Glycaemic management during the inpatient enteral feeding of stroke patients with diabetes

Joint British Diabetes Societies (JBDS) for inpatient care

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Supporting, Improving, Caring

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Self-Management of Diabetes in Hospital March 2012 JBDS 04

The Management of Adults with Diabetes undergoing Surgery and Elective Procedures: improving standards April 2011 JBDS 03

The Hospital Management of Diabetic Ketoacidosis in Adults March 2010 JBDS 02

The Hospital Management of Hypoglycaemia in Adults with Diabetes Mellitus March 2010 JBDS 01

All of these publications can be found on the NHS Diabetes website at www.diabetes.nhs.uk

Contents

Foreword

Glycaemic management during the inpatient enteral feeding of stroke patients with diabetes

A diagnosis of diabetes at least doubles the risk of stroke[1]. Thus a considerable proportion of patients presenting to hospital with acute stroke will have type 2 diabetes, and less commonly type 1 diabetes. An estimated 150,000 people suffer a stroke in the UK every year[2], occupying around 20 per cent of all acute hospital beds and 25 per cent of long term beds[3]. A standard approach to the management of patients with stroke is the provision of adequate nutrition. Frequently this involves a period of enteral feeding should the stroke have resulted in an impaired ability to swallow food safely.

There is currently considerable variability in the management of diabetes inpatients fed enterally following a stroke. Variation in the inpatient management of hyperglycaemia and hypoglycaemia in people receiving enteral feeding following stroke may worsen patient recovery and the potential for rehabilitation.

The aim of this document is to provide guidance to multidisciplinary teams (MDT) – general physicians and stroke specialists, general medical ward and stroke unit nursing staff, dietitians and nutrition teams. It aims to provide pragmatic guidance for the inpatient management of people with stroke who have diabetes and who require a period of enteral feeding in order to improve patient outcomes and patient experience.

This document has been produced by the Joint British Diabetes Societies for Inpatient Care (JBDS – IP) on behalf of Diabetes UK, the Association of British Clinical Diabetologists (ABCD), and the Diabetes Inpatient Specialist Nurse (DISN) UK Group, in collaboration with NHS Diabetes and the Primary Care Diabetes Society (PCDS).

This document is produced from a review of the limited available clinical evidence in this area together with the input of a working group of clinical staff with expertise in diabetes, enteral feeding and stroke medicine. It has sought input from diabetes nurses, diabetologists, dietitians, stroke physicians and pharmacists throughout the United Kingdom.

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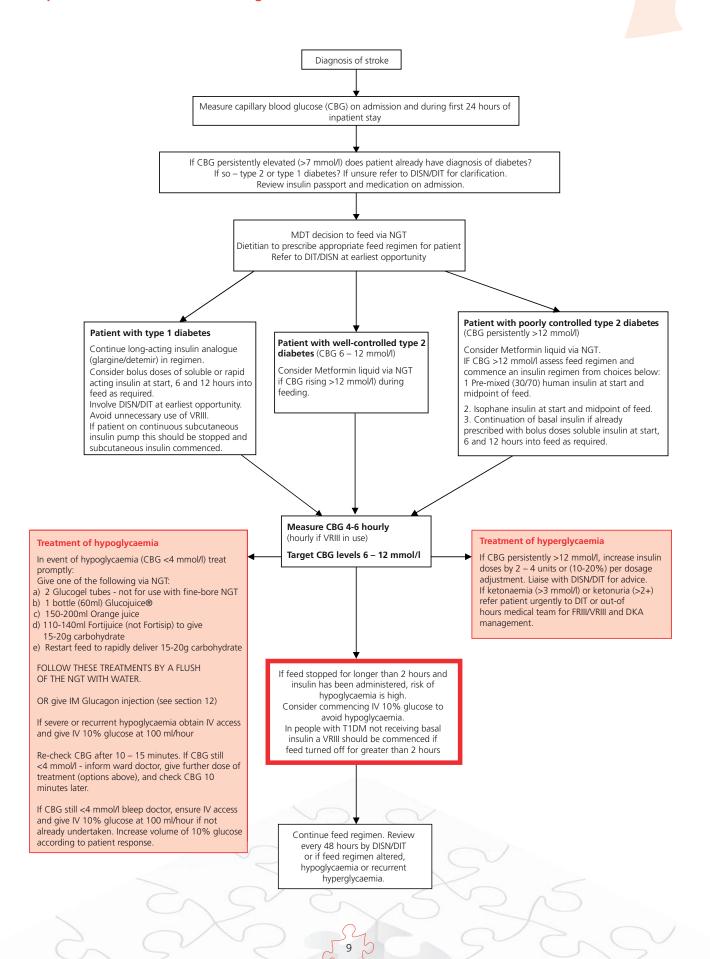University Hospitals of Leicester Dietitians

Summary of recommendations

- 4-6 hourly capillary blood glucose (CBG) monitoring of all patients presenting with stroke and diabetes or newly recognised hyperglycaemia.

- Refer patient to diabetes inpatient specialist nurse (DISN)/diabetes inpatient team (DIT) at earliest opportunity for individual assessment.

- Patients with type 1 diabetes should continue their basal insulin at all times – whether receiving insulin via the subcutaneous or intravenous route – and should not have insulin omitted.

- Continue subcutaneous basal analogue insulin (Glargine or Detemir) if patient treated with basal analogue insulin on admission.

