

JBDS-IP

Joint British
Diabetes Societies
for inpatient care

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

Summary

Revised March 2016



Association of British Clinical Diabetologists



Excellence in short stay surgery



The Royal College
of Anaesthetists



Lead authorship

Dr Ketan Dhatariya – Consultant in Diabetes, Norfolk and Norwich University Hospitals NHS Foundation Trust
Dr Nicholas Levy – Consultant in Anaesthesia, West Suffolk NHS Foundation Trust
Dr Daniel Flanagan – Consultant in Diabetes, Plymouth Hospitals NHS Trust
Louise Hilton – Senior Diabetes Nurse, Bolton PCT
Dr Anne Kilvert – Consultant in Diabetes, Northampton General Hospital NHS Trust
Dr Gerry Rayman – Consultant in Diabetes, The Ipswich Hospital NHS Trust
Dr Bev Watson – Consultant in Anaesthesia, The Queen Elizabeth Hospital Kings Lynn NHS Foundation Trust

Contributors

Professor David Cousins – Head of Patient Safety for Medication and Medical Devices, (formerly National Patient Safety Agency (NPSA) – In June 2012, the key functions and expertise for patient safety developed by NPSA transferred to the NHS Commissioning Board Special Health Authority)
Carol Jairam – Diabetes Specialist Nurse, Charing Cross Hospital, Imperial College Healthcare NHS Trust
Stephanie Leonard – Sister in the preadmission unit, Bolton NHS Foundation Trust
Dr Karen Leyden – Consultant in Anaesthesia, Northampton General Hospital NHS Trust
Dr Anna Lipp – Consultant in Anaesthesia, Norfolk & Norwich University Hospitals NHS Foundation Trust
Professor Dileep Lobo – Professor of Gastrointestinal Surgery, Nottingham University Hospitals NHS Trust
Dr Nigel Penfold, Consultant in Anaesthesia, Council Member of Royal College of Anaesthetists,
Dr Maggie Sinclair-Hammersley – Consultant in Diabetes, John Radcliffe Hospital, Oxford University Hospitals NHS Trust

Supporting organisations

Diabetes UK: Tracy Kelly, Head of Care
Joint British Diabetes Societies (JBDS) for Inpatient Care, Chair: Professor Mike Sampson (Norwich)
Diabetes Inpatient Specialist Nurse (DISN) UK Group, Chair: Esther Walden (Norwich)
Association of British Clinical Diabetologists (ABCD), Chair: Dr Rob Gregory (Leicester)

JBDS IP Group

Dr Belinda Allan, Hull and East Yorkshire Hospital NHS Trust
Dr Hamish Courtney, Belfast Health and Social Care Trust, Northern Ireland
Dr Ketan Dhatariya, Norfolk and Norwich University Hospitals NHS Foundation Trust
Dr Daniel Flanagan, Plymouth Hospitals NHS Trust
Dr Stella George, East and North Hertfordshire NHS Trust
Dr Rob Gregory, Chair, Association British Clinical Diabetologists
June James, University Hospitals of Leicester NHS Trust
Tracy Kelly, Diabetes UK
Dr Omar Mustafa, King's College Hospital NHS Foundation Trust
Dr Colin Perry, NHS Greater Glasgow and Clyde
Dr Gerry Rayman, The Ipswich Hospitals NHS Trust
Dr Stuart Ritchie, NHS Lothian
Dr Aled Roberts, Cardiff and Vale University NHS Health Board
Professor Mike Sampson (Norwich), Chair, Joint British Diabetes Societies (JBDS) for Inpatient Care
Dr Maggie Sinclair-Hammersley, Oxford University Hospitals NHS Trust
Debbie Stanisstreet, East and North Hertfordshire NHS Trust
Professor Jonathan Valabhji, National Clinical Director for Obesity and Diabetes
Esther Walden, Norfolk and Norwich University Hospital NHS Foundation Trust
Dr Peter Winocour, East and North Hertfordshire NHS Trust

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

Foreword



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

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

Professor Jonathan Valabhji

National Clinical Director for Obesity and Diabetes, NHS England

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.

