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Diabetes UK Position Statements and Care Recommendations

NHS Diabetes guideline for the perioperative management of the adult patient with diabetes*

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Abstract

These Joint British Diabetes Societies guidelines, commissioned by NHS Diabetes, for the perioperative management of the adult patient undergoing surgery are available in full in the Supporting Information.

This document goes through the seven stages of the patient journey when having surgery. These are: primary care referral; surgical outpatients; preoperative assessment; hospital admission; surgery; post-operative care; discharge. Each stage is given its own considerations, outlining the roles and responsibilities of each group of healthcare professionals. The evidence base for the recommendations made at each stage, discussion of controversial areas and references are provided in the report.

This document has two key recommendations. Firstly, that the management of the elective adult surgery patients should be with modification to their usual diabetes treatment if the fasting is minimized because the routine use of a variable rate intravenous insulin infusion is not recommended. Secondly, that poor preoperative glycaemic control leads to post-outcomes and thus, where appropriate, needs to be addressed prior to referral for surgery.

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Keywords diabetes, guidelines, perioperative management, surgery, variable rate intravenous insulin infusion

Summary of key points

Organization and planning of care

K1. Careful planning, taking into account the specific needs of the patient with diabetes, is required at all stages of the patient pathway from general practitioner referral to post-operative discharge.

K2. The patient should be involved in planning for all stages.

K3. Hospital patient administration systems should be able to identify all patients with diabetes so they can be prioritized on the operating list.

K4. High-risk patients (poor glycaemic control/complications of diabetes) should be identified in surgical outpatients or at preoperative assessment and plans should be put in place to manage their risk.

K5. Early preoperative assessment should be arranged to determine a perioperative diabetes management strategy and to identify and optimize other co-morbidities.

K6. Routine overnight admission for preoperative management of diabetes should not be necessary.

K7. Starvation time should be minimized by prioritizing patients on the operating list.

K8. Surgical and anaesthetic principles of the Enhanced Recovery Partnership Programme should be implemented to promote earlier mobilization, with

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*This document is an abridged and modified version of Management of Adults with Diabetes Undergoing Surgery and Elective Procedures: Improving Standards. It has been adapted specifically for Diabetic Medicine.

This article [NHS Diabetes guideline for the perioperative management of the adult patient with diabetes] was written by [K. Dhatariya, N. Levy, A. Kilvert, B. Watson, D. Cousins, D. Flanagan, L. Hilton, C. Jairam, K. Leyden, A. Lipp, D. Lobo, M. Sinclair-Hammersley and G. Rayman] of NHS UK. It is published with the permission of the Controller of HMSO and the Queens Printer for Scotland.

resumption of normal diet and return to usual diabetes management.

K9. Multi-modal analgesia should be combined with appropriate anti-emetics to enable an early return to normal diet and usual diabetes regimen.

K10. The patient should resume diabetes self management as soon as possible where appropriate.

K11. A policy which includes plans for diabetes management should be in place for safe discharge.

K12. Outcomes should be audited regularly.

Diabetes specialists

K13. Clear guidelines should indicate when the diabetes specialist team should become involved.

K14. All hospitals should implement a Diabetes Inpatient Specialist Nurse service.

Perioperative use of intravenous insulin

K15. The term 'variable rate intravenous insulin infusion' should replace the ambiguous term 'sliding scale'.

K16. 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 variable rate intravenous insulin infusion wherever possible.

K17. Patients expected to miss more than one meal should have a variable rate intravenous insulin infusion.

K18. The recommended first-choice substrate solution for a variable rate intravenous insulin infusion is 0.45% sodium chloride with 5% glucose and either 0.15% potassium chloride or 0.3% potassium chloride.

K19. Insulin should always be prescribed according to National Patient Safety Agency recommendations for safe use of insulin.

Perioperative blood glucose monitoring

K20. Capillary blood glucose levels should be monitored and recorded at least hourly during the procedure and in the immediate post-operative period.

K21. Hospitals should have clear guidelines for the management of blood glucose when it is outside the acceptable range.

K22. Training for blood glucose measurement and diabetes management should be introduced for clinical staff caring for patients with diabetes.

K23. The World Health Organization 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 and affects more than 10% of people undergoing surgery [1]. Work has been previously been undertaken to try and raise standards of care for inpatients with diabetes [2–4].

Diabetes leads to increased morbidity and length of stay of the surgical patient. The perioperative mortality rate is reported to be up to 50% higher than that of the population without diabetes [5]. The reasons for these adverse outcomes are multifactorial but include:

- hypo- and hyperglycaemia [5–7];
- multiple co-morbidities, including microvascular and macrovascular complications [8–14];
- complex polypharmacy, including misuse of insulin [15];
- management errors when converting from the intravenous insulin infusion to usual medication;
- perioperative infection [5];
- failure to appreciate that patients with diabetes need a higher level of care [8,16,17];
- failure to identify patients with diabetes [2,18,19];
- lack of institutional guidelines for management of diabetes [5,20];
- poor knowledge of diabetes amongst staff delivering care.

The impact of surgery on diabetes

Surgery is frequently accompanied by a period of starvation, both of which induce a catabolic state [21]. This can be attenuated in patients with diabetes by an infusion of insulin and glucose [22,23].

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 [21]. 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.

Patients with diabetes are more susceptible to infection and poor perioperative glycaemic control has a significant impact on the risk of post-operative infection across a variety of surgical specialties [5,24].

The role of the diabetes inpatient specialist team

The Diabetes National Service Framework concluded that inpatient services could be improved by the provision of a diabetes inpatient specialist nurse service, supported by diabetologists [25].

A diabetes inpatient specialist nurse service has been shown to reduce the length of stay for patients with diabetes, whatever the reason for admission [26–29]. 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. Diabetes UK recommends that all trusts should implement such a diabetes inpatient specialist nurse service at a level of 1.0 whole time equivalent per 300 beds.

The diabetes specialist team can play a pivotal role through teaching, training and support, to ensure that other members of staff are able to facilitate the pathway.

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 inpatient environment [30,31]. One third of all inpatient medical errors leading to death within 48 h of the error involve insulin administration [32].

Iatrogenic complications from errors of insulin prescribing are common [33–35]. 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 2011–2012 [36], as well as the National Patient Safety Agency issuing Rapid Response Reports on the safe prescribing of insulin [15,37].

NHS Diabetes has recently launched an e-learning module for the safe use of intravenous insulin [38]. This will allow compliance with National Patient Safety Agency guidance [37].

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 glucose, insulin and potassium ('GIK') or 'Alberti' regimen [23], but more recently, the insulin has been delivered independently using a variable rate intravenous insulin infusion. The use of a variable rate intravenous insulin infusion does have advantages. These include:

- accurate delivery of insulin via syringe driver;
- allowing tight blood glucose control in the intra-operative starvation period when used appropriately;
- flexibility for independent adjustment of fluid and insulin.

However, the use of a variable rate intravenous insulin infusion together with infusion of a separate solution containing glucose and potassium is not without its potential complications. These include:

- delayed introduction of the variable rate intravenous insulin infusion;
- administration of insulin and/or glucose-containing solutions without an electronic infusion control device;
- incorrect setting of infusion pumps and syringe drivers;
- failure to monitor blood glucose regularly or to adjust the rate of insulin infusion if the blood glucose is consistently outside the target range;
- ketoacidosis, resulting from insulin omission in fasting patients, usually with Type 1 diabetes;
- severe hypoglycaemia, if glucose infusions or enteral feeds are discontinued but the insulin infusion is continued;
- subcutaneous insulin administered by the patient just prior to or at the same time as the variable rate intravenous insulin infusion is commenced, leading to hypoglycaemia;
- hyponatraemia;
- use of the wrong insulin protocol; hospitals may have several variable rate intravenous insulin infusion protocols for use in different circumstances;
- delays and errors in transferring back to the patient's normal regimen from an insulin infusion: this may prolong length of stay [39].

Because of these and other issues, many units are now successfully managing the perioperative glucose control in the elective surgical patient by manipulating the patient's usual diabetes medication [40]. Successful modification of the usual glucose-lowering agents can only be utilized if the starvation period is short and other criteria are fulfilled. These are listed in Box 1.

Safe use of variable rate intravenous insulin infusions

Variable rate intravenous insulin infusions are often poorly managed in the perioperative setting and thus require explicit guidelines [20,41]. See Appendix 5 and Appendix 7 of the Supporting Information for detailed guidance [42].

If the patient is normally treated with insulin, the variable rate intravenous insulin infusion should not be discontinued until a short -acting bolus has been given and background insulin is in place. See Appendix 7 of the Supporting Information, which provides guidance for transfer from a variable rate intravenous insulin infusion to subcutaneous insulin or oral therapy [42].

Treatment requirements may differ from usual in the immediate post-operative period where there is a risk of

Box 1 Factors favouring perioperative diabetes control by modification of usual glucose-lowering medications

- Good diabetes control prior to admission (HbA_{1c} < 69 mmol/mol, 8.5%)
- High probability that the patient will be capable of self managing their diabetes during the immediate post-operative period
- Short starvation period (only one missed meal)
- Surgery/procedure can be carried out early on a morning or afternoon list

glycaemic instability 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. Guidelines should be in place to ensure that the ward staff know when to call for specialist help.

Diabetes and the Enhanced Recovery Partnership Programme [43]

Enhanced recovery of patients undergoing surgery has particular relevance for patients with diabetes [44–46]. The ethos of the Enhanced Recovery Partnership Programme has been embraced by these guidelines and is summarized in Box 2.

Enhanced Recovery Partnership Programme and the 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

A pathway of care for elective surgery is shown in Fig. 1.

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 referral [47].

