Clinical Support Guide | Intravenous Insulin Infusion (MR-INF-A) (MR-INF-B)

Protocol author: Diabetes Service, Rural Support Service
Protocol sponsor: Drug & Therapeutics Advisor Committee
Approved by: Drug & Therapeutics Advisory Committee on: 13/12/2019
Next review due: 13/06/2021

Summary
This protocol outlines responsibilities and actions required by medical staff, nurses and midwives to ensure the safety and quality of patient care.

Policy/Procedure reference
This protocol supports the SA Health Recognising and Responding to Clinical Deterioration Policy Directive and Guideline, Diabetes Service Plan and Diabetes Inpatient Model of Care.

Keywords
Clinical, Protocol, medical, nursing, midwifery, emergency, safety, quality, standards.

Document history
Is this a new LHN Protocol? N
Does this protocol amend or update an existing protocol? Y
Diabetic Ketoacidosis Management in Adults with Type 1 Diabetes, 2019
Does this protocol replace an existing protocol? N

Applies to
This protocol applies to all hospital medical, nursing and midwifery staff.

Objective File No.
2019 - to be updated

Version control and change history

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Clinical Support Guide | Intravenous insulin infusion

This clinical support guide is only for the management and titration of intravenous (IV) insulin infusion. It does not explain dose titration for any other type of insulin or method of administration.

1. Background

Hyperglycaemia on general medical and surgical units is associated with an 18 fold increase in in-hospital mortality, longer length of stay and greater risk of infection.\(^1\) The use of IV insulin to treat hyperglycaemia has been shown to reduce mortality, sepsis and acute renal failure by up to 45%.\(^2\)

2. Purpose

The aim of this document is to support best practice in the titration and stabilisation of the person with diabetes requiring an IV infusion of insulin. The clinical guide is to be used in conjunction with the CHSA Intravenous Actrapid Infusion Protocols (MR-INF-A Adult - DKA/Type 1 and MR-INF-B Adult – HHS/Type 2 protocols). Actrapid is the insulin of choice for IV insulin infusion.\(^3\)

3. Indications for IV insulin infusion

For the purposes of this clinical guide, indications for use in South Australian Regional hospitals are:

- Diabetic ketoacidosis (DKA), including euglycaemic DKA
- Hyperosmolar hyperglycaemic state (HHS).
- Surgical management of type 1 and 2 diabetes.
- Type 1 diabetes - patient not eating/fasting.

Careful consideration for use with:

- Hyperglycaemia on admission or persistent hyperglycaemia during hospitalisation.

Situations where these protocols are not in scope thus not approved are:

- Peri-partum management of diabetes (refer to SA Health Perinatal Guidelines for IV insulin protocol). Insulin and blood glucose are documented on the Partogram.
- Paediatric patients. Consultation with a paediatrician or paediatric service is recommended. A written medication authority from a medical practitioner is required.

4. Medication management

- Maintain basal insulin doses and cease rapid acting insulin.
- Review any oral medications and withhold if potential to worsen clinical state. Immediately cease sodium-glucose co-transporter-2.
- Review medications as part of discharge planning, and consider discontinuing the sodium-glucose co-transporter-2 in at risk patients.
5. Nursing considerations

Number of nursing staff and frequency of observations will be determined by patient stability and treatment intensity. There is a need for a 1:1 or 1:2 nurse:patient ratio if an IV insulin infusion is used as hourly observations are required.

Observations include:

- 2 intravenous lines setup plus syringe pump for IV insulin infusion
- capillary blood glucose and blood ketone monitoring
- fluid balance record (catheterisation and hourly measures) calculate and report deficit or positive fluid balance hourly
- pulse oximetry, temperature, pulse, respirations and blood pressure
- cardiac monitoring if hyperkalaemia or hypokalaemia
- level of consciousness - Glasgow coma scale (GCS).

5. Targets for blood glucose

The blood glucose (BG) target range during an intravenous insulin infusion is 7.0 – 10.0mmol/L for adult inpatients:

6. Frequency of blood glucose monitoring

All patients require hourly BG monitoring for the duration of the infusion unless BG has been within target range for at least six hours. In this situation, 2 hourly BG monitoring may be ordered by the medical practitioner. If there are any changes to the infusion rate, IV fluids or TPN, revert back to hourly monitoring.

7. Identifying the protocol type

There are two IV insulin infusion protocols. The required protocol should be specified by the medical practitioner.

