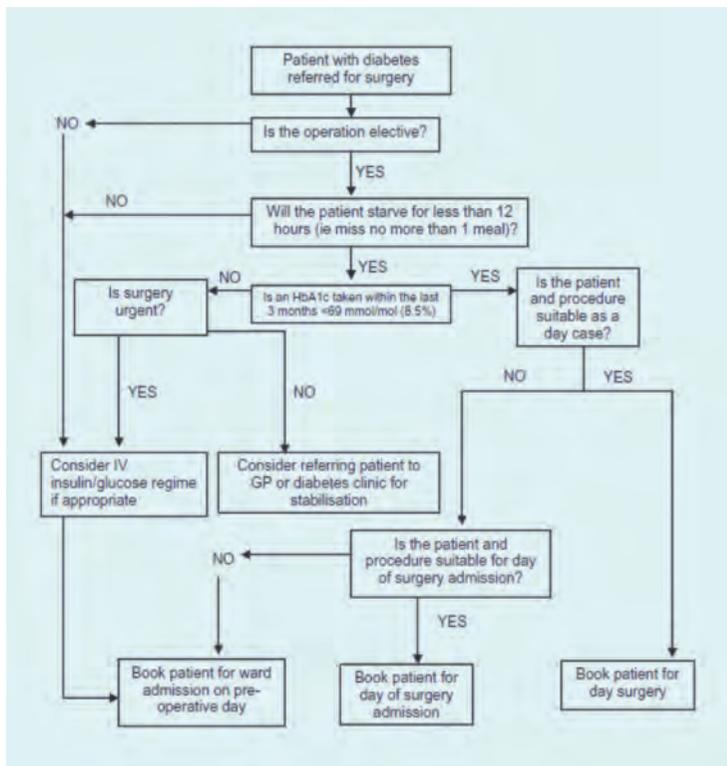
Patients with diet controlled diabetes are all suitable for day case surgery if the procedure itself is suitable for day surgery and all other criteria are fulfilled.

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

- they fulfill all day case criteria,
- they can be first/early on a morning or afternoon list.

See the algorithm below for guidance.

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



APPENDIX 4:

Guideline for 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 (HbA1c <69 mmol/mol or 8.5%) undergoing surgery with a short starvation period.
- Medication should be managed as in *Appendix 1* or *Appendix 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. Aim for blood glucose concentration 6-10 mmol/L; 4-12 mmol/L is acceptable.

Management of hyperglycaemia

- **Blood glucose greater than 12 mmol/L either pre or post surgery**
 - Check capillary ketone levels using an appropriate bedside monitor if available.
 - If capillary blood ketones are greater than 3 mmol/L or urinary ketones greater than +++ cancel surgery, follow DKA guidelines and contact the diabetes specialist team or the on-call medical team for advice.
- **Pre-operative hyperglycaemia:** (blood glucose greater than 12 mmol/L with blood ketones less than 3 mmol/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 blood glucose by 3 mmol/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. If surgery cannot be delayed commence 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 VRIII.

- **Post-operative hyperglycaemia** (blood glucose greater than 12 mmol/L with blood ketones less than 3 mmol/L or urine ketones less than +++)

Type 1 diabetes: give subcutaneous rapid acting analogue insulin. Assume that 1 unit will drop blood glucose by 3 mmol/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 12 mmol/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 later to ensure it is falling. Repeat the subcutaneous insulin after 2 hours if the blood glucose is still above 12 mmol/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

- To avoid peri-operative hypoglycaemia, consider the potential for hypoglycaemia if the admission capillary blood glucose is less than 6 mmol/L and respond as below. **NB** patients on diet alone are not at risk of hypoglycaemia and are excluded from the guideline below:
 - If CBG is 4-6 mmol/L and the patient has symptoms of hypoglycaemia: Consider giving 50-100mls of 10% dextrose as a stat iv bolus and repeat the CBG after 15minutes.
 - If CBG is less than 4 mmol/L; give 80- 100 mls of 20% glucose and repeat the blood glucose after 15 minutes.
 - Try to avoid stopping the VRIII in patients with Type 1 diabetes. If it is stopped, recommence as soon as the blood glucose rises above 5 mmol/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 Hypoglycaemia Guidelines** ^[88], 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 normoglycaemia (ideally, blood glucose concentrations between 6-10 mmol/L, although 4 to 12 mmol/L is acceptable).