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Main recommendations

Organisation and planning of care

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

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

Diabetes specialists

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

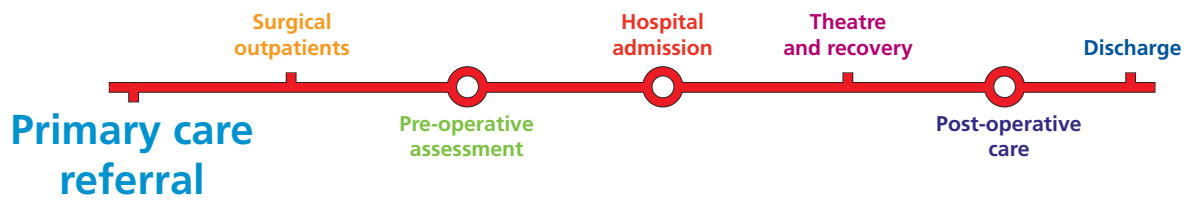
Peri-operative use of intravenous insulin

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

Peri-operative blood glucose monitoring

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

Primary care



Aims

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

Recommendations

1. Provide the current HbA_{1c}, blood pressure and weight measurements with details of relevant complications and medications in the referral letter (Appendix 12).
2. Optimise glycaemic control, aiming for an HbA_{1c} of less than 69mmol/mol before referral if possible, and if it is safe to do so.
3. Consider referral to the diabetes specialist team for advice if the HbA_{1c} is greater than 69mmol/mol (8.5%) and it is felt that further optimisation is safely achievable. 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. The referral letter should state if the GP feels that the glycaemic control is as good as it could be, and that the patient is judged to be ready for the elective procedure.
4. Patients with hypoglycaemic unawareness should be referred to the diabetes specialist team irrespective of HbA_{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).

Surgical outpatients



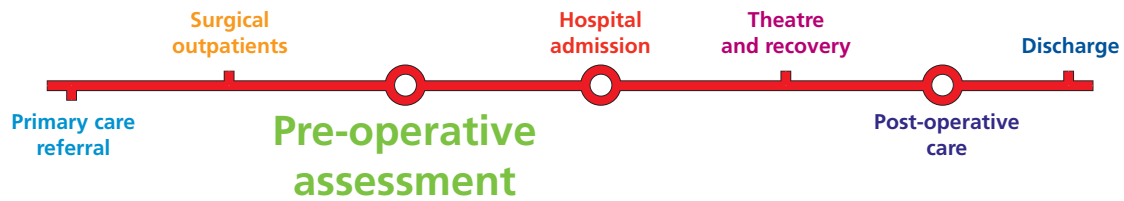
Aims

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

Recommendations

1. Systems should be in place to allow early pre-operative assessment to identify people with suboptimal diabetes control.
2. Clear institutional plans based on British Association of Day Surgery Directory of Procedures should be in place to facilitate day of surgery admission and prevent unnecessary overnight pre-operative admission.
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 VRlll and an unnecessary overnight stay.
6. Unless Diabetes Inpatient Specialist Nurses or other members of the Diabetes Inpatient Specialist Team are available for consultation 7 days per week, it may be prudent to avoid operating on patients with diabetes routinely at weekends. However, weekend operating may be acceptable if there is an adequate level of diabetes related specialist support available.

Pre-operative assessment



Aims

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

Recommendations

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

- 3.5mmol/L are safe and do not require IV glucose or other rescue treatment.
- i. The patients' usual diabetes medication should also be written up on the drug chart with the appropriate adjustments made (see Appendices 1 and 2).
 - j. Ensure that patients with diabetes are not placed on an evening list. This avoids prolonged starvation times, the use of a VRll and potentially an unnecessary overnight stay.
 - k. During venous thromboembolism risk assessment ensure no contraindications to anti-embolism stockings e.g. patients with peripheral vascular disease or neuropathy.
 - l. Patients with 'at risk' feet should be identified and steps taken to document this clearly where it will be easily visible to theatre and ward teams.
 - m. Plan duration of stay and make preliminary discharge arrangements.
 - n. Ensure that admission ward staff are appraised of plans and able to activate them on the day of admission.
 - o. Consider the need for home support following discharge, and involve the primary care team in discharge planning.