- MR-INF-A (DKA/Type 1) is an adult protocol to be used for patients with type 1 diabetes and in conjunction with the CHSA Diabetic Ketoacidosis (DKA) protocol.
- MR-INF-B (HHS/Type 2) is also an adult protocol to be used for patients with type 2 diabetes and in conjunction with the CHSA Hyperglycaemia Hyperosmolar State (HHS) protocol.

8. Preparation of insulin infusion - Equipment

- Actrapid insulin cartridge
- Syringe driver pump
- 50 unit (0.5mls) insulin syringe
- 50ml leur lock syringe
- Blunt tip cannula
- ‘Medication added’ label
9. Preparation of insulin infusion
Equipment and supplies as per local instructions.

1. Draw up 50 units of Actrapid insulin in a subcutaneous insulin syringe.

2. Draw up 49.5mls of 0.9% sodium chloride (normal saline) in a 50ml leur lock syringe.

3. Leave enough space in the normal saline syringe and inject the insulin into the syringe. This will make the solution up to 50mls in total.

4. Apply a blunt tip cannula and mix gently.
5. Attach a ‘medication added’ label to the syringe stating the quantities added of each medication as above. Concentration = 1 unit insulin per 1 ml of normal saline, ie 50 units in 50mls.

6. Attach extension tubing to the syringe and manually prime the line with the insulin/saline solution.

7. Position the syringe on a syringe driver pump ensuring the flange of the barrel and base of plunger are firmly engaged.

8. Assemble IV fluids as ordered (usually normal saline) using a giving set with an anti-reflux valve. Prime the line and attach to the patients IV cannula. The insulin infusion line MUST be attached via a side-line port below the anti-reflux valve on the giving set.

9. Commence infusions as ordered.
**Regional Local Health Networks**

**DKA/Type 1 Protocol - Adult**

**Figure 2: Intravenous actrapid infusion – DKA/Type 1 protocol (Adult)**

### Intravenous Actrapid Infusion

**DKA / TYPE 1 Protocol - Adult (MR-INF-A)**

**Hospital:** …

**Target BGL range:**

- **BGL Frequency**
  - Hourly
  - 2 Hourly

**BGL Record (mmol/L)**

<table>
<thead>
<tr>
<th>Time</th>
<th>BGL Record (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20:00</td>
<td>Day/Month</td>
</tr>
</tbody>
</table>

**If patient remains in column 1 for four measurements, and still has not achieved target, call MO**

**BGL reading**

**Insulin injection rate (Units/hr)**

**Column 1, 2, 3**

**Nurse (or initials)**

**Initial Hypo reaction (?)**

**MO notified (+)**

### Intravenous Insulin Protocol

**DKA / TYPE 1**

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGL &lt; 4.0 means Hypoglycaemia</td>
<td>BGL &lt; 4.0 means Hypoglycaemia</td>
<td>BGL &lt; 4.0 means Hypoglycaemia</td>
</tr>
<tr>
<td>Units/hr</td>
<td>Units/hr</td>
<td>Units/hr</td>
</tr>
<tr>
<td>&lt;5.0</td>
<td>&lt;5.0</td>
<td>&lt;7.0</td>
</tr>
<tr>
<td>5.0 - 6.4</td>
<td>5.0 - 6.4</td>
<td>6.5 - 8.0</td>
</tr>
<tr>
<td>6.5 - 9.9</td>
<td>6.5 - 9.9</td>
<td>9.0 - 12.0</td>
</tr>
<tr>
<td>10.0 - 11.4</td>
<td>10.0 - 11.4</td>
<td>11.5 - 12.9</td>
</tr>
<tr>
<td>11.5 - 12.9</td>
<td>11.5 - 12.9</td>
<td>13.0 - 14.0</td>
</tr>
<tr>
<td>12.0 - 14.0</td>
<td>12.0 - 14.0</td>
<td>15.0 - 16.4</td>
</tr>
<tr>
<td>15.0 - 16.4</td>
<td>15.0 - 16.4</td>
<td>16.5 - 17.9</td>
</tr>
<tr>
<td>16.5 - 17.9</td>
<td>16.5 - 17.9</td>
<td>17.0 - 20.0</td>
</tr>
<tr>
<td>18.0 - 20.0</td>
<td>18.0 - 20.0</td>
<td>&gt;20.0</td>
</tr>
<tr>
<td>&gt;20.0</td>
<td>&gt;20.0</td>
<td>&gt;20.0</td>
</tr>
</tbody>
</table>

**New patients always begin in the green column - Column 1**

**Moving up:** At such BGL measurement ask the following two questions
- Is the patient’s BGL 10 mmol/litre or less?
- Has the BGL dropped by at least 2.5 mmol/litre in the last hour?

