The Hospital Management of Hypoglycaemia in Adults with Diabetes Mellitus

Revised September 2013

DIABETES UK
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ABCD
Association of British Clinical Diabetologists

DISN
UK GROUP

WEDS
Welsh Endocrine Diabetes Society

This document is coded JBDS 01 in the series of JBDS documents:

Other JBDS documents:

The Management of the hyperosmolar hyperglycaemic state (HHS) in adults with diabetes August 2012 JBDS 06

Glycaemic management during the inpatient enteral feeding of stroke patients with diabetes June 2012 JBDS 05

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 DKA in Adults Revised September 2013 JBDS 02

These documents are available to download from the ABCD website at http://www.diabetologists-abcd.org.uk/JBDS/JBDS.htm and the Diabetes UK website at www.diabetes.org.uk

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Foreword

The original JBDS-IP hypoglycaemia guideline (March 2010) was written by practicing clinicians drawing from their experiences of managing hypoglycaemia in UK hospitals. This document has now been revised by the original authors. During the revision process comments were requested from all interested parties mentioned on page 6. Many comments were received, all were considered and the authors would like to thank everyone who contributed for their constructive comments.

A regular theme occurred with many Trusts having taken the traffic light algorithm and adapted it to suit their own needs. We received many examples of excellent adapted algorithms. However, this highlighted the fact that different Trusts have different preferences with regards to the type of quick and long acting carbohydrate used. For this reason the algorithm in this document has been kept generic so that it can continue to be easily adapted.

Another issue highlighted was the lack of a suitable IV glucose preparation in the volumes recommended in the guideline. This has now been resolved with the availability of 20% glucose in 100ml vials.

JBDS has audited the implementation of this guideline using SurveyMonkey®. One hundred and eighteen hospitals responded of which 24 have adopted this guideline in its entirety, 74 have adopted but adapted it to suit their Trust and 10 are currently adopting it within their Trust. This demonstrates that 92% of responding hospitals have recognised the value of this guideline.

We hope that all teams find this a useful document and adopt the principles, adapting them where necessary to suit individual needs, thus ensuring good quality, timely and effective treatment for all.

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Introduction

This guideline is for the management of hypoglycaemia in adults (aged 16 years or older) with diabetes mellitus within the hospital setting. Local policies may exist for the treatment of younger adults aged between 16 to 18 years and you may need to refer to these.

This guideline is aimed at all healthcare professionals involved in the management of people with diabetes in hospital. Since the introduction of the original guideline in 2010, the practice of using 50% intravenous (IV) glucose has become much less commonplace, although it is still occasionally used. Expert opinion would suggest that the use of hyperosmolar solutions such as 50% glucose increase the risk of extravasation injury. Furthermore, Moore et al (2005) found that the smaller aliquots used to deliver 10% glucose resulted in lower post treatment glucose levels. For these reasons 10% or 20% glucose solutions are preferred (a suitable 20% preparation is now available).
The authors recommend the IV glucose preparation chosen is prescribed on an 'as required' (PRN) basis for all patients with diabetes. If agreed locally, glucagon (and IV glucose) may be given without prescription in an emergency for the purpose of saving a life (Medicines, Ethics & Practice 2012) or via a Patient Group Directive. Please note that intramuscular (IM) glucagon is only licensed for the treatment of insulin overdose, although it is also used in the treatment of hypoglycaemia induced by sulfonylurea therapy.

Nurses using this guideline must work within the Nursing and Midwifery Council (NMC) professional code of conduct and work within their own competencies.

This guideline is designed to enable adaptation to suit local practice where required.

Hypoglycaemia in Adults with Diabetes

Hypoglycaemia is the commonest side effect of insulin and sulfonylureas in the treatment of all types of diabetes mellitus and presents a major barrier to satisfactory long term glycaemic control. Metformin, pioglitazone, the DPP-4 inhibitors, SLGT-2 inhibitors and GLP-1 analogues prescribed without insulin or sulfonylurea therapy are unlikely to result in hypoglycaemia. Hypoglycaemia results from an imbalance between glucose supply, glucose utilisation and current insulin levels. Hypoglycaemia should be excluded in any person with diabetes who is acutely unwell, drowsy, unconscious, unable to co-operate, presenting with aggressive behaviour or seizures.

Fifteen to twenty percent of inpatients in England and Wales have known diabetes; this increases to 25% in some high risk groups (Sampson et al 2007). The hospital environment presents additional obstacles to the maintenance of good glycaemic control and the avoidance of hypoglycaemia (Farrokhi et al 2012).

Definition

Hypoglycaemia is a lower than normal level of blood glucose. It can be defined as "mild" if the episode is self-treated and "severe" if assistance by a third party is required (DCCT, 1993). For the purposes of people with diabetes who are hospital inpatients, any blood glucose less than 4.0mmol/L should be treated.

Frequency

People with type 1 diabetes mellitus (T1DM) experience around two episodes of mild hypoglycaemia per week. Studies such as the DCCT excluded patients with a history of severe hypoglycaemia and reported lower incidences of hypoglycaemia than would be observed in an

unselected group of patients. In unselected populations, the annual prevalence of severe hypoglycaemia has been reported consistently at 30-40% in several large studies (Strachan, 2007).

Severe hypoglycaemia is less common in people with insulin treated type 2 diabetes mellitus (T2DM) but still represents a significant clinical problem. Patients with insulin treated T2DM are more likely to require hospital admission for severe hypoglycaemia than those with T1DM (30% versus 10% of episodes) (Donnelly et al 2005). The risk of hypoglycaemia with sulfonylurea therapy is often underestimated and as a consequence of the duration of action of the tablets, is frequently prolonged. Elderly patients or those with renal impairment are at particular risk of hypoglycaemia. The UK Hypoglycaemia Group Study showed equivalent levels of severe hypoglycaemia in those treated with sulfonylureas compared with insulin therapy of less than two years duration (UK Hypoglycaemia Group, 2007).

Frequency in hospitalised patients

Farrokhi et al (2012) reports a prevalence of severe hypoglycaemia ranging from 5% to 32% in hospital inpatients treated with insulin.

NaDIA (National Diabetes Inpatient Audit 2012) data shows 22.4% of inpatients with diabetes experienced one or more hypoglycaemic episodes (blood glucose less than 4.0mmol/L) with 10.5% experiencing one or more hypoglycaemic episodes less than 3.0mmol/L. The highest proportion of episodes took place overnight (34.3%).

Patients with type 1 diabetes had the highest prevalence with 40.4% experiencing a hypoglycaemic episode between 3- 4mmol/L and 28.8% experiencing a hypoglycaemic episode <3mmol/L. Injectable treatment was required by 2.2% of patients.

