Mandatory Training Workbook 2017

Safe Use of Insulin

For all Clinical Staff who prescribe, dispense, prepare and administer insulin.

Checklist

- Read through this section of the workbook.
- Complete the on-line assessment on My PACT.
- If further information is required please contact the Diabetes Team on ext. 1482 / Bleep 2141.

Learning Outcomes

- To provide staff with an overview of insulin and its action
- To provide staff with an overview of how to administer insulin safely
- To provide staff with an overview of the management of hypoglycaemia

This e-learning workbook aims to ensure that patient safety is maintained at all times and that risks associated with insulin therapy are reduced.

Background

Diabetes Mellitus (DM) has often been described as a worldwide epidemic. The International Diabetes Federation (IDF) in 2015 predicted that in excess of 640 million people are likely to have been diagnosed with diabetes by 2040. In the UK it is estimated that there are 4.5million people with diabetes (Diabetes UK, 2016).

With the increasing number of people being diagnosed with diabetes, research has shown that the use of insulin has trebled since 1991 and estimate that 421,000 people were being treated with insulin in 2010.

The increase in the use of insulin has led to an increase in insulin related drug errors. Insulin is frequently included in the list of top 10 high-alert medicines worldwide. The National Patient Safe Agency (NPSA) issued an alert in 2010 regarding insulin related errors as they had received 3,881 wrong dose incident reports involving insulin. These included one death and one severe harm incident due to 10-fold dosing errors from abbreviating the term ‘Unit’. Three deaths and 17 other incidents between January 2005 and July 2009 were also reported where an intravenous syringe was used to measure and administer insulin.

One recommendation from the alert was that a training programme should be put in place for all healthcare staff (including medical staff) who are expected to administer, prepare or prescribe insulin. This workbook intends to fulfil this recommendation.

What is Diabetes?

Diabetes is a common life-long health condition of which there are two main types, Type 1 diabetes and Type 2 diabetes.

Type 1 Diabetes

- Develops when the insulin-producing cells in the body have been destroyed and the body is unable to produce insulin.
- It is an autoimmune condition; is not caused by lifestyle.
- Accounts for approximately 10% of all cases of diabetes.

Type 2 Diabetes

- Develops when the insulin-producing cells in the body are unable to produce enough insulin, or when the insulin that is produced does not work properly (known as insulin resistance).
- Accounts for approximately 90% of all cases of diabetes.

Risk Factors for Type 2 Diabetes

- Aged over 40 years old if you are white
- Aged over 25 if you are African-Caribbean, Black African or South Asian
- Being overweight
- A family history of diabetes
- Previous heart attack or stroke
- Schizophrenia, bipolar illness or depression or if you are receiving antipsychotic medication
- Polycystic ovaries, gestational diabetes or having a baby weighing over 10 pounds

Diabetes UK have created a useful video which further describes the differences between Type 1 and Type 2 Diabetes - https://www.diabetes.org.uk/Diabetes-the-basics/

What is Insulin?

Insulin is a hormone secreted by the beta cells within the pancreas. It is released in response to rising blood glucose levels, for example after eating a meal. It regulates how much glucose is within the bloodstream and allows cells that require glucose to use it for energy.

Insulin is used to treat those with diabetes and you will use insulin within Liverpool Heart and Chest Hospital (LHCH) in a variety of different settings;

- Type 1 DM - treated with insulin from diagnosis
- Type 2 DM - can be treated with insulin as well as oral tablets
- Subcutaneous and IV insulin can be used to optimise glucose levels during the peri-operative period
- PPCI – subcutaneous and IV insulin can be used to optimise glucose levels on admission

Insulin can also be used to treat women with gestational diabetes (diabetes during pregnancy).

The main side effects of insulin therapy are hypoglycaemia (low blood glucose) and lipohypertrophy (fatty lumps developing around the injection sites). Blood glucose monitoring is a vital part of the care that should be provided to those with diabetes whilst in hospital, particularly for those who are

treated with insulin. Illness or surgery can cause blood glucose levels to fluctuate and insulin doses may need to be reviewed on a regular basis.