- If the answer to either question is **YES** - patient progresses one column
- If the answer to both questions is **NO** - patient moves up one column

**Moving Down:**

- If BGL <4.0 mmol/litre for Two consecutive measurements or insulin has been switched off - patient moves down one column

### Nursing Administration Record (Insulin IV infusion)

<table>
<thead>
<tr>
<th>Date/time commenced</th>
<th>Nurse 1</th>
<th>Nurse 2</th>
<th>Time stopped</th>
<th>Volume infused [ml]</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/14 1800</td>
<td>Rucker</td>
<td>Sullivan</td>
<td>2100</td>
<td>3.7 ml</td>
</tr>
</tbody>
</table>

Adapted with permission from Northern Adelaide Local Health Network
Figure 3: Intravenous actrapid infusion – HHS/Type 2 protocol (Adult)

INTRAVENOUS ACTRAPID INFUSION

HHS / TYPE 2
PROTOCOL - ADULT
(MR-INF-B)

Hospital: 

BGL Frequency

Dr's Name: 

Target BGL range:

UR Number: 

Surname: 

Adult patient 7 to 10 mmol/L

Given name: 

If BGL is within target range for at least 4 hours, mark as satisfied. If any deviation from target range, mark as unsatisfied. 

Second given name: 

D.O.B: / / 

Sex: 

BGL reading

Inulin infusion rate (units/hr)

Column 1, 2, 3

Nurse(s) initiates

Return/ Hipo/hyper tension (-)

MO notified (-)

Intravenous Insulin Protocol - HHS/TYPE 2

<table>
<thead>
<tr>
<th>BGL</th>
<th>Column 1 Units/hr</th>
<th>Column 2 Units/hr</th>
<th>Column 3 Units/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6.4</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>6.5 - 7.9</td>
<td>0.5</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>8.0 - 9.9</td>
<td>1.0</td>
<td>2.0</td>
<td>3.0</td>
</tr>
<tr>
<td>10.0 - 11.4</td>
<td>1.5</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td>11.5 - 12.9</td>
<td>2.0</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td>13.0 - 14.9</td>
<td>3.0</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td>15.0 - 16.4</td>
<td>4.0</td>
<td>6.0</td>
<td>7.0</td>
</tr>
<tr>
<td>16.5 - 17.9</td>
<td>5.0</td>
<td>7.0</td>
<td>8.0</td>
</tr>
<tr>
<td>&gt;18.0</td>
<td>6.0</td>
<td>8.0</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Have patient's always begin in the green column - Column 1

Moving up: At each BGL measurement ask the following two questions:

• Is the patient's BGL 10 mmol/L or less?

• Has the BGL dropped by at least 2.5 mmol/L in the last hour?

If the answer to either question is YES - patient remains in the current column.

If the answer to both questions is NO - patient moves up one column.

Moving Down: If BGL <4.0 mmol/L for Two consecutive measurements or insulin has been switched off - patient moves down one column.

NURSING ADMINISTRATION RECORD (Insulin IV infusion)

Insulin (units) and sodium chloride 0.9% (mL) | Data/time commenced | Nurse 1 | Nurse 2 | Time stopped | Volume infused (mL)
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>50 units Actrapid Insulin + 45.6 mL Sodium Chloride 0.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60 units Actrapid Insulin + 45.6 mL Sodium Chloride 0.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 units Actrapid Insulin + 45.6 mL Sodium Chloride 0.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Page 1 of 2
10. Important points of difference between charts

> Check title of chart to ensure you have the correct one.

> Column values for BG and infusion rate are different.

> Recording methods for all information are identical.

11. Documenting on the BG monitoring section

> Document the date and time in the appropriate column

> The BG is graphed with a dot (·) in the centre of the square which coincides with the BG level. Eg 16.1 or 16.8mmol/L is a dot in the box that corresponds to 16. Connect to the previous dot with a straight line.

> Document the numerical value of the BG in the designated row below the graph.

> Record IV insulin infusion rate as it relates to BGL. New patients always begin in the green column (column 1).

> Record the column being used to titrate the infusion at that point in time eg column 1, 2 or 3.

> Nurse taking and recording BGL to initial in allocated box.