Action plan

1. Provide the current HbA_{1c}, blood pressure and weight measurements, with details of relevant complications and medications in the referral letter.
2. Optimize glycaemic control before referral if possible.
3. Consider referral to the diabetes specialist team for advice if the HbA_{1c} is > 69 mmol/mol (8.5%). A high HbA_{1c} is an indication for intensive blood glucose control, but it may not be realistic to delay referral until the HbA_{1c} measurement has been repeated.
4. Patients with hypoglycaemic unawareness should be referred to the diabetes specialist team irrespective of HbA_{1c}.
5. Optimize other diabetes-related co-morbidities.
6. Provide written advice to patients undergoing investigative procedures requiring a period of starvation.

Surgical outpatients

Aims

- Arrange preoperative assessment as soon as possible after the decision is taken to proceed with surgery.
- Avoid overnight preoperative 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 preoperative admission [48].
3. Hospital patient administration systems should be able to identify all patients with diabetes so they can be prioritized 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.
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 variable rate intravenous insulin infusion and an unnecessary overnight stay.

Preoperative assessment

Aims

- Ensure that glycaemic control is optimized prior to surgery.
- Establish an individualized diabetes management plan, agreed with the patient, for the pre-admission and perioperative period.

Box 2 Pertinent elements of the Enhanced Recovery Partnership Programme

- Optimize preoperative health, commencing in primary care
- Anaesthetic preoperative assessment with medical optimization, risk stratification and discharge planning
- Admission on the day of surgery with prior patient engagement and appropriate medication adjustment
- Minimal perioperative physiological trespass
- Early post-operative nutrition and return to normal medicines
- Discharge once predetermined criteria met and patient in agreement

FIGURE 1 Pathway of care for elective surgery.

- Ensure that co-morbidities are recognized and optimized 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.
- Identify high-risk patients requiring critical care management.

Action plan

1. All patients with diabetes scheduled to undergo an elective procedure necessitating a period of starvation should attend a preoperative assessment clinic as soon as possible.
2. Preoperative assessment clinic staff should:

2.1. Assess adequacy of glycaemic control. The risks of proceeding when control is suboptimal should be balanced against the urgency of the procedure.

2.2. Consider referral to the diabetes specialist team according to local policy [49]. This should include all patients with hypoglycaemia unawareness and may include those with HbA_{1c} > 69 mmol/mol (8.5%).

2.3. Identify other co-morbidities with referral to the appropriate team for optimization where necessary.

2.4. Plan inpatient admission including:

2.4.1. Timing of admission.

2.4.2. Location.

2.4.3. Timing of surgery.

2.4.4. Preadmission management of medications.

2.4.5. Availability of usual insulin (patient may need to bring if non-formulary).

2.4.6. Plans for Enhanced Recovery Partnership Programme in the context of diabetes.

2.5. Ensure the patient is fully consulted and engaged in the proposed plan of management.

2.6. Give the patient written instructions with the changes they need to make to their medication prior to admission explicitly highlighted.

2.7. Plan initial preoperative management of diabetes.

2.8. Ensure that patients with diabetes are not placed on an evening list. This avoids prolonged starvation times, the use of a variable rate intravenous insulin infusion, and potentially an unnecessary overnight stay.

2.9. During venous thromboembolism risk assessment ensure there are no contraindications to anti-embolism stockings; e.g. patients with peripheral vascular disease or neuropathy [50].

2.10. Plan duration of stay and make preliminary discharge arrangements.

2.11. Ensure that admission ward staff are appraised of plans and able to activate them on the day of admission.

2.12. Consider the need for home support following discharge, and involve the primary care team in discharge planning.

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

Action plan

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.
2. Identify high-risk patients (poor glycaemic control/complications of diabetes) and make arrangements for postoperative admission to critical care if indicated.
3. Base management on Enhanced Recovery Partnership Programme principles, but omit the preoperative high-carbohydrate drink in people with insulin-treated diabetes.
4. Determine the treatment pathway in advance depending on the anticipated duration of starvation. Avoid a variable rate intravenous insulin infusion if the starvation period is short (only one missed meal).
5. Prioritize patients with diabetes on the list. This reduces the starvation time and hence the likelihood of the patient requiring a variable rate intravenous insulin infusion.
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 variable rate intravenous insulin infusion is required. It is recognized that this is not readily available at present but this guidance recommends that this becomes standard practice.
7. Capillary blood glucose (CBG) target ranges are controversial. Aim for capillary blood glucose between 6 and 10 mmol/l, but 4–12 mmol/l is acceptable. Avoid wide swings in capillary blood glucose.

8. Monitor capillary blood glucose regularly when the patient is under sedation. Hypoglycaemia sometimes manifests as drowsiness, which may be wrongly attributed to sedation.
9. Consider continuation of long-acting analogues (Glargine/Lantus®, Detemir/Levemir®) alongside the variable rate intravenous insulin infusion during the perioperative period. This is generally recommended but local policies should be adhered to.
10. Prescribe and administer insulin according to National Patient Safety Agency guidance.
11. Involve the diabetes specialist team if blood glucose targets are not achieved and maintained.
12. Identify high-risk feet and provide pressure relief where necessary. Avoid use of anti-embolism stockings where contraindicated.
13. 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 and 10 mmol/l where possible (acceptable range 4–12 mmol/l).
- Optimize 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 patient with diabetes undergoing surgery (see Controversial areas and Appendix 3 of this document). Until further data are available, the authors recommend the following:

- The substrate solution to be used alongside the variable rate intravenous insulin infusion should be based on serum electrolytes, measured daily and selected from:
- 0.45% saline with 5% glucose and 0.15% potassium chloride;
- 0.45% saline with 5% glucose and 0.3% potassium chloride.

Detailed guidance for setting up a variable rate intravenous insulin infusion is provided in Appendix 5 of the Supporting Information [42].

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 [51].
- Glucose-containing solutions should be avoided unless the blood glucose is low.

Theatre and recovery

Aims

- Maintain good glycaemic control throughout.
- Maintain normal electrolyte concentrations.
- Optimize 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 World Health Organization surgical safety checklist bundle with target blood glucose 6–10 mmol/l (acceptable range 4–12 mmol/l).
2. Implement the agreed care plan.
3. Avoid unnecessary use of variable rate intravenous insulin infusion.
4. Check the capillary blood glucose level prior to induction of anaesthesia.
5. Monitor the capillary blood glucose level regularly during the procedure (at least hourly—more frequently if readings outside the target range).
6. Maintain the blood glucose in the range 6–10 mmol/l where this can be safely achieved. A range of 4–12 mmol/l is acceptable.
7. Correct a high blood glucose using additional subcutaneous insulin or by introducing a variable rate intravenous insulin infusion.
8. Prescribe fluid regimen as required.
9. Document the capillary blood glucose level, insulin infusion rate and substrate infusion on the anaesthetic record as recommended by the Royal College of Anaesthetists and Association of Anaesthetists of Great Britain and Ireland [52,53].
10. Consider the use of individualized goal-directed therapy [51].
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 and promote early return to normal diet and usual diabetes management [54–56].

Post-operative care

Aims

- Ensure glycaemic control and fluid and electrolyte balance are maintained.
- Optimize 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 (drugs/diabetes management/infection/pressure damage).

Action plan

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 National Patient Safety Agency guidance, in consultation with the patient wherever possible [15,41].
5. Aim for a capillary blood glucose level in the 6–10 mmol/l range where this can be achieved safely. A range of 4–12 mmol/l is acceptable.
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 [57].

Discharge

Aims

- Ensure early discharge determined by pre-agreed clinical and social criteria.
- Ensure that factors likely to delay discharge are identified at the preoperative 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. 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 ability of the patient or carer 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' preoperative 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 [58]. 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.

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 variable rate intravenous insulin infusion 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), these should be continued along with the variable rate intravenous insulin infusion.

The HbA_{1c} 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.

Controversial areas

1. Glycaemic control

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

In view of the dangers of hypo- and hyperglycaemia [5,59–64] it is reasonable to recommend that blood glucose should be maintained in the range 6–10 mmol/l [65] if this can be achieved safely. However, a range from 4 to 12 mmol/l is acceptable.

Is an elevated preoperative HbA_{1c} associated with adverse outcomes following a range of surgical procedures?

Elevated preoperative HbA_{1c} has been related to adverse outcomes following a variety of surgical procedures [66–69]. There is evidence that good control preoperatively, as measured by the HbA_{1c} level, is associated with improved outcomes after a range of non-cardiac surgical procedures [5,70].

What is the acceptable upper limit of HbA_{1c} for patients undergoing elective surgery?

There is insufficient evidence to recommend an upper limit of HbA_{1c} 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 and 75 mmol/mol (8–9%) is acceptable, depending on individual circumstances. For many patients a lower target HbA_{1c} 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.

2. Fluid management in patients requiring a variable rate intravenous insulin infusion

Background

Fluid and electrolyte mismanagement is a recognized cause of morbidity and mortality in patients undergoing abdominal surgery [71–79]. 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 may lead to serious complications including death [80].

Aims of fluid therapy for the patient with diabetes

Major surgery or prolonged starvation (more than one missed meal) places the surgical patient with diabetes 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 and 10 mmol/l (4–12 mmol/l is acceptable);
- maintenance of euvolaemia [51];
- 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 l of water [81]. 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 [51].

Choice of perioperative fluid for patients requiring variable rate intravenous insulin infusion None of the UK fluid protocols currently available for the management of the adult perioperative patient with diabetes can combine maintenance of glycaemic control with normal electrolyte balance (See Appendix 3 of this document). This failure contributes to the excess morbidity and increased length of stay of these adult surgical patients.

As there are no randomized 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 (reducing the risk of error);
- compliance with National Patient Safety Agency alerts 1 and 22 [82,83];
- minimum cannulae and pumps required.

Following the National Patient Safety Agency alert no. 22 [82], many paediatric surgical units now use 0.45% saline with 5% glucose with additional potassium chloride as their 'default' fluid running alongside a variable rate intravenous insulin infusion [75,84].

