INSULIN PRESCRIBING AND ADMINISTRATION VIA INTRAVENOUS INFUSION IN THE ICU, ICU2 AND CICU ST GEORGE HOSPITAL

This drug information business rule is **NOT** a standing order.

| Cross references (including NSW Health/ SESLHD policy directives) | NSW Health Medication Handling in NSW Public Hospitals PD2007_077
Australian Commission on Safety and Quality in Healthcare Guidelines for using the National Inpatient Medication Chart 7/2009 |
<table>
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<tbody>
<tr>
<td><strong>1. Accreditation requirements</strong></td>
<td>Insulin must be prescribed by a medical officer (MO) and prepared and administered by a registered nurse (RN) or MO responsible for care of ICU patients.</td>
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<tr>
<td><strong>2. Risk rating</strong></td>
<td>High</td>
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</table>
| **3. Description/presentation** | • Actrapid: rapid onset, short acting insulin to be used in all intravenous infusions (IVI) unless otherwise requested.
• Analogue Insulin: synthetic insulin with rapid onset via subcutaneous (SC) route
• Clinical Guidelines for administration of actrapid insulin via intravenous (IV) infusion in ICU1, ICU2 and CICU. |
| **4. Indications** | • Glycaemia control in critical illness
• To be used when patients in ICU require insulin via IV infusion
• Treatment of insulin requiring diabetes. |
| **5. Contraindications and/or Precautions** | • This rule does not apply to patients outside of ICU or to patients within ICU for whom IV insulin has been prescribed for the purpose treatment of hyperkalemia, diabetic ketoacidosis (DKA), hyperosmolar hyperglycaemic state (HHS - previously HONK) or calcium channel blocker, beta-blocker overdose – high doses to be used in consultation with clinical toxicologist |
| **6. Process** | Insulin is a hormone secreted by the beta cells of the pancreas. Its principal action is to lower blood glucose levels (BGL) by promoting cellular uptake into skeletal muscle and fat cells as well as inhibiting production and release of glucose by the liver. It plays a role in regulating the metabolism of proteins, lipids and counter-regulatory hormones. Insulin can also significantly affect serum potassium levels by affecting cellular uptake, and hydration state through reduction of osmotic diuresis. Insulin has multiple indications for use in the critically ill patient. Dosage is highly variable among individuals, disease states, and over the time course of illness. 

Independent of a diagnosis of diabetes, hyperglycaemia is associated with increased mortality and morbidity in patients treated in intensive care. Iatrogenic hypoglycaemia from prescribed insulin is associated with increased mortality. IV delivery of insulin provides more stable and titratable delivery than the SC route, but carries high risk given the complexity of its therapeutic regime and the possibility of severe, rapid onset hypoglycaemia and/or rebound hyperglycaemia on its cessation.

This business rule specifies the procedures for preparing and administering insulin via IV infusion. It also provides a standardised protocol for dosage initiation, titration and cessation of IV insulin suitable for many, but not all ICU patients. The medical team may choose to apply this standardised protocol or determine dose on an individual case basis.
### 6.1 Preparation and Administration

- **Soluble Insulin**
  Actrapid should be used for IV infusion.

- **Storage**
  Vial is to be stored in the fridge, labelled with patient details and date of first use and discarded 30 days post opening.

- **Compatible fluids**
  - Normal Saline
  - 5% Dextrose
  - Gelofusine

- **Incompatible Fluids**
  Fluids containing concurrent drugs.

#### 6.1.2 Standard IV insulin dosage protocol

- Target BGL range = 6 - 10 mmol/L, unless otherwise documented by MO
- A BGL > 10mmol/L in a patient not receiving insulin should be notified to the medical team who will decide whether or not to treat high BGLs with IV insulin
- Initial dose and subsequent titration of IV insulin infusion can be prescribed according to a standard protocol (refer 6.1.4) or individually tailored to patients requirements at the medical team’s discretion
- Prescription must be documented by medical team
- Initial infusion rate will take into consideration patients current and target BGL, co-morbidities, pre-existing insulin requirements, co-administration of glucose containing solutions and drugs affecting serum glucose levels such as corticosteroids.