Clinical Features

The symptoms of hypoglycaemia warn an individual of its onset and vary considerably between individuals. Autonomic symptoms are generated by the activation of the sympatho-adrenal system and neuroglycopenic symptoms are the result of cerebral glucose deprivation. The brain is dependent on a continuous supply of circulating glucose as the substrate to fuel cerebral metabolism and to support cognitive performance. If blood glucose levels fall sufficiently, cognitive dysfunction is inevitable (Evans & Amiel, 2002). The 11 most common symptoms were used to form the Edinburgh Hypoglycaemia Scale and are reproduced in the below table (Deary et al 1993).

Table 1: Edinburgh Hypoglycaemia Scale

Autonomic	Neuroglycopenic	General malaise
• Sweating	• Confusion	• Headache
• Palpitations	• Drowsiness	• Nausea
• Shaking	• Odd behaviour	
• Hunger	• Speech difficulty	
	• Incoordination	

Risk Factors for Hypoglycaemia

Table 2: Risk Factors for Hypoglycaemia

Medical issues	Lifestyle issues
• Strict glycaemic control • Previous history of severe hypoglycaemia • Long duration of type 1 diabetes • Duration of insulin therapy in type 2 diabetes • Lipohypertrophy at injection sites • Impaired awareness of hypoglycaemia • Severe hepatic dysfunction • Renal failure (on dialysis) • Acute kidney injury • Impaired renal function • Inadequate treatment of previous hypoglycaemia • Terminal illness • Bariatric surgery involving bowel resection	• Increased exercise (relative to usual) • Irregular lifestyle • Increasing age • Alcohol • Early pregnancy • Breast feeding • No or inadequate blood glucose monitoring **Reduced carbohydrate intake** • Food malabsorption e.g.gastroenteritis, coeliac disease

Be aware that the following can also precipitate hypoglycaemia:

- Concurrent use of drugs with hypoglycaemic agents e.g. warfarin, quinine, salicylates, fibrates, sulphonamides (including cotrimoxazole), monoamine oxidase inhibitors, NSAIDs, probenecid, somatostatin analogues, SSRIs. Do not stop or withhold medication, discuss with the medical team or pharmacist
- Loss of counterregulatory hormone function (e.g. Addison's disease, growth hormone deficiency, hypothyroidism, hypopituitarism)

Potential causes of inpatient hypoglycaemia

Common causes of inpatient hypoglycaemia are listed in table 3. One of the most serious and common causes of inpatient hypoglycaemia is insulin prescription errors including:

- Misreading poorly written prescriptions – when 'U' is used for units (i.e. 4U becoming 40 units)
- Confusing the insulin name with the dose (e.g. Humalog Mix25 becoming Humalog 25 units)
- Transcription errors (e.g. where patient on animal insulin is inadvertently prescribed human insulin or where handwriting is unclear)

Table 3: Potential causes of Inpatient Hypoglycaemia

Medical issues	Reduced carbohydrate intake
• Inappropriate use of 'stat' or 'PRN' rapid/short acting insulin • Acute discontinuation of long term steroid therapy • Recovery from acute illness/stress • Mobilisation after illness • Major amputation of a limb • Incorrect type of insulin or oral hypoglycaemic therapy prescribed and administered • Inappropriately timed insulin or oral hypoglycaemic therapy in relation to meal or enteral feed • Change of insulin injection site • IV insulin infusion with or without glucose infusion • Inadequate mixing of intermediate acting or mixed insulins • Regular insulin doses or oral hypoglycaemia therapy being given in hospital when these are not routinely taken at home	• Missed or delayed meals • Less carbohydrate than normal • Change of the timing of the biggest meal of the day (i.e. main meal at midday rather than evening) • Lack of access to usual between meal or before bed snacks • Prolonged starvation time e.g. 'Nil by Mouth' • Vomiting • Reduced appetite • Reduced carbohydrate intake

Morbidity and Mortality

Hypoglycaemia can cause coma, hemiparesis and seizures. If the hypoglycaemia is prolonged the neurological deficits may become permanent. Acute hypoglycaemia impairs many aspects of cognitive function, particularly those involving planning and multitasking. The long term effect of repeated exposure to severe hypoglycaemia is less clear.

The ACCORD study highlighted a potential risk of intensive glycaemic control. Recognised and unrecognised hypoglycaemia was more common in the intensive group than in the standard group. In the intensive group, a small but statistically significant inverse relationship of uncertain clinical importance was identified between the number of hypoglycaemic episodes and the risk of death among participants (ACCORD, 2012).

Turchin et al (2009) examined data from 4368 admission episodes for people with diabetes of which one third were on regular insulin therapy. Patients experiencing inpatient hypoglycaemia experienced a 66% increased risk of death within one year and spent 2.8 days longer in hospital compared to those not experiencing hypoglycaemia. Garg et al (2013) reported increased mortality rates for inpatients on insulin therapy who experienced hypoglycaemia (blood glucose < 2.8mmol/L) compared to those with no hypoglycaemia (20.3% versus 4.5%). However, only 41-51% of these participants had diabetes and sub-group analysis of those with diabetes would have been useful.

Impaired awareness of hypoglycaemia

Impaired awareness of hypoglycaemia (IAH) is an acquired syndrome associated with insulin treatment. IAH results in the warning symptoms of hypoglycaemia becoming diminished in intensity, altered in nature or lost altogether. This increases the vulnerability of affected individuals of progression to severe hypoglycaemia.
The prevalence of IAH increases with duration of diabetes and is much more common in type 1 than in type 2 diabetes (Graveling & Frier, 2010).

Management of Hypoglycaemia

Introduction

People experiencing hypoglycaemia require quick acting carbohydrate to return their blood glucose levels to the normal range. The quick acting carbohydrate should be followed up by giving long acting carbohydrate either as a snack or as part of a planned meal. All patients experiencing hypoglycaemia should be treated without delay. Where it is safe to do so, a blood glucose measurement should be taken to confirm hypoglycaemia (especially if there is any suspicion that the person may be currently under the influence of alcohol). If measurement is difficult (e.g. in a patient undergoing a seizure) then treatment should not be delayed.

After acute treatment, consideration should be given to whether the hypoglycaemia is likely to be prolonged, i.e. as a result of long acting insulin or sulfonylurea therapy; patients may require a continuous infusion of dextrose to maintain blood glucose levels. Normal blood glucose levels in a person without diabetes are 3.5-7.0mmol/L. To avoid potential hypoglycaemia, Diabetes UK recommends a practical policy of "make four the floor", i.e. 4.0mmol/L the lowest acceptable blood glucose level in people with diabetes. Regular blood glucose monitoring enables detection of asymptomatic biochemical hypoglycaemia.