Until there are clinical studies to verify the safest solution for the adult surgical patient with diabetes on a variable rate intravenous insulin, the use of 0.45% saline with 5% glucose and 0.15% potassium chloride is advocated as the first choice solution, as in paediatric practice. The authors acknowledge the current limited commercial availability of this fluid, and the cost differential compared with conventionally used fluids in adults. Negotiations are taking place to address these issues and wider use of the recommended solutions will reduce cost and increase availability

3. The continued use of glucose-lowering agents in the perioperative period

3.1. Long-acting insulin analogues

Many units advocate the continuation of long-acting insulin analogues alongside the variable rate intravenous insulin infusion. This has the advantage that no time is lost in re-establishing basal insulin once the variable rate intravenous insulin infusion is discontinued.

There is debate amongst diabetes teams as to whether the dose of long-acting insulin analogues should be reduced, depending on whether the patient has small frequent meals and snacks or not, and local policies should be agreed. If the dose of background insulin is correct, then blood glucose levels may

remain steady whilst not eating; however, many people may be on too much background insulin and only maintain their blood glucose levels by snacking regularly. It may be difficult to know, without the specialist team being involved, what any individual patient needs to do with their background insulin prior to fasting.

3.2. 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 [85].

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 produced by the Royal College of Radiologists [86] recommended that there is no need to stop metformin after contrast has been administered in patients with a normal serum creatinine and/or eGFR of > 50 ml min^{-1} 1.73 m^{-2}. If the serum creatinine is above the reference range or the eGFR is below 50 ml min^{-1} 1.73 m^{-2}, the need to stop the metformin should be discussed with the referring clinician.

Competing interests

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Online document. Management of adults with diabetes undergoing surgery and elective procedures: improving standards. Full position statement.

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Appendix 1

Guideline for perioperative adjustment of insulin (short starvation period—no more than one missed meal)

Insulins	Day prior to admission	Day of surgery	
		Patient for morning surgery	Patient for afternoon 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 the total dose as intermediate acting only in the morning. Do not give any short-acting insulin in the morning. Check blood glucose on admission. Leave the evening meal dose un changed	Calculate the total dose of both morning insulins and give half the total dose as intermediate acting only in the morning. Do not give any short-acting insulin in the morning. Check blood glucose on admission. Leave the evening meal dose unchanged
Three, 4 or 5 injections daily	No dose change	Basal bolus regimens: omit the morning and lunchtime short-acting insulins. Keep the basal unchanged*. Premixed morning insulin: 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

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

Appendix 2

Guideline for perioperative adjustment of non-insulin medication (short starvation period—no more than one missed meal)

Tablets	Day prior to admission	Day of surgery	
		Patient for morning surgery	Patient for afternoon surgery
Acarbose	Take as normal	Omit morning dose if 'nil by mouth'	Give morning dose if eating
Meglitinide (repaglinide or nateglinide)	Take as normal	Omit morning dose if 'nil by mouth'	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, Glimeperide.)	Take as normal	Once daily morning omit Twice daily omit morning	Once daily morning omit Twice daily omit morning and afternoon
Pioglitazone	Take as normal	Take as normal	Take as normal
DPP-IV inhibitor (e.g. Sitagliptin, Vildagliptin, Saxagliptin)	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

*If contrast medium is to be used and eGFR less than 50 ml min^{-1} 1.73 m^{-2}, metformin should be omitted on the day of the procedure and for the following 48 h.
DPP-IV, dipeptidyl peptidase 4; GLP-1, glucagon-like peptide 1.

Appendix 3*

Advantages and disadvantages of intravenous solutions

	Advantages	Disadvantages
0.45% saline with 5% glucose with 0.15% potassium chloride at 83–125 ml/h with a continuous variable rate intravenous insulin infusion	• Constant supply of substrate • Meets daily sodium and potassium requirements • Safety profile of regimen demonstrated in the paediatric population with diabetes	• Not widely available • Hypotonic solution *in vivo* with reference to plasma and may still predispose to hyponatraemia • May exceed daily requirements of sodium
0.9% saline with 5% glucose with 0.15% potassium chloride at 83–125 ml/h with a continuous variable rate intravenous insulin infusion	• Constant supply of substrate • Meets sodium and potassium requirements • Safety profile of regimen demonstrated in the paediatric population with diabetes	• Not widely available • Will exceed daily sodium chloride requirement and predispose to oedema and hyperchloraemic metabolic acidosis
0.18% saline with 4% glucose with 0.15% potassium chloride at 83–125 ml/h with a continuous variable rate intravenous insulin infusion	• Constant supply of substrate • Meets daily sodium and potassium requirements • Widely available	• Associated with hyponatraemia. Use in children has been curtailed by the National Patient Safety Agency • Hypotonic solution *in vivo* with reference to plasma
5–10% glucose with 0.15% potassium chloride at 125 ml/h with a continuous variable rate intravenous insulin infusion	• Constant supply of substrate • Widely available	• Does not provide any sodium • Associated with hyponatraemia

Appendix 3* (Continued)

	Advantages	Disadvantages
5–10% glucose with 0.15% potassium chloride at 125 ml/h with additional 0.9% saline at a variable rate to correct the hyponatraemia and a continuous variable rate intravenous insulin infusion	• Constant supply of substrate • Widely available	• Requires three infusion pumps (one for the glucose, one for the saline and one for the insulin) • May need multiple venous access leading to difficulties in obtaining blood samples and venous access • May lead to fluid overload
10% glucose with 0.15% potassium chloride at 60 ml/h with additional 0.9% saline at 60 ml/h with a continuous variable rate intravenous insulin infusion	• Constant supply of substrate • Widely available	• Needs three infusion pumps (one for the glucose, one for the saline and one for the insulin) • May need multiple venous access leading to difficulties obtaining blood samples and venous access
10% glucose with 0.15% potassium chloride at 100 ml/h if capillary blood glucose less than 15 mmol/l with a continuous variable rate intravenous insulin infusion 0.9% saline with 0.15% potassium chloride at 100 ml/h if capillary blood glucose more than 15 mmol/l with a continuous variable rate intravenous insulin infusion		• Erratic supply of substrate • Unpredictable administration of sodium • Increased nursing workload and difficulties in maintaining accurate fluid balance charts with constant changes of fluid bags according to capillary blood glucose
500 ml 10% glucose and 0.15% potassium chloride with 5 units insulin if capillary blood glucose less than 6 mmol/l 500 ml 10% glucose and 0.15% potassium chloride with10 units insulin if capillary blood glucose 6–10 mmol/l 500 ml 10% glucose and 0.15% potassium chloride with 15 units insulin if capillary blood glucose 10–20 mmol/l 500 ml 10% glucose and 0.15% potassium chloride with 20 units insulin if capillary blood glucose more than 20 mmol/l All administered at 100–125 ml/h and with additional 0.9% saline to treat established hyponatraemia	• Intrinsically safe as substrate and insulin are co-administered • Evidence to support its use	• Increased nursing workload and difficulties in maintaining accurate fluid balance charts with constant changes of fluid bags according to capillary blood glucose • Hyponatraemia is a recognized complication • May lead to fluid overload with the co-administration of additional 0.9% saline

*Appendix 6 in main guideline document (see Supporting Information).
The rate of fluid infusion suggested should be for as long as the patient is fasted. Once they are ready to eat and drink, the intravenous fluid infusion can be stopped.
The cost of 0.45% saline with 5% glucose with 0.15% potassium chloride is significantly higher than either 0.9% physiological saline solution or 5% glucose solution. At the time of writing, there have been circuitous discussions between the bulk purchasers in the National Health Service (NHS) and the fluid manufacturers. The manufacturers suggest that the cost of the fluid will go down as demand goes up. However, the NHS purchasers say they will only buy more when the costs come down.
0.45% saline with 5% glucose with 0.15% potassium chloride is widely available, but because it is currently only recommended for use in the paediatric population [82], it is currently most widely stocked in those areas.

THE PERI-OPERATIVE MANAGEMENT OF THE ADULT PATIENT WITH DIABETES

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THE PERI-OPERATIVE MANAGEMENT OF THE ADULT PATIENT WITH DIABETES

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The peri-operative management of the adult patient with diabetes

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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, whist others feature broader aspects of surgical working life such as education, leadership and the law.

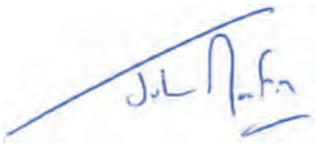
This IPPP focuses on **The peri-operative management of the adult patient with diabetes**. Diabetes affects at least 4% to 5% of people in the UK, with the prevalence in the UK in-patient population now ranging from 10% to 28%. Diabetes leads to increased morbidity and length of stay, thereby increasing 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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ISSUES IN PROFESSIONAL PRACTICE

The peri-operative management of the adult patient with diabetes

CONTENTS

APPENDICES

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 multi-factorial 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 [47, 48] and the Enhanced Recovery Partnership Programme has particular relevance for patients with diabetes [49, 50]. 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 [33]. 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 then 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 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 [54]. 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 [55 - 60].

In the virtual absence of clinical studies in general surgery, and considering the basic biological data on the harmful effects of hyperglycaemia [61], it is reasonable to recommend that blood glucose should be maintained in the range 6 to 10 mmol/L[62] 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 [63].

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 [1, 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 [65]. Elevated pre-operative HbA1c has been related to adverse outcomes following spinal surgery [66], vascular surgery [67], colorectal surgery [68], and cardiac surgery [69].

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 [70 - 78]. 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 [79].

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 [52],
- 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 [80]. 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 [52]. 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 [25].

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 [81, 82],
- minimum cannulae and pumps required.