- Target CBG 6-12 mmol/l during enteral feeding of people with diabetes.

- Early involvement of a dietitian to determine an appropriate feed regimen.

- Aim to minimise use of intravenous insulin infusions as far as possible – aim to establish patient on to subcutaneous insulin or glucose-lowering agents administered via the nasogastric tube (NGT) at the earliest opportunity.

- Premixed human insulin at start and midpoint of feed, or isophane insulin at start and, if necessary, the midpoint of feed are recommended first line options for glycaemic management of patients with poorly controlled type 2 diabetes during enteral feeding.

- Administration of soluble human insulin at the time of feed commencement is recommended for a bolus feeding regimen. For those patients prescribed a long acting analogue insulin (e.g. Glargine, Detemir) on admission to hospital and receiving continuous feeding with CBG>12 mmol/l, soluble human insulin may be administered at the start and, if necessary, midpoint of the feed.

- Liquid Metformin administered via NGT may be useful as a sole treatment, or adjunct, for people with type 2 diabetes.

- Crushing of oral tablet medications for administration via NGT is not recommended.

- Monitor capillary glucose pre-feed and then 4-6 hourly when feed running; monitor hourly if feed unexpectedly switched off.

- Involve DISN/DIT immediately in event of hypoglycaemia or recurrent hyperglycaemia.

Table of acronyms

NGT – nasogastric tube	**PEG** - percutaneous endoscopic gastrostomy	**DISN** – diabetes inpatient specialist nurse
VRIII – variable rate intravenous insulin infusion	**DKA** – diabetic ketoacidosis	**DIT** - diabetes inpatient team
FRIII - fixed rate intravenous insulin infusion	**NPSA** - National Patient Safety Agency	**JBDS** – Joint British Diabetes Societies
CBG – capillary blood glucose	**CSIII** - continuous subcutaneous insulin infusion	**T2DM** – type 2 diabetes mellitus
NPH – neutral protamine hagedorn	**GLP-1** - glucagon like peptide-1 mimetics	**T1DM** – type 1 diabetes mellitus

Algorithm for the Management of hyperglycaemia during enteral feeding of stroke patients with diabetes – JBDS guideline

Diagnosis of stroke

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Measure capillary blood glucose (CBG) on admission and during first 24 hours of inpatient stay

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If CBG persistently elevated (>7 mmol/l) does patient already have diagnosis of diabetes?
If so – type 2 or type 1 diabetes? If unsure refer to DISN/DIT for clarification.
Review insulin passport and medication on admission.

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MDT decision to feed via NGT
Dietitian to prescribe appropriate feed regimen for patient
Refer to DIT/DISN at earliest opportunity

Patient with type 1 diabetes

Continue long-acting insulin analogue (glargine/detemir) in regimen.
Consider bolus doses of soluble or rapid acting insulin at start, 6 and 12 hours into feed as required.
Involve DISN/DIT at earliest opportunity.
Avoid unnecessary use of VRIII.
If patient on continuous subcutaneous insulin pump this should be stopped and subcutaneous insulin commenced.

Patient with well-controlled type 2 diabetes (CBG 6 – 12 mmol/l)

Consider Metformin liquid via NGT if CBG rising >12 mmol/l) during feeding.

Patient with poorly controlled type 2 diabetes
(CBG persistently >12 mmol/l)

Consider Metformin liquid via NGT.
IF CBG >12 mmol/l assess feed regimen and commence an insulin regimen from choices below:
1 Pre-mixed (30/70) human insulin at start and midpoint of feed.

2. Isophane insulin at start and midpoint of feed.
3. Continuation of basal insulin if already prescribed with bolus doses soluble insulin at start, 6 and 12 hours into feed as required.

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Measure CBG 4-6 hourly
(hourly if VRIII in use)
Target CBG levels 6 – 12 mmol/l

Treatment of hypoglycaemia

In event of hypoglycaemia (CBG <4 mmol/l) treat promptly:
Give one of the following via NGT:
a) 2 Glucogel tubes - not for use with fine-bore NGT
b) 1 bottle (60ml) Glucojuice®
c) 150-200ml Orange juice
d) 110-140ml Fortijuice (not Fortisip) to give 15-20g carbohydrate
e) Restart feed to rapidly deliver 15-20g carbohydrate

FOLLOW THESE TREATMENTS BY A FLUSH OF THE NGT WITH WATER.

OR give IM Glucagon injection (see section 12)

If severe or recurrent hypoglycaemia obtain IV access and give IV 10% glucose at 100 ml/hour

Re-check CBG after 10 – 15 minutes. If CBG still <4 mmol/l - inform ward doctor, give further dose of treatment (options above), and check CBG 10 minutes later.

If CBG still <4 mmol/l bleep doctor, ensure IV access and give IV 10% glucose at 100 ml/hour if not already undertaken. Increase volume of 10% glucose according to patient response.

Treatment of hyperglycaemia

If CBG persistently >12 mmol/l, increase insulin doses by 2 – 4 units or (10-20%) per dosage adjustment. Liaise with DISN/DIT for advice.
If ketonaemia (>3 mmol/l) or ketonuria (>2+) refer patient urgently to DIT or out-of-hours medical team for FRIII/VRIII and DKA management.

