

Protocol (Clinical)

Title: Diabetic Ketoacidosis Management in Adults with Type 1 Diabetes

Protocol author: Diabetes Service, Rural Support Service

Protocol sponsor: Drug & Therapeutics Advisor Committee

Approved by: Drug & Therapeutics Advisory Committee on: 13/12/2019

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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 <i>amend or update</i> an existing protocol? Y <i>Diabetic Ketoacidosis Management in Adults with Type 1 Diabetes, 2019</i> Does this protocol <i>replace</i> an existing protocol? N
Applies to	This protocol applies to all hospital medical, nursing and midwifery staff.
Objective File No.	2020-02587

Version control and change history

Version	Date	Amendment	Amended by:
1.0	13/04/2016	Original version	Jane Giles
2.0	17/01/2019	New Template	Jane Giles
3.0	13/12/2019	Reviewed with no changes	Jane Giles

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1. Attached Documents

Document Name
Intravenous Actrapid Infusion DKA / TYPE 1 Protocol & Chart – Adult (MR-INF-A)
Intravenous Actrapid Infusion HHS / TYPE 2 Protocol & Chart – Adult (MR-INF-B)
Intravenous Insulin Infusion (MR-INF-A) & (MR-INF-B) - Clinical Support Guide

2. References

Document Name
Northern Adelaide Local Health Network (2019) <i>Protocol for The Management of Diabetic Ketoacidosis in Adults</i> . Northern Adelaide Local Health Network, Adelaide.
Joint British Diabetes Societies Inpatient Care Group (2010) <i>The Management of Diabetic Ketoacidosis in Adults</i> . March. National Health Service Diabetes, United Kingdom.
Country Health SA Local Health Network (2015) <i>Procedure for the use of intravenous potassium chloride</i> . CHSA LHN, Adelaide.

3. Accreditation Standards

National Safety and Quality Health Service Standards (NSQHSS)

1	2	3	4	5	6	7	8	9	10
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Governance for Safety and Quality in Healthcare	Partnering with Consumers	Preventing & Controlling Healthcare Associated Infections	Medication Safety	Patient Identification & Procedure Matching	Clinical Handover	Blood & Blood Products	Preventing & Managing Pressure Injuries	Recognising & Responding to Clinical Deterioration	Preventing Falls & Harm from Falls

Evaluation and Quality Improvement Program (EQUIP)

11	12	13	14	15
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Service Delivery	Provision of Care	Workforce Planning and Management	Information Management	Corporate Systems and Safety

4. Consultation

Version	Consultation
1.0	Northern Adelaide Local Health Network, Diabetes and Endocrine Service CHSA Diabetes Specialist Nurse Network
2.0	Northern Adelaide Local Health Network, Diabetes and Endocrine Service CHSA Diabetes Specialist Nurse Network
3.0	Northern Adelaide Local Health Network, Diabetes and Endocrine Service Regional Diabetes Specialist Nurse Network

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Diabetes Ketoacidosis Protocol in Adults with Type 1 Diabetes

Early consultation with appropriate regional or metropolitan hospital or MedStar

DO NOT USE FOR
HYPERGLYCAEMIC
HYPEROSMOLAR STATE

Management of DKA – Consult with emergency physician/endocrinologist
IV fluids and IV Actrapid Infusion DKA / Type 1 Protocol - Adult

Severe

Yes

Up-transfer to an appropriate regional or metropolitan hospital

No

Initial investigations – vitals, 2 x IV cannula, urgent pathology (VBG, UEC, Osmolality, FBE, LFT, plasma glucose, capillary blood ketones, blood culture, ECG, CXR, urinalysis, CRP)

IV fluids

IV insulin

IV 0.9% sodium chloride
1000ml/hour

Commence IV Actrapid Infusion DKA / Type 1 Protocol - Adult

Part A - 0-60 minutes

Bag no.	Time (h)	Rate
2	1-3	500ml/h
3	3-5	500ml/h
4	5-9	250ml/h
5	9-13	250ml/h
6	13-19	166ml/h

