Country Health SA Local Health Network

Protocol (Clinical)

Title: Hyperglycaemic Hyperosmolar State Management in Adults with Type 2 Diabetes

Protocol developed by: CHSALHN Diabetes Service

Protocol Sponsor: CHSALHN, Executive Director, Medical Services

Approved by: CHSALHN, Clinical Governance Committee on: 17/01/2019

Next review due: 17/01/2020

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, CHSALHN Diabetes Service Plan and Diabetes Inpatient Model of Care.
Keywords	Clinical, Protocol, CHSA, medical, nursing, midwifery, emergency, safety, quality, standards.
Document history	Is this a new CHSALHN Protocol? **N** Does this protocol *amend or update* an existing protocol? **Y** *Hyperglycaemic Hyperosmolar State Management in Adults with Type 2 Diabetes, 2016* Does this protocol *replace* an existing protocol? **N**
Applies to	This protocol applies to all hospital medical, nursing and midwifery staff.
Objective File No.	2019-02201

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

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)
Clinical Support Guide; Intravenous Insulin Infusion. (MR-INF-A) & (MR-INF-B)

2. References

Document Name
Joint British Diabetes Societies Inpatient Care Group (2012) The Management of Hyperosmolar Hyperglycaemic State (HHS) in Adults with Diabetes. August. National Health Service Diabetes, United Kingdom.
Northern Adelaide Local Health Network (2019) Protocol for The Management of Hyperglycaemic Hyperosmolar State in Adults. Northern Adelaide Local Health Network, Adelaide.
Country Health SA Local Health Network (2015) Procedure for the use of intravenous potassium chloride. CHSA LHN, Adelaide.

3. Accreditation Standards

***National Safety and Quality Health Service Standards* (2nd edition)**

1 ☒	2 ☐	3 ☐	4 ☒	5 ☒	6 ☐	7 ☐	8 ☒
Clinical Governance	Partnering with Consumers	Preventing & Controlling Healthcare Associated Infection	Medication Safety	Comprehensive Care	Communicating for Safety	Blood Management	Recognising & Responding to Acute Deterioration

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

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Acknowledgements

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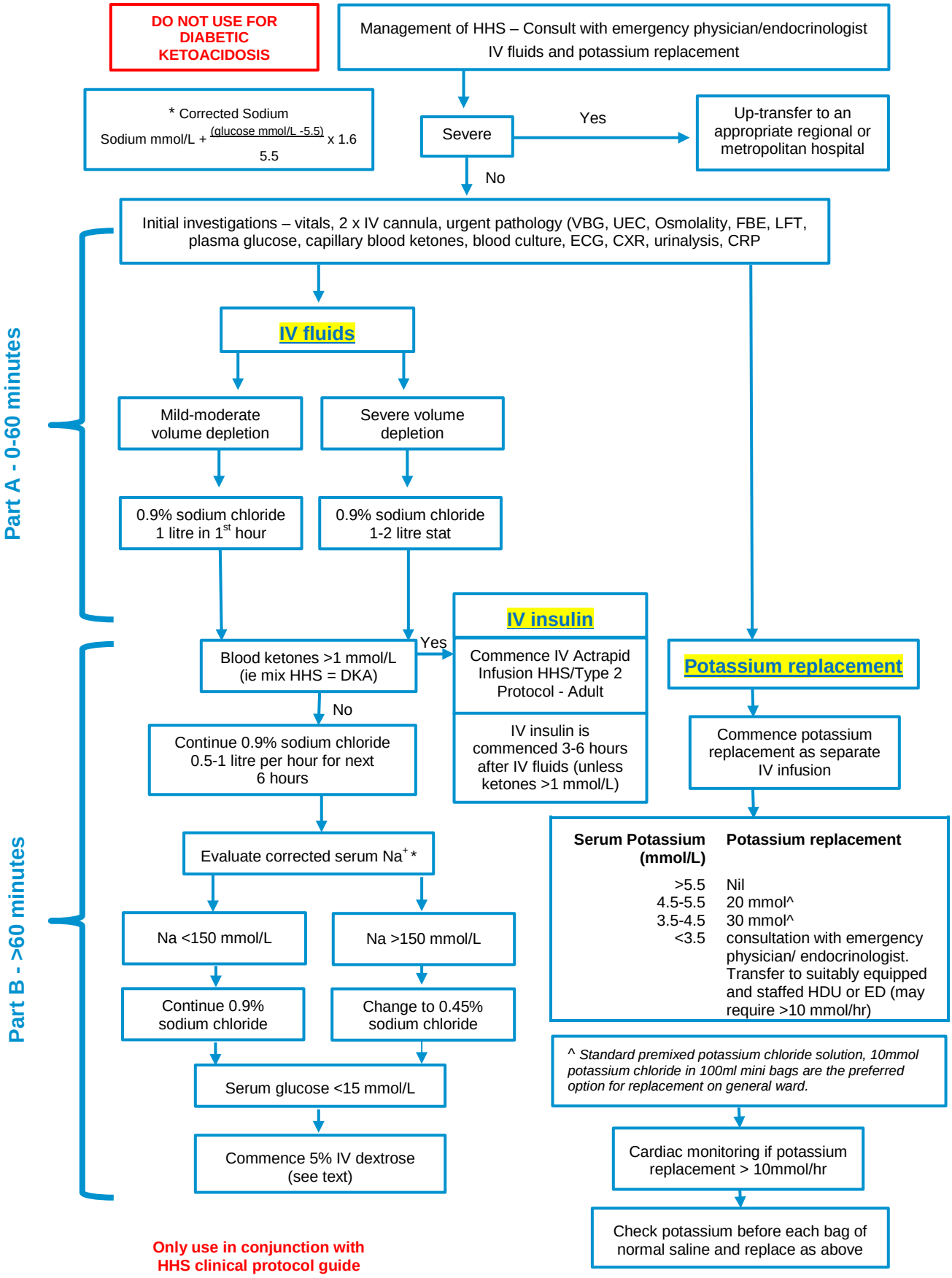
Hyperglycaemic Hyperosmolar State Protocol in Adults with Type 2 Diabetes

Early consultation with appropriate regional, metropolitan hospital or MedStar