If feed stopped for longer than 2 hours and insulin has been administered, risk of hypoglycaemia is high.
Consider commencing IV 10% glucose to avoid hypoglycaemia.
In people with T1DM not receiving basal insulin a VRIII should be commenced if feed turned off for greater than 2 hours

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Continue feed regimen. Review every 48 hours by DISN/DIT or if feed regimen altered, hypoglycaemia or recurrent hyperglycaemia.

Introduction

The purpose of this guideline is to assist UK diabetes teams, general physicians, stroke physicians, nursing staff, junior doctors, and other healthcare professionals in the management of enteral feeding in people with diabetes who have had a stroke.

The guideline is based on the premise that the majority of feeding in these circumstances is likely to be continuous enteral feeding with a defined rest period. However, some units also utilise bolus feeding regimens.

All patients who present with stroke should have a capillary blood glucose checked on admission to hospital, as hyperglycaemia in stroke patients is common, and associated with worse outcomes[4]. However, lowering blood glucose in people with diabetes during acute stroke has not been shown to significantly improve outcomes[5,6,7], although glucose lowering with insulin limits cerebral infarct size in animal studies[8]. Hyperglycaemia is likely to be encountered if a patient with diabetes is to be fed via the enteral route. The opinion of this writing group is that controlling hyperglycaemia resulting from enteral feeding will benefit people with diabetes who have had a stroke.

This guideline aims to concentrate solely on control of blood glucose during enteral feeding in people with stroke. Basic principles may be extrapolated, with the input of local diabetes teams, into other clinical situations such as percutaneous endoscopic gastrostomy (PEG) feeding, parenteral feeding, and enteral feeding in other neurological conditions. A discussion on the relative benefits of tight glucose control on outcomes following stroke per se in people with diabetes lies outside the remit of this document[9].

In hospitalised stroke patients fed by the enteral route, the management of hyperglycaemia should be balanced against the risks of hypoglycaemia. Hypoglycaemia during the rest period between feeds is a potentially life-threatening event[10], and close monitoring of the patient is recommended at all times. Thus the focus in the management of hyperglycaemia should be the maintenance of blood glucose within an acceptable range whilst limiting the risk of hypoglycaemia. It is the recommendation of these guidelines that the diabetes inpatient team (DIT) be involved at the earliest opportunity to provide specialist guidance surrounding blood glucose control.

The case studies shown below are examples of poor outcomes experienced by people with diabetes during enteral feeding.

Case study 1

Anna, 54 had been diagnosed with type 1 diabetes at the age of 5. She has had poor control for the last 10 years. She was admitted with a stroke and commenced enteral feeding, which was titrated up to the full rate over 48 hours. She is given an intravenous insulin infusion – a variable rate intravenous insulin infusion (VRIII) - for the first 72 hours of her hospital admission, with hourly capillary glucose monitoring.

The NGT was dislodged and removed, and the intravenous insulin infusion was stopped leaving her without insulin.

The NGT was re-sited several hours later but nursing staff were unable to aspirate through the NGT, and a chest X-ray was ordered. There was a delay in getting the x-ray and a delay in it being reviewed. No blood glucose monitoring was carried out.

Staff checked the blood glucose before recommencing the feed and it was 27 mmol/l. An on-call doctor was called and capillary ketones and arterial blood gases were measured. The patient was found to be acidotic and ketotic, and transferred to the Intensive Care Unit for treatment of DKA.

Case study 2

Bill, 82, had been diagnosed with type 2 diabetes at the age of 58 years. Prior to hospital admission he was prescribed Glargine, metformin and gliclazide. He was admitted with a left hemiparesis, and a stroke was diagnosed in the medical assessment unit. An NGT was inserted and enteral feeding commenced. The patient was administered feed over an 18-hour period, with two doses of premixed insulin administered at the start and mid-point of feed.

The NGT became blocked two hours into the feed, and the feed infusion was stopped. The insulin was administered by the ward staff as "patients with diabetes mustn't miss insulin doses". At 10 a.m. the following morning the patient was found to be clammy and drowsy – a capillary blood glucose was 1.9 mmol/l.

Nursing a patient on the ward with an enteral feed

A discussion on the issues in relation to swallow, oral feeding and the insertion of an NGT following stroke are beyond the scope of this document[11].

It is important to recognise that most patients requiring enteral feeding will be cared for on a general medical or stroke ward. A multidisciplinary approach to managing the patient with enteral feeding is advocated. It is advantageous to include the DISN or DIT to plan the diabetes treatment once the enteral feed protocol is recommended by the dietitian or the multidisciplinary feeding/nutrition team. Medical teams should be mindful of the refeeding syndrome in those patients in whom feeding is delayed – a description of the diagnosis and management of refeeding syndrome is also beyond the scope of this document.

Nursing staff need to have a good understanding of:

• Capillary glucose monitoring.

• The definition of hyperglycaemia and hypoglycaemia.

• The duration of action of different insulin products.

• Knowledge of the circumstances in which the DISN/DIT should be consulted.

• The ability to titrate and stop feed when required.

• Managing hypoglycaemia in an appropriate and timely manner.

Nursing staff should be aware that immobility and impaired movement and sensory disturbances increase the risk of foot/heel ulceration. If heel ulceration occurs the foot team or DIT must be contacted.