Monitor blood glucose, bicarbonate, ketones

Commence daily long-acting insulin analogue (eg Lantus) at 2100hrs

Potassium replacement

Commence potassium replacement as separate IV infusion

Part B - >60 minutes

Serum glucose <15.0 mmol/L

Option 1 – change IV fluids to 4% dextrose + 0.18% sodium chloride OR
Option 2 - commence 10% dextrose at 125 ml/hr AND continue 0.9% sodium chloride solution (see p. 9)

Serum Potassium (mmol/L)	Potassium replacement
>5.5	Nil
3.5-5.5	Up to 30 mmol [^]
<3.5	consultation with emergency physician/endocrinologist. Transfer to a suitably equipped and staffed HDU or ED (may require >10mmol/hr)

[^] Standard premixed potassium chloride solution, 10mmol potassium chloride in 100ml mini bags are the preferred option for replacement on general ward.

Cardiac monitoring if potassium replacement >10 mmol/hr

Check potassium before each bag of normal saline and replace as above

Only use in conjunction with DKA clinical protocol guide

Diabetic Ketoacidosis in Adults: Introduction

Diabetic Ketoacidosis (DKA) is a life-threatening complication of type 1 diabetes mellitus and needs to be treated as a medical emergency. DKA is associated with a significant morbidity and mortality and must be diagnosed promptly and managed intensively. DKA is a complex disordered metabolic state characterised by ketonaemia, hyperglycaemia and metabolic acidosis. This results from absolute or relative insulin deficiency accompanied by an increase in counter-regulatory hormones (glucagon, epinephrine, cortisol, growth hormone). In addition to the significant metabolic and electrolyte derangements, patients may have additional medical or surgical co-morbidities, which may have triggered DKA such as sepsis, which must be diagnosed and appropriately managed. The clinical presentation of DKA may represent a new diagnosis of type 1 diabetes or inadequate insulin in the patient known to have type 1 diabetes.

Consultation with appropriate regional / metropolitan hospital / MedStar is required

At any point, if patient deteriorates, subsequent consultation is advised.

Severe cases will mandate retrieval to appropriate regional or metropolitan hospital. Less severe cases may be able to be managed at larger country hospitals.

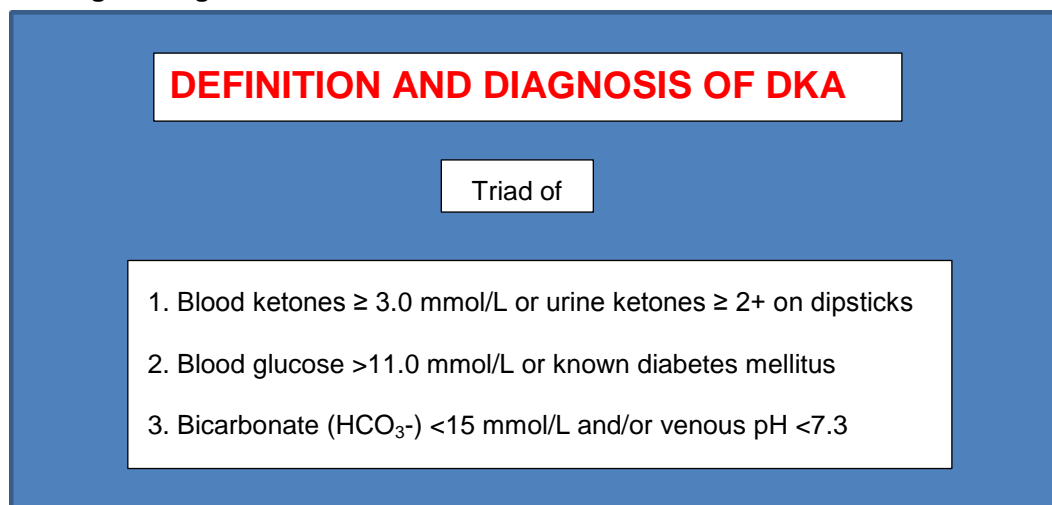
Paediatric patients, treatment of DKA and intravenous fluid resuscitation requires a paediatrician.