#### 6.1.3 Prescribing and Documentation

- Prescription documented by MO on critical care flow charts or in the Clinical Information System
- Insulin infusion may be prepared and commenced by a RN or MO only. Other designations of nurses, including enrolled nurses are not permitted to administer or double check/witness insulin for infusion or injection
- Insulin infusions should be administered via a dedicated IV line
- Insulin **must not** be added directly to a burette
- Use an insulin syringe with a needle tip of 12.7mm when loading insulin
- Once loaded into the syringe gently rotate the syringe to ensure adequate mixing of insulin
- Insulin infusion syringe is to be changed every 24 hours to ensure stability of the solution
- A completed additive label must be attached to the syringe
- Prior to connecting to the patient, new administration lines must be primed with 20mls of the Actrapid /Saline mixture to overcome insulin binding to plastic surfaces
- The rate at which insulin is to be administered must be written in units/hour
- All infusion rates must be checked by two (2) RNs on preparation and during bedside handover
- Infusion rate must be checked at all shift changes
- Line patency must be checked regularly and cannula resited when indicated
- It is recommended that the insulin infusion remains connected at all times. If, however the insulin is disconnected for one hour or more, for a reason other than hypoglycaemia, resume the infusion at the previous rate, re-check BGL in one hour, and adjust accordingly.
- IV glucose solutions may be requested by medical team but are not mandatory co-infusions with IV insulin.

6.1.4 Standard insulin infusion protocol

<table>
<thead>
<tr>
<th>BGL Result (mmol/L)</th>
<th>Initial Bolus (Once only)</th>
<th>Initial rate (IU/hour)</th>
<th>Subsequent infusion (IU/hr)</th>
<th>Repeat (hours)</th>
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<tbody>
<tr>
<td>&gt;18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.1-18</td>
<td>2</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>10.1-14.9</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>8-10</td>
<td>0</td>
<td></td>
<td>If BGL stable or falling continue current rate. If BGL rising then increase infusion by 0.5 IU/hr</td>
<td>1 hourly interval. If BGL and infusion rate unchanged for 2 consecutive readings then 2 hourly. Then if stable for 2 consecutive readings then 4 hourly</td>
</tr>
<tr>
<td>5-7.9</td>
<td>0</td>
<td></td>
<td>If stable continue current rate if BGL falling for 2 consecutive hours then decrease rate by 0.5 IU/hr</td>
<td></td>
</tr>
<tr>
<td>4.0-4.9</td>
<td>0</td>
<td></td>
<td>Cease</td>
<td>Every 15 minutes unless otherwise specified</td>
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<tr>
<td>&lt;4.0</td>
<td>Call MO</td>
<td></td>
<td>Cease</td>
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NOTIFY MO IF:

- BGL < 3.5 mmol/L
- BGL < 4 or > 18
- Infusion rate < 0.5 IU/hr or > 10 IU/hr
- Interruption to feeding, enteral or parenteral
- Interruption to insulin infusion

Standard Insulin infusion protocol adapted from Adelaide ICU Medical Manual 2012 4
### 6.2 Nursing Care and Monitoring

#### Blood Glucose Monitoring

- BGL measurement is to be checked on admission using an arterial blood gas (ABG) in all patients who are admitted to ICU1, ICU2 or CICU.
- BGL is to be routinely checked every 4 hours in patients who are invasively mechanically ventilated, shocked, on vasopressor therapy, receiving insulin or oral hypoglycaemic agents, liver impairment, with abnormal admission BGL readings (BGL < 6 mmol or > 10 mmol), or at the request of the medical team.
- Finger prick point of care (POC) testing is acceptable for measurement of BGL.<sup>2</sup>
- POC glucose monitoring will be via the ACCU-CHEK Advantage ™ BGL. Formal serum pathology testing is used to verify BGL >20 and below < 3.5 mmol/L. However, verification of results by pathology should not delay intervention especially in the case of a BGL < 3.5 mmol/L.
- Patients commenced on insulin infusion must have their BGL taken at least hourly until the BGL is within the target range for 2 consecutive readings. Once BGL and insulin infusion dose are stable for 2 hours then measure 2nd hourly. Once stable for 4 hours measure 4 hourly.
- More frequent BGL monitoring is to be considered if the patient’s BGL is likely to vary, for example:
  - after adjustment of enteral/parental nutrition or glucose containing solutions;
  - in the presence of poor gastric absorption;
  - if the insulin infusion is stopped, altered or recommenced;
  - if the patient is receiving medications that may affect insulin requirements e.g. glucocorticoids, thyroid hormones or inotropes; and after any significant changes in patients clinical condition.
- All other patients are to receive BGL monitoring every 24 hours.