Insulin Errors

The most common medication errors involving insulin are;

- The wrong type of insulin being prescribed / administered
- The wrong dose of insulin being prescribed / administered
- Insulin being given at the wrong time or being omitted

However it is at the point of administration where the majority of errors occur. The increasing availability of higher strength insulin and bio-similar insulin are two other areas that may increase the risk of insulin errors.

The consequences of an insulin error can be **potentially catastrophic** for patients. An **overdose** of insulin can cause severe hypoglycaemia, causing seizures, coma and even death. An **underdose** of insulin can cause hyperglycaemia and sometimes Diabetic Ketoacidosis (DKA).

In order to reduce the risk of insulin errors we must remember

*The **Right** insulin, in the **Right** device, at the **Right** dose, in the **Right** way and at the **Right** time*

The *Right* Insulin

In the UK there are currently over 25 different types of insulin that could be prescribed for patients. One problem is that many of the insulin brands have similar names such as Humalog or Humulin M3, but both have very different effects on blood glucose levels and serious consequences can occur if the wrong insulin is prescribed and/or administered.

Insulin is generally defined by how quickly or how long it lasts for. Most insulin prescribed and used is human or analogue (modified human) insulin however there are some patients that use animal insulin (Pork / Beef).

Definition of different types of insulin

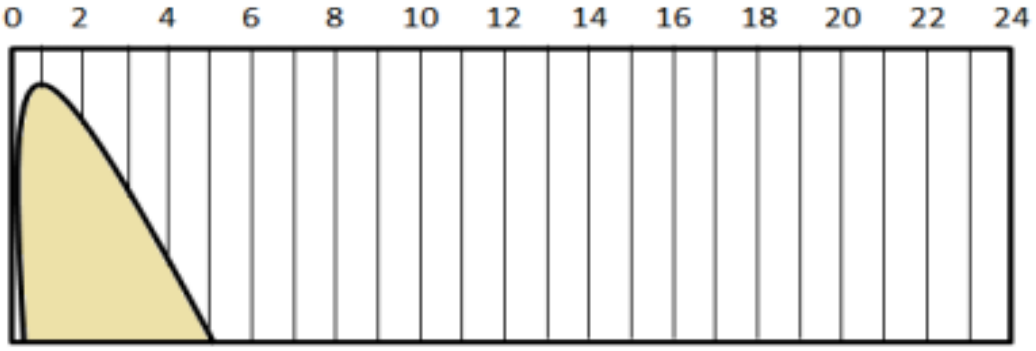
- **Analogue insulin** – lab grown human insulin modified to affect length of action
- **Human insulin** – synthetic insulin produced to match our own insulin
- **Animal insulin** – derived from animals (pigs and cows)
- **Biosimilar insulin** – lab grown human insulin

Different insulin has different modes of action which are described below.

Rapid acting insulin

Insulin: Novo Rapid, Humalog, Apidra

Profile of Action

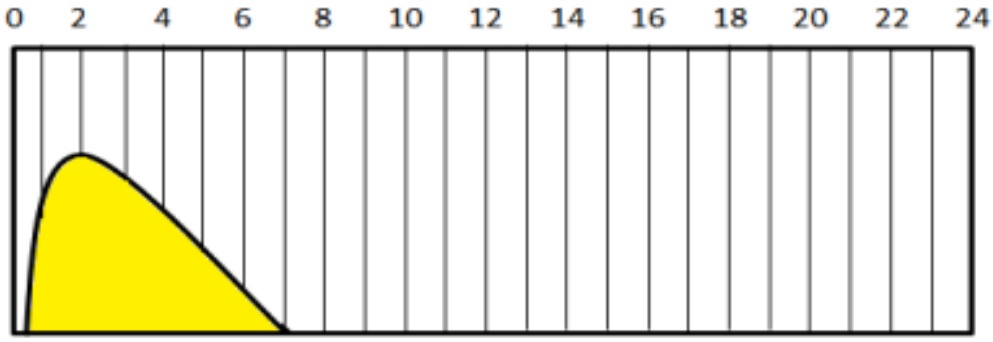


- Onset of action 5-15 minutes
- Must be given just before or just after meals
- Should not be prescribed to be administered at 10pm
- Should not be administered alongside IV insulin
- Patients usually on long acting insulin as well