Nursing staff and insulin prescribers should undertake the NHS Diabetes e-learning packages – "Safe use of insulin"[12] and "Intravenous Insulin Infusions"[13] to acquire relevant knowledge in respect of insulin administration.

The diabetes inpatient team should be available for;

• Advising the stroke or medical team to prescribe the type and dose of insulin according to the patient's capillary blood glucose, the type and duration of the feed.

• Consultation in the event of hypoglycaemia and persistent hyperglycaemia.

• Education of staff in clinical areas involved in the management of patients with stroke who have diabetes.

As the patient's clinical condition changes, nursing staff may need to refer back to the DIT to alter insulin doses, or transfer to oral hypoglycaemic agents, as the feed regimen is altered, NGT displaced, oral feeding recommenced, or the patient's activity levels increase with physiotherapy.

Commencing NG feeding in a patient with elevated blood glucose

People with diabetes should be referred to the DISN or the DIT at the earliest opportunity, preferably prior to feed commencement.

Local guidelines should be adhered to for the setting up of syringe pumps, giving sets, intravenous access, skin bundles and intravenous insulin infusions. The National Patient Safety Agency (NPSA) has produced an alert in relation to NGT insertion[14].

Diabetes-specific feeds have been used in clinical studies in the UK and around the world[15]. However, clinical experience with diabetes specific feed is not widespread within the UK. Thus until further evidence is available to demonstrate benefits of diabetes specific feeds over standard feed preparations, this guideline advises that people with diabetes receive standard feed preparations.

Blood glucose targets

Outline

- Fasting/Pre-feed 5-8 mmol/l

- Feeding 6-12 mmol/l

- If capillary blood glucose <4 mmol/l or persistently >12 mmol/l on two consecutive occasions or evidence of ketonaemia/ketonuria then inform the DISN/DIT or on-call medical team

Evidence to support target ranges of blood glucose for inpatients with diabetes is weak[16,17]. Data to support target glucose ranges for people with diabetes receiving enteral feed is weaker still.[18] There is much debate on the target blood glucose for people with diabetes in the acute stages following a stroke[19,20] with little evidence on how best to achieve this control[21].

However, infection rates and other morbidity outcomes from inpatient hospital stay increase with deteriorating glucose control[22]. Similarly, patients experiencing hypoglycaemia in hospital experience lengthened hospital stay[23] and hypoglycaemia may have consequences in the acute and long term[24]. Patients with evolving cerebral damage may be particularly vulnerable to the neuroglycopaenic effects of hypoglycaemia[25]. Thus intuitively, avoidance of excessive hyperglycaemia and hypoglycaemia should be aspirational in the management of all people with diabetes in hospital.

The JBDS guideline for the perioperative management of people with diabetes[26], recommends glucose targets of 6-10 mmol/l. In the pre-feed state the perioperative guideline authors agreed that glucose targets should be 5-8 mmol/l.

It is the opinion of this writing group that a target glucose range of 6-12 mmol/l is appropriate for the management of diabetes during enteral feeding in an attempt to limit the risk of hypoglycaemia.

If the capillary blood glucose is persistently greater than 12 mmol/l (on two consecutive occasions), or in the event of hypoglycaemia (capillary blood glucose <4 mmol/l), then the DISN or DIT should be contacted. Out of hours, the medical on-call team should be contacted. If these teams are unavailable see sections below in relation to hypoglycaemia and hyperglycaemia.

Frequency of bedside glucose monitoring

Outline

- Depends on whether feed is continuous, intermittent or bolus.

- Monitor blood glucose pre-feed and then 4-6 hourly when patient receiving subcutaneous insulin and continuous feed.

- If intermittent feeding monitor blood glucose pre-feed, 4-6 hourly during feed, and 2 hour post-feed.

- If bolus only feeding then monitor blood glucose pre-feed, 2 hour post-feed and 4-6 hourly during prolonged intervals between feeds.

- Beware of risk of hypoglycaemia during fasted period between feeds.

- Monitor blood glucose hourly if patient receiving VRIII.

- Beware of hypoglycaemia as cause of drowsiness in patients with stroke.

The frequency of bedside capillary blood glucose testing should be a clinical decision based on the stability of the patient. As a general rule, inpatients with diabetes should have a bedside capillary blood glucose checked 4-6 hourly. When patients are receiving subcutaneous insulin then capillary blood glucose should be checked 4 – 6 hourly. In the event of hypoglycaemia or recurrent hyperglycaemia, capillary blood glucose may need to be recorded on a more frequent basis (e.g. every 15 minutes following treatment for hypoglycaemia) in order to assess response to an intervention or to ensure return of glucose to the accepted range. A capillary blood glucose should be checked prior to feed commencement in continuous, bolus or intermittent feeding.

It should be stressed that patients receiving enteral feed should not have their blood glucose checked only at the ward meal times. The care of people with diabetes receiving enteral feeding should be based on clinical need rather than that dictated by ward culture.

When the feed is stopped unexpectedly, and insulin has been or is being administered, healthcare practitioners should be acutely aware of the risk of hypoglycaemia. In this "fasted" state, we recommend the capillary blood glucose be checked hourly. Consider checking the capillary blood glucose in anyone with a recent stroke who has increased drowsiness – the cause of the reduced conscious level may be hypoglycaemia.

Management of blood glucose

Outline

- Aim to keep glucose within target range 6-12 mmol/l.