Order of lists

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

the theatre list, so that they may have lunch at the correct time after a morning procedure, or evening meal at the correct time after an afternoon procedure. For this reason, elective evening operating is not recommended for patients taking blood glucose lowering medication. However, prioritisation is not needed for patients who have diet controlled diabetes.

Responsibility for optimisation of glycaemic control (i.e. an HbA_{1c} of less than 69mmol/mol, if it is safe to do so)

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

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

Hospital admission



Aims

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

Recommendations

1. Provide written guidelines for hospital staff and patients for the modification of commonly used diabetes treatment regimens on the day prior to and day of surgery (Appendices 1, 2, 8 & 9).
2. Identify high-risk patients (poor glycaemic control/complications of diabetes) and make arrangements for post-operative admission to critical care if indicated.
3. Base management on Enhanced Recovery Partnership Programme principles but omit the pre-operative high carbohydrate drink in people with insulin treated diabetes if a VRIII is not required.
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 5% dextrose in 0.45% sodium chloride 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.
7. Ensure that Glucogel®, glucagon and rapid acting insulin is routinely prescribed to allow prompt treatment of hypo- or hyperglycaemia in the patient who is either unconscious or unable to cooperate. The target blood glucose in the pre-operative, anaesthetised or sedated patient should be 6-10mmol/L (up to 12mmol/L may be acceptable). The target of 6-10mmol/L is for those who are treated with glucose lowering agents – i.e. insulin, (either subcutaneously, or via an insulin infusion) or sulphonylurea therapy. In the **awake** patient on agents that do not produce hypoglycaemia, provided they have not been given insulin, lower blood glucose values down to 3.5mmol/L are safe and do not require IV glucose or other rescue treatment.
8. Monitor CBG regularly when the patient is under sedation. Hypoglycaemia sometimes manifests as drowsiness, which may be wrongly attributed to sedation.
9. Capillary blood glucose (CBG) target ranges are controversial. Aim for CBG between 6-10mmol/L but 6-12mmol/L is acceptable. Avoid wide swings in CBG.
10. For patients requiring a VRIII, the long-acting analogue (Glargine/Lantus®, Degludec/Tresiba®, Detemir/Levemir®) should be continued alongside the VRIII during the peri-operative period.

Evidence shows that this reduces the risk of rebound hyperglycaemia when the VRlll is discontinued. **The dose the patient takes when they are well should be reduced by 20% whilst they are in hospital.**

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

Factors influencing the choice of peri-operative diabetes management

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

Anticipated short starvation period (only one missed meal)

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

Anticipated long starvation period (more than one missed meal)

Most patients will require a VRlll. Written guidelines should be in place to ensure safe use and should include the following:

- Indications for use of the VRlll and when to commence

- Remember to reduce the dose of long acting background insulin by 20%
- Drugs to be withheld whilst on the VRlll
- Drugs to be continued whilst on the VRlll
- 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 VRlll and substrate solution (Appendix 5)
- How and where to record glucose levels and rates of insulin infusion
- When and how to take down the VRlll (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.

JBDS has produced a guideline for the use of a VRlll in medical inpatients. The VRlll shown in Appendix 5 has been modified from this.

Foot care

Patients who are at high risk of developing foot ulcers should have measures taken to protect their feet and other high risk areas during surgery. High risk patients include those with a history of previous ulceration and/or amputation, those with current ulceration, and those receiving dialysis. Those with peripheral vascular disease and neuropathy are also at increased risk. These should be examined for on admission. Pressure areas should be inspected prior to induction of anaesthesia and high risk areas protected using suitable equipment such as foam pressure relieving equipment, silicon and gel pads. All efforts should be made to inspect these same areas immediately post-operatively and at regular intervals during the post-operative period to ensure they are not becoming discoloured and remain intact. Hospital acquired pressure ulcers are a cause of significant morbidity.