Short acting insulin

Insulin: Actrapid, Humulin S

Profile of Action



- Should be given 30 minutes before food
- Often used as STAT medication if patient is hyperglycaemic
- Patients may be on longer acting insulin if this is their usual insulin

Medium Acting Insulin

Insulin: Humulin I, Insulatard

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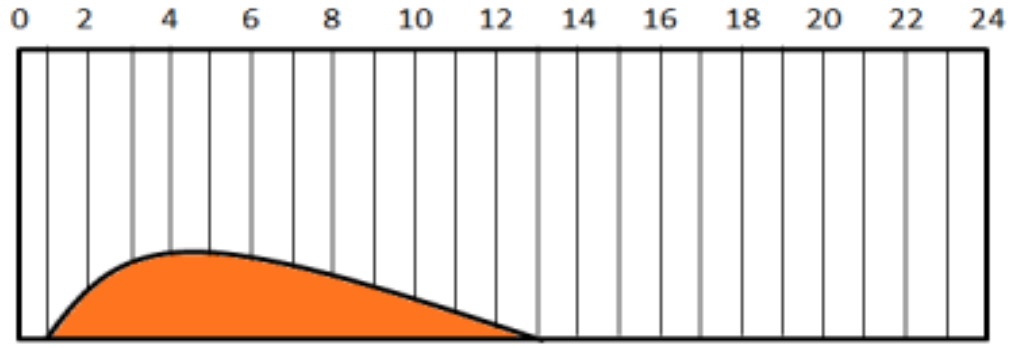
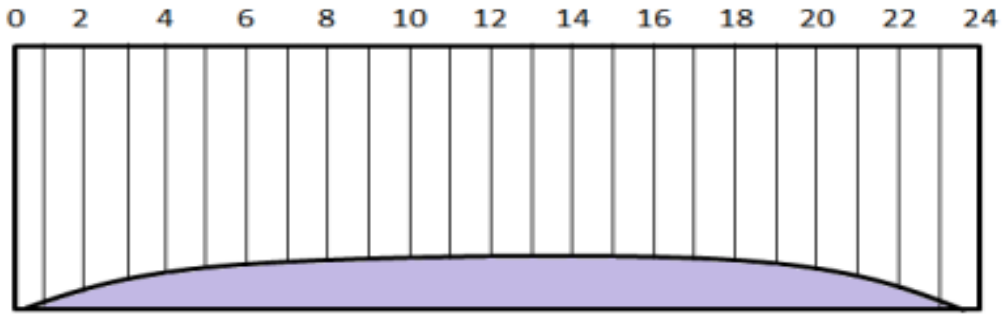


- Onset of action 30-60 minutes
- Can be administered with or without food
- Can be given once or twice a day – timings of injection should be consistent
- Often used if patient is on NG feed whilst an inpatient

Long Acting Insulin

Insulin: Levemir, Lantus, Tresiba

Profile of Action

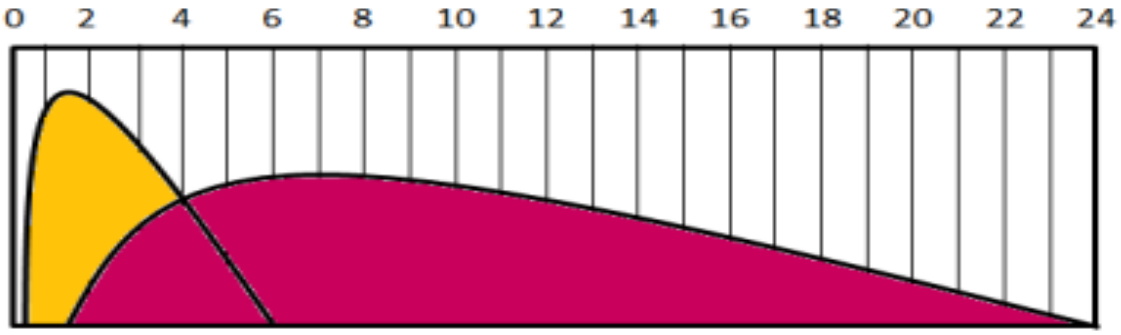


- Usually given once daily (Levemir can be given twice daily)
- Can be given without food
- Should continue to be given alongside IV insulin

Mixed Insulin

Insulin: Novo Mix 30, Humalog Mix 25, Humalog Mix 50, Humulin M3

Profile of Action



- Usually administered twice daily (Novo Mix 30 can be given three times per day)
- Should be administered with breakfast and evening meal
- Should not be prescribed for 10pm
- Should not be administered alongside IV insulin

Biosimilar Insulin

New drugs are normally protected by patent which limits the production and marketing to one manufacturer e.g. only Novo Nordisk can manufacture and sell Novo Mix 30. However lots of patents have already or are due to expire which will allow other manufacturers to produce similar products.