Evidence for treatment options

There is limited evidence regarding the quantity of quick acting carbohydrate required to successfully treat an episode of hypoglycaemia. The initial quantities chosen were the result of expert consensus subsequently backed up with glucose clamp studies (Brodows et al, 1984, Slama et al, 1990). Vindedzis et al (2012) compared 15g versus 20g and found that 32-63% of episodes resolved after one treatment with 15g carbohydrate compared with 55-89% of episodes with 20g carbohydrate. Larsen et al (2006) used continuous glucose monitoring (CGM) to monitor 125 adult patients with T1DM over 6 days; they defined adequate treatment as ingesting 10-20g of quick acting carbohydrate. They reported that 30% of hypoglycaemic episodes were under-treated and 38% were over-treated. Participants that were under-treated had a 57% chance of remaining hypoglycaemic at the repeat test, this compares with 30% for those adequately treated and 26% for those over treated. This reinforces the suggestion that treatment of hypoglycaemia with less than 10g of quick acting carbohydrate is likely to be inadequate.

Chocolate is no longer recommended for the treatment of hypoglycaemia. Chocolate contains quick acting carbohydrate and fat; and the addition of fat has been shown to slow the absorption of quick acting carbohydrate (Cedermark et al, 1993, Shively et al, 1986). Sugar or sucrose is also less commonly recommended as it takes longer to affect blood glucose levels than glucose (Georgakopoulos et al, 1990). Orange juice (which contains fructose) remains a popular treatment for hypoglycaemia. The results of two studies using a modified glucose clamp technique have suggested that orange juice may not be the most effective treatment in adults with T1DM (Slama et al, 1990, Brodows et al, 1984). Brodows et al reported that almost double the amount of orange juice was required to produce a similar increment compared with glucose tablets. The total sugar content of any fruit juice varies according to the ripeness of the fruit, the season it is picked and the addition of any sugar when packaged (Slama et al, 1990). A more recent study showed that fructose (in the form of a fruit bar) was less effective than sucrose in successfully treating hypoglycaemia in children with type 1 diabetes. The fibre in the bar may have slowed down the absorption of the fructose, reducing its efficacy as a treatment for hypoglycaemia (Husband et al, 2010). By contrast, a recent "real-world" study of children with type 1 diabetes attending a diabetes camp found orange juice to be as effective as other treatments (McTavish and Wiltshire, 2011).

Several studies have examined the time interval between treatment and re-testing to confirm resolution of hypoglycaemia. All are supportive of a minimum interval of at least 10 minutes before retesting to ensure resolution of hypoglycaemia (McTavish and Wiltshire, 2011). Slama et al (1990) concluded that repeating carbohydrate intake

every 5-10 minutes would not allow adequate time for the treatment to take effect thus leading to over treatment. Vindedzis et al (2012) reported that when hypoglycaemia was treated with 20g of carbohydrate, 55% were adequately treated after a 5 minute wait, compared with 89% after a 10 minute wait.

"Hypo" boxes

Areas of good practice have successfully used "hypo boxes" for the management of hypoglycaemia (Baker et al, 2007). These boxes are often in a prominent place e.g. on resuscitation trolleys and are brightly coloured for instant recognition. They contain all the equipment required to treat hypoglycaemia from cartons of fruit juice to IV cannulas. Suggested contents of a "hypo box" can be found in Appendix 2.
There are now commercially available hypo boxes.

Conclusion

This is a general guideline for the treatment of hypoglycaemia but each patient should be individually assessed and management altered where necessary. You may want to agree local guidance for the self management of hypoglycaemia in conjunction with certain other medical conditions (e.g. renal impairment, heart failure). Many people with diabetes carry their own supplies of oral carbohydrate and should be supported to self manage when capable and appropriate. Following assessment this should be recorded in their hospital care plan. Patients capable of self care should alert nursing staff that an episode of hypoglycaemia has occurred so that their management plan can be altered if necessary. Many episodes of hypoglycaemia are avoidable so every preventable measure should be taken.

Easily accessible quick and long acting carbohydrate must be available in your clinical area and all staff should be aware of its location.

Treatment of Hypoglycaemia

Adults who have poor glycaemic control may start to experience symptoms of hypoglycaemia above 4.0mmol/L. There is no evidence that the thresholds for cognitive dysfunction are reset upwards; therefore the only reason for treatment is symptomatic relief. **So adults who are experiencing hypoglycaemia symptoms but have a blood glucose level greater than 4.0mmol/L – treat with a small carbohydrate snack only** e.g. 1 medium banana, a slice of bread or normal meal if due. All adults with a blood glucose level less than 4.0mmol/L with or without symptoms of hypoglycaemia should be treated as outlined below.

A. Adults who are conscious, orientated and able to swallow

1) Give 15-20g quick acting carbohydrate of the patient's choice where possible. Some examples are:
   - o 5-7 Dextrosol® tablets (or 4-5 Glucotabs®)
   - o 90-120ml of *original* Lucozade®
   - o 1 bottle (60ml) Glucojuice®
   - o 150-200ml pure fruit juice e.g. orange
   - o 3-4 heaped teaspoons of sugar dissolved in water.

N.B. Patients following a low potassium diet (due to chronic kidney disease) should not use orange juice to treat hypoglycaemia.

N.B. Sugar dissolved in water is not an effective treatment for patients taking acarbose as it prevents the breakdown of sucrose to glucose.

2) Repeat capillary blood glucose measurement 10-15 minutes later. If it is still less than 4.0mmol/L, repeat step 1 (no more than 3 treatments in total).

3) If blood glucose remains less than 4.0mmol/L after 30-45 minutes or 3 cycles, **contact a doctor**. Consider 1mg of glucagon IM (may be less effective in patients prescribed sulfonylurea therapy/patients currently under the influence of alcohol) or IV 150-200ml of 10% glucose over 15 minutes, (e.g. 600-800ml/hr). Care should be taken if larger volume bags are used to ensure that the whole infusion is not inadvertently administered. Volume should be determined by clinical circumstances (refer to Appendix 5 for administration details).

4) Once blood glucose is above 4.0mmol/L and the patient has recovered, give a long acting carbohydrate of the patient's choice where possible, taking into consideration any specific dietary requirements. Some examples are:
   - o Two biscuits
   - o One slice of bread/toast
   - o 200-300ml glass of milk (not soya)
   - o Normal meal if due (must contain carbohydrate).

N.B. Patients given glucagon require a larger portion of long acting carbohydrate to replenish glycogen stores (double the suggested amount above). However, nausea associated with glucagon injections may be an issue.

N.B. Patients who self-manage their insulin pumps (CSII) may not need a long acting carbohydrate but should take initial treatment, continue their pump and assess for the cause of the episode.

5) **DO NOT omit insulin injection if due** (However, insulin regime review may be required).

6) Document event in patient's notes. Ensure regular capillary blood glucose monitoring is continued for 24 to 48 hours. Ask the patient to continue this at home if they are to be discharged. Give hypoglycaemia education or refer to Diabetes Inpatient Specialist Nurse (DISN).