Following the recent National Patient Safety Agency (NPSA) alert number 22 [81], many paediatric units now use 0.45% saline with 5% glucose with additional potassium chloride as their 'default' fluid [74, 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 [52]. It has been suggested that administration of Hartmann's solution to patients with Type 2 diabetes, may lead to hyperglycaemia [84]. 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/L[85]. 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 contra-indications 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 [86].

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 [87] 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/1.73m^2. If the serum creatinine is above the reference range, or the eGFR is below 50ml/min/1.73m^2, 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 (***Appendix 12*** 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: • 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

3, 4 or 5 injections daily	No dose change	**Basal bolus regimens:** omit the morning and lunchtime short acting insulins. Keep the basal unchanged.* **Premixed AM insulin:** 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

* 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 mls/min/1.73m^2, 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.

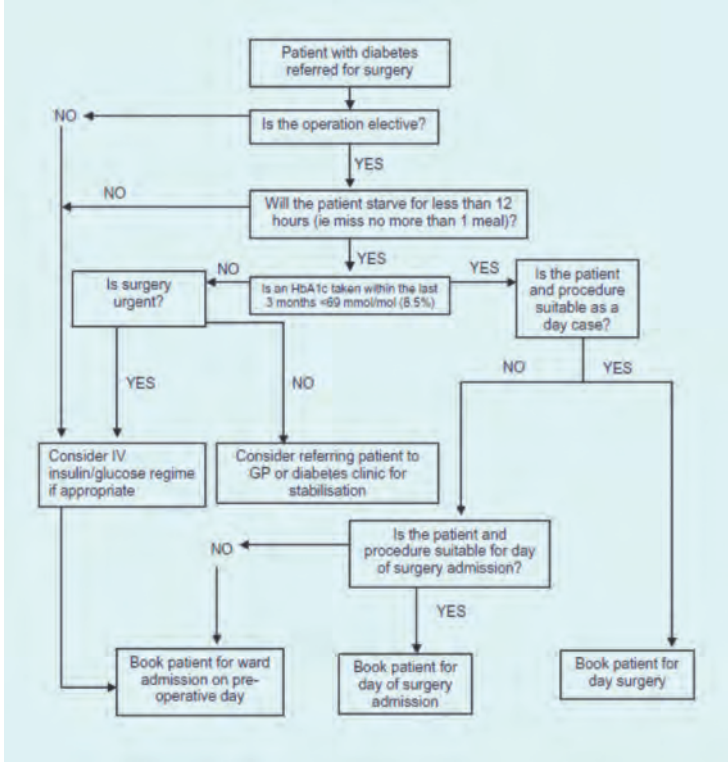
Patients with diet controlled diabetes are all suitable for day case surgery if the procedure itself is suitable for day surgery and all other criteria are fulfilled.

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 in 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 VRIII 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 recommenced if the eGFR is greater than 50 mls/min/1.73m^2.

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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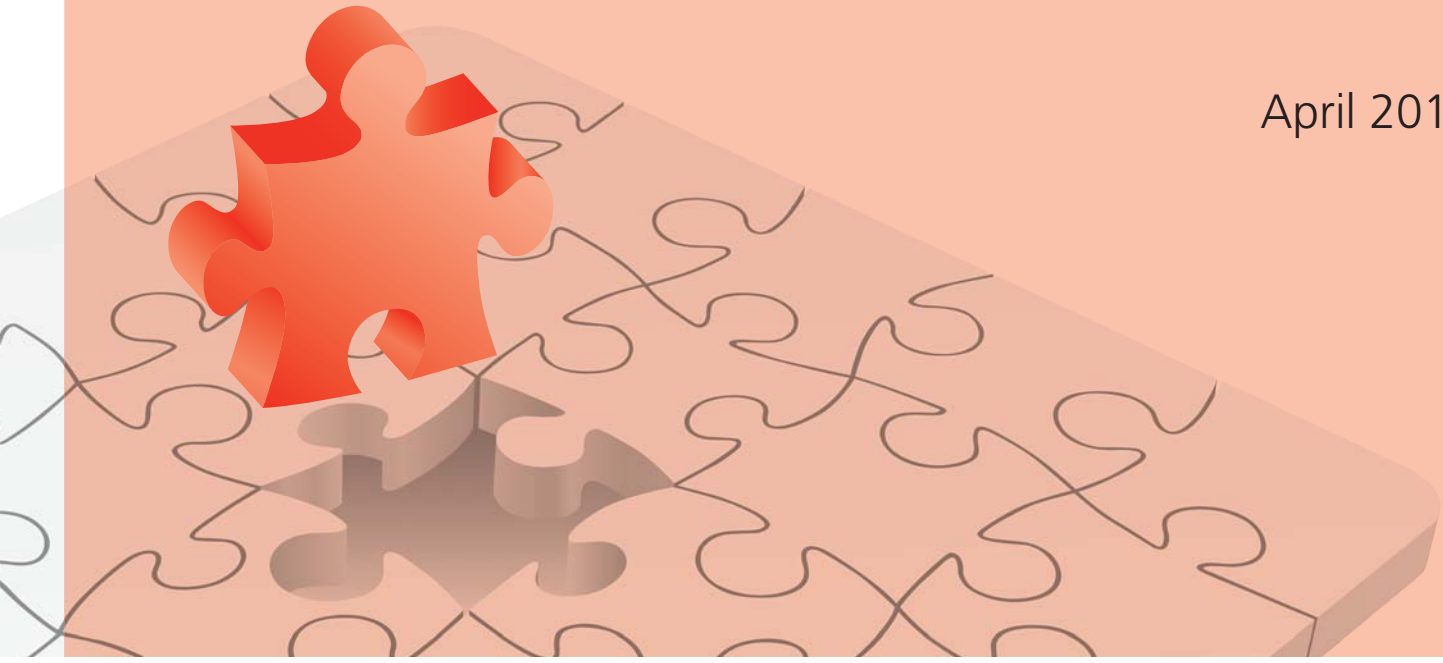
Diabetes

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

April 2011



Supporting, Improving, Caring

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Foreword

These guidelines have been commissioned by NHS Diabetes and written by the Joint British Diabetes Societies Inpatient Care Group and representatives from the specialist societies surgeons and anaesthetists. The document has also been informed by focus groups from Diabetes UK. The aim of the guidelines is to improve standards of care for people with diabetes undergoing operative or investigative procedures requiring a period of starvation.

Target audience

The guidelines emphasise the need for patient centred care at every stage and we hope that they will be of use to all healthcare professionals whose work brings them into contact with this vulnerable group of patients.

The target audience specifically includes:

- General practitioners, practice nurses and district nurses
- Pre-operative assessment nurses
- Anaesthetists
- Surgeons
- Trainee medical staff
- Post-operative recovery and surgical ward nurses
- Diabetologists
- Diabetes inpatient specialist nurses, diabetes specialist nurses and educators
- Hospital pharmacists
- Hospital managers
- Commissioners
- Patients.

Most importantly, this document is addressed to those writing and implementing local perioperative care policies and to medical and nursing educators. Managers have a responsibility to ensure that guidelines based on these recommendations are put in place. The guidelines aim to cover all stages of the patient pathway but are not designed to be read from cover to cover. Recommendations for each stage are intended to stand alone so that individual health care professionals can identify their role in the process.

These are the first UK national guidelines in this area of diabetes care and the first to address the whole pathway from referral to discharge. They will be a resource for those responsible at every stage of the pathway for the care of the surgical patient with diabetes.

We wish to congratulate the authors on producing clearly written, comprehensive, practical and easy to follow documents in a complex area of diabetes care. We thoroughly recommend the guidelines to diabetes, surgical, anaesthetic and primary care colleagues.

Dr Gerry Rayman
NHS Diabetes Clinical Lead for Inpatient Diabetes Care

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Director of NHS Diabetes


Primary care referral
Surgical outpatients
Pre-operative assessment
Hospital admission
Theatre and recovery
Post-operative care
Discharge

Contents

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 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. 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.
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 optimise other co-morbidities.
6. Routine overnight admission for pre-operative management of diabetes should not be necessary.
7. Starvation time should be minimised by prioritisng patients on the operating list.
8. 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.
9. Multi-modal analgesia should be combined with appropriate anti-emetics to enable an early return to normal diet and usual diabetes regimen.
10. The patient should resume diabetes self-management as soon as possible where appropriate.
11. A policy which includes plans for diabetes management should be in place for safe discharge.
12. Outcomes should be audited regularly.

Diabetes specialists

13. Clear guidelines should indicate when the diabetes specialist team should become involved.
14. All hospitals should implement a Diabetes Inpatient Specialist Nurse (DISN) service.

Peri-operative use of intravenous insulin

15. The term ‘variable rate intravenous insulin infusion’ (VRIII) should replace the ambiguous term ‘sliding scale’.
16. 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.
17. Patients expected to miss more than one meal should have a VRIII.
18. 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.
19. Insulin should be prescribed according to National Patient Safety Agency (NPSA) recommendations for safe use of insulin.

Peri-operative blood glucose monitoring

20. Capillary blood glucose (CBG) levels should be monitored and recorded at least hourly during the procedure and in the immediate postoperative period.
21. Hospitals should have clear guidelines for the management of blood glucose when it is outside the acceptable range.
22. Training for blood glucose measurement and diabetes management should be introduced for clinical staff caring for patients with diabetes.
23. 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 is the most common metabolic disorder, affecting at least 4-5% of people in the UK. 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. A recent audit has shown that the prevalence of diabetes in the UK inpatient population now ranges from 10-28%, exceeding previous estimates by at least 50%[1] and this figure is certain to rise in the future. Because 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 inpatient costs. This is a particular problem in surgical patients where the excess bed days were recently estimated to be 45% greater than for people with diabetes admitted to medical wards[2]. The peri-operative mortality rate is reported to be up to 50% higher than that of the non-diabetic population[3]. 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[4-7].