With biological drugs, such as insulin, it is very difficult to make an exact copy which can be guaranteed to react in exactly the same way as the originally approved drug. A biological copy (called a biosimilar rather than a generic version) can't be said to be identical to the original. Biosimilar insulin is becoming increasingly popular within the treatment of diabetes. Please be aware that when prescribing a biosimilar insulin the brand name should be used not the generic name.

For example Lantus is insulin glargine and Abasaglar is biosimilar insulin glargine. Patients who are admitted on Abasaglar should not be given Lantus instead and vice versa as they are not identical insulin.

Higher Strength Insulin

Until recently insulin has been a standard strength of 100 units/ml or U100. As patients are starting to require larger amounts of insulin to manage their condition higher strength insulin have been created to help reduce the frequency and volume of insulin patients have to inject.

Higher strength insulin can be double strength (200 units/ml or U200), treble strength (300 units/ml or U300) and we have patients on five times strength insulin (500 units/ml or U500) although this is not common.

When administering higher strength insulin you dial up the same number of units the patient is prescribed – **you do not need to perform any calculations**. Essentially higher strength insulin provides the same number of insulin in a smaller volume of liquid.

For example;

150 units of insulin glargine (**Lantus U100)** would be delivered in **1.5mls** of liquid however
150 units of insulin glargine **(Toujeo U300)** would be delivered in **0.5mls** of liquid

All of the higher strength insulin products are **only** available in a pre-filled pen.

The main safety consideration for higher strength insulin is that you should **NEVER** draw up insulin out of a pre-filled pen to use on another patient as there is a real risk of overdose.

For **prescribers** please ensure that you prescribe the brand name of the insulin and specify the strength. Higher strength insulin will not automatically appear in the search boxes on EPR – they will have to be entered manually.

Patients who are admitted on higher strength insulin should be referred to the Diabetes team for review.

Summary of Insulin and their characteristics

Type of insulin	Brand Name	Source	When to inject	Onset of Action	Peak of Action	Duration of Action
Rapid Acting Insulin	Novo Rapid Humalog Apidra	Analogue	Just before, with or after food	5-15 minutes	2 hours	4 hours
Short Acting Insulin	Actrapid Humulin S Insuman Rapid	Human	30 minutes before food	20-30 minutes	2.5 hours	4-6 hours
Medium Acting Insulin	Insulatard Humulin I Insuman Basal	Human	30-60 minutes before food	30-45 minutes	8-10 hours	18-20 hours
Long Acting Insulin	Levemir Lantus Tresiba*	Analogue	Can be given at any times irrespective of food – must be given at the same time	3-4 hours	No peak	Up to 24 hours *can last for up to 42 hours
Pre Mixed Insulin	Humulin M3 Insuman Comb 15 Insuman Comb 25 Insuman Comb 50 Hypurin Porcine 30/70 Mix	Human Porcine (Pork)	20-45 minutes before food	20-30 minutes	2-4 hours	18-20 hours
Pre Mixed Insulin	Novo Mix 30 Humalog Mix 25 Humalog Mix 50	Analogue	Just before or just after a meal	10-15 minutes	2 hours	18-20 hours

- **For prescribers** – please remember to double check when prescribing electronically that the correct insulin has been chosen. For example if '*hum' is typed* in the search box Humalog, Humalog Mix 25, Humalog Mix 50, Humulin I, Humulin S and Humulin M3 will appear in the list and it is easy to select the wrong option.

The *Right* Device

Insulin is available in a number of different forms;

- Vials (to be used with insulin syringes)
- Cartridges (to be used with cartridge pens only)
- Prefilled pens

Not all insulin preparations are available in all of these forms.

