TREATMENT WITH INSULIN

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Principles of Treatment

- Insulin by injection is given as replacement therapy in people with absolute or relative deficiencies in insulin secretion.
- A balance must be maintained between carbohydrate consumed, insulin administered and exercise taken - all of which can affect blood glucose concentration. The aim of treatment is to maintain near normoglycaemia.
- Self-monitoring of blood glucose and HbA1c measurements are necessary to ensure that treatment is effective and targets are being met.
- Remember, all prescriptions are free for all patients on oral antidiabetic drugs and insulin therapy.

A trial of insulin is justified in any patient with Type 2 diabetes who is symptomatic and in whom better glucose control is likely to be associated with health gain

Generally

- Soluble (regular), short-acting insulin should be injected **subcutaneously** 15-30 minutes before meals
- Insulin analogues (e.g. Humalog or NovoRapid) are fast acting and can be injected immediately before eating or during or after meals.
- Insulins should be stored in the `fridge', but not in the freezer compartment. Insulin pens in current use may be kept at room temperature.
- Diet should be reviewed for all patients starting insulin to emphasise regular meals with a consistent carbohydrate content, although this will depend on individual lifestyle and the type of insulin regimen
- Appropriate education on hypoglycaemia and diabetic ketoacidosis (DKA) is essential to allow effective self-management.
- Treatment needs to be individualised and must take account of things such as shift work, lifestyle, holidays, exercise etc.
- Referral to a dietitian is required to allow diet to be tailored to the individual taking into account age, lifestyle, occupation, shift patterns, exercise etc.

In general, insulin should never be stopped without prior consultation with a consultant diabetologist

Aims of Insulin Treatment

- Abolition of symptoms of hyperglycaemia
- Maintenance of ideal body weight
- Avoidance of hypoglycaemia
- Maintaining as near normal a blood glucose as is practical and safe for the individual.

Insulin Injection Sites and Injection Technique

Injection Sites

- The use of several different injection areas is recommended to avoid the development of lipohypertrophy
- Insulin is absorbed more rapidly from the abdomen than from the thighs or arms, except long acting analogues, which appear to have more uniform absorption. This should be

taken into account when prescribing different insulins. Exercise accelerates the rate of insulin absorption from the injection sites on the legs.

Injection Technique

The technique of insulin administration should be taught by a nurse with specialist skills in diabetes.

- Check insulin dose
- Pinch up fold of skin
- Inject needle at 90 degrees into this fold Avoid lumpy and hypertrophied areas
- Dispose of syringe and/or needle carefully.

There is no need to swab the skin before or after insulin injection

Commonly Used Insulin Preparations

There are three main types of insulin preparations.

Those of **short** duration which have relatively rapid onset of action are called *Soluble* insulins. The traditional soluble insulins include Actrapid, Velosulin and Humulin S. For those patients who require animal insulin there is a pork insulin preparation called Hypurin Porcine Neutral and a beef insulin preparation called Hypurin Bovine Neutral Fast acting insulin *analogues* (Humalog and NovoRapid) are available which have a more rapid onset and shorter duration of action than the soluble insulins.

Insulins with an intermediate time-action are called *Isophane* insulins and include Insulatard and Humulin I. For those patients who prefer animal insulins there is Porcine and Bovine Hypurin Isophane and Pork Insulatard. A *lente* insulin is available called Monotard which has a similar time-action profile.

There are some insulins whose onset is **slower** and whose action is **longer.** These have been traditionally called *insulin zinc suspension* insulins and include Ultratard and Humulin Zn although these insulins are now rarely used.

Longer-acting analog insulins are available called insulin Glargine (Lantus) and insulin Detemir (Levemir), which have a duration of action of up to 24 hours.

Fixed mixtures of insulin are available which contain Soluble and Isophane insulins in varying proportions, e.g. Mixtard 30 (30% soluble, 70% Isophane) – Mixtard 50, Humulin M3, Hypurin Porcine 30/70 Mix and, Pork Mixtard 30. In addition there are mixtures of analogues such as Humalog Mix 25, Humalog Mix 50 and NovoMix 30.