N.B. If the hypoglycaemia was due to sulfonylurea or long acting insulin therapy then be aware that the risk of hypoglycaemia may persist for up to 24-36 hours following the last dose, especially if there is concurrent renal impairment.

B. Adults who are conscious but confused, disorientated, unable to cooperate or aggressive but are able to swallow

1) If the patient is capable and cooperative, follow section **A in its entirety**.

2) If the patient is not capable and/or uncooperative, but is able to swallow give **either** 1.5 -2 tubes GlucoGel®/Dextrogel® squeezed into the mouth between the teeth and gums **or** (if this is ineffective) give glucagon 1mg IM (may be less effective in patients prescribed sulfonylurea therapy/patients currently under the influence of alcohol).

3) Repeat capillary blood glucose levels after 10-15 minutes. If it is still less than 4.0mmol/L repeat steps 1 and/or 2 (no more than 3 treatments in total and only give IM glucagon once).

4) If blood glucose level remains less than 4.0mmol/L after 30-45 minutes (or 3 cycles of **A**1), **contact a doctor**. Consider IV 150-200ml of 10% glucose over 15 minutes, (e.g. 600-800ml/hr). Care should be taken if larger volume bags are used to ensure that the whole infusion is not inadvertently administered. Volume should be determined by clinical circumstances (refer to Appendix 5 for administration details).

5) Once blood glucose is above 4.0mmol/L and the patient has recovered, give a long acting carbohydrate of the patient's choice where possible, taking into consideration any specific dietary requirements.
Some examples are:
   - o Two biscuits
   - o One slice of bread/toast
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   - o Normal meal if due (must contain carbohydrate).

N.B. Patients given glucagon require a larger portion of long acting carbohydrate to replenish glycogen stores (double the suggested amount above).

N.B. Patients who self-manage their insulin pumps (CSII) may not need a long acting carbohydrate but should take initial treatment, continue their pump and assess for the cause of the episode.

6) **DO NOT omit insulin injection if due** (However, insulin regime review may be required).

7) Document event in patient's notes. Ensure regular capillary blood glucose monitoring is continued for 24 to 48 hours. Ask the patient to continue this at home if they are to be discharged. Give hypoglycaemia education or refer to DISN.

N.B. If the hypoglycaemia was due to sulfonylurea or long acting insulin therapy then be aware that the risk of hypoglycaemia may persist for up to 24-36 hours following the last dose, especially if there is concurrent renal impairment.

C. Adults who are unconscious and/or having seizures and/or are very aggressive

1) Check: **Airway (and give oxygen)**
Breathing
Circulation
Disability (including GCS and blood glucose)
Exposure (including temperature)

If the patient has an insulin infusion in situ, stop immediately

Request immediate assistance from medical staff (e.g. "fast bleep" a doctor)

2) The following three options (i-iii) are all appropriate; local agreement should be sought:

i) If IV access available, give 75-100ml of 20% glucose over 15 minutes, (e.g. 300-400ml/hr). A 100ml preparation of 20% glucose is available that will deliver the required amount after being run through a standard giving set. If an infusion pump is available use this, but if not readily available the infusion should not be delayed (see Appendix 5 for administration details). Repeat capillary blood glucose measurement 10 minutes later. If it is still less than 4.0mmol/L, repeat.

ii) If IV access available, give 150-200ml of 10% glucose over 15 minutes, (e.g. 600-800ml/hr). If an infusion pump is available use this, but if not readily available the infusion should not be delayed. Care should be taken if larger volume bags are used to ensure that the whole infusion is not inadvertently administered. Repeat capillary blood glucose measurement 10 minutes later. If it is still less than 4.0mmol/L, repeat (refer to Appendix 5 for administration details).

iii) Glucagon 1mg IM (may be less effective in patients prescribed sulfonylurea therapy/patients currently under the influence of alcohol). Glucagon, which may take up to 15 minutes to take effect, mobilises glycogen from the liver and will be less effective in those who are chronically malnourished (e.g. alcoholics), or in patients who have had a prolonged period of starvation and have depleted glycogen stores or in those with severe liver disease. In this situation or if prolonged treatment is required, IV glucose is better.

3) Once the blood glucose is greater than 4.0mmol/L and the patient has recovered give a long acting carbohydrate of the patient's choice where possible, taking into consideration any specific dietary requirements. Some examples are:
- o Two biscuits
- o One slice of bread/toast
- o 200-300ml glass of milk (not soya)
- o Normal meal if due (must contain carbohydrate).

N.B. Patients given glucagon require a larger portion of long acting carbohydrate to replenish glycogen stores (double the suggested amount above).

N.B. Patients who self manage their insulin pumps (CSII) may not need a long acting carbohydrate.

4) **DO NOT omit insulin injection if due** (However, insulin regime review may be required).

5) <u>If the patient was on IV insulin, continue to check blood glucose every 15 minutes until above 3.5mmol/L, then re-start IV insulin after review of dose regimen. Consider concurrent IV 10% glucose infusion at 100ml/hr</u>

6) Document event in patient's notes. Ensure regular capillary blood glucose monitoring is continued for 24 to 48 hours. Ask the patient to continue this at home if they are to be discharged. Give hypoglycaemia education or refer to DISN.

N.B. If the hypoglycaemia was due to sulfonylurea or long acting insulin therapy then be aware that the risk of hypoglycaemia may persist for up to 24-36 hours following the last dose, especially if there is concurrent renal impairment.

D. Adults who are 'Nil by Mouth'

1) If the patient has a variable rate intravenous insulin infusion, adjust as per prescribed regimen, and seek medical advice. Most variable rate intravenous insulin infusions should be restarted once blood glucose is above 4mmol/L although a rate adjustment may be indicated.

2) Options i and ii (intravenous glucose) as above in section **C** (2) are both appropriate treatment options. Again local agreement should be sought.

3) Once blood glucose is greater than 4.0mmol/L and the patient has recovered consider 10% glucose at a rate of 100ml/hr (refer to Appendix 5 for administration details) until patient is no longer 'Nil by Mouth' or has been reviewed by a doctor.

4) Document event in patient's notes. Ensure regular capillary blood glucose monitoring is continued for 24 to 48 hours. Ask the patient to continue this at home if they are to be discharged. Give hypoglycaemia education or refer to DISN.

N.B. If the hypoglycaemia was due to sulfonylurea or long acting insulin therapy then be aware that the risk of hypoglycaemia may persist for up to 24-36 hours following the last dose, especially if there is concurrent renal impairment.

E. Adults requiring enteral feeding

Patients requiring total parenteral nutrition (TPN) should be referred to a dietitian/nutrition team and diabetes team for individual assessment

Risk factors for hypoglycaemia

- Blocked/displaced tube
- Change in feed regimen
- Enteral feed discontinued
- TPN or IV glucose discontinued
- Diabetes medication administered at an inappropriate time to feed
- Changes in medication that cause hyperglycaemia e.g. steroid therapy reduced/stopped
- Feed intolerance
- Vomiting
- Deterioration in renal function
- Severe hepatic dysfunction

Treatment – To be administered via feed tube:

Do not administer these treatments via a TPN line.