Vials and Insulin syringes

Vials of insulin can be used more than once. If the patient uses vials, then the vial should be labelled with the patient's details and can only be used for this patient. The vial should be labelled with the date of opening and discarded after 28 days.

The only exception to single patient use is Actrapid vials being used for preparation of Variable Rate Intravenous Insulin Infusions. In this case the vial should be labelled with the date of opening and discarded after 28 days.

Insulin syringes are specifically designed for drawing up and administering insulin. The markings denote the number of units to be administered. Insulin must **never** be drawn up and administered with a standard syringe as this can lead to an overdose of insulin.

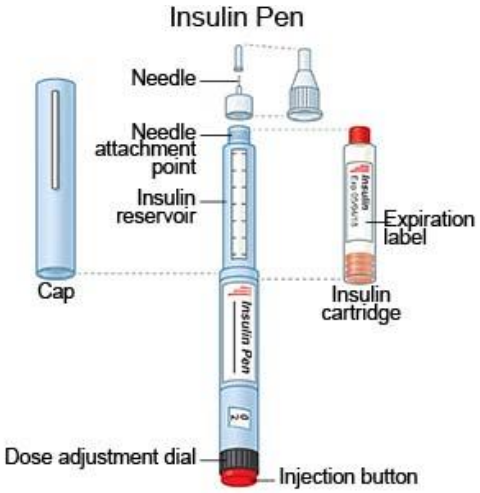
In line with an EU directive in 2010 on safe sharps the LHCH now uses BD Safety Glide 0.5ml Safety Insulin Syringes.

Cartridges for cartridge pens

Cartridges can only be used in specific manufacturer's cartridge pens. For example only Novo Nordisk insulin cartridges can only be used in Novo Nordisk cartridge pens and the same applies to Lilly and Sanofi insulin cartridges and pens.

Please ensure that if a patient is using a cartridge pen or if staff are using a cartridge pen to administer insulin that the insulin has been checked alongside the prescription and that the expiry date is checked. At times the expiry date is not always visible and so the cartridge may need to be

removed from the pen. If this happens please ensure that the plunger is right next to the bung on the insulin cartridge (this can be checked by performing an 'airshot') to ensure that the patient receives the correct dose of insulin the next time the pen is used.



If a patient uses cartridges and their cartridge pen is lost or broken, please contact the Diabetes team as we have a small supply of cartridge pens. In the event we cannot replace the cartridge pen, pre-filled pens will need to be prescribed and provided to ensure the patient does not miss any insulin doses.

Insulin must not be drawn out of a cartridge with an insulin syringe as this can make the insulin unstable and lead to air bubbles in the cartridge.

Pre-filled insulin pens

Pre-filled insulin pens are the most common kind of insulin pen device you will come across. They are a sealed unit that cannot be refilled and so should be disposed of safely when empty.

Insulin must not be drawn up out of a prefilled insulin pen with an insulin syringe as it may damage the pen or contaminate the insulin.

Please be aware that insulin pens will look similar. Please ensure that you check the insulin prescription and the insulin pen labels to ensure you are using the correct insulin.

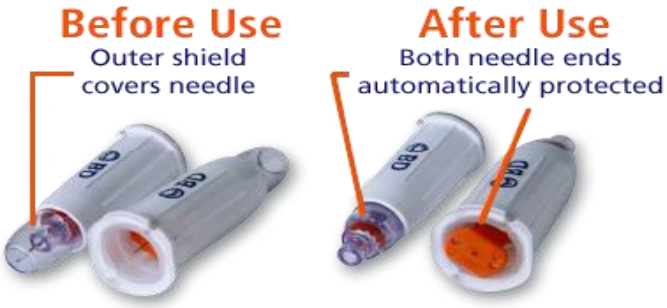
Please see the insulin comparison and identification guide, created by Pan Mersey, for more information regarding insulin pen devices.

http://www.panmerseyapc.nhs.uk/safety/documents/S16.pdf?UNLID=132314369201732114259

Insulin Pen Safety Needles

Cartridge pens and pre-filled insulin pens require a single use disposable pen needle for administration. Insulin pen needles can come in a variety of different sizes (4mm, 5mm, 6mm or 8mm). In LHCH if patients are administering their own insulin they should use either their own needles if they have brought a supply or BD 5mm needles which are stocked on the wards.