Insulin Administration Devices and Blood Glucose Monitoring Equipment

1. Syringes

Plastic syringes may still be the preferred method of delivery for some patients e.g. those using two different insulin preparations simultaneously which require free mixing of insulin, or those patients using large volumes of insulin which cannot be administered with a pen device. Syringes with attached needles are obtained on prescription, and are available in a 50 unit and 100 unit size.

Syringes are available for use with standard length needles (12.7mm) and short length needles (8mm).

2. Pen Injection Devices

Many patients use a pen injector device for insulin administration. This is available in two forms, either a reusable form for use with a cartridge or a pre-filled (disposable) type. The principal advantage of pen injection devices is the convenience of carrying and administering the insulin.

Disposable (Pre-filled) pens are particularly useful for patients with limited dexterity and visual impairment. Pre-filled pens are available on prescription.

Some Re-usable Pens are available from Diabetes Clinics or can be provided on prescription and are free to patients. Cartridges containing insulin are mostly 3ml in volume and are obtained on prescription. Most 1.5ml pens have been withdrawn from production.

Pen needles are available on prescription. 6mm, 6mm and 5mm lengths are used most commonly.

Re-use of Needles is not recommended.

3. Glucose Monitoring Equipment

A wide variety of blood glucose meters are available but electrodes (test strips) are not interchangeable for use between the various brands. Contact any of the Diabetes Specialist Nurses for further details and advice.

Disposal of Sharps

Syringes

Needles should be clipped off using the “BD Safe Clip” which is available on prescription. This device shears off and secures up to 200 needles, which can then be disposed of safely with the household refuse. The syringe minus the needle can then be dropped into an old ring pull can or lidded container. When it is full the lid should be secured or the opening taped over, put into a plastic bag and disposed with the refuse.

Lancets

Lancets should be treated with the same respect making sure the lancet is pushed firmly into the lancet cover before putting into containers or cans. Similarly pen devices should be disposed of with the same care.

Insulin Regimens and Dosage Adjustment

Principles of Dosage Adjustment

No one set of advice can cope with all situations.

Never change insulin on the basis of single blood glucose readings
Check monitoring technique/injection technique

- Identify the periods of day in which problems are occurring with glycaemic control and look for a pattern in blood glucose readings
- Be alert to fictitious blood glucose values being recorded by some individuals. This may be suggested by major discrepancy with the HbA1c concentration.
- Review insulin dose distribution.
- Review eating patterns including alcohol consumption.
- Review whether poor control in one part of the day is not a consequence of a previous period.
- Agree an adjustment of dose by 2 units initially.
- Most patients are capable of becoming skilled at self-adjustment of their insulin dose and regimen.

Twice Daily Regimen

Insulin is administered as two injections before meals, usually before breakfast and before evening meal. This is most commonly distributed as a one third:two thirds mixture of soluble and isophane insulin or given as a fixed biphasic insulin mixture e.g. Human Mixtard 30 or Humulin M3. Pre-mixed formulations of rapid-acting and intermediate-acting insulin analogues (Humalog Mix 25, Humalog Mix 50, NovoMix 30) are also suitable for twice daily administration.

To adjust insulin doses on a 'free-mixing' regimen

- If glucose high/low **before breakfast**, increase/decrease **EVENING long-acting** insulin.
- If glucose high/low **before lunch**, increase/decrease **MORNING short-acting** insulin.
- If glucose high/low **before evening meal**, increase/decrease **MORNING long-acting** insulin.
- If glucose high/low **before bed**, increase/decrease **EVENING short-acting** insulin.

To adjust insulin doses for a fixed (biphasic) insulin mixture

- If glucose high/low **before breakfast**, increase/decrease **EVENING** insulin dose
- If glucose high/low **before evening meal**, increase/decrease **MORNING** insulin dose
- Other adjustments may necessitate a change of the mixture. For further advice, contact your local Diabetes Specialist Nurse.