> If the Hypoglycaemia Protocol (see appendix 1) is initiated or a medical practitioner is contacted, tick the corresponding box on the chart.

> Medical practitioner to be contacted if the patient remains in column 3 for four (4) measurements and has still not achieved target BGL.

Figure 4: example of how to chart the information
12. Intravenous insulin protocol

- New patients always begin in the green column – Column 1.
- **Moving up** – At each BG measurement ask the following two questions.
  - Is the patient’s BG 10.0mmol/L or less?
  - Has the BG dropped by at least 2.5mmol/L in the last hour?
  - If the answer to either question is **YES** - patient remains in the current column.
  - If the answer to both questions is **NO** - patient moves up **one column**.
- **Moving down**
  - If BG <4.0mmol/L for **two consecutive** measurements or insulin has been switched off – patient moves down **one column**.

13. Nursing medication administration record

At commencement of IV insulin infusion and with EACH syringe change, two nurses to check and sign the nursing administration record as per example below:

**Figure 5: Example of how to complete the nursing administration record**

<table>
<thead>
<tr>
<th>Insulin (units) and sodium Chloride 0.9% (mL)</th>
<th>Date/time commenced</th>
<th>Nurse 1</th>
<th>Nurse 2</th>
<th>Time stopped</th>
<th>Volume infused (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 units Actrapid Insulin + 49.5mL Sodium Chloride 0.9%</td>
<td>12/14/19 9:00</td>
<td>Jones</td>
<td>Jones</td>
<td>9:00</td>
<td>300</td>
</tr>
<tr>
<td>50 units Actrapid Insulin + 49.5mL Sodium Chloride 0.9%</td>
<td>12/14/19 9:00</td>
<td>Jones</td>
<td>Jones</td>
<td>9:00</td>
<td>300</td>
</tr>
</tbody>
</table>

IV insulin infusion hourly rate is to be checked by two nurses and both initials are to be documented as per the example below:

**Figure 6: Example of how to complete the nursing administration hourly rate record**

14. Pump and line management

- Senior nurse to check the order and settings on the syringe driver at the commencement of their shift AND with each syringe change.
- Check the IV insertion site and connections at commencement of each shift AND at each syringe/line change.
- Always check the rate changes with a second nurse.
- Change the Leur Lock Syringe every 24 hours. Lines replaced every 4 days.
15. What can go wrong?
> If the patient remains in column 3 for four (4) BG measurements, and still has not achieved target, call the supervising medical practitioner immediately.
> Remember that this protocol has adjustments built in so that moving up and down will adjust for each person’s individual insulin sensitivity. Hypoglycaemia, although always a possibility, will occur less frequently than with subcutaneous sliding scales.
> At any time, a registered nurse should contact the prescribing medical practitioner if they have any concerns related to the IV insulin infusion or blood glucose results.

16. When to Stop/Suspend infusion
> If hypoglycaemia occurs:
  > suspend infusion and follow hypoglycaemia protocol
  > notify the medical practitioner if infusion is suspended for >45 minutes.

17. Discharge planning
> Once the patient has remained in the same column for 10-12 hours with target BG achieved, the medical practitioner can review for transition to alternate and appropriate therapy in preparation for discharge.

18. Transition off IV insulin infusion
**IV insulin can only be discontinued once subcutaneous basal insulin has been on board for 4 hours.**
> Patients **must not** have their IV insulin infusion discontinued until 4 hours after commencement of basal (e.g. glargine) subcutaneous insulin.
> IV insulin (actrapid) has a half-life of only 7 minutes with duration of only 1 hour.
> IV insulin can only be discontinued once basal insulin has been on-board for 4 hours.
> IV insulin adjustments can continue based on blood glucose levels as this ensures adequate insulin coverage during transition.