Diabetes related patient factors associated with worse outcomes

Poor peri-operative glycaemia control

Glycaemic control has a significant impact on the risk of post-operative infection across a variety of surgical specialities[3]. Post-operative glycaemic control significantly influences the healing of deep sternal wound infection after open heart surgery[8] and has been shown to have a similar on impact on healing in other forms of surgery[3]. The 2009 National Inpatient Diabetes Survey found that 25% of patients on surgical wards experienced a hypoglycaemic event and inpatient hypoglycaemia is associated with increased mortality[1]. Diabetic ketoacidosis, though completely avoidable, still occurs on surgical wards and can result in post-operative death[9].

Complications of diabetes

Diabetes is associated with a two to four fold increase in cardiovascular disease including hypertension, coronary artery disease and stroke[10]. 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[11]. 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 renal failure 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[12].

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[4]. 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[13,14]. Since most post-operative deaths occur in the high-risk population, better identification and management of these patients might lead to substantial improvements in outcomes. Particular care should be paid to assessment of patients with diabetes to identify those at high risk of peri-operative complications.

The patient experience

Two recent reports by the Health Care Commission and Diabetes UK on patients' experience of inpatient care make sober reading[15,16].
The following quotes reflect patients' experience 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 2am 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' 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[15].

"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[17]. The American Diabetes Association (ADA) and the UK NHS Institute for Innovation and Improvement both recommend an identifier in the medical record for all patients with diabetes admitted to hospital[2,18].

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[19]. An analysis of 44 US hospitals revealed shortcomings in diabetes management including persistent hyperglycaemia[20]. Poor glycaemic control increases morbidity with high risk of post-operative infection[3].

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 regimes 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[21,22].

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[23]. 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[24]]
- 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[18]:

- 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.

Diabetes UK has produced guidance for patients in the document 'Diabetes care in hospital: What care to expect during your hospital stay'[25].

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 patients[16] and evidence of actual harm[3,26], there is an urgent need to improve peri-operative diabetes care across the UK.
These guidelines have been produced 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 emphasises 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 [15,24]. The guidelines emphasise 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.

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

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
- 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[27]. This can be attenuated in patients with diabetes by infusion of insulin and glucose (approximately 180g/day)[28,29]. 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[27]. 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[3,8].

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. 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 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 in-patients 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[30].

A DISN service has been shown to reduce the length of stay for patients with diabetes, whatever the reason for admission[31-34]. A recent national survey of inpatient diabetes services in the United Kingdom has demonstrated that nearly 50% of acute hospitals do not have a DISN[19]. 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[35]. 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[36,37] and the Enhanced Recovery Partnership Programme has particular relevance for patients with diabetes[38,39]. 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 of the Enhanced Recovery Partnership Programme 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 including 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.

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

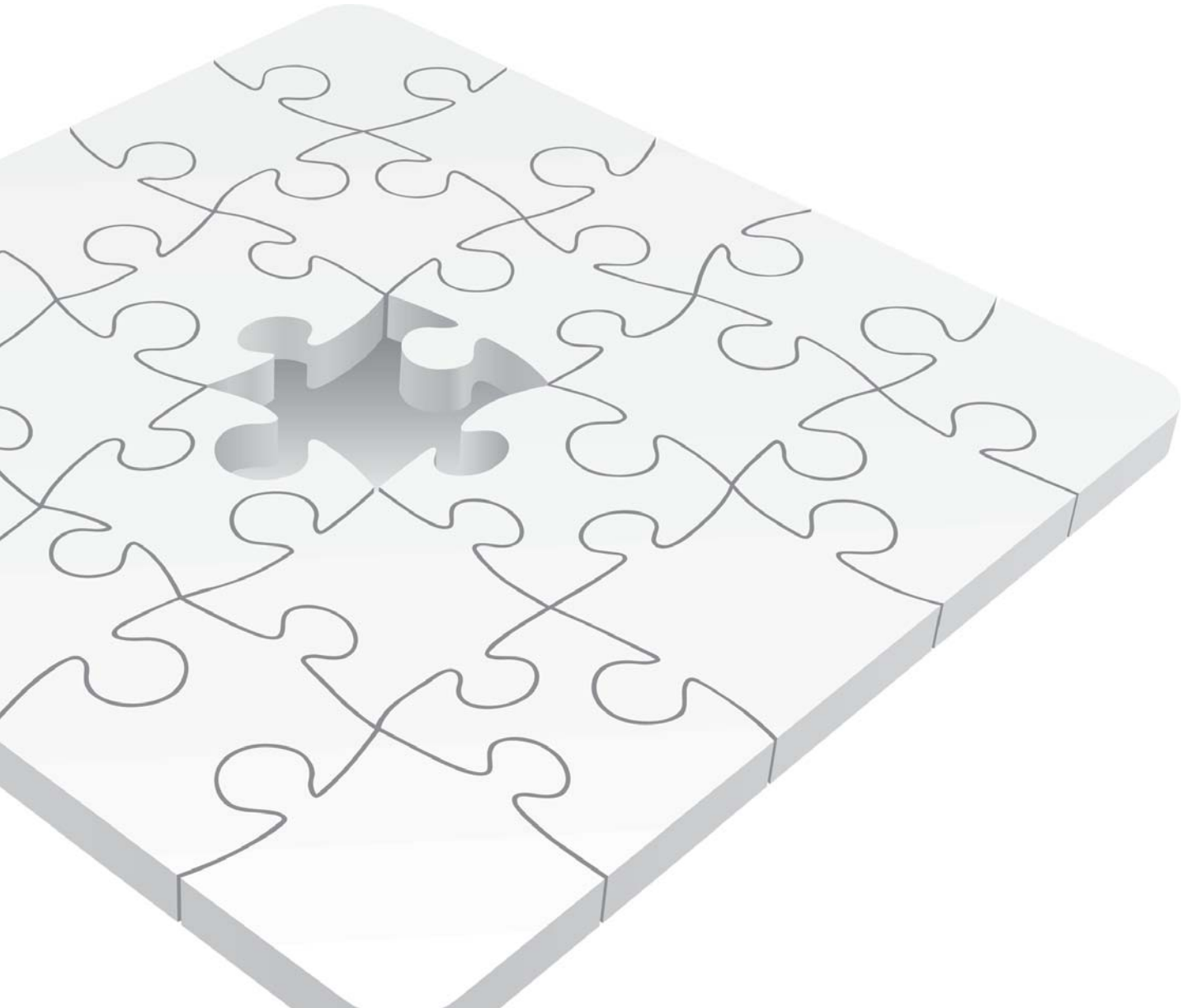
The elements of the Enhanced Recovery Partnership Programme

- 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.

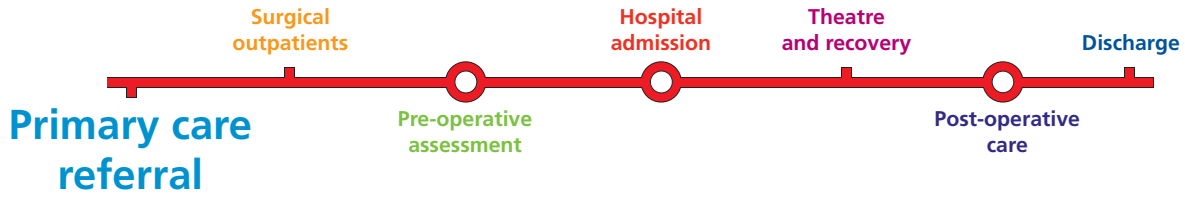
Use of oral carbohydrate loading

The Enhanced Recovery Partnership Programme recommends the administration of 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 HbA_{1c}, blood pressure and weight measurements with details of relevant complications and medications in the referral letter (Appendix 12).
2. Optimise glycaemic control before referral if possible.
3. Consider referral to the diabetes specialist team for advice if HbA_{1c} is greater than 69 mmol/mol (8.5%) (see Controversial areas, page 34). A high HbA_{1c} is an indication for intensive blood glucose control but it may not be realistic to delay referral until the HbA_{1c} has been repeated.
4. Patients with hypoglycaemic unawareness should be referred to the diabetes specialist team irrespective of HbA_{1c}.
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
  - BMI
  - BP
  - HbA_{1c}
  - eGFR

Surgical outpatients

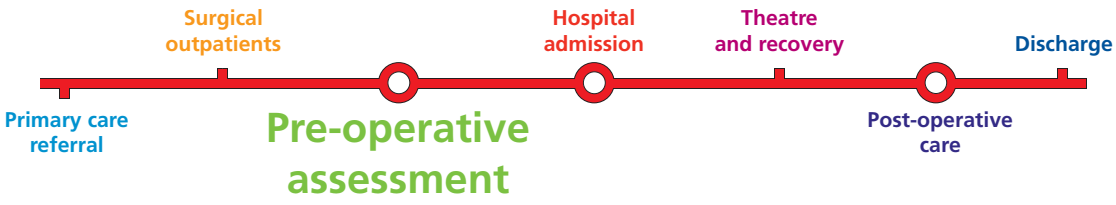
Aims

- 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 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[40].
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 36).

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 peri-operative period e.g. bridging therapy for warfarin, renal replacement therapy
- Identify high-risk patients requiring critical care management (see page 8 in the full document).

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[35]. This should include all patients with hypoglycaemia unawareness and may include those with HbA_{1c} greater then 69 mmol/mol (8.5%) (see Controversial areas, page 34).
   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 (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 15).
   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 patients with diabetes are not placed on an evening list. This avoids prolonged starvation times, the use of a VRIII and potentially an unnecessary overnight stay (see Controversial areas, page 34).
   i. During venous thromboembolism risk assessment ensure no contraindications to anti-embolism stockings e.g. patients with peripheral vascular disease or neuropathy[41].
   j. Plan duration of stay and make preliminary discharge arrangements.
   k. Ensure that admission ward staff are appraised of plans and able to activate them on the day of admission.
   l. 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. 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 34).