Basal-Bolus Regimen

This consists of an injection of a soluble insulin or rapid-acting insulin analogue before each of three main meals (bolus), and a basal insulin supply, either in the form of isophane, given as late in the evening as possible (before bedtime) or a long-acting insulin analogue (Lantus or Levemir) which can be given either in the evening or in the morning. Approximately 30% of the total daily insulin is provided as the basal insulin and the remainder is divided and given as bolus doses before each meal. Although this regimen consists of multiple injections, it does not necessarily give better blood glucose control, on average, than twice daily regimens. The main advantage of this regimen is improved flexibility, especially in coordinating insulin doses with meal size and physical exercise. It is therefore particularly useful for younger patients and those on shift work.

For dosage adjustment with a basal-bolus regimen:

- If glucose high/low **before breakfast**, increase/decrease **EVENING long-acting** insulin
- If glucose high/low **before lunch**, increase/decrease **MORNING short-acting** insulin
- If glucose high/low **before evening meal**, increase/decrease **LUNCHTIME short-acting** insulin
- If glucose high/low **before bed**, increase/decrease **EVENING short-acting** insulin

Rapid-Acting Insulin Analogues

- Rapid-acting analogues of insulin (e.g. Humalog, NovoRapid) may be used both in twice daily and basal bolus regimens
- **For some patients on rapid-acting insulin analogues, monitoring of post-prandial (2 hours) glucose may be required to assist with dosage adjustment.**

Over Insulinisation

The following symptoms are suggestive of over insulinisation:

- Recurrent Hypoglycaemia
- Wide excursions of blood glucose values
- Weight gain
- Subtle features of chronic hypoglycaemia
  - headache
  - craving to eat
  - personality change in elderly

Too Little Insulin

The following symptoms are suggestive of too little insulin:

- Chronic hyperglycaemia/osmotic symptoms
- Weight loss
- Feeling non-specifically unwell
- Nocturia, nocturnal thirst
- Chronic Fatigue ("hyperglycaemic malaise")

Insulin in the Elderly

Age itself is not a contraindication to insulin therapy

- Targets for glycaemic control in the elderly need not be as stringent as in the younger patient
- The aims of treatment are to control hyperglycaemia with particular avoidance of hypoglycaemia.
- It may be necessary to avoid short-acting insulin in the very elderly. Regimens using twice daily isophane or once daily long-acting insulin analogue are often effective in this age group, and reduce the risk of hypoglycaemia.

Insulin therapy in Type 2 diabetes

The most common indication for insulin in these patients is deteriorating glycaemic control on oral antidiabetic agents. The decision to introduce insulin can be difficult and the following factors should be taken into account:

- Age
- Other health problems, e.g. diabetic complications such as visual impairment
- Social circumstances, e.g. patients holding a vocational driving licence
- Patient's attitude to insulin injections
- Compliance with diet
- Patients weight

Starting insulin is best managed as an outpatient under the supervision of the Consultant Diabetologist and a Diabetes Specialist Nurse.

A frequent problem encountered in treating those with Type 2 diabetes, is an inevitable gain in weight after starting insulin. On average, this is around 4 kg after 6 months of treatment. Patients should be warned that this might occur particularly if they do not limit their energy intake. As part of the education process for starting insulin, patients should receive a dietetic review and advice.

Patients should be offered a dietetic referral to discuss potential weight problems and dietary changes to prevent/minimise weight gain.

In some circumstances, a combination of insulin and oral antidiabetic agents may be indicated in people with Type 2 diabetes, but this is most often reserved for obese, insulin resistant patients.

As Type 2 diabetes is an insulin resistant state, high doses of insulin may be needed to obtain adequate glycaemic control.

The decision to use combined insulin and oral antidiabetic therapy should be taken by a Consultant Diabetologist.