- All T1DM patients will require VRIII, with IV 10% glucose if feed off/not prescribed and nil by mouth.

- Continue long acting analogue insulin if patient is already taking it.

- If no access to DISN/DIT refer to local guidelines for management of hyperglycaemia.

This guideline may apply to all people with new or known hyperglycaemia following stroke. All patients with a capillary blood glucose consistently >12 mmol/l should be treated following the advice given in section 9. A VRIII is reactive management to an elevated capillary blood glucose and much discussion in the literature is devoted to the effectiveness of a VRIII[27]. Furthermore, there is little evidence to suggest that intravenous insulin dose can be used to predict an appropriate subcutaneous insulin dose. Thus the use of subcutaneous insulin at the earliest opportunity to manage hyperglycaemia is desirable.

People with known type 1 diabetes will require insulin at all times delivered subcutaneously or intravenously. If a patient with type 1 diabetes is nil by mouth and no enteral feed is prescribed or the feed is stopped for longer than two hours, a VRIII will be required. Follow local VRIII protocols in order to avoid hypoglycaemia and achieve target glucose range 6-12 mmol/l. If the patient is receiving long-acting analogue insulin, continue this while the VRIII is running.

Patients admitted to hospital on a basal bolus insulin regimen should be reviewed by the DISN or DIT at the earliest opportunity. These patients should continue the basal long-acting analogue insulin during enteral feeding. Bolus doses of soluble or rapid-acting insulin may then be re-introduced to manage hyperglycaemia – see below.

Patients admitted with continuous subcutaneous insulin infusion (CSII) devices should be referred to the DISN/DIT for assessment. We recommend that unless the patient is fully competent and able to manage the insulin pump, that it be discontinued, and a subcutaneous insulin injection regimen be commenced.

There are currently no data to support the use of glucagon like peptide-1 mimetics (GLP-1) or gliptins in the management of hyperglycaemia during enteral feeding. However, because these agents work in a glucose-dependent manner, they may be useful. We encourage teams with experience of their use in this situation to publish their outcomes.

Choice of agent to achieve glucose control

Outline

- Treat if capillary blood glucose persistently >12 mmol/l.

- Involve patient and DISN/DIT at the earliest opportunity.

- Commence subcutaneous insulin aiming for a blood glucose 6-12 mmol/l.

- Minimise the use of intravenous insulin infusions/VRIII.

The titration of enteral feed may take at least 72 hours, and the use of a VRIII for the whole of this period will involve multiple capillary blood glucose checks for the patient. The administration of subcutaneous insulin will be effective, and more acceptable to patients.

There is little evidence to guide us in the estimation of initial doses of insulin required to control hyperglycaemia, and thus the following strategies are suggested.

Strategies for commencing insulin in patients with diabetes receiving enteral feed:

- Involvement of the DISN or DIT - this is likely to be the most efficient way of initiating subcutaneous insulin.
- Refer to local protocols for insulin initiation – some teams may wish to prescribe a specific amount of insulin (e.g. 40 units per 24 hours in two divided doses) and titrate upwards to achieve glucose control.
- Utilise a tool for the estimation of the number of insulin units to be prescribed taking account of carbohydrate intake in the enteral feed - see an example in Appendix 2.

Metformin liquid administered via the NGT may be considered for mild hyperglycaemia (e.g. capillary blood glucose up to 12 mmol/l) in people with well controlled type 2 diabetes, or as an adjunct in uncontrolled type 2 diabetes.

Crushing oral hypoglycaemic medications, such as sulphonylureas, to manage hyperglycaemia during enteral feeding is not advised given the unpredictable absorption and difficulties in administration associated with this action, as well as the risk of tube blockage with crushed debris. However, once the enteral feed is stopped and the patient is able to swallow safely, the patient with type 2 diabetes may be able to return to oral pharmacotherapy to control hyperglycaemia.

Subcutaneous Insulin: Options

There are many options available when choosing an insulin regimen. It is important to note that a "one size fits all" approach is not possible in this situation. The patient has to be managed as an individual and the insulin chosen for its appropriateness with the feed regimen. Points to consider are:

- type of diabetes
- duration of feed
- frequency of rest periods
- HbA1c of patient
- age and size of patient.

Options available for choice of insulin are:

1. A pre-mixed (30/70) human insulin at the time of feed commencement, with the second dose at the midpoint of the feed. 50% of the required insulin can be administered with each dose. Pre-mixed insulin is invaluable if the feed duration is shortening gradually, as the second dose can be reduced and the first can be increased, as hourly volume increases.

2. A commonly used alternative would be isophane insulin. This regime requires a single administration of isophane at the start of the feed, though is likely to require a further dose of isophane at the midpoint of the feed. Alternatively, bolus short-acting soluble insulin doses may be added during the feed period (e.g. at the start and mid-point of the feed or at the start and then 6 hourly during the feed).

3. Continuation of the basal bolus insulin regime already prescribed. The basal insulin should be administered at feed commencement and bolus doses of soluble or rapid-acting analogue insulin may be administered at 6 and 12 hours into the feed, if required. This regimen is of particular use for people with type 1 diabetes. Splitting the bolus insulin dose may also be an option - this will need to be discussed with the DISN/DIT.

4. Bolus feeding may be managed with single doses of soluble human insulin 20 minutes prior to the administration of the bolus feed. Basal insulin should be continued for those with type 1 diabetes or those with type 2 diabetes established on basal insulin.