At discontinuation of IV insulin infusion, two nurses to sign the nursing administration record as per example below:

**Figure 7: Example of the nursing administration record when ceasing the IV insulin infusion**

<table>
<thead>
<tr>
<th>Insulin (units) and sodium Chloride 0.9% (mL)</th>
<th>Date/time commenced</th>
<th>Nurse 1</th>
<th>Nurse 2</th>
<th>Time stopped</th>
<th>Volume infused (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 units Actrapid Insulin + 49.6mL Sodium Chloride 0.9%</td>
<td>12:14/19</td>
<td>Jones</td>
<td>Jones</td>
<td>0600</td>
<td>18 ml</td>
</tr>
<tr>
<td>50 units Actrapid Insulin + 49.8mL Sodium Chloride 0.9%</td>
<td>0600</td>
<td>Marks</td>
<td>Jones</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 units Actrapid Insulin + 49.8mL Sodium Chloride 0.9%</td>
<td>0600</td>
<td>Marks</td>
<td>Jones</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

19. Switching from IV to the Basal Bolus Insulin protocol
> Ensure long-acting insulin has been on board for a minimum of 4 hours before IV infusion is discontinued.
  > Calculate total insulin required over the last 6 hours and multiply this amount by 4 (=TDD)
    > 50% of TDD is given as basal insulin
    > 50% of TDD is given in three divided doses with meal.
20. Switching from IV to pre-mixed insulin

> If pre-mixed insulin (twice/day) is chosen, 2/3 TDD is given at breakfast and 1/3 is given with the evening meal. Continue supplemental insulin.

21. Switching from IV to continuous subcutaneous insulin infusion (CSII) or insulin pump

> A patient’s endocrinologist should be consulted if transitioning to insulin pump therapy.
> Insulin pump therapy is to be recommenced at the previous basal rate settings with the IV Infusion running concurrently.
> IV Insulin Infusion rate will be titrated down based on blood glucose levels.
> If a meal is due during the 4 hours of transition, the insulin pump’s advanced settings are to be used to calculate the meal-related bolus.
> The insulin pumps’ advanced settings consider the pre meal blood glucose test result, blood glucose target, insulin sensitivity factor, insulin:carbohydrate ratio and insulin action time (also known as ‘insulin on board’) to suggest a meal-related bolus dose to be delivered.
> The patient can self-administered this suggested meal-related bolus dose or administer a reduction in the suggested dose if concerned about post prandial hypoglycaemia.
> The CSII Inpatient Rate Record (MR-CIR) is to be used by the patient to document the meal-related bolus administered.
> After at least 4 hours of basal insulin via the insulin pump AND if the patient has tolerated food and fluid AND if the blood ketone remains less than 0.3mmol/L, the IV infusion can be discontinued.
> After the IV Infusion is discontinued, maintain insulin pump therapy (using both basal and advanced settings at main meal times). Continue hourly blood glucose for 2-4 hours then if stable, reduce blood glucose monitoring frequency to QID. The blood ketone should be rechecked in 1 hour and then as instructed by the medical officer.

22. Transitioning to oral medications

> Identify medications options that are safe for the patient. If reason for DKA was sodium-glucose co-transporter-2 use, then this medication should not be re-commenced.
> Assess pre admission HbA1c to inform discharge medication adjustment
    > Above target - Will need assessment for increase in usual therapy; arrange follow up GP appointment and diabetes education follow up.

23. Documentation

> Capillary BG levels
> Insulin doses/infusion rate and any IV fluid therapy
> Capillary blood ketone levels
> Hypo treatments
> Rate changes
> Medical practitioner notifications
Appendix 1

Hypoglycaemia management

The hypoglycaemia protocol below has been developed to standardise the management of hypoglycaemia in hospitals and aged care facilities. Two pathways are included on the flowchart (safe to swallow/unconscious or unsafe to swallow). This protocol still applies for patients on an insulin infusion.

Figure 8: Hypoglycaemia protocol
1. Attached Documents

| Document Name | Treatment of hypoglycaemia in patients with diabetes protocol (2019) |

2. References

<table>
<thead>
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<th>Document Name</th>
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3. Accreditation Standards

**National Safety and Quality Health Service Standards (NSQHSS)**

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<thead>
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**Evaluation and Quality Improvement Program (EQuIP)**

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<td>Provision of Care</td>
<td>Workforce Planning and Management</td>
<td>Information Management</td>
<td>Corporate Systems and Safety</td>
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4. Consultation

<table>
<thead>
<tr>
<th>Version</th>
<th>Consultation</th>
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<tbody>
<tr>
<td>1.0</td>
<td>CHSA Diabetes Specialist Nurse Network, CHSA Clinical Nurse Consultants and emergency department staff.</td>
</tr>
<tr>
<td>2.0</td>
<td>CHSA Diabetes Specialist Nurse Network, CHSA Clinical Nurse Consultants and emergency department staff.</td>
</tr>
<tr>
<td>3.0</td>
<td>Regional Diabetes Specialist Nurse Network, Regional Nurse Unit Managers and emergency department staff.</td>
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