MONOGRAPH

Insulin

Scope (Staff):	Medical, Pharmacy, Nursing
Scope (Area):	All Clinical Areas

Child Safe Organisation Statement of Commitment

CAHS commits to being a child safe organisation by applying the National Principles for Child Safe Organisations. This is a commitment to a strong culture supported by robust policies and procedures to reduce the likelihood of harm to children and young people.

This document should be read in conjunction with this DISCLAIMER

⚠ HIGH RISK MEDICINE ⚠

QUICKLINKS

DRUG CLASS

Insulin can increase or restore the body's ability to metabolise glucose by enhancing cellular glucose uptake; inhibiting endogenous glucose output and lipolysis.[1]

Insulin is a High Risk Medicine.

INDICATIONS AND RESTRICTIONS

- Diabetes mellitus.
- Diabetic ketoacidosis (DKA).
- Hyperglycaemia during illness.
- Perioperative management of patients with type 1 diabetes mellitus.
- Hyperkalaemia (in conjunction with glucose infusion) not responding to other treatment options.

CONTRAINDICATIONS

- Hypersensitivity to insulin or any component of the formulation.[2]
- Hypoglycaemia (blood glucose level < 3.9 mmol/L).[1, 2]
- DO NOT administer intermediate, long-acting and biphasic insulins intravenously or via an insulin infusion pump.[3]

PRECAUTIONS

- Acute trauma or illness – insulin requirement may increase.[3]
- Surgery – monitor blood glucose and blood ketones perioperatively; insulin infusion may be required in complex or prolonged surgery. Consult with an Endocrinologist for advice.[3]

FORMULATIONS

Listed below are products available at PCH, other formulations may be available, check with pharmacy if required:

- 50 units/50 mL insulin Actrapid® (neutral) in sodium chloride 0.9% (Baxter®) – for intravenous infusion
- Penfill cartridges – for use with a non-disposable insulin pen device
- Disposable prefilled pen devices

Imprest location: Formulary One

All products listed below have a concentration of 100 units/mL.

Formulation	Onset of action	Duration of action
Ultra-short- acting analogues • Novorapid® (aspart) • Humalog® (lispro)	10 – 15 mins[4, 5]	3 – 5 hours[4,7]
Short-acting • Actrapid® (neutral)	30 – 60 mins[4, 5,8]	up to 8 hours[5]
Intermediate-acting • Humulin NPH®, Protaphane® (isophane)	1 – 2 hours[4, 5,8]	16 – 24 hours[5]
Long-acting analogues • Levemir® (determir) • Optisulin® (glargine)	1 – 2 hours[5, 6]	12 – 24 hours[7,6] (Dose dependent)
Long-acting mixed with	10 – 15 mins[5]	16 – 18 hours[5]

ultra-short-acting (biphasic insulin) • NovoMix 30® (aspart 30% + aspart protamine 70%)			

PRESCRIBING

Insulin orders are to be prescribed as follows:

- Full **brand names** must be prescribed. Different brands of insulin are not bioequivalent. Do not substitute brands.[5]
- Subcutaneous – when prescribing on the MR860.40 and MR860.41 charts, only write the **number** of units intended; do not rewrite the word "units" as this word is pre-printed.
  - When prescribing on any other chart 'UNITS' must be written in full.
  - DO NOT use a trailing zero when prescribing an insulin dose.

Frequency/Route	Chart
Intermittent subcutaneous injection	MR860.40 Subcutaneous Insulin Prescribing and Blood Glucose Monitoring Chart
Continuous subcutaneous insulin pump	MR860.41 Subcutaneous **Insulin Pump** Prescribing and Blood Glucose Monitoring Chart
Intravenous insulin infusion	MR828.00 Parenteral Fluid Therapy Order Chart
Intermittent Subcutaneous insulin injection with Carbohydrate Counting	Subcutaneous Insulin Carbohydrate Counting Prescribing and Blood Glucose Monitoring Chart (MR860.42)

DOSAGE & DOSAGE ADJUSTMENTS

Neonates: Refer to Neonatal Medication Protocols

(Neonates in PCC: Refer to "intravenous infusion administration" section of this monograph for standard concentration)

Determine insulin dosage and regimen depending on individual treatment targets and titrate according to blood glucose level.

> The lowest dosing increment for insulin is **0.5 units**; dose rounding should be made in discussion with endocrinology or Paediatric Critical Care (PCC) team.