As the feed rate and volume increases, the subcutaneous insulin dose will need to be titrated appropriately, by 10-20% per titration. Some patients may require far larger dose titrations to achieve adequate glucose control – involve the DISN or DIT as early as possible in the care of these patients.

See Appendix 1 for further insulin options and tools to aid a decision on which type of insulin regime may be most suitable for the patient.

Careful consideration of the timing of insulin in relation to the rest period should be undertaken – insulin administered towards the end of the enteral feed may induce hypoglycaemia during the rest period. Some patients have tube feeds at night to allow activities or some oral intake during day, and the effects of exertion and bolus oral feeding will need to be factored in to the insulin regime. Other patients are fed during the day, and in these circumstances, the risk of nocturnal hypoglycaemia is high, particularly if medium- or long-acting insulin products are administered.

Many NHS organisations favour the use of human insulin (isophane) in the initial management of type 2 diabetes. However, long-acting basal analogues (e.g. Glargine, Detemir) may be more safely used in non-hospitalised patients with type 1 diabetes, as the risk of hypoglycaemia with these agents may be reduced[28]. A decision on substituting analogue for human insulin is likely to be best made by a DISN/DIT. All insulin regimes should be reviewed at least every 48 hours by the DISN/DIT.

| **Table 1** |
Giving insulin to a patient with type 1 diabetes

• Factors to consider –   Age
                            Type of insulin regimen
                            Level of usual diabetes control
                            Type and duration of feed

• Continue subcutaneous basal analogue insulin if VRIII utilised at any point
• If patient receiving VRIII, when VRIII to be stopped, continue subcutaneous basal analogue insulin and titrate accordingly
• If hyperglycaemia persists during feeding consider splitting basal analogue insulin if feed continuous, or the addition of human soluble or rapid-acting analogue insulin at start of feed and at six hourly intervals making sure to avoid rest period
• If hyperglycaemia persists during bolus feed give human soluble insulin or rapid-acting analogue insulin with feed bolus
• Monitor regularly - if patient experiences hypoglycaemia during rest period patient may require a reduction in the basal insulin dose

Actions to undertake if feed stopped

Whatever the reason for stopping the feed it is necessary to remember that insulin already administered will continue to drive blood glucose down. The patient should thus be monitored for signs of hypoglycaemia and the capillary blood glucose level measured regularly.

For people who have been administered subcutaneous insulin, the risk of hypoglycaemia is high if the feed is stopped, and the capillary blood glucose should be checked hourly, and more frequently (up to every 15 minutes) if symptoms or signs of hypoglycaemia are present. If the feed is stopped at an unplanned time and subcutaneous insulin is due, delay but do not omit the insulin dose – it is advised that the insulin dose should be given when the feed is recommenced. Consult the DISN, DIT or on-call medical team if unavailable, should the feed be withheld for a prolonged period.

If patients with type 1 diabetes are not being administered basal insulin or premixed insulin, a VRIII combined with IV 10% glucose would be advisable should the feed be stopped for a prolonged period (e.g. >2 hours). If the patient has received basal insulin, and the feed is off, then hourly monitoring of blood glucose will be required.

Actions in event of hyperglycaemia

Hyperglycaemia in hospital confers poor outcomes in critical illness[29,30] and following stroke[31]. For the purpose of these guidelines, hyperglycaemia is considered to be a capillary blood glucose level above 12 mmol/l.

In patients with type 1 diabetes and hyperglycaemia on two consecutive occasions, the patient should undergo blood or urinary ketone assessment. In the presence of ketonaemia (>3 mmol/l) or ketonuria (>2+), consider a fixed rate intravenous insulin infusion (FRIII) to suppress ketone body formation as suggested in the JBDS DKA guidelines[32], and refer the patient urgently to the DIT or if unavailable, the on-call medical team.

In the absence of ketonaemia, subcutaneous insulin doses can usually be increased safely by 2 – 4 units (or 10-20%) incrementally, and increased daily if necessary, until the target capillary glucose control is achieved. Some patients may require much larger insulin titrations – involve DISN or DIT, if hyperglycaemia persists despite titration of insulin doses.

Actions to avoid in event of hyperglycaemia

Use of one-off "stat" doses of insulin should be avoided. Recommencing a VRIII should be avoided if possible, unless the patient is clinically unwell and the measured capillary blood glucose is rising uncontrollably.

Actions in event of hypoglycaemia

Any capillary blood glucose less than 4.0 mmol/l should be treated and the patients prescribed treatment reviewed. In a patient who requires enteral feeding following stroke there may be specific risk factors for the development of hypoglycaemia – see table 2.

Table 2
Specific risk factors for hypoglycaemia in people requiring enteral feeding following stroke
• Feed stopped to give medication
• Feed stopped for physiotherapy/ procedure
• Vomiting
• Misplacement or removal of NGT
• Insulin and oral medication not given at appropriate time for feed
• Reduced carbohydrate intake as feed volume reduced
• Alteration of type of feed, or timing of feed
• Change in time or duration of rest period
• Hypoglycaemia in the previous 24 hours
• Increased physical activity (e.g. during physiotherapy input)
• Use of steroids – titration, omission or cessation

Patients with stroke requiring enteral feeding will have varying degrees of neurological injury, potentially masking the symptoms of hypoglycaemia – for instance confusion, drowsiness, odd behaviour, speech difficulty or un-coordination. In the event of hypoglycaemia, rapid action is indicated to correct the capillary blood glucose to above 4 mmol/l, and to maintain blood glucose at this level. Table 3 indicates suggested actions to be undertaken in the event of hypoglycaemia in this patient group adapted from the national guidelines for the management of hypoglycaemia produced by the JBDS[33].