1) Give 15-20g quick acting carbohydrate of the patient's choice where possible. Some examples are:
   - o 25ml original undiluted Ribena®
   - o 45-60ml Fortijuce®
   - o 1 bottle (60ml) Glucojuice®
   - o 3-4 heaped teaspoons of sugar dissolved in water

N.B. All treatments should be followed by a water flush of the feeding tube to prevent tube blockage.

2) Repeat capillary blood glucose measurement 10 to 15 minutes later. If it is still less than 4.0mmol/L, repeat step 1 (no more than 3 treatments in total).

3) If blood glucose remains less than 4.0mmol/L after 30-45 minutes (or 3 cycles), consider 150-200ml of 10% glucose over 15 minutes, (e.g. 600-800ml/hr). Care should be taken if larger volume bags are used to ensure that the whole infusion is not inadvertently administered.

4) Once blood glucose is above 4.0mmol/L and the patient has recovered, give a long acting carbohydrate. Some examples are
   - o Restart feed
   - o If bolus feeding, give additional bolus feed (read nutritional information and calculate amount required to give 20g of carbohydrate)
   - o 10% IV glucose at 100ml/hr. Volume should be determined by clinical circumstances (refer to Appendix 5 for administration details).

5) **DO NOT omit insulin injection if due** (However, insulin regime review may be required).

6) Document event in patient's notes. Ensure regular capillary blood glucose monitoring is continued for 24 to 48 hours. Ask the patient to continue this at home if they are to be discharged. Give hypoglycaemia education or refer to DISN. Ensure patient has been referred to a dietician for individualised hypoglycaemia treatment advice.

N.B. If the hypoglycaemia was due to sulfonylurea or long acting insulin therapy then be aware that the risk of hypoglycaemia may persist for up to 24-36 hours following the last dose, especially if there is concurrent renal impairment.

When hypoglycaemia has been successfully treated

- Complete an audit form, and send it to the DISN (see Appendix 3 for Audit form). Some Trusts have utilised pre-printed stickers in patients' notes both for documentation and audit purposes. For an example see Appendix 4. Consider completing an incident form if appropriate. If "hypo boxes" are used replenish as appropriate.
- Identify the risk factor or cause resulting in hypoglycaemia (see tables 2 and 3).
- Take measures to avoid hypoglycaemia in the future. The DISN or diabetes medical team can be contacted to discuss this.
- Unless the cause is easily identifiable and both the nursing staff and patient are confident that steps can be taken to avoid future events, a medical or DISN review should be considered. If the hypoglycaemia event was severe or recurrent, or if the patient voices concerns then a review is indicated.
- Please **DO NOT** omit the next insulin injection or start variable rate intravenous insulin infusion to 'stabilise' blood glucose. If unsure of subsequent diabetes treatment, discuss with the diabetes team/DISN e.g. it may be safe to omit a meal time bolus dose of rapid acting insulin if the patient is declining food and has had their usual basal insulin.
- Medical team (or DISN if referred) to consider reducing the dose of insulin prior to the time of previous hypoglycaemia events. This is to prevent further hypoglycaemia episodes occurring.
- Please **DO NOT** treat isolated spikes of hyperglycaemia with 'stat' doses of rapid acting insulin. Instead maintain regular capillary blood glucose monitoring and adjust normal insulin regimen only if a particular pattern emerges.

Audit Standards

	Processes
Protocol	Availability of diabetes management guidelines based on national examples of good practice including management of patients who are nil-by-mouth or enterally fed
Implementation	Availability of hospital-wide pathway agreed with diabetes speciality team Defined rolling education programme for ward staff and regular audit of key components including staff knowledge of correct treatment targets, blood glucose meter calibration, and quality assurance Percentage of wards with "hypo boxes" (or equivalent) Percentage of people with diabetes able to access treatments to manage their own hypos
Specialist review	People with diabetes who are admitted to hospital with hypoglycaemia are reviewed by a specialist diabetes physician or nurse prior to discharge
	Outcome measures
Incidence	Benchmark incidence of severe hypoglycaemia against equivalent national and regional data for admissions using widely available local and national datasets
Income	Percentage of hospital discharges delayed by inpatient hypoglycaemia episode
Identification & prevention	Cause of hypoglycaemia identified & recorded Percentage of appropriate insulin/ anti-hyperglycaemic medication dose adjustment regarding prevention of hypoglycaemia (snap shot audit of different areas of Trust on monthly basis)
Resolution	Time to recovery

Acknowledgements

We would like to thank Debbie Stanisstreet and the Department of Diabetes and Endocrinology, East and North Hertfordshire NHS Trust whose original hypoglycaemia guideline gave us a starting point for this document.

We would like to thank Dr Rifat Malik for producing the Audit Standards for hypoglycaemia.

We would like to thank Dr Clare Crowley for her work in acquiring a suitable individual use IV 20% glucose preparation.

Guideline update

This guideline should be updated regularly.