#### Potassium

- Serum potassium (K+) can fall rapidly on commencing IV insulin.
- K+ level will be checked concurrently with BGL when using ABG measurement.
- The medical team must document the method and frequency of K+ measurement required.
- The MO is to be informed immediately of a level below 3.0 mmol.
- IV K+ may be requested, typically targeting a serum value between 4-4.5 mmol/L.

#### Ketones

- The medical team may request monitoring of ketone bodies.
- Monitoring may take the form or urinary ketones, skin pin-prick ketones (BOHB) or anion gap (AG) assessment using ABG.

### 6.2.1 Management of hypoglycaemia: BSL < 4.0 mmol

- Hypoglycaemia may occur without symptoms but symptoms generally include perspiration, anxiety, palpitations, hunger, and tremor. Untreated hypoglycaemia may lead to confusion, seizure and coma. Hypoglycaemia even transient may result in permanent brain injury or death and must be treated urgently as a medical emergency.<sup>2</sup>
- Notify medical team.
- If patient is asymptomatic, cease IV insulin and seek medical review.
- If patient is symptomatic and/or if BSL is < 2.5mmol/L, cease IV insulin, seek urgent medical review, and give ordered 50mls of 50% dextrose IV push
- Monitor BGL every 15 minutes until medical review and give repeat boluses of 50mls of 50% glucose (25g)

6.2.2 Ceasing insulin infusion
- The medical team need to consider and document any ongoing insulin requirements
- Transition to SC insulin may be required in patients with pre-existing insulin requiring diabetes
- Transition should be delayed until vasopressor therapy has ceased, severe oedema resolved and there are no anticipated procedures or interruptions in nutrition
- For changeover to analogue insulin i.e. humalog, novorapid, novomix 30, humalog mix 25 the IV insulin infusion can be ceased at the same time the SC injection is commenced
- For changeover to SC non-analogue short acting insulin, the infusion is usually ceased 30-60 minutes after commencing the initial SC dose, and 2-4 hours after SC dose of long acting insulin such as glargine or neutral protamine hagedorn (NPH).

7. Keywords
- Insulin infusion, intravenous insulin, BGL

8. Functional Group
- Intensive Care Units

9. External references
- 1. Australian Diabetes Society, Guidelines for Routine Glucose Control in Hospital

10. Consumer Advisory Group (CAG) approval of patient information brochure (or related material)
- N/A

11. Implementation and Evaluation Plan
- Education and audit of patients who have hypo/hyperglycaemic events
  Audit Plan
  Retrospective audit of the incidence of hypoglycaemia (in patient population indicated in protocol) 3 months prior to implementation of protocol and audit of hypoglycaemia incidence post protocol implementation.

12. Knowledge evaluation
- Q1: What is the regime for taking BGL measurements in patients who are stable within the target?
  A: BGL taken at least hourly until the BGL is within the target range for 2 consecutive readings. Once BGL and insulin infusion dose are stable for 2 hours then measure 2nd hourly. Once stable for 4 hours measure 4 hourly.
Q2: When can an insulin infusion be transitioned to SC insulin?  
A: After medical documentation, when patient is stable (vasopressor therapy discontinues, oedema resolved, no interruptions to nutrition), patient has pre existing insulin requirements. Changeover time is dependent on analogue or non analogue, long or short acting insulin.

Q3: At what level is hypoglycaemia identified?  
A: BGL < 4 mmols/l

13. Who is responsible  
Nursing Co-director Critical Care  
Medical Director Intensive Care Unit

Approval for (Insert Clinical Business Rule Title)  
* N/A where appropriate

*Nursing/Midwifery Co-Director  
Name/position: Antoinette Borg A/NCD and Deb Cansdell NCD

*Medical Co-Director approval  
Name /position: A/Professor Theresa Jacques

*Drug and Therapeutics Committee (SGH)  
Chairperson name/position: A/Professor Winston Liauw

Executive Sponsor  
Name/Position: Dawn Fowler CGM

Contributors to CIBR development  
E.g. CNC, Medical Officers (names and position title/specialty)

Revision and approval history

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision number</th>
<th>Author (Position)</th>
<th>Revision due</th>
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<tr>
<td>March 2014</td>
<td>0</td>
<td>Dr Cartan Costello ICU Staff Specialist</td>
<td>March 2017</td>
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<tr>
<td></td>
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<td>Sarah Jones ICU CNC</td>
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Director of Operations Ratification  
Name: Cath Whitehurst  
March 2014