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. 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.

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.

Action plan

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.
4. Determine the treatment pathway in advance depending on the anticipated duration of starvation. Avoid a VRIII 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 VRIII.
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 VRIII 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 34).
7. Capillary blood glucose (CBG) target ranges are controversial. Aim for CBG between 6-10 mmol/L but 4-12 mmol/L is acceptable. Avoid wide swings in CBG.
8. Monitor CBG regularly when the patient is under sedation. Hypoglycaemia sometimes manifests as drowsiness, which may be wrongly attributed to sedation.
9. 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 39).
10. Prescribe and administer insulin according to NPSA guidance.
11. Involve the diabetes specialist team if blood glucose targets are not achieved.
12. Identify high risk feet and provide pressure relief where necessary. Avoid use of anti-embolism stockings where contraindicated.
13. Ensure that preparation for discharge is ongoing.

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.

Anticipated short starvation period (only one missed meal)

Patients with good control (HbA_{1c} less than 69 mmol/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 starvation period than more than one missed meal

Most patients will require a VRIII. Written guidelines should be in place to ensure safe use[19,22] and should include the following:

- Indications for use of the VRIII and when to commence
- 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.

An example of a guideline is given in Appendix 5. Outcomes should be audited and adverse events documented to ensure the process is effective and safe.

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_{1c} 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 levels below 4 mmol/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
- Maintain blood glucose level 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, and this is detailed separately (see Controversial areas, page 34 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 will lead to a price reduction and establish best practice.

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) provide further excellent detailed guidance[42].

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[42]
- Glucose containing solutions should be avoided unless the blood glucose is low.

See Controversial areas, page 38 for discussion of fluid options for patients not requiring an insulin infusion. Further detailed recommendations can be found in the 2008 British Consensus Guidelines on Intravenous Fluid Therapy for Adult Surgical Patients[42].

Special circumstances

Continuous subcutaneous insulin infusion (CSII) pump

There are very few data on the use of continuous subcutaneous insulin infusions (CSII) 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. 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[43]). 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. Seek advice 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 will be no opportunity for pre-admission planning. The blood glucose 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. The HbA1c 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 30).

Stress hyperglycaemia

Stress hyperglycaemia may occur in people not previously known to have diabetes. Recent data suggest that this group is at particularly high risk of post-operative morbidity and mortality[3].

Stress hyperglycaemia should be treated just as aggressively as known diabetes during the acute episode but after recovery re-assessment is required. Those with normal blood glucose levels will need a formal oral glucose tolerance test or fasting blood glucose 6 weeks later to determine whether they have diabetes (as for hyperglycaemia and acute coronary syndrome). 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 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. Implement the agreed care plan.
3. Avoid unnecessary use of VRIII.
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. Maintain the blood glucose in the range 6–10 mmol/L where this can be safely achieved. A range of 4-12 mmol/L is acceptable.
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 and Association of Anaesthetists of Great Britain and Ireland[44,45].
10. Consider the use of individualised goal directed therapy[42].
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 postoperative nausea and vomiting (PONV) and promote early return to normal diet and usual diabetes management[46-48].

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 RCA[44]. 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[49]. 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.

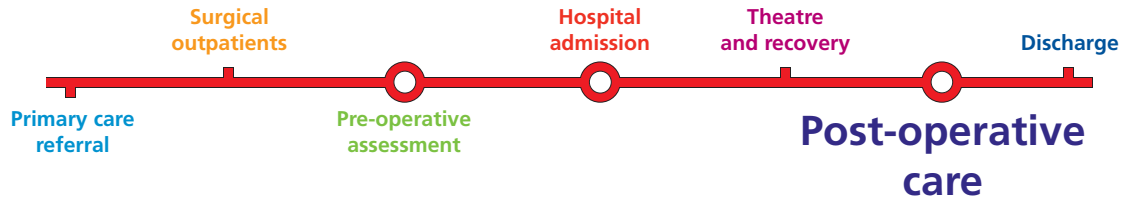
Note: The 2010 Confidential Enquiry into Maternal and Child Health (CEMACH) reported on the standards of anaesthetic record keeping in women with diabetes undergoing caesarean section[45]. In the majority of cases standards of record keeping set by the Royal College of Anaesthetists and the Association of Anaesthetists of Great Britain and Ireland were not met. A key recommendation of the CEMACH report was therefore that anaesthetists should adhere to the published standards for anaesthetic documentation[44].

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 12 mmol/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, page 34 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.

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[50].

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[35].

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 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 (see page 15)
- Avoid iatrogenic injury (drugs/diabetes management/infection/pressure damage).

Action plan

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 (see Appendix 6).
4. Prescribe and administer insulin in line with NPSA guidance, in consultation with the patient wherever possible[21,22].
5. Aim for a CBG in the 6-10 mmol/L range where this can be achieved safely. A range of 4-12 mmol/L is acceptable.
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[51].

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[52,53]. 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[54].

Between November 2003 and August 2009 15,227 insulin incidents were reported in the NHS in England and Wales. Of these 972 incidents resulted in moderate harm with severe or fatal outcomes in a further 18[21].

- Hand written abbreviations such as 'u' and 'iu' were a major cause of dose errors; misinterpretation led to patients being given 10 times or 100 times the intended dose
- Hypoglycaemia is common in hospitalised patients treated with insulin[55] and can incur significant costs[56]. Clinical protocols and guidelines are sometimes inadequate. Nursing staff may not be authorised to administer glucose without a prescription glucose products are not always readily available in clinical areas. The recent introduction of national guidelines for the management of hypoglycaemia should address this problem[57]
- 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[26,58,59]. The following errors account for 60% of all insulin-related incidents reported in the UK and 67% of all incidents reported in the USA[60]:

- 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[61].

BOX 9

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 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 [21,62]:

- 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)

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[63].

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 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. Training in blood glucose management is essential for all staff dealing with patients with diabetes[64]. **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.**

Emergency surgery

By definition, emergency surgery is unplanned and the additional metabolic stress of the emergency situation is likely to lead to hyperglycaemia. Most patients will require a VRIII peri-operatively and may need subcutaneous insulin to ensure good glycaemic control in the post-operative period. The diabetes specialist team should be involved at an early stage to optimise blood glucose management.

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[65]; 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[23,66].

The diabetes specialist team should be involved at an early stage if blood glucose is not well controlled[35]. 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.

Action plan

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[67]. Etzwiler[68] 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 postoperative 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, page 39). The hospital pharmacist has a crucial role to play in ensuring that the discharge medication is safe and that the patent 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[69,70], although the methodology of these studies has been questioned[71]
- A randomised controlled trial with blinded assessment compared intra-operative "tight" glucose control (4.4-5.6 mmol/L) with routine control (glucose less than 11.1 mmol/L) in 400 cardiac surgical patients and concluded the outcome was not improved in patients with "tight" control regardless of diabetes status[72]
- A retrospective cohort study found that increased post-operative glucose values were an independent risk factor for infection in patients undergoing peripheral vascular surgery[73]
- A randomised pilot study compared conventional blood glucose treatment (< 12 mmol/L) with insulin therapy (< 6.6 mmol/L) in neurosurgery and found a decreased infection rate but no difference in mortality and outcome[74]
- Trials in which "strict" glucose control was implemented, typically less than 6.1 mmol/L, reported that hypoglycaemia occurred with an incidence of 9 to 17%[72].

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[75]. 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 10 mmol/L, which is similar to the values at which clinical infections become more common[3].

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 blood glucose should be maintained in the range 6 to 10 mmol/L[76] if this can be achieved safely. A range from 4-12 mmol/L is 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[2]. It also reduces 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[77].

Is an elevated pre-operative HbA_{1c} associated with adverse outcomes following a range of surgical procedures?

There is evidence that good control pre-operatively, as measured by the HbA_{1c} level is associated with improved outcomes after a range of non-cardiac surgical procedures[3,78]. In a recent study of patients undergoing hip and knee arthroplasty patients with uncontrolled diabetes assessed by HbA_{1c}, had a significantly increased risk of surgical and systemic complications, higher mortality, and increased length of stay[79]. Elevated pre-operative HbA_{1c} has been related to adverse outcomes following spinal surgery[80], vascular surgery,[81], colorectal surgery[82], and cardiac surgery[83].

What is the acceptable upper limit of HbA_{1c} for patients undergoing elective surgery?

There is insufficient evidence to recommend an upper limit of HbA_{1c} 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 HbA_{1c} 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_{1c} is associated with poorer outcomes whether diabetes has been diagnosed or not[81,84]. There may be a role for routine measurement of HbA_{1c} 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[30].

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[85].

There is evidence that this model reduces excess bed occupancy[32-34], but a recent UK survey of in-patient diabetes services found that nearly 50% of acute hospitals do not have a DISN[19].

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[86]. 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[28]. The recommended carbohydrate load of 180 g 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 regimen' with all 3 components administered from the same bag of intravenous fluid lacks flexibility and has consequently evolved into a regimen in which the intravenous insulin is independently administered via a syringe driver while the glucose and potassium are administered via a volumetric pump[87].

This regimen, 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[87-89]. 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[63].

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[15,16].

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[90-94]. To date the only published data available demonstrated that this approach is safe[94].

BOX 11

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 overdoses 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.

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[87,88,95-101]. 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[99]. 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[96,97]. 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[102]. The National Patient Safety Agency (NPSA) recommends that hypotonic fluids should be avoided in paediatric patients[103] and this advice should probably be extended to adults.