The following criteria must be met for local management;

	Yes	No
1) Availability of medical staff who are competent in managing this disorder and who can attend in person to review patient (at short notice).	<input type="checkbox"/>	<input type="checkbox"/>
2) Availability of nursing staff competent and confident in managing acute medical emergencies and who can provide 1:1 or 1:2 nursing care.	<input type="checkbox"/>	<input type="checkbox"/>
3) Availability of point of care testing.	<input type="checkbox"/>	<input type="checkbox"/>

Each service to self-assess their capacity to manage this condition based on knowledge of their staff availability, qualification, experience and competency.

The focus of management of DKA is on restoring hydration, clearing ketones, correcting electrolyte losses and normalising blood glucose level.



Assessment of severity

Recommend up transfer to an appropriate regional or metropolitan hospital HDU/ICU if one or more of the following is present;

- > Blood ketones >6.0 mmol/L
- > Bicarbonate <5 mmol/L
- > Venous/arterial pH <7.1
- > Hypokalaemia (<3.5 mmol/L)
- > Glasgow Coma Scale (GCS) <12 or abnormal AVPU scale*
- > Oxygen saturation <92% on air (assuming normal baseline respiratory function)
- > Systolic blood pressure <90 mmHg
- > Pulse >100 or <60 bpm
- > Urine output <0.5 ml/kg/hr
- > Serum creatinine >200 µmol/L
- > Microvascular event such as myocardial infarction or stroke
- > Other serious co-morbidity – eg end stage kidney disease, heart failure or conditions that would warrant admission to HDU/ICU in their own right
 - > hypothermia
 - > elderly patient
 - > pregnant patient.

*AVPU – Alert / Voice / Pain / Unresponsive

Goal of treatment

The goals of treatment for DKA include;

- > restoration of circulatory volume
- > clearance of ketones
- > correction of electrolyte losses (mainly potassium)
- > normalisation of blood glucose.

Other goals include prevention of:

- > hypokalaemia
- > hypoglycaemia
- > other potential complications eg cerebral oedema
- > arterial or venous thrombosis.

Principles

This protocol is designed to be followed in a sequential manner.

- > use IV 0.9% sodium chloride solution (**fluid of choice**) as the principal fluid to restore circulating volume and reverse dehydration.
- > use IV insulin infusion (Intravenous Actrapid Infusion DKA / Type 1 Protocol - Adult). (Actrapid is the **insulin of choice** for IV infusion)
- > Do not use a priming dose (bolus) of insulin unless there is significant delay (≥ 1 hour) in setting up an insulin infusion
- > monitoring of potassium level and replacement via IV fluid
- > metabolic treatment targets
 - > reduction of blood ketone concentration by 0.5 mmol/L per hour
 - > increase venous bicarbonate by 3.0 mmol/L per hour
 - > reduce capillary blood glucose by 3.0 mmol/L per hour
 - > potassium should be maintained between 4.0 – 5.0 mmol/L
- > subcutaneous long-acting analogue insulin SHOULD be continued
- > bicarbonate administration is not recommended routinely
- > phosphate should not be supplemented routinely.

If patient not responding, consult with regional or metropolitan hospital and consider up transfer

Nursing considerations

Level of nursing care and frequency of observations will be determined by patient stability and treatment intensity, eg a patient will need a 1:1 or 1:2 nursing ratio as hourly observations are needed and an insulin infusion is used. Observations include;

- 1) capillary blood glucose ketone monitoring
- 2) fluid balance record (catheterisation and hourly measures) calculate and report deficit or positive fluid balance hourly
- 3) pulse oximetry
- 4) pulse, respirations and blood pressure
- 5) cardiac monitoring if hyperkalaemia or hypokalaemia (continue to cardiac monitor for patients requiring IV potassium replacement)
- 6) level of consciousness - Glasgow coma scale (GCS)
- 7) Two (2) intravenous access lines are required. One for the insulin infusion, the other for hydration and potassium replacement as required. Potassium chloride replacement via additional port on the hydration line (eg piggyback). Must not run potassium infusion via the insulin line.
 - a. An infusion pump or other rate limiting device must always be used for both an IV insulin infusion and IV potassium chloride.
 - b. Standard premixed potassium chloride solution, 10mmol potassium chloride in 100ml mini bags are the preferred option for replacement. Premix 30mmol potassium chloride in 1 litre 0.9% sodium chloride also in stock for use if needed.