Diabetes mellitus

Subcutaneous (4 weeks – 18 years of age):

Initially: 0.3 – 1 units/kg/**DAY** in divided doses.[8]

Usual maintenance: 0.7 – 1.5 units/kg/**DAY** in divided doses.[8]

Higher doses may be required based on patient clinical factors and should be discussed with endocrinology.[7]

- *Multiple* daily injections (basal-bolus): 50 – 70% of total daily dose is usually given as ultra-short acting insulin in divided doses, before meals and significant snacks. The remainder of the estimated total daily dose is given as long-acting insulin in 1 or 2 doses.[7]
- *Continuous* subcutaneous infusion: allows administration of small insulin doses accurately.[7]

Diabetic ketoacidosis (DKA)

Refer to Diabetic Ketoacidosis guideline for details on management options.

Intravenous infusion - insulin Actrapid® (neutral)**:**

- Patients requiring IV insulin infusion must be managed in PCC unit.[9,10]
- Prime IV tubing with 20 mL of the diluted insulin infusion to reduce insulin adsorption to the plastic tubing.[8]
- Initial continuous infusion rate (then titrate according to response)[8]:
    - Child < 5 years: 0.05 units/kg/hour (max 5 units/hour)
    - Child ≥ 5 years: 0.05 - 0.1 units/kg/hour (max 5 units/hour)
- Do not give IV insulin boluses to DKA patients at the start of insulin infusion (increased risk of cerebral oedema).[8]
- Once DKA has been corrected and the patient is rehydrated (i.e. pH >7.3, bicarbonate >18 mmol/L) and blood glucose level has stabilised, administer 0.1 units/kg of insulin Actrapid® (neutral) **subcutaneously**, 2 hours before ceasing insulin infusion.[1,10]

Subcutaneous - insulin Actrapid® (neutral)

- For patients presenting with a blood gas pH >7.2 or if IV administration is not possible.
    - Initially 0.1 units/kg, then 0.1 units/kg every 2 hours.[9]
    - Following correction of DKA, give 0.1 units/kg every 4 – 6 hours, then discuss with endocrinology regarding transition to an appropriate insulin regimen.[9]
- For managing patients on insulin pumps, refer to Insulin Pump Management Procedure.

Hyperkalaemia

Refer to Hyperkalaemia guideline for details on management options.

- Insulin would be used in addition to a glucose infusion if necessary (i.e. **not all** patients receiving glucose infusion for the management of hyperkalaemia require an insulin infusion).
- IV: 0.05 – 0.1 units/kg/hour of insulin neutral (Actrapid®), titrated in increments of 0.05 units/kg/hour to maintain blood glucose level at 10 – 15 mmol/L.[10, 11]

- Give 5 mL/kg of IV glucose 10% prior to or with insulin infusion.[12]
    - Consider infusing 5 – 10 mL/kg/hour of IV glucose 10% concurrently (equivalent to 1 – 2 mL/kg/hour of IV glucose 50%). IV glucose 50% must only be administered via a central venous access device (CVAD).[3, 10]

Renal impairment:

- eGFR calculator
- Insulin requirements may decrease in patients with renal impairment; lower doses may be necessary.[4]

Hepatic impairment:

- Insulin requirements may decrease in patients with hepatic impairment; lower doses may be necessary.[4]

ADMINISTRATION

Allow refrigerated insulin to warm up to room temperature for about 30 minutes prior to administration as cold insulin may be more painful to inject.[5]

Subcutaneous insulin injection:

Insulin Pens MUST be used to deliver all subcutaneous insulin doses. These are single patient use devices and MUST be labelled with a patient addressograph.

- For insulin administration using a pen device, refer to Insulin Administration - Pen Device.
- Penfill cartridges can be used for refilling insulin pumps.
- Gently roll and invert cartridges of cloudy insulin (Humulin NPH®, Protaphane®, NovoMix 30®) prior to drawing up the required dose (product should appear white and uniformly cloudy).[5]
- Rotate the site of injection; do not massage the injected area.[7]

Insulin Actrapid® (neutral)

- Give 30 minutes before meals and significant snacks.[7]
- It is available as:
    - Actrapid Penfill 3 mL cartridges which can be used with NovoPen Echo® non-disposable pen device (allows 0.5-unit doses; dose range 0.5 - 30 units).[2]

Insulin NovoRapid® (aspart)

- Give no more than 5 minutes before meals and significant snacks.[7]
- It is available as:
    - NovoRapid FlexPen® 3 mL disposable prefilled pen
    - NovoRapid Penfill® 3 mL cartridges which can be used with NovoPen Echo® non-disposable pen device.[2]