Many studies have shown that hypotonic intravenous solutions predispose to hyponatraemia[102,104-108]:

- In an audit of diabetic surgical patients there was a 30% incidence of hyponatraemia when a 5% glucose infusion and VRIII was used[109]
- In sick hospital patients, the use of hypotonic fluids is a major risk factor for the development of hyponatraemia[105]
- A review of women who developed severe post-operative hyponatraemic encephalopathy concluded that the use of hypotonic fluids was the major contributing factor[106].

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 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 level between 6-10 mmol/L (4-12 mmol/L is acceptable)
- Maintenance of euvolaemia[42]
- Maintenance of serum electrolytes within the normal range.

The daily requirement of the *healthy* adult is 50-100 mmol of sodium, 40-80 mmol of potassium, and 1.5-2.5 litres of water[110]. 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[42]. Patients with diabetes require 180g glucose per day, and additional potassium is required to prevent hypokalaemia when glucose and insulin are co-administered[28]. Supplements of magnesium, calcium and phosphate may also be necessary[28].

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[103,111]
- Minimum cannulae and pumps required.

Following the recent National Patient Safety Agency (NPSA) alert number 22[103], many paediatric units now use 0.45% saline with 5% glucose with additional potassium chloride as their 'default' fluid[112,113]. 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 pre-dispose 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[98]. 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[42]. It has been suggested that administration of Hartmann's solution to patients with Type 2 diabetes, may lead to hyperglycaemia[114]. However, 1 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/L[112]. 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® 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.

For patients not requiring a VRIII, there is debate about whether the dose of long acting insulin analogue should be reduced by one third or maintained at the usual level. 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. 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 2 mmol/L overnight it would be prudent to reduce the basal (long acting) insulin. If the blood glucose remains stable overnight the normal basal insulin dose should be maintained.

The only published study[94] reported no problems when the usual dose of basal insulin was continued. Local guidelines should give clear advice to patients and staff about the use of the long acting analogue.

Elective evening 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 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.

Prevention of pharmacological iatrogenic incidents

This section deals with medications other than insulin (see Safe use of insulin, page 30).

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 renally excreted. Renal failure may lead to high plasma levels which, if greater than 5mcg/ml, are associated with an increased risk of lactic acidosis[115].

A number of guidelines available for the use of metformin (see BOX 13) recommend withdrawing treatment perioperatively. However, evidence for this approach is lacking and there is some evidence that perioperative continuation of metformin is safe[116].

This guideline recommends that for patients undergoing a short starvation period (one missed meal only), metformin should be stopped when the preoperative fast begins and restarted post-operatively once the patient is eating again. Anaesthetists and surgeons must however, be aware of the dangers of co-prescribing potentially nephrotoxic agents and patients discharged early after surgical intervention need to know when to seek medical help should they become unwell (see section on discharge, page 32).

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[117] 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/1.73m^2 . If the serum creatinine is above the reference range or the eGFR is below 50ml/min/1.73m^2, the need to stop the metformin should be discussed with the referring clinician.

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 RAAS[117]
- **Oedema:**
  - NSAIDs may increase the risk of oedema, especially if given concurrently with glitazones.

Dexamethasone

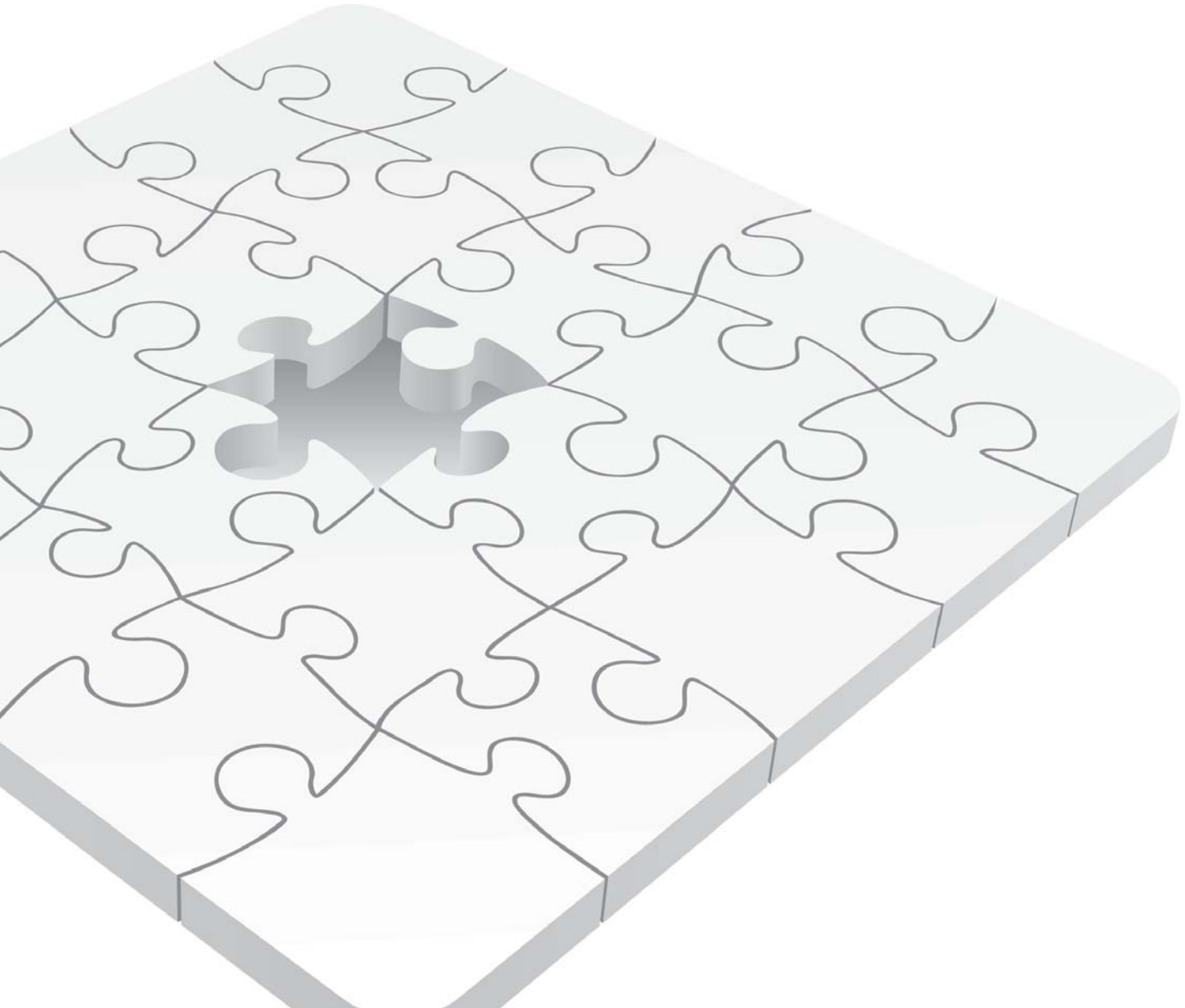
All glucocorticoids have the potential to increase blood glucose levels, but the size of the effect depends on the dose, route of administration and patient characteristics. The use of dexamethasone for the treatment of post-operative nausea and vomiting is controversial as its advantages of allowing earlier resumption of normal diet may be outweighed by the complication of prolonged hyperglycaemia[40,46]. The diabetes specialist team should be consulted for management of steroid-induced hyperglycaemia.

BOX 13

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

- **NICE CG66 Type 2 diabetes, 2008[118]**
  - Review the dose of metformin if the serum creatinine exceeds 130 µmol/l or the eGFR is below 45 ml/minute/1.73 m^2
  - Stop the metformin if the serum creatinine exceeds 150 µmol/l or the eGFR is below 30 ml/minute/1.73 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 ml/minute/1.73 m^2
- **BNF 60 Sept 2010[119]**
  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'
- **Merck Serono datasheet Glucophage 500 mg and 850 mg film coated tablets[115]**
  Metformin 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.

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 (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 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 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 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 levels kept between 6 and 10 mmol/L (although 4 to 12 is acceptable) during their admission.	100%
Percentage of patients with evidence of poor peri-operative glycaemic control: - 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
3, 4, or 5 injections daily	No dose change	**Basal bolus regimens:** omit the morning and lunchtime short acting insulins. Keep the basal unchanged.* **Premixed AM insulin:** 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

*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 39).

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 and PM
Pioglitazone	Take as normal	Take as normal	Take as normal
DPP IV inhibitor (e.g. Sitagliptin, Vildagliptin, Saxagliptin)	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

NB – 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 mls/min/1.73m^2, 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.