Treatment Plan – Part A

Within first hour: Immediate management upon diagnosis: 0 to 60 minutes (continuous on-site medical supervision is necessary)

Time = 0 when intravenous fluids are commenced. If there is a problem with intravenous access, critical care advice should be sought immediately. Consultation with an appropriate regional or metropolitan hospital or MedStar should be requested immediately.

The aim within this time period is to:

Further assess and decide if transfer of the patient is required or if the patient can be managed locally

- 1) commence IV 0.9% sodium chloride – 1 litre to run over 1 hour
 - > if Systolic BP <90 mmHg, give 500ml over 15 minutes and reassess
 - > caution in the elderly where too rapid rehydration may precipitate heart failure but insufficient may fail to reverse acute kidney injury
- 2) commence IV insulin infusion (Intravenous Actrapid Infusion DKA / Type 1 Protocol - Adult) (Appendix 1)
 - > do not use priming dose (bolus) of insulin unless there is significant delay (\geq 1 hour) in setting up an insulin infusion
- 3) establish monitoring regime appropriate to patient
 - i. hourly capillary blood glucose and blood ketone measurement (may use blood from arterial or CVC line if in place to reduce finger trauma)
 - ii. hourly urine output
 - iii. 2-hourly serum potassium for the first six hours (replace potassium as per table on page 9)
 - iv. clinical assessment of the patient
 - > respiratory rate, temperature, blood pressure, pulse, oxygen saturation
 - > GCS – a drowsy patient requires critical care input
 - > examine for a source of sepsis or cause of DKA
- 4) investigations
 - > capillary blood ketones
 - > capillary blood glucose
 - > venous plasma glucose
 - > venous blood gas (arterial blood gas if require pO₂)
 - > full blood count
 - > blood cultures
 - > ECG
 - > chest x-ray
 - > urinalysis and culture
- 5) continuous cardiac monitoring
- 6) continuous pulse oximetry
- 7) commence DVT prophylaxis
- 8) assess for precipitating causes and treat appropriately (eg consider IV antibiotics if sepsis identified or suspected)

If patient not responding, consult with regional / metropolitan hospital and consider up transfer

Suggested IV fluid regimen

Bag no.	Time (hr)	Fluid	Rate	Potassium chloride (KCL) [#]
1	0 -1	0.9% sodium chloride	1000ml/hour	None <i>(may be required if more than 1 litre of IV fluid has been given to resuscitate hypotensive patients)</i>
2	1-3	0.9% sodium chloride	500ml/hour	<i>Monitor K⁺ level & replace with IV potassium chloride as per table on page 9</i>
3	3-5	0.9% sodium chloride	500ml/hour	
4	5-9	0.9% sodium chloride	250ml/hour	
5	9-13	0.9% sodium chloride	250ml/hour	
6	13-19	0.9% sodium chloride	166ml/hour	
Reassessment of cardiovascular status at 12 hours is mandatory				

[#] See **Treatment Plan B: 60 minutes to 6 hours** for potassium chloride replacement regimen

- > commence daily long-acting insulin at the usual time
- > monitor vital signs and GCS hourly
- > hourly fluid balance record (minimum urine output 0.5 ml/kg/hr).

Treatment Plan – Part B

60 minutes to 6 hours (continuous on-site medical supervision is necessary)

The aim within this time period is to:

- 1) clear the blood of ketones and suppress ketogenesis
 - > achieve a rate of fall of ketones >0.5 mmol/L per hour
 - > in the absence of ketone measurement
 - > bicarbonate should rise by 3 mmol/L per hour
 - > blood glucose should fall by 3.0 mmol/L per hour

If the blood ketones and blood glucose are not falling as expected, check the syringe driver (or pump) for malfunction or problem with the intravenous line

- 2) maintain potassium in the normal range
 - > hypokalaemia (less than 3.5 mmol/L) and hyperkalaemia (greater than 6 mmol/L) are life-threatening conditions and require consultation with or up transfer to metropolitan endocrine service.