If staff are administering insulin to a patient using a cartridge pen or pre-filled pen then you must use BD AutoShield Due 5mm safety needles in order to reduce the risk of needle stick injuries. A new pen needle must be used for each injection and used needles disposed of safely in sharps bin.



Insulin Pumps

Insulin pumps are becoming increasingly common method of administering insulin to people with Type 1 Diabetes. Within LHCH there are patients with Cystic Fibrosis Related Diabetes (CFRD) who may use an insulin pump in order to manage their blood glucose levels.

Insulin pumps deliver a continuous supply of short or rapid acting insulin subcutaneously via a cannula. Bolus doses may also be administered via the insulin pump at meals times if blood glucose levels are elevated.

Patients that are able to self-manage their insulin pump and monitor their blood glucose levels should be able to continue to do so. If in the event the insulin pump is intentionally stopped or stops working the patient could be at risk of Diabetic Ketoacidosis. In this instance subcutaneous insulin (or IV insulin if patient is acutely unwell) must be administered as soon as possible.

If the patient is unable to manage the pump, for example after surgery, they will require subcutaneous insulin until they can restart the insulin pump themselves.

The *Right* Dose

Before administering an insulin injection **always check the dose with the prescription chart**. Insulin will have a second check option on EPR similar to when a controlled drug is being administered.

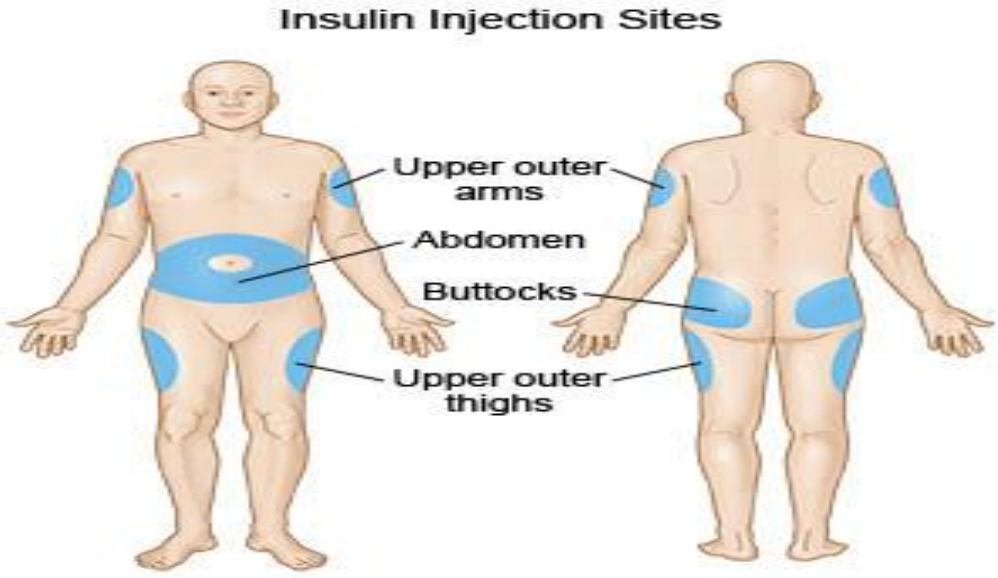
If in doubt **ask the patient** regarding their doses of insulin – they are usually the experts. GP summaries often do not state the dose of insulin the patient administers but will specify the formulation e.g. Novo Rapid penfill cartridge 100 units/ml – this refers to the strength of the insulin not the dose.

If there is any doubt in the amount of insulin prescribed please check. It is not acceptable to omit insulin but it can be delayed for a short period of time whilst a prescription is checked. Giving the wrong dose of insulin can have a potentially harmful effect on a patient.