Theatre and recovery



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

Aims

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

Recommendations

1. Implement the WHO surgical safety checklist bundle with maintenance of intraoperative blood glucose levels between 6-10mmol/L where possible. The target blood glucose in the pre-operative, anaesthetised or sedated patient should be 6-10mmol/L (up to 12mmol/L may be acceptable). The target of 6-10mmol/L is for those who are treated with glucose lowering agents – i.e. insulin, (either subcutaneously, or via an insulin infusion) or sulphonylurea therapy. In the **awake** patient on agents that do not

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

2. Implement the agreed care plan.
3. A patient with a VRIII needs at least 2 cannulae – one dedicated for insulin and glucose, and the others for anaesthetic drugs, and additional fluids.
4. Check the CBG prior to induction of anaesthesia.
5. Monitor the CBG regularly during the procedure (at least hourly – more frequently if readings outside the target range).
6. Avoid unnecessary use of VRIII, **but never stop an insulin infusion in someone with type 1 diabetes unless subcutaneous insulin has been given.**
7. Correct a high blood glucose using additional subcutaneous insulin or by introducing a VRIII (Appendix 4).
8. Prescribe fluid regimen as required (Appendix 5).
9. Document the CBG, insulin infusion rate and substrate infusion on the anaesthetic record as recommended by the Royal College of Anaesthetists and the Association of Anaesthetists of Great Britain and Ireland.
10. Consider the use of individualised goal directed therapy.
11. Ensure arrangements are in place to admit high-risk patients to critical care if necessary.
12. Implement surgical and anaesthetic principles of the Enhanced Recovery Partnership

Programme to promote early return to normal diet and usual diabetes management.

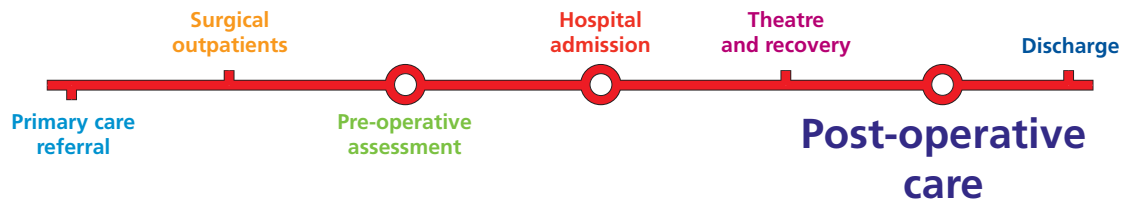
13. Use anaesthetic techniques to reduce the incidence of post-operative nausea and vomiting (PONV) and promote early return to normal diet and usual diabetes management.

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. 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. There are no recommendations for other procedures but hourly blood glucose measurement should suffice if the blood glucose is stable and in the target range.

Note: The 2010 Confidential Enquiry into Maternal and Child Health reported on the standards of anaesthetic record keeping in women with diabetes undergoing Caesarean section. 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.

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.

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.

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

Aims

- Ensure blood glucose levels are appropriately maintained. The acceptable post-operative range in the **awake** patient not on a VRIII is 4-12mmol/L, however if a VRIII is used, then the acceptable range remains 6-12mmol/L.
- Fluid and electrolyte balance should be maintained.

- Optimise pain control.
- Encourage an early return to normal eating and drinking, facilitating return to the usual diabetes regimen.
- Follow the principles of the Enhanced Recovery Partnership Programme.
- Avoid iatrogenic injury (drugs/diabetes management/infection/pressure damage).

Recommendations

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

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. 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.

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

- Ensure that insulin is prescribed using the brand name, written out in full.
- Ensure that where it is hand written, that the prescription is legible, and that abbreviations such as 'u' and 'iu' are avoided.
- Whenever insulin is prescribed on a drug chart, then treatment for hypoglycaemia must also be prescribed – to be available if necessary.
- 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.