Principles

- There is no “one size fits all”.
- **If the patient is already on a long acting insulin analogue (e.g. Levemir® or Lantus®) these should be continued (see *Controversial areas*, page 22 of the full document).**
- 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 initially to ensure that the intravenous insulin infusion rate is correct.
- If the blood glucose remains over 12 mmol/L for 3 consecutive readings and is not dropping by 3 mmol/L/hr or more, the rate of insulin infusion should be increased.
- If the blood glucose is less than 4 mmol/L, the insulin infusion rate should be reduced to 0.5 units per hour, and the low blood glucose should be treated as per the **National Guideline for the Management of Hypoglycaemia in Adults with Diabetes** ^[88] irrespective of whether the patient has symptoms. However, if the patient has continued on their long acting background insulin, then their VRII 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. two or more missed meals).
- Decompensated diabetes.

Administration

- Make up a 50 ml syringe with 50 units of soluble human insulin 49.5 ml of 0.9% sodium chloride solution. This makes the concentration of insulin 1 unit/ml.
- The initial crystalloid solution to be co-administered with the VRIII is 0.45% saline with 5% glucose and 0.15% KCl. This should be given via an infusion pump.

- Subsequently, the substrate solution to be used alongside the VR88 should be selected from:
 - 0.45% saline with 5% glucose and 0.15% KCl, or
 - 0.45% saline with 5% glucose and 0.3% KCl.
- Selection should be based on serum electrolytes which must be measured daily.
- Very occasionally, the patient may develop hyponatraemia without overt 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, or
 - 0.9% saline with 5% glucose and 0.3% KCl.
- 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).

Caution: do not infuse insulin without substrate unless in ITU/HDU setting.

Rate of insulin infusion

Bedside capillary blood glucose (mmol/L)	Initial rate of insulin infusion (units per hour)
<4.0	0.5 (0.0 if a long acting background insulin has been continued)
4.1 – 7.0	1
7.1 – 9.0	2
9.1 – 11.0	3
11.1 – 14.0	4
14.1 – 17.0	5
17.1-20	6
>20	Seek diabetes team or medical advice

If increased doses of insulin are consistently being required (blood glucose above 15 and not falling) advice should be sought from the specialist diabetes team.

Guidelines for setting up a variable rate intravenous insulin infusion

- Intravenous fluid must be administered using a volumetric infusion pump.
- 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 6-10 mmol/L (acceptable range 4-12 mmol/L).
- 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 200 mmol/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 recent **British Consensus Guidelines for Intravenous Fluid Therapy for the Adult Surgical Patient (GIFTASUP)** provides further detailed guidance ^[52].

APPENDIX 6: 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 50 mls/min/1.73m².

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 postoperative stress, infection or altered food intake.
- Consult the diabetes specialist team if the blood glucose concentrations are outside the acceptable range (4-12 mmol/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® 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 some form of 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 concentrations 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 injections

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') or insulin naïve.

Patients on a continuous subcutaneous insulin infusion, or previously insulin naïve, should be referred to the diabetes inpatient specialist team.

APPENDIX 7: 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 two hours, day and night.
- **TEST** your urine for ketones every time you go to the toilet, or your blood ketones every two hours if you have the equipment to do this.
- **DRINK** at least 100 mls water/sugar free fluid every hour – you must drink at least 2.5 litres per day during illness (approximately 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:
 - 400 mls milk.
 - 200 mls carton fruit juice.
 - 150-200 mls 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 four hours or more.
- **HIGH** blood glucose levels with symptoms of illness (above 15 mmol/L - you may need more insulin).
- **KETONES** at ++2 or +++3 in your urine or 1.5 mmol/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.

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