The *Right* Way at the *Right* Time

Insulin Injection Technique

- A clean needle should be used for each injection.
- A two unit air test shot should be performed to ensure that the insulin pen and needle are working correctly.
- Always check the expiry date before injecting insulin
- Pre mixed insulin and medium acting insulin (cloudy) should be re-suspended prior to injecting. Re-suspend by gently rolling and shaking insulin pen ten times.
- Please ensure you check the patient wristband prior to administration.
- Insulin should be injected at a 90 degree angle into subcutaneous tissue and can be administered in the follows areas;



- Once needle is inserted and plunger has been pressed, please continue to hold for ten seconds to allow all of the insulin to be administered
- Injection sites should be rotated to prevent fatty lumps developing (lipohypertrophy).

- Needles should be disposed of in a sharps bin.

Timing of injecting insulin is crucial. Please remember that rapid acting insulin, short acting insulin and pre mixed insulin should be administered at meal times. Long acting insulin should be injected at approximately the same time each day irrespective of meal times.

One of the most common complaints from patients is the mistiming of insulin injections. Insulin regimes and correct administration times are paramount to good glucose control and all efforts should be made to make insulin administration a priority at meal times.

If appropriate, patients should be encouraged to remain in charge of their diabetes management. If the patient is safe to do so the self-administration policy can be implemented following a review by the Diabetes Team. Please see the Medicines Policy http://nww.staffintranet.lhch.nhs.uk/media/2408/medicines-v160.pdf for more information (page 48 onwards for self-administration of insulin).

Intravenous Insulin

Variable Rate Intravenous Insulin Infusions (VRIII) can be used to treat patients with;

- Diabetic Ketoacidosis (DKA)
- Hyperosmolar Hyperglycaemic State (HHS) – previously known as HONK (Hyperosmolar non-ketotic state)
- Patients who are nil by mouth waiting or fasting before a procedure or surgery
- Patients who are hyperglycaemic due to an acute event or illness.

Hyperkalaemia can also be treated with an intravenous insulin and glucose infusion.

The action of intravenous insulin only lasts between 5-8 minutes so in the event the cannula tissues, the pump stops or the infusion runs out patients can experience hyperglycaemia as a result. It is essential that the infusion is recommenced as soon as possible to prevent hyperglycaemia and potential DKA in those with Type 1 diabetes.

Signs of Hyperglycaemia can include

- Increased thirst
- Increased urination
- Fatigue
- Blurred vision
- Abdominal pain and vomiting in T1DM when in DKA

IV insulin should not be administered unless the patient is prescribed appropriate IV fluids, receiving NG, PEG or TPN feeds or if they are eating and drinking normally.

If Lantus or Levemir insulin is part of the patient's usual insulin regime, this needs to be continued even when the patient is being treated with IV insulin. Both of these insulins are long acting and if they are omitted it can make it difficult to control blood glucose levels once the IV insulin has been discontinued. If in doubt please ask – long acting insulin should not be omitted.

When a patient is ready to have their usual insulin regime, they should have subcutaneous insulin administered 30-60 minutes before the IV insulin is discontinued.

Please see the intravenous insulin for acutely ill peri-procedural patient's policy for more information http://nww.staffintranet.lhch.nhs.uk/media/2389/intravenous-insulin-for-acutely-ill-peri-procedural-patients-v62.pdf

Side Effects of Insulin

Hypoglycaemia (low blood glucose level, less than 4mmols/L) and lipohypertrophy (fatty lumps) are the two most common side effects of insulin therapy.

Hypoglycaemia

Hypoglycaemia is a lower than normal level of blood glucose. Any blood glucose level of less than 4mmols/L should be treated.

Please note patients with suboptimal glycaemic control may start to experience hypo-like symptoms with a blood glucose level greater than 4.0mmols/L and should be provided with a small snack to help treat the hypo-like symptoms.

Symptoms of Hypoglycaemia

Autonomic	Neuroglycopenic	General Malaise
Sweating Shaking / trembling Hunger Palpitations	Confusion Drowsiness Odd / aggressive behaviour Speech difficulty	Headache Nausea