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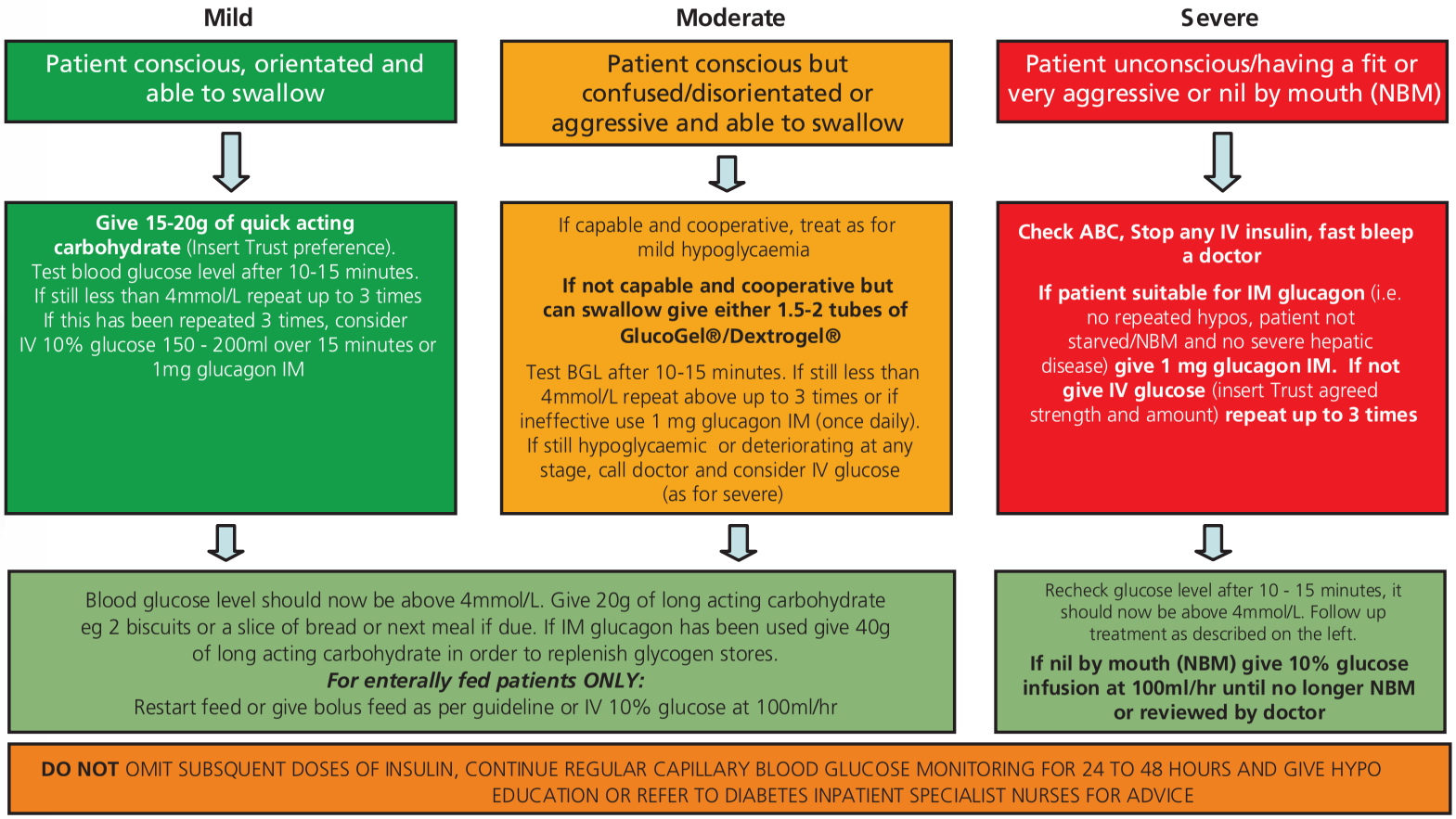
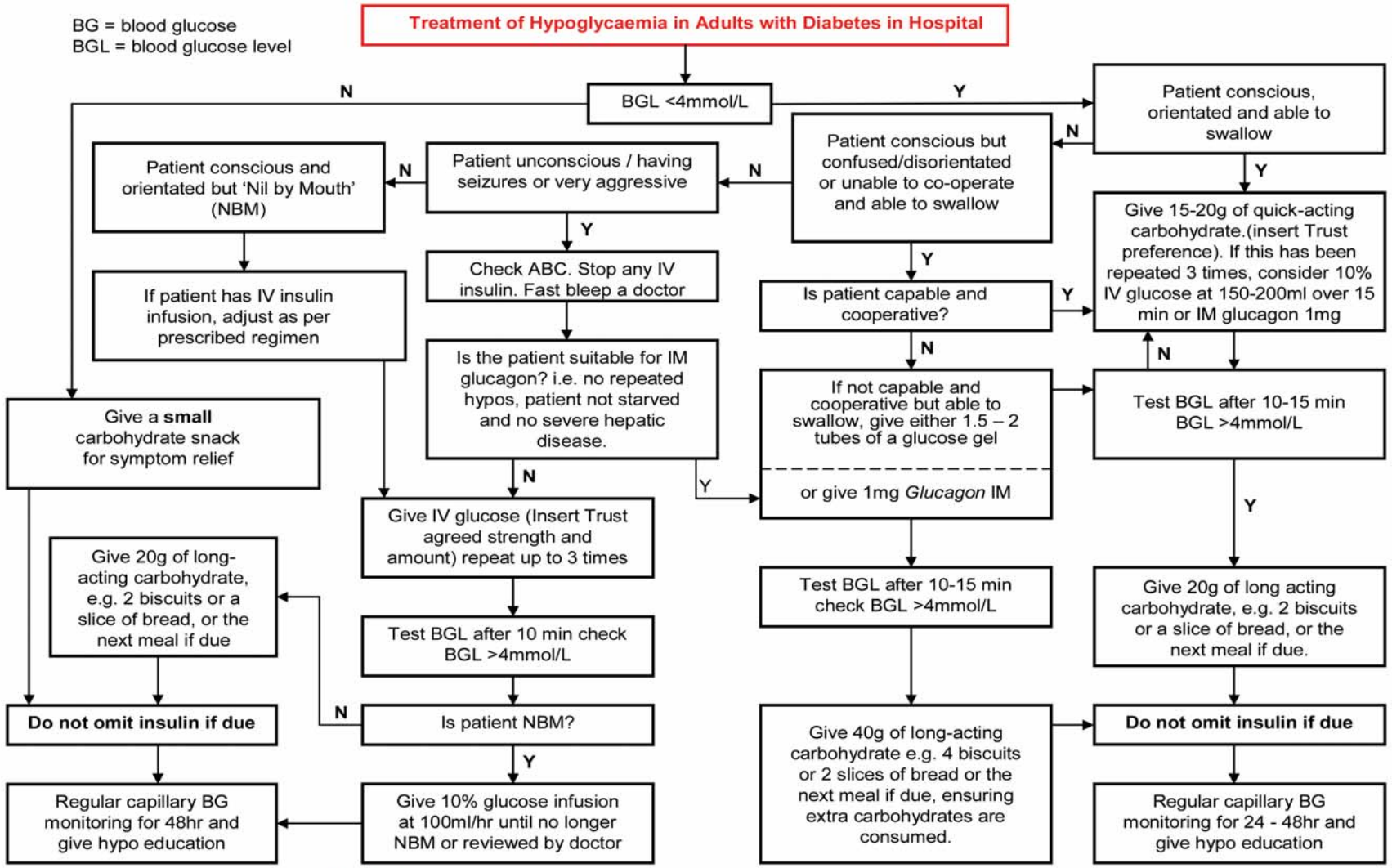
Algorithm for the Treatment of Hypoglycaemia in Adults with Diabetes in Hospital

Hypoglycaemia is defined as blood glucose of less than 4mmol/L (if symptomatic but blood glucose is above 4mmol/L then give a small carbohydrate snack for symptom relief)