Table 3
Treatment of hypoglycaemia in those with impaired swallow and with NGT in situ[33,34]
If patient has blood glucose less than 4 mmol/l give one of the following treatments:

If patient has no IV access give via NGT ONE of the following;
   a. 2 Glucogel tubes - not for use with fine-bore NGT
   b. 1 bottle (60ml) Glucojuice®
   c. 150-200ml Orange juice
   d. 110-140ml Fortijuice (not Fortisip) to give 15-20g carbohydrate
   e. Restart feed to rapidly deliver 15-20g carbohydrate
Follow these treatments by FLUSHING THE NGT WITH WATER.
 	
Alternatively:
Give IM Glucagon injection (providing no severe hepatic disease or repeated hypos)
	If severe or recurrent hypoglycaemia and patient has IV access give 10% glucose at 100 ml/hour

After 10 - 15 minutes re-check capillary blood glucose.
If capillary blood glucose level less than 4 mmol/l inform doctor, give another dose of treatment (see options above) then re-check blood glucose 10 minutes later.
If blood glucose still less than 4 mmol/l bleep a doctor, and if not already done so ensure IV access and start IV 10% glucose at 100 ml/hour, increasing IV volume given if necessary, according to patient response.

When blood glucose level greater than 4 mmol/l and the patient has recovered, give a long-acting carbohydrate. Some examples are
   a. Restart feed
   b. If bolus feeding, give additional bolus feed (read nutritional information and calculate amount required to give 15-20 g carbohydrate)
   c. IV 10% gluose at 100 ml/hour. Volume should be determined by clinical circumstances.

DO NOT OMIT INSULIN INJECTION IF DUE IN TYPE 1 DIABETES although dose alteration may be required. Review the insulin regimen and the insulin dose administered prior to the hypoglycaemic event.
Document event in patients notes Ensure at least 4-6 hourly capillary blood glucose monitoring continued for next 24 – 48 hours

Areas of Uncertainty

Outline

- Blood glucose target range

- Insulin dose adjustment according to carbohydrate content of feed

- Starting insulin at a defined rate and titrating upwards and other protocols

The JBDS perioperative management of diabetes guidelines[22] suggest targeting a capillary blood glucose of 6-10 mmol, tolerating a range of 4-12 mmol/l. The consensus of this writing group is that tolerating a range as low as 4 mmol/l is unsafe in a patient group with a recent cerebrovascular event, who may be susceptible and perhaps sensitive to hypoglycaemia. Until further evidence emerges regarding the safety and beneficial effects of tight glucose control down to a capillary blood glucose of 4 mmol/l, then this group believes that a target capillary blood glucose of 6-12 mmol/l is appropriate, and safe, for patients with diabetes following stroke.

Some centres utilise a protocol whereby the dose of subcutaneous insulin is calculated according to patient characteristics and the carbohydrate content of the NG feed (Appendix 2). Other centres advocate commencing an insulin infusion at feed commencement (e.g. 2 units/hr), and titrating the insulin infusion according to the blood glucose (Appendix 3), or the use of subcutaneous insulin "sliding scales". We advise that this type of intervention is only undertaken with close supervision by a senior member of the DIT[34]. Further experience with these insulin administration protocols may result in a review of this guideline in future years.

The treatment of hypoglycaemia during enteral feeding appears to be controversial. Treating hypoglycaemia with nutritional supplements such as Ensure® plus or Fortisip® may not be effective as the protein and fat content of the supplements may delay carbohydrate absorption. Fortijuce® may be a more appropriate option for the treatment of hypoglycaemia given its lower fat, and higher glucose content.

The administration of fizzy drinks via an NGT also appears to be controversial, as damage to the lining of the feeding tube may occur with repeated use. However, cola has been used to unblock enteral feeding tubes by nutrition teams.

Some dietitians advocate the administration of Glucogel via the NGT in the event of hypoglycaemia, as this is generally available in the ward environment, and if followed by a flush, should be safe, and effective at elevating plasma glucose rapidly. There are, however, difficulties with drawing up Glucogel for administration, and thus other options for the acute management of hypoglycaemia in those nil by mouth may need to be explored.