Potassium level in first 24hr (mmol/L)	Potassium replacement
Over 5.5	Nil
3.5 – 5.5	30 mmol
Below 3.5	consultation with emergency physician/endocrinologist. Transfer to suitably equipped and staffed HDU/ICU (may require >10 mmol/hr)

- > *Standard premixed potassium chloride solution, 10mmol potassium chloride in 100ml mini bags are the preferred option for replacement. Premix 30mmol potassium chloride in 1 litre 0.9% sodium chloride in stock for use.*
- > *The maximum rate on the ward is 10mmol K⁺/hour. If a higher concentration or rate is required, consultation with an emergency physician or an endocrinologist is required and consideration for transfer to a suitably equipped and staffed HDU or ED.*
- > *An infusion pump or other rate limiting device must always be used.*
- > *2 intravenous access lines are required. One for the insulin infusion, the other for hydration. Potassium chloride replacement via additional port on the hydration line (eg piggyback). Must not run potassium infusion via the insulin line*

3) Review insulin needs

- > if not already commenced, commence daily long-acting insulin at the usual time
- > avoidance of hypoglycaemia
- > if blood glucose falls below 15.0 mmol/L
 - > option 1 – change IV fluids to 4% dextrose + 0.18% sodium chloride
 - OR
 - > option 2 – commence 10% dextrose at 125 ml/hr AND continue 0.9% sodium chloride solution. This is the preferred option if blood glucose level is <15.0 mmol/L and bicarbonate is <12 mmol/L or is not rising by 3 mmol/hr

IV Insulin infusion must not be ceased

4) Continue to;

- > monitor vital signs and GCS hourly
- > hourly fluid balance record (minimum urine output 0.5 ml/kg/hr)
- > measure venous blood gas for pH, bicarbonate and potassium at 60 minutes, 2 hours and then 2 hourly.

If patient not responding, consult with regional / metropolitan hospital and consider up transfer

Treatment Plan – Part C

6 to 12 hours

The aim within this time period is to:

- 1) ensure that clinical and biochemical parameters are improving
 - > continue charting blood glucose and ketones hourly
 - > take appropriate action (as outlined in B. time 60 minutes to 6 hours above)
- 2) continue IV fluid replacement
 - > hourly fluid balance chart
- 3) continue IV insulin infusion
- 4) continue treatment of any underlying precipitant
- 5) avoid hypoglycaemia
 - > if blood glucose falls below 15.0 mmol/L
 - option 1** – change IV fluids to 4% dextrose + 0.18% sodium chloride
 - OR
 - option 2** – commence 10% dextrose at 125 ml/hr AND continue 0.9% sodium chloride solution (preferred option if blood glucose level is <15.0 mmol/L and bicarbonate is <12 mmol/L or is not rising by 3 mmol/hr)
- 6) ensure referral has been made to the diabetes educator. Referral to or consultation with physician/endocrinologist to identify discharge plan (insulin schedule and doses) and post discharge follow up needs.

If patient not responding, consult with specialist service and consider up transfer

Treatment Plan – Part D

12 to 24 hours

By 24 hours, the blood ketones and acidosis is expected to have resolved.

The aim within this time period is to:

- 1) ensure continuing improvement of clinical and biochemical parameters
 - > continue charting blood glucose hourly
 - > check venous pH, bicarbonate, potassium, blood ketones
- 2) continue IV fluid replacement if not eating and drinking
- 3) continue treatment of any underlying precipitant
 - > if patient not improving seek advice from metropolitan endocrine service
- 4) continue IV insulin if ketonaemia persists or bicarbonate has not normalised
 - > adjust insulin infusion rate as per IV insulin protocol.

Do not stop insulin infusion until

When patient is eating and drinking normally AND ketones <0.3 mmol/L, venous pH >7.3

- 5) transitioning to subcutaneous basal bolus insulin
 - a. long-acting insulin has to be on board for at least 4 hours before discontinuing IV infusion
 - b. starting subcutaneous insulin in a patient who was not previously known to have type 1 diabetes;
 - I. calculate total insulin requirements (four times insulin used in last 6 hours = Total Daily Dose (TDD))
 - II. 50% of TDD is given as a basal insulin (long acting insulin)
 - III. 50% of TDD is given in three divided doses at mealtimes (rapid acting insulin)
 - c. the fasting BG reflects adequacy of long-acting insulin
 - d. continue blood glucose monitoring QID as per Blood Glucose / Blood Ketone Monitoring Chart. Subsequent insulin dose adjustments may be necessary based on capillary blood glucose levels.
- 6) if transitioning to insulin pump therapy, please consult with endocrinologist for advice

If patient not responding, consult with regional or metropolitan hospital and consider up transfer

After care

All **patients known to have type 1 diabetes** prior to admission should have their basal bolus insulin regimen re-established. Assess HbA1c to evaluate pre-admission diabetes control for those with known type 1 diabetes. The HbA1c level will help inform any changes to meet discharge insulin needs.