For enterally fed patients please see section E of the Hypoglycaemia Guideline

BGL = blood glucose level


BG = blood glucose
BGL = blood glucose level
Treatment of Hypoglycaemia in Adults with Diabetes in Hospital
BGL <4mmol/L
N
Y
Patient conscious, orientated and able to swallow
N
Patient conscious but confused/disorientated or unable to co-operate and able to swallow
Y
Give 15-20g of quick-acting carbohydrate.(insert Trust preference). If this has been repeated 3 times, consider 10% IV glucose at 150-200ml over 15 min or IM glucagon 1mg
Patient conscious and orientated but 'Nil by Mouth' (NBM)
N
Patient unconscious / having seizures or very aggressive
N
Y
Check ABC. Stop any IV insulin. Fast bleep a doctor
Is patient capable and cooperative?
Y
N
If patient has IV insulin infusion, adjust as per prescribed regimen
Is the patient suitable for IM glucagon? i.e. no repeated hypos, patient not starved and no severe hepatic disease.
If not capable and cooperative but able to swallow, give either 1.5 – 2 tubes of a glucose gel
or give 1mg Glucagon IM
Test BGL after 10-15 min BGL >4mmol/L
N
Y
Give a small carbohydrate snack for symptom relief
N
Y
Give IV glucose (Insert Trust agreed strength and amount) repeat up to 3 times
Test BGL after 10-15 min check BGL >4mmol/L
Give 20g of long-acting carbohydrate, e.g. 2 biscuits or a slice of bread, or the next meal if due
Give 20g of long acting carbohydrate, e.g. 2 biscuits or a slice of bread, or the next meal if due.
Do not omit insulin if due
N
Is patient NBM?
Y
Give 40g of long-acting carbohydrate e.g. 4 biscuits or 2 slices of bread or the next meal if due, ensuring extra carbohydrates are consumed.
Do not omit insulin if due
Regular capillary BG monitoring for 48hr and give hypo education
Give 10% glucose infusion at 100ml/hr until no longer NBM or reviewed by doctor
Regular capillary BG monitoring for 24 - 48hr and give hypo education
**For enterally fed patients please see Section E of Hypoglycaemia Guideline.
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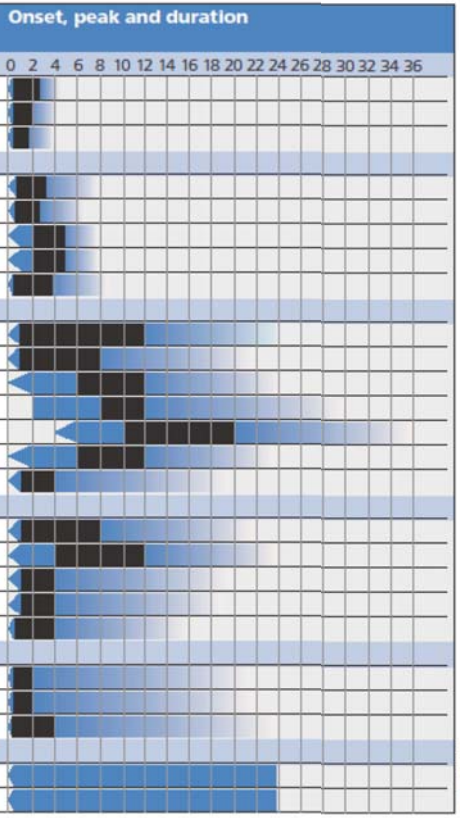
Insulins

Diabetes UK

Name	Manufacturer	Source	Delivery system	Taken	Onset, peak and duration
Rapid-acting analogue					
NovoRapid	Novo Nordisk	Analogue	Vial, cartridge, prefilled pen	Just before / with / just after food	
Humalog	Lilly	Analogue	Vial, cartridge, prefilled pen	Just before / with / just after food	
Apidra	Sanofi-Aventis	Analogue	Vial, cartridge (two types), prefilled pen (two types)	0–15 mins before, or soon after, a meal	
Short-acting / neutral					
Actrapid	Novo Nordisk	Human	Vial	30 mins before food	
Humulin S	Lilly	Human	Vial, cartridge	20–45 mins before food	
Hypurin Bovine Neutral	Wockhardt UK	Bovine	Vial, cartridge	30 mins before food	
Hypurin Porcine Neutral	Wockhardt UK	Porcine	Vial, cartridge	30 mins before food	
Insuman Rapid	Sanofi-Aventis	Human	Cartridge, prefilled pen	15–20 mins before food	
Medium and long-acting					
Insulatard	Novo Nordisk	Human	Vial, cartridge, prefilled insulin doser	As advised by the healthcare team	
Humulin I	Lilly	Human	Vial, cartridge, prefilled pen	About 30 mins before food or bed	
Hypurin Bovine Isophane	Wockhardt UK	Bovine	Vial, cartridge	As advised by the healthcare team	
Hypurin Bovine Lente	Wockhardt UK	Bovine	Vial	As advised by the healthcare team	
Hypurin Bovine PZI	Wockhardt UK	Bovine	Vial	As advised by the healthcare team	
Hypurin Porcine Isophane	Wockhardt UK	Porcine	Vial, cartridge	As advised by the healthcare team	
Insuman Basal	Sanofi-Aventis	Human	Vial, cartridge, prefilled pen	45–60 mins before food	
Mixed					
Humulin M3	Lilly	Human	Vial, cartridge, prefilled pen	20–45 mins before food	
Hypurin Porcine 30/70 Mix	Wockhardt UK	Porcine	Vial, cartridge	As advised by the healthcare team	
Insuman Comb 15	Sanofi-Aventis	Human	Cartridge, prefilled pen	30–45 mins before food	
Insuman Comb 25	Sanofi-Aventis	Human	Vial, cartridge, prefilled pen (two types)	30–45 mins before food	
Insuman Comb 50	Sanofi-Aventis	Human	Cartridge, prefilled pen	20–30 mins before food	
Analogue mixture					
Humalog Mix 25	Lilly	Analogue	Vial, cartridge, prefilled pen	Just before / with / just after food	
Humalog Mix 50	Lilly	Analogue	Cartridge, prefilled pen	Just before / with / just after food	
NovoMix 30	Novo Nordisk	Analogue	Cartridge, prefilled pen	Just before / with / just after food	
Long-acting analogue					
Lantus	Sanofi-Aventis	Analogue	Vial, cartridge (two types), prefilled pen (two types)	Once a day, any time (but at same time each day)	
Levemir	Novo Nordisk	Analogue	Cartridge, prefilled pen, prefilled insulin doser	Once or twice daily (at same time each day)	



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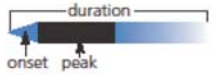

Times are approximate and may vary from person to person. This is a guide only.

All the information in this wallchart has been supplied and checked by the manufacturers.