Safe use of variable rate intravenous insulin infusions (VRIII)

Prior to Alberti's seminal paper in 1979, the peri-operative management of the surgical patient with diabetes was haphazard, and was associated with an unacceptable level of morbidity and mortality. Alberti's Glucose, Insulin, Potassium (GIK) regimen was based on sound scientific principles and was shown to be superior to 2 other regimens, and thus by the mid 1980s was the most accepted method of managing diabetes peri-operatively in the Oxford region. It involved infusing a 500ml bag of 10% glucose at 125ml/hr, and to the bag 10 units of insulin and 1 g potassium chloride was added. However, if the patient's CBG fell out of the range of 5-10mmol/L, the whole bag of fluid was discarded and a different amount of insulin was added. Thus

the Alberti regime is both intensive and wasteful, and had the potential for error with the number of additives to the fluid bag. Subsequently by 1993, the Alberti had become superseded by the regime in which the substrate and the insulin were separated into 2 separate infusions. The glucose was administered at 125ml/hr and the insulin was administered at a rate appropriate to the serum glucose level. This regime became known as the "sliding scale"*, and was subsequently almost universally adopted in the UK for the peri-operative management of the surgical patient. This was despite no studies either assessing the efficacy of it to maintain the CBG in the target range of 5-10mmol/L, or whether the regimen was safe.


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

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

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

Thus the aim of these guidelines is twofold:

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



For patients requiring a VRIII, the long-acting analogue (Glargine/Lantus®, Degludec/Tresiba®, Detemir/Levemir®) should be continued alongside the VRIII during the peri-operative period. Evidence shows that this reduces the risk of rebound hyperglycaemia when the VRIII is discontinued. **The dose of long acting insulin that the patient takes when they are well should be reduced by 20% whilst they are in hospital, (see Controversial Areas).**

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

Treatment requirements may differ from what the patient usually takes when they are well in the immediate post-operative period with risk of both hypo- and hyperglycaemia and clinical staff may need to take decisions about diabetes management. Training in blood glucose management is essential for all staff dealing with patients with diabetes. **The diabetes specialist team should be consulted if there is uncertainty about treatment selection or if the blood glucose targets are not achieved and maintained.**

Discharge



Discharge planning should be built into the pre-operative assessment process in collaboration with the patient and should look beyond the inpatient episode of care. This is to ensure patient safety after discharge and reduce the risk of readmission; 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.

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

Aims

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

Recommendations

1. In consultation with the patient, decide the clinical criteria that the patient must meet before discharge.
2. Set a date and/or time of discharge as early as possible. This should include weekends.
3. Identify whether the patient has simple or complex discharge planning needs and plan how they will be met.
4. Involve the diabetes specialist team if diabetes related delays in discharge are anticipated.
5. Provide patient education to ensure safe management of diabetes on discharge.
6. Discharge should not be delayed solely because of poor glucose control. The patient or carer's ability to manage the diabetes should be taken into consideration. Discuss with the diabetes specialist team if necessary.
7. Systems should be in place to ensure effective communication with community teams, particularly if changes to the patients' pre-operative diabetes treatment have been made during the hospital stay.
8. Diabetes expertise should be available to support safe discharge and the team that normally looks after the patient's diabetes should be contactable by telephone.

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 Diabetes UK and TREND-UK (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
Does the Trust take part in the National Inpatient Diabetes Audit (NaDIA)?	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%
Insulin must always be prescribed by brand name, written out in full	100%
All clinical areas and community staff treating patients with insulin have adequate supplies of insulin syringes and subcutaneous needles, which staff can obtain at all times	100%
An insulin syringe must always be used to measure and prepare insulin for an intravenous infusion	100%
A training programme should be put in place for all healthcare staff (including medical staff) expected to prescribe, prepare and administer insulin	100%
Policies and procedures for the preparation and administration of insulin and insulin infusions in clinical areas are reviewed to ensure compliance with the above	100%

Department of Health 'Never Event' Standard⁷¹:

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 who are listed for elective surgery who are admitted on the day of the procedure	100%. An exclusion for this is where other significant co-morbidity needs pre-operative optimisation
Percentage of people with diabetes who have a surgical condition that would normally be managed as a day case who have no other day surgery contraindications who are listed for day case surgery	100%. An exclusion for this is where other significant factors necessitate an inpatient stay
Percentage of people with diabetes who are listed on the first third of the operating list (morning or afternoon lists)	95%
Percentage of people in whom a VRILL is established with correct configuration of the one-way and anti-siphon valves	100%
Length of stay for patients with diabetes undergoing surgery or procedures	No longer than 10% greater than for people without diabetes

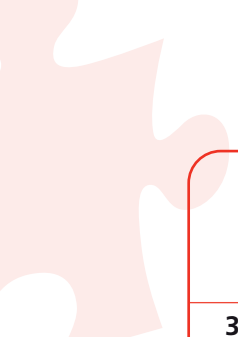
Percentage of people with diabetes and a condition not usually requiring a post-operative overnight stay who are operated on electively during an evening list	0%
Percentage of patients with diabetes who receive hourly monitoring of blood glucose during their procedure, and in recovery	100%
Percentage of time that people with diabetes have their pre-operative and intraoperative blood glucose levels kept between 6 to 12mmol/L	100%
Percentage of patients with evidence of poor peri-operative glycaemic control: <ul style="list-style-type: none"> - 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%

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

Appendix 1:

Guideline for peri-operative adjustment of insulin

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



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

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

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

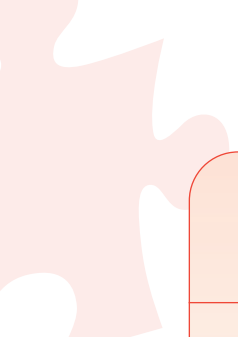
The management of perioperative hyperglycaemia and hypoglycaemia is outlined in Appendix 4.

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

Appendix 2:

Guideline for peri-operative adjustment of non-insulin medication

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



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

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

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

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

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

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

** If contrast medium is to be used and eGFR less than 60ml/min/1.73m², metformin should be omitted on the day of the procedure and for the following 48 hours.

Appendix 3:

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

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

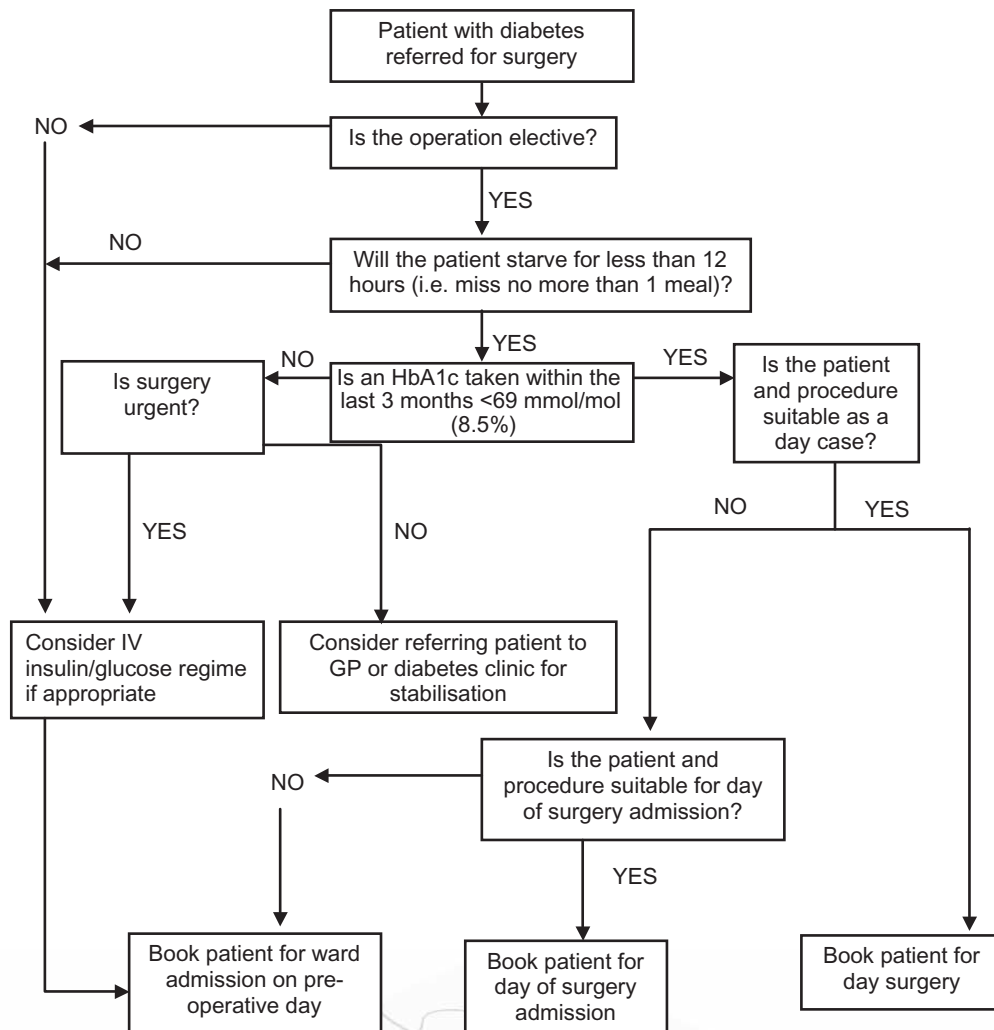
See the algorithm below for guidance.