Appendix 1 - Available insulins and guidelines for appropriate use

Type of insulin regimen	Name of insulin available	Pros	Cons	When to use
Pre-mixed human/ analogue insulin at start and mid point of feed	Humulin M3®, Insuman Combo Humalog mix 25 and 50/50, Novomix 30	Required bd. Moderately long-acting profile – 8-12 hours. Fewer injections.	If feed stops insulin continues to work – risk of hypoglycaemia.	For use in feeds that are 12 – 24 hours long. Use 1 – 2 doses during feed, as required.
Intermediate-acting human insulin (Isophane) at start of feed	Insulatard, Humulin I or Insuman Basal	Isophane has moderately long-acting profile – 8-12 hours. Cost effective insulin. May only require one injection daily – but will require 2 in most cases.	If feed stops insulin continues to work – risk of hypoglycaemia. Peak of action at 8 hours – may cause hypoglycaemia. May need extra soluble human insulin added earlier or later in feed.	Use in feeds that are 12 – 24 hours long. Use 1 – 2 doses during feed, as required.
Short-acting human insulin	Soluble human - Actrapid, Humulin S, Insuman rapid	Short-acting insulin added in is a flexible and cost-effective option.	Glucose-lowering effects of short-acting insulin alongside premixed or moderately long-acting insulin may be unpredictable.	Single doses of short-acting insulin may be best used in the context of repeated bolus feeding. Give insulin dose 20 minutes before feed starts.
Rapid-acting insulin analogue	Novorapid, Apidra® or Humalog	Rapid onset of action. 3 – 4 hour period of action - flexible.	Unlikely to be effective unless used alongside intermediate-acting or basal insulin. Rapid-acting analogues are costly.	May be useful for patients with type 1 diabetes receiving bolus feeds.
Long-acting analogue Insulin od or bd	Lantus® od or Levemir® od or bd Glargine, Detemir, Toujeo,Tresiba or Abasaglar	Long-acting insulin works well to cover 20 – 24 hour feeds. Useful for type 1 patients.	Long-acting insulin more expensive. Not appropriate for shorter bolus feeds as may cause hypoglycaemia. Also risk of hypoglycaemia in rest period or if feed interrupted for long periods.	For use with patients requiring 16 – 24 hr feeds with hyperglycaemia not controlled with isophane or pre-mixed insulin, or in patients with type 1 diabetes.

Please note – some patients, especially those with long-standing type 1 diabetes, may be prescribed animal insulins not mentioned above e.g. porcine or bovine insulin. For these patients a decision should be made to continue the animal insulin or change to human or analogue insulins during the acute phase of inpatient management. Involve the diabetes team at the earliest opportunity for assistance with this decision.

Appendix 2 –
Calculating the insulin dose according to a weight based equation

Below is an example of a locally-used formula to calculate insulin dose from carbohydrate content of feed and rate of feed administration[35].

1. **Calculating the initial insulin requirement and dose**

Before we can attempt to calculate the initial insulin requirement for patients starting on enteral feeding a few points and calculations must first be taken into account.

 a. **Total carbohydrate intake from enteral feed**

 That is the total carbohydrate intake expected from the enteral feed over the **duration of feed** (e.g. 16, 20, 24 hrs). This is calculated as:

 [Infusion rate (ml/hour)] x [carbohydrate content (g/100 ml)] x [duration of feeding] ÷100

 b. **Carbohydrate-to-insulin ratio (CIR)**

 This is how many grams of carbohydrate/glucose are covered by 1 unit of insulin. The blood glucose rise from enteral feeds is much more than would occur for normal meals: therefore, 1 unit of insulin will cover less of a carbohydrate load.

 i. If not usually on insulin use a CIR value of 10.

 ii. If usual **Total Daily Insulin Dose (TDID)** less than 40 units use a value of **8**.

 iii. If usual **Total Daily Insulin Dose (TDID)** more than 40 units use a value of **6**.

 c. **Daily nutritional insulin requirement**

 This is the daily insulin required to cover the enteral feed over the duration of feeding (e.g. 16, 20, 24 hrs). This is calculated as:

 [Total carbohydrate intake from feed] **divided by** [Carbohydrate-to-insulin ratio]

This number of units is then divided into to two doses: the first to be given at the start of the feed and the other given at the midpoint of the feed.

Example: Calculating insulin dose from cardohydrate feed content

Type 2 diabetes patient 68 kg. Not previously on insulin
Carbohydrate content of feed (g/100 ml) = 12.3
Intended infusion rate of enteral feed (ml/hour) = 75
Intended duration of feed (hrs per day) = 20

Not previously on insulin - therefore CIR = 10

$$\text{Total Humulin M3 dose} = \frac{12.3 \times 75 \times 20}{10 \times 100} = 18.45 \text{ units/24 hrs}$$

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 d. **Daily basal insulin requirement**

 For patients with type 1 diabetes, with poor glycaemic control despite twice daily insulin, the patient may require additional basal insulin (e.g. Lantus or Levemir) to meet the basal glucose target levels. This daily basal insulin requirement may be roughly calculated as:

 Daily basal insulin requirement = [Body weight] x [0.1 - 0.2 units/kg]

Appendix 3 -

Example of a locally used individual protocol for starting enteral feed and titration of intravenous insulin in type 2 diabetes.

- Start Fresubin® feed at 21 ml/hour continuously over 24 hours (no rest period).

- Start IV (intravenous) short-acting soluble insulin infusion at 2 units per hour.

- Monitor blood glucose hourly.

- Aim for blood glucose between 6-12 mmol/l.

- If blood glucose above 12 mmol/l increase insulin to 3 units per hour. If after a further 2 hours at 3 units per hour the blood glucose is still above 12 mmol/l, request medical review.

- If blood glucose below 8 mmol/l reduce insulin to 1 unit per hour. If below 4 mmol/l reduce insulin to 0.5 units per hour.

- If enteral feeding tube is accidentally removed while on IV insulin, stop the insulin infusion and monitor blood glucose. If hypoglycaemia occurs follow hypoglycaemia guidelines.

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