Company contacts **Lilly:** 01256 315000 **Novo Nordisk:** 0845 600 5055 **Sanofi-Aventis:** 0845 606 6887 **Wockhardt UK:** 01978 661261

Diabetes Update

Appendix 2: Example of contents of hypo box

- Copy of hypoglycaemia algorithm (laminated and attached to inside of lid)
- 2x 200ml carton fruit juice (or 120 ml Lucozade® original for renal patients)
- 2 x packets of dextrose tablets
- 1x mini pack of biscuits (source of long acting carbohydrate)
- 3x tubes (1 box) Glucogel® (formerly known as Hypostop)
- 20% glucose IV solution (100ml vial)
- 1x green venflon 18G
- 1x grey venflon 16G
- 1x 10ml sterile syringe
- 3 x 10ml sodium chloride 0.9% ampoules for flush
- 1x green sterile needle 21G
- Chlorhexidine spray/alcohol wipes
- 1x IV dressing (venflon cover)
- 10% glucose for IV infusion (500ml bag)
- Audit form
- Instructions on where to send audit form and replenish supplies
- 1x Glucagon pack – to be kept in the nearest drug fridge or labelled with reduced expiry date of 18 months if stored at room temperature

"Hypo box" contents should be checked on a daily basis to ensure it is complete and in date. It is the responsibility of the member of staff who uses any contents to replenish them after use.

N.B. Chosen preparation of IV glucose should also be included or kept nearby with appropriate giving set.

N.B. Appropriate portable sharps disposal equipment should also be kept nearby.

Appendix 3

Hypoglycaemia Audit Form

(To be completed by a Healthcare Professional after each hypoglycaemic episode)

Patient Details/Sticker:

Hosp No: ..... DoB: .....

Surname: .....

Forename(s): .....

Male ☐ Female ☐ NHS No .....

Healthcare Professional Details:

Name: .....

Grade/Band: .....

Ward: ---------- **Consultant:** ----------

Date of Event: ____ / ____ / ____ **Time of Event:** _____: _____ hrs (24 hr clock)

Hypoglycaemic episode type please insert letter from key below: ☐

Key:

A. Patient was conscious, orientated and able to swallow
B. Patient was conscious but confused, disorientated, aggressive or had an unsteady gait but was able to swallow
C. Patient was unconscious and/or having seizures and/or was very aggressive
D. Patients was conscious, orientated but 'Nil by Mouth'
E. Patients requiring enteral feeding

		Treatment administered
Blood Glucose (BG) at time of event:	☐	☐
BG - 10 minutes after treatment:	☐	☐
BG - 15 minutes after treatment: **Treatment (if required):**	☐	☐

Was Hypoglycaemia Treatment Guideline followed? **Yes** ☐ **No*** ☐ *(Please tick appropriate box)*

***If No, please give details:** ☐

Hypoglycaemia Audit Form (Cont'd)

Did the patient self-manage? **Yes** ☐ **No*** ☐ *(Please tick appropriate box)*

Patient recovered? **Yes** ☐ **No*** ☐ *(Please tick appropriate box)*

***If No, please give details:**

What steps were taken to identify the reason for the hypoglycaemia?
Please give details:

What steps were taken to prevent a recurrence?
Please give details:

Please comment on the ease and effectiveness of the Treatment Guideline and make any suggestions on how it could be improved.

Thank you

Please return completed form to the DISN or diabetes department

Appendix 4: Example of a Hypoglycaemic Episode Label

Harrogate and District NHS Foundation Trust

Hypoglycaemic Episode

Ward: _____

Consultant: _____

Completed by:

Name: _____

Sign: _____

Date: ____/____/____

Affix Patient Label

Hypoglycaemic episode code (from key below):

Key:

A. Patient was conscious, orientated and able to swallow
B. Patient was conscious but confused, disorientated, aggressive or had an unsteady gait but was able to swallow
C. Patient was unconscious and/or having seizures and/or was very aggressive
D. Patient was conscious, orientated, but 'Nil by Mouth'
E. Patients requiring enteral feeding

	Blood Glucose (BG)(mmol/L)	Treatment Administered (see options inside hypo kit)
Starting BG Time: __:__ (24hr clock)		
BG after 10/15 mins Time: __:__		
Further BG after further 10/15mins (if required) Time: __:__		

PLEASE STICK IN MEDICAL NOTES AFTER HYPOGLYCAEMIC EPISODE HAS BEEN TREATED.

CONSIDER REFERRAL TO DISN (DIABETES INPATIENT SPECIALIST NURSE) X 5345 / BLEEP 5345 FOR:
REPEATED EPISODES; HYPO - RELATED ADMISSIONS; SEVERE HYPO; PATIENTS ON ENTERAL FEEDS

Cause of Hypoglycaemic episode	Action taken to prevent recurrence

With kind permission from Laura Dinning, Harrogate and District NHS Foundation Trust

Appendix 5

written by Dr Clare Crowley, Consultant Medicines Safety Pharmacist, Oxford University Hospitals NHS Trust.

Sample injectable monograph
To provide healthcare staff with essential technical information in clinical area at point of use, in accordance with NPSA Patient Safety Alert 20 'Promoting safer use of injectable medicines'

MEDICINE: GLUCOSE 10% & 20% INFUSION

Indication: Management of adult hypoglycaemia, where dose should be prescribed by volume and concentration to minimise confusion.

Available as: 10% glucose 500ml solution for IV infusion (0.1g/ml)

20% glucose 100ml solution for IV infusion (0.2g/ml)

Example calculations
Should not be required if prescribed via concentration and volume as advised

Usual adult dose: see guidelines

Administration:
IV injection: Not recommended

IV infusion:

20% glucose - short term peripheral use via a secure cannula into a large vein is acceptable for the emergency management of hypoglycaemia with close monitoring of the infusion site for thrombophlebitis. Central access is preferred where available and is desirable if 20% infusion has to be continued after the initial dose.

10% glucose - peripherally via a secure cannula into a large vein or central access (preferred where available). If peripheral infusion continues for more than 24 hours change infusion site to minimise thrombophlebitis. Care should be taken to ensure that the whole 500ml infusion is not inadvertently administered.

IM injection: Contraindicated

Subcutaneous injection: Contraindicated

Preparation & final concentration
Ready to use infusion. If only part of the infusion is needed discard any unused portion.

Rate of administration
Give 75-100ml of 20% glucose (or 150-200ml 10% glucose) over 10-15 minutes. For the initial emergency management of hypoglycaemia this may be administered via a giving set alone. In all other situations, an infusion pump is required. With 10% glucose, care should be taken to ensure that the whole 500ml infusion is not inadvertently administered.

Flush
Sodium chloride 0.9%, glucose 5% - flush well to reduce vein irritation

Do not administer blood through the same infusion equipment

Compatible infusions
Not applicable

Storage and handling
Do not use unless solution is clear and container undamaged

High strength solution – packaging looks similar to other infusion fluids take care to confirm correct strength selected

Cautions and side effects

- Hyperglycaemia, monitor blood glucose
- Avoid extravasation – may cause tissue damage
- Pain and phlebitis may occur during administration as the solution is hypertonic. This is a particular risk if infused too quickly. Monitor the infusion site, if any signs of phlebitis, stop infusion, remove cannula and resite
- Fluid and electrolyte disturbances including oedema, hypokalaemia and hypomagnesaemia

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