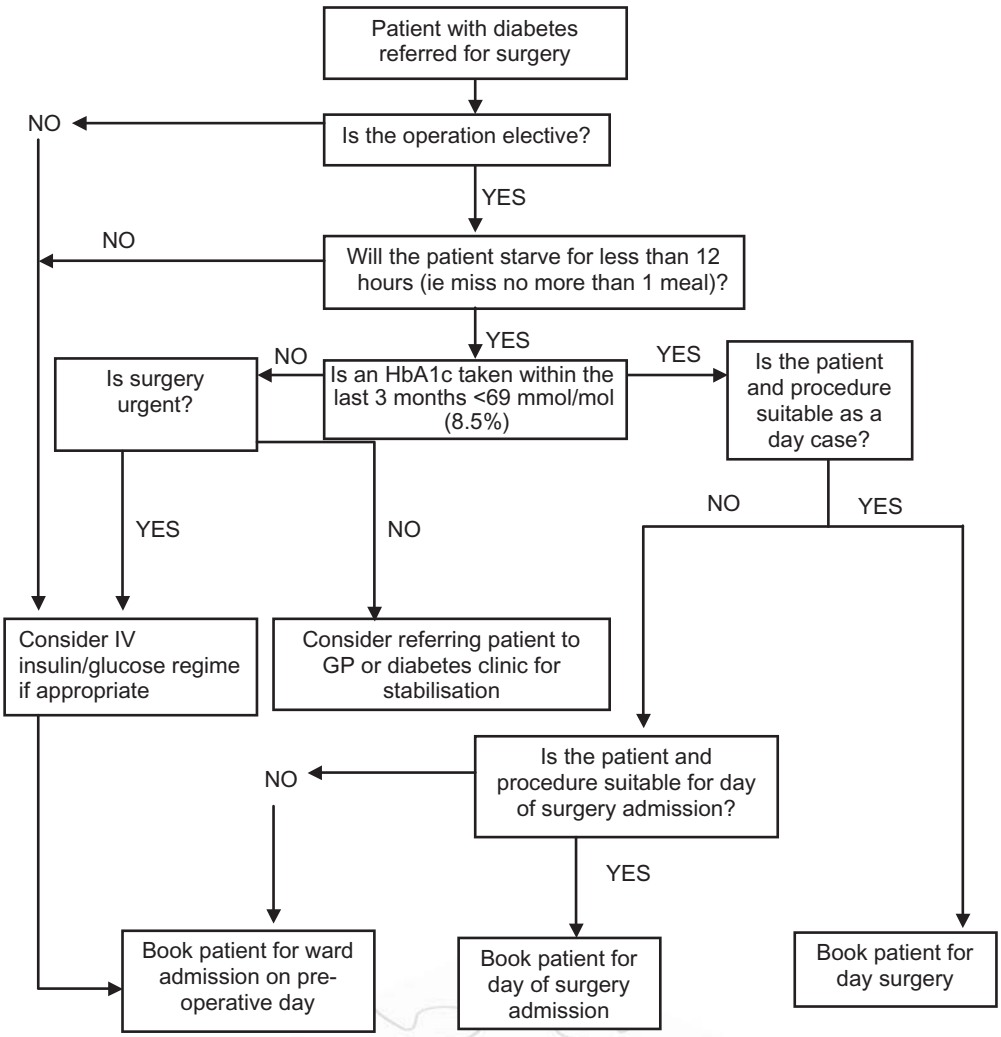
People with diabetes controlled by oral or injected medication are suitable for day case surgery if:

- 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).

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 mmol/mol or 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. Aim for blood glucose level 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 in 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[57], 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 levels between 6-10 mmol/L, although 4 to 12 mmol/L is acceptable).

Principles

- There is no one fit for 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 39 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[57] 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. 2 or more missed meals)
- Decompensated diabetes.

Administration

- Make up a 50 ml syringe with 49.5mls of 0.9% sodium chloride solution
- 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 VRIII 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
    - 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) provide further excellent detailed guidance[42].

Appendix 6:

Advantages and disadvantages of intravenous solutions

	Advantages	Disadvantages
0.45% saline with 5% glucose with 0.15% potassium chloride at 83-125 ml/hr with a continuous VRIII	• Constant supply of substrate • Meets daily sodium and potassium requirements • Safety profile of regimen demonstrated in the paediatric diabetic population	• Not widely available • Hypotonic solution in vivo with reference to plasma and may still predispose to hyponatraemia • May exceed daily requirements of sodium
0.9% saline with 5% glucose with 0.15% potassium chloride at 83-125 ml/hr with a continuous VRIII	• Constant supply of substrate • Meets sodium and potassium requirements • Safety profile of regimen demonstrated in the paediatric diabetic population	• Not widely available • Will exceed daily sodium chloride requirement and predispose to oedema and hyperchloraemic metabolic acidosis
0.18% saline with 4% glucose with 0.15% potassium chloride at 83-125 ml/hr with a continuous VRIII	• Constant supply of substrate • Meets daily sodium and potassium requirements • Widely available	• Associated with hyponatraemia. Use in children has been curtailed by the NPSA • Hypotonic solution in vivo with reference to plasma
5-10% glucose with 0.15% potassium chloride at 125 ml/hr with a continuous VRIII	• Constant supply of substrate • Widely available	• Does not provide any sodium • Associated with hyponatraemia
5-10% glucose with 0.15% potassium chloride at 125 ml/hr with additional 0.9% saline at a variable rate to correct the hyponatraemia and a continuous VRIII	• Constant supply of substrate • Widely available	• Requires 3 infusion pumps (1 for the glucose, 1 for the saline and 1 for the insulin) • May need multiple venous access • May lead to fluid overload
10% glucose with 0.15% potassium chloride at 60 ml/hr with additional 0.9% saline at 60 ml/hr with a continuous VRIII	• Constant supply of substrate • Widely available	• Needs 3 infusion pumps (1 for the glucose, 1 for the saline and 1 for the insulin) • May need multiple venous access

	Advantages	Disadvantages
10% glucose with 0.15% potassium chloride at 100ml/hr if CBG less than 15mmol/L with a continuous VRIII 0.9% saline with 0.15% KCl at 100 ml/hr if CBG more than 15mmol/L with a continuous VRIII		• Erratic supply of substrate • Unpredictable administration of sodium • Increased nursing workload and difficulties in maintaining accurate fluid balance charts with constant changes of fluid bags according to CBG
500mls 10% glucose and 0.15% KCl with 5 units insulin if CBG less than 6 mmol/L 500mls 10% glucose and 0.15% KCl with10 units insulin if CBG 6-10 mmol/L 500mls 10% glucose and 0.15% KCl with 15 units insulin if CBG 10-20 mmol/L 500mls 10% glucose and 0.15% KCl with 20 units insulin if CBG more than 20 mmol/L All administered at 100-125 ml/hr and with additional 0.9% saline to treat established hyponatraemia	• Intrinsically safe as substrate and insulin are co-administered • Evidence to support its use	• Increased nursing workload and difficulties in maintaining accurate fluid balance charts with constant changes of fluid bags according to CBG • Hyponatraemia is a recognised complication • May lead to fluid overload with the co-administration of additional 0.9% saline
Hartmann's Solution	• Causes minimal metabolic and electrolyte disturbance • 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	• Has insufficient calories to provide a safe substrate solution when given with a continuous infusion of insulin • Has insufficient potassium to run alongside a continuous insulin infusion • Continuous use over several days will lead to salt retention as well as hypokalaemia

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 recommenced if the eGFR is greater than 50 mls/min/1.73m^2.

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 (4-12 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 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 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

(NB 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 1st 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 bed time.

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®				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) or Victoza® (liraglutide)

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 am.

If your operation is in the afternoon:

- Eat breakfast before 7 am and take no food after this time
- Drink clear fluids such as black tea or coffee, sugar-free squash or water up to 10 am
- 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 4 mmol/L take 4 glucose tablets or 150 mls 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 [insert 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 [to be completed by assessing nurse].

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What to do with your medication before the surgery

Tablets	Day before going into hospital	Day of surgery	
		If your surgery is in the morning	**If your surgery is in the afternoon**
Acarbose	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.
Meglitinide (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.
Metformin If you are due to have contrast media this **may** 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.
Sulphonylureas (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.
Thiazolidinediones (Pioglitazone)	Take as normal	Take as normal	Take as normal
DPP-IV inhibitors (Sitagliptin, saxagliptin, vildagliptin)	Take as normal	Omit your morning dose.	Omit your morning dose.
You should restart taking your normal tablets the morning after surgery. However, your blood glucose may be higher than usual for a day or so.			

If you are taking Byetta® (exenatide) or Victoza® (liraglutide) by injection these medications should not be taken the day of surgery and restarted once once you start eating and drinking normally.

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 am.

If your operation (procedure) is in the afternoon:

- Eat breakfast before 7 am 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 am
- 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 4 mmol/L take 4 glucose tablets or 150 mls 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 restart 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 feel sick or are sick 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 before going into hospital	Day of surgery	
		If your surgery is in the morning	**If your surgery is in the afternoon**
Once daily (evening) (Lantus®/Glargine or Levemir/Detemir®) Insulatard® or Humulin I®	No dose change	No dose change necessary*.	No dose adjustment necessary*.
Once daily (morning) (Lantus®/Glargine or Levemir/Detemir®) Insulatard® or Humulin I®	No dose change	Take your normal dose*. Your blood glucose will be checked on admission.	Take your normal dose*. Your blood glucose will be checked on admission.
Twice daily (Novomix 30®, Humulin M3®, Humalog Mix 25®, Humalog Mix 50®)	No dose change	Halve the usual dose. Your blood glucose will be checked on admission. Resume your normal insulin with your evening meal.	Halve the usual dose. Your blood glucose will be checked on admission. Resume your normal insulin with your evening meal.
3, 4, or 5 injections daily	No dose change	Do not take 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 your normal dose*. If you normally take a pre-mixed insulin the dose should be halved. Do not take your lunchtime dose. Resume your normal insulin with your evening meal.	Take usual morning insulin dose(s). Do not take lunchtime dose. Your blood glucose will be checked on admission. Resume your normal insulin with your evening meal.
You should restart taking your normal insulin the morning after surgery (procedure). However, your blood glucose may be higher than usual for a day or so.			

*Some units would recommend reduction of usual dose of long acting analogue by one third, particularly if you take regular snacks during the day.

Appendix 9:

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

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®).

Day before procedure: non insulin treated patients

- Do not take any diabetes tablets.

Day of procedure: insulin treated or non insulin treated patients

Please refer to the guidelines for the day of surgery (procedure) (Appendix 8). However, if the colonoscopy is due for the afternoon, then halve the morning dose of insulin(s).

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 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 4 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.

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, feeling or being sick
- 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 you are being sick 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*

Poor glycaemia control is associated with greater post-operative morbidity and mortality. By optimising pre-operative diabetes control you can help reduce the risk of post-operative mortality by 50%.

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.

Please could 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_{1c}
- eGFR

Importance of good glycaemia 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_{1c} below 69 mmol/mol (8.5%) prior to surgery.** To avoid the risk of postponement or cancellation, please review the treatment of any patient with an HbA_{1c} 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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