In **patients where the admission represented a new diagnosis of type 1 diabetes**, basal bolus insulin is to be continued.

All patients should receive appropriate diabetes education prior to discharge and follow up once discharged. The patients' sick day action plan should be reviewed and reinforced. Endocrinology follow up is highly recommended.

The patients' general practitioner should be provided with a detailed discharge summary as soon as possible.

INTRAVENOUS ACTRAPID INFUSION DKA / TYPE 1 PROTOCOL - ADULT (MR-INF-A)	<p style="text-align: center; font-size: small;">Affix patient identification label in this box</p> UR Number: Surname: Given name: Second given name: D.O.B: ___ / ___ / _____ Sex:
Hospital:	

BGL Frequency <input type="checkbox"/> Hourly <input type="checkbox"/> 2 Hourly* <small>* (only if BGL is within target range for at least 6 hours. If any alteration in insulin infusion rate, IV fluids or TPN revert to hourly BGL's.)</small>	Dr's Name: Signature: Pager No:	Target BGL range: Adult Inpatient 7 to 10 mmol/L
Review need for IV Insulin infusion daily before 12 pm. If continuing, rewrite on a new page.		

20..... Day/Month															
Time															
BGL Record (mmol/L)	20														
If patient remains in column 3 for four measurements, and still has not achieved target, call MO	15														
	10														
	5														
	4														
	3														
	2														
BGL reading															
Insulin infusion rate (Units/hr)															
Column 1, 2, 3															
Nurse (s) initials															
Ketones/Hypo intervention (✓)															
MO notified (✓)															

Intravenous Insulin Protocol DKA / TYPE 1					
Column 1		Column 2		Column 3	
BGL	Units/hr	BGL	Units/hr	BGL	Units/hr
BGL < 4.0 means Hypoglycaemia		BGL < 4.0 means Hypoglycaemia		BGL < 4.0 means Hypoglycaemia	
<5.0	Off	<5.0	Off	<5.0	Off
5.0 - 6.4	0.5	5.0 - 6.4	1.0	5.0 - 6.4	2.0
6.5 - 9.9	1.0	6.5 - 9.9	2.0	6.5 - 9.9	4.0
10.0 - 11.4	1.5	10.0 - 11.4	3.0	10.0 - 11.4	5.0
11.5 - 12.9	2.0	11.5 - 12.9	4.0	11.5 - 12.9	6.0
13.0 - 14.9	3.0	13.0 - 14.9	5.0	13.0 - 14.9	8.0
15.0 - 16.4	3.0	15.0 - 16.4	6.0	15.0 - 16.4	10.0
16.5 - 17.9	4.0	16.5 - 17.9	7.0	16.5 - 17.9	12.0
18.0 - 20.0	5.0	18.0 - 20.0	8.0	18.0 - 20.0	14.0
>20.0	6.0	>20.0	12.0	>20.0	16.0

New patients 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/litre or less?
- Has the BGL dropped by at least 2.5mmol/litre 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)	Date/time commenced	Nurse 1	Nurse 2	Time stopped	Volume infused (mL)
50 units Actrapid Insulin + 49.5mL Sodium Chloride 0.9%					
50 units Actrapid Insulin + 49.5mL Sodium Chloride 0.9%					
50 units Actrapid Insulin + 49.5mL Sodium Chloride 0.9%					

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INTRAVENOUS ACTRAPID INFUSION DKA / TYPE 1 PROTOCOL - ADULT MR-INF-A

Adopted from the *Intravenous Actrapid Infusion DKA/Type 1 protocol – Adult, Northern Adelaide Local Health Network.*

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Notes page

This notes page can be used to track consultation discussions (e.g. conversations with specialist services).

Date / Time	Record of conversation (e.g. person consulted, key points, follow up etc.)