Insulin Humalog® (lispro)

- Give immediately before meals and significant snacks.[7]

  It is available as:

  - Humalog KwikPen® 3 mL disposable prefilled pen
  - Humalog Penfill® 3 mL cartridges which can be used with the HumaPen®- Luxura HD non-disposable pen device (allows 0.5-unit doses; dose range 0.5 – 30 units).[2]

Insulin Optisulin® (glargine)

- Available as:
  - Optisulin SoloStar® 3 mL disposable prefilled pen
  - Optisulin Penfill® 3 mL cartridges that can be used with Junior STAR® non-disposable pen device (allows 0.5-unit doses, dose range 0.5 – 30 units).[2]

Intravenous insulin infusion:

- Neonates (in PCC only): 10 units in 30 mL (0.3 unit/mL) insulin Actrapid ® (neutral) in sodium chloride 0.9%.
  - Using a 1 mL BD volumetric syringe, **draw up 10 units (0.1 mL) of insulin** from an Actrapid® 100 units/mL penfill cartridge and dilute to a final volume of **30 mL** with sodium chloride 0.9%.
- All other patients: Use 50 units in 50 mL (1 unit/mL) insulin Actrapid ® (neutral) in sodium chloride 0.9% (Baxter®) pre-filled syringe.
  - If the pre-filled syringe is not available in both PCH ED and PCC, nursing staff may prepare the infusion in the clinical area.
  - Using a 1 mL BD volumetric syringe, **draw up 50 units (0.5 mL) of insulin** from an Actrapid® 100 units/mL penfill cartridge and dilute to a final volume of **50 mL** with sodium chloride 0.9%.

Filling Insulin Pump reservoir:

Use a volumetric syringe and an insulin penfill cartridge (Novorapid® or Humalog®) to fill insulin pump reservoir, see Insulin Pump Management Procedure.

Intermittent injection: May be administered undiluted.

COMPATIBILITY *(LIST IS NOT EXHAUSTIVE)*

Compatible fluids:

Glucose 5%, glucose 10%, sodium chloride 0.9%.[3]

Compatible at Y-site:

Esmolol, milrinone, potassium chloride, sodium nitroprusside, Hartmann's solution, Ringer's solution.[4,3]

Only commonly used drugs are listed below. This is not a complete list of incompatible drugs. Compatibilities of IV drugs must be checked when two or more drugs are given concurrently.

INCOMPATIBLE drugs:

Aminophylline, dopamine, glycopyrronium (glycopyrrolate), ketamine, labetalol, micafungin, noradrenaline (norepinephrine), phentolamine, phenylephrine, piperacillin-tazobactam, protamine, rocuronium.[4,3]

MONITORING

Blood glucose, CGM (continuous glucose monitoring), glycosylated haemoglobin (HbA_{1c}), serum potassium (infusion).[2] Frequency of monitoring to be determined by treating consultant.

ADVERSE EFFECTS

Acute side effects: hypoglycaemia, allergic reaction, hypokalaemia, injection site reaction (erythema, lipodystrophy, lipoatrophy, itch).

Chronic side effects: weight gain, insulin resistance, lipohypertrophy/lipoatrophy.[2, 5]

STORAGE

- Refrigerate unopened insulin at 2 – 8ºC (do not freeze). Once opened, store at room temperature and discard unused portion after 28 days.[3]
  - ➢ Exceptions: Humulin NPH® cartridge – discard unused portion 21 days after opening.[3]
- Protect from light.[3]

INTERACTIONS

There are also many drugs that may affect blood glucose concentration. This medication interacts with many other medications; consult PCH approved references (e.g. Clinical Pharmacology), a clinical pharmacist or PCH Medicines Information Service on extension 63546 for more information.

Please note: The information contained in this guideline is to assist with the preparation and administration of **insulin**. Any variations to the doses recommended should be clarified with the prescriber prior to administration

Related CAHS internal policies, procedures and guidelines
PCH ED Guideline: Diabetes Ketoacidosis
PCH CPM: Diabetes Mellitus Type 1 and 2 Surgical Protocol
PCH: CPM: Diabetes Sick Day Management

Related CAHS internal policies, procedures and guidelines
PCH ED Guideline: Hyperkalaemia
PCH CPM: Diabetes Hypoglycaemia Management
PCH CPM: Blood Glucose Monitoring

References

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Useful resources (including related forms)
Diabetes WA Fact Sheets

This document can be made available in alternative formats on request for a person with a disability.

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