Risk Factors to consider for Hypoglycaemia

<table>
<tr><th>Medical Issues</th><th>Lifestyle Issues</th><th>Reduced carbohydrate intake</th></tr>
<tr><td rowspan="3">• Strict glycaemic control
• Previous history of hypos
• Long duration of Type 1 diabetes
• Duration of insulin therapy in Type 2 diabetes
• Lipohypertrophy at injection sites
• Impaired hypo awareness
• 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</td><td rowspan="3">• Increased exercise (relative to usual activity levels)
• Irregular lifestyle
• Increasing age
• Alcohol
No or inadequate blood glucose monitoring</td><td>Food malabsorption e.g. gastroenteritis, coeliac disease.</td></tr>
<tr><td>Medicines – when used with hypoglycaemic agents</td></tr>
<tr><td>Warfarin, quinine, salicylates, fibrates, sulphonamides (including cotrimoxazole), NSAIDs, SSRIs, monoamine oxidase inhibitors

Do not stop or withhold medication, discuss with pharmacy / medical team</td></tr>
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Potential causes of Inpatient Hypoglycaemia

Medical Issues	Reduced Carbohydrate Intake
• Inappropriate use of stat or PRN rapid/short acting insulin • Higher dose of insulin than usual • Acute discontinuation of long term steroid therapy • Recovery from acute/illness or stress • Mobilisation after illness/surgery • Incorrect type of insulin prescribed and administered • Inappropriately timed insulin therapy in relation to meal or enteral feed • Change of insulin injection site • IV insulin infusion • Regular medication being given when not routinely taken at home	• Missed or delayed meals • Less carbohydrate that normal • Change of the timing of the biggest meal of the day • Lack of access to usual snacks • Prolonged starvation • Vomiting Reduced appetite

Treatment of Hypoglycaemia

Patients who are conscious, orientated and able to swallow:

1. Treat with 15-20g quick acting carbohydrate of the patient's choice wherever possible
   - 90-120ml of original Lucozade®
   - 1 bottle (60ml) Glucojuice®
   - 150-200ml or sugary drink i.e. pure fruit juice, full sugar cola
   - 3-4 heaped teaspoons of sugar in warm (not hot) tea

N.B. Diet drinks and some flavoured waters do not contain glucose and therefore are not effective for treating hypoglycaemia. Orange juice should not be used in patients following a low potassium diet.

2. Repeat capillary blood glucose measurement 10-15 minutes later. If it is still less than 4.0mmols/L repeat step 1 (no more than 3 treatments in total).
3. If blood glucose level is still less than 4.0mmols/L after 30-45 minutes or 3 cycles of treatment contact a doctor.
4. Consider 1mg Glucagon IM – can take up to 15 minutes to take effect (may be less effective in those treated with sulphonylureas / under the influence of alcohol) or 150-200mls of 10% glucose over 15 minutes. Volume should be determined by clinical circumstances.
5. Once blood glucose level is above 4.0mmols/L and patient has recovered give more complex carbohydrate e.g. two digestive biscuits, one slice of bread/toast, 200-300mls milk (not soya) or their normal meal if it is due.
6. Ensure regular capillary blood glucose monitoring is continued for 24-48 hours.
7. Refer to Diabetes Specialist Nurse.

Do not omit insulin injection if due (however dose adjustments may be required).

In extreme cases severe hypoglycaemia can cause loss of consciousness, seizures, coma and death. If a patient has lost consciousness treat as medical emergency and request immediate assistance from medical team.

Lipohypertrophy

Lipohypertrophy is the development of fatty lumps around insulin injection sites and are caused by injecting repeatedly into the same area. Lipohypertrophy can affect the rate absorption of insulin leading to erratic blood glucose levels. Injection sites should be examined regularly and any areas where there is evidence of lipohypertrophy should be avoided. In some cases it may be that insulin doses need to be reduced if the patient starts to inject in a new area.

Evidence of lipohypertrophy can only be detected on examining the injection sites at times. Where there is extensive lipohypertrophy it can be visible without a physical examination.


Example of extensive lipohypertrophy.

General Points about Insulin

- Unopened insulin should be stored in a fridge between 2°C and 8°C.
- Insulin should not be frozen or left in direct sunlight as this can affect its effectiveness.
- Once opened, insulin can be kept at room temperature for 28 days after which it should be discarded.
- Before using insulin please check its appearance to ensure there are no particles in the solution.

Further support

If a patient, their relatives or staff require any additional advice or support with regards to any aspect diabetes management please refer to the Diabetes Specialist Nurses via EPR or by contacting extension 1482 or bleep 2141.