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

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

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

Suitability of patients with diabetes for day surgery



Appendix 4:

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

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

Management of hyperglycaemia

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

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

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

Management of hypoglycaemia and hypoglycaemia risk

- Admission or peri-operative hypoglycaemia (capillary blood glucose less than 6mmol/L).

N.B. patients on diet alone are not at risk of hypoglycaemia and are excluded from the guideline below:

- If CBG is 4-6mmol/L and the patient has symptoms of hypoglycaemia: consider giving 50ml of 20% glucose as a stat iv bolus and repeat the CBG after 10 minutes
- If CBG is less than 4mmol/L; give 75-100ml of 20% glucose (i.e. 300-400 ml/hr using an infusion pump) and repeat the capillary blood glucose after 10 minutes
- Try to avoid stopping the VRIII in type 1 diabetic patients. If it is stopped recommence as soon as the blood glucose rises above 5mmol/L
- Persistent hypoglycaemia should be referred urgently to the diabetic specialist team or the on-call medical team
- Increase frequency of blood glucose monitoring until normoglycaemia achieved and then revert to monitoring blood glucose hourly until the patient is eating and drinking

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

Appendix 5:

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

Aim

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

Principles

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

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

Indication for VRIII

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

Administration

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

Fluids to run alongside the VRIII

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

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

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

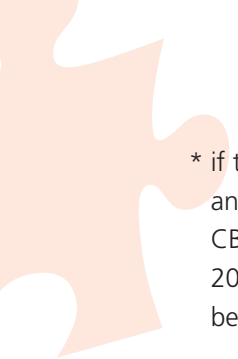
Cautions:

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

Rate of insulin infusion

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

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

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

Treatment of CBG <4mmol/L whilst on VRIII

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

Management of CBG 4.1-6mmol/L

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

Guidelines for setting up a variable rate intravenous insulin infusion

- Intravenous fluid must be administered using a volumetric infusion pump and an infusion/IV fluid stand must always be available
- Delivery of the substrate solution and the VRIII must be via a single cannula **with appropriate one-way and anti-siphon valves**

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

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

Appendix 6:

Advantages and disadvantages of intravenous solutions

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

	Advantages	Disadvantages
<p>10% glucose with 0.15% KCl at 100ml/hr if CBG less than 15mmol/L with a continuous VRIII</p> <p>0.9% saline with 0.15% KCl at 100ml/hr if CBG more than 15mmol/L with a continuous VRIII</p>		<ul style="list-style-type: none"> • 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 • Difficulty in monitoring fluid balance • Cannot be recommended
<p>500ml 10% glucose and 0.15% KCl with 5 units insulin if CBG less than 6mmol/L</p> <p>500ml 10% glucose and 0.15% KCl with 10 units insulin if CBG 6-10mmol/L</p> <p>500ml 10% glucose and 0.15% KCl with 15 units insulin if CBG 10-20 mmol/L</p> <p>500ml 10% glucose and 0.15% KCl with 20 units insulin if CBG more than 20mmol/L</p> <p>All administered at 100-125 ml/hr and with additional 0.9% saline to treat established hyponatraemia</p>	<ul style="list-style-type: none"> • Intrinsically safe as substrate and insulin are co-administered • Evidence to support its use 	<ul style="list-style-type: none"> • 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, Ringer's lactate and Plasma-Lyte 148®	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Probably 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 VRlll to subcutaneous insulin or oral treatment

Restarting oral hypoglycaemic medication

- Recommence oral hypoglycaemic agents at pre-operative doses once the patient is ready to eat and drink.
- Be prepared to withhold or reduce sulphonylureas if the food intake is likely to be reduced.
- Metformin should only be recommended if the eGFR is greater than 60ml/min/1.73 m².

Restarting subcutaneous insulin for patients already established on insulin

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

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

For the patient on basal bolus insulin

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

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

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

Contact the diabetes team for advice.

For the patient on a twice daily fixed-mix regimen

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

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

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

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

Calculating subcutaneous insulin dose in insulin-naïve patients

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

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

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

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

Calculating a basal bolus (QDS) regimen

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

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

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

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

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

Calculating a twice daily (BD) regimen

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

Appendix 8:

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

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

Before your operation or procedure:

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

If your operation is in the morning:

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

If your operation is in the afternoon:

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

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

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

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

Remember to bring with you to hospital

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

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

What to do with your medication before the surgery

Tablets	Day prior to admission	Day of surgery	
		Patient for a.m. surgery	Patient for p.m. surgery
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 / Glucophage MR 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, alogliptin, linagliptin)	Take as normal	Take as normal	Take as normal
GLP-1 analogue (e.g. exenatide, liraglutide, lixisenatide)	Take as normal	Take as normal	Take as normal
SGLT-2 inhibitors (e.g. dapagliflozin, canagliflozin)	Take as normal	Omit your morning dose	Omit your morning dose
You should resume taking your normal tablets the morning after surgery. However, your blood glucose may be higher than usual for a day or so.			

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

[To be adapted depending on the procedure]

Before your operation or procedure:

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

If your operation (procedure) is in the morning

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

If your operation (procedure) is in the afternoon

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

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

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

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

Remember to bring with you to hospital

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

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

What to do with your insulin before surgery (procedure)

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

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

Appendix 9:

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

Advice should be sought from your normal diabetes care provider

Gastroscopy / Bronchoscopy

- Follow guidelines for surgery as in leaflets above

Colonoscopy

Day before procedure: insulin-treated patients

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

Day before procedure: non insulin treated patients

- Omit any diabetes tablets.

Day of procedure: insulin treated or non insulin treated patients

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

Appendix 10:

Sick Day Rules for People with Diabetes

These are a guide only, local practice may vary

What should I do if I am unwell?

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

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

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

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

Appendix 11:

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

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

Appendix 12:

GP letter with recommendations for referral of patients for surgery

Dear Local GP

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

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

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

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

Up-to-date current diabetes care

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

Specific complications of diabetes

- At risk foot
- Renal impairment
- Cardiac disease

Recent values for

- BMI
- BP
- HbA_{1c}
- eGFR

Importance of good glycaemic control prior to surgery

There is evidence that poor pre-operative glycaemic control is associated with greater post-operative mortality and morbidity after elective surgery. **In view of this we recommend that every effort be made to achieve an HbA_{1c} below 69mmol/mol (8.5%) prior to surgery and it is felt that further optimisation is safely achievable.** To avoid the risk of postponement or cancellation, please review the treatment of any patient with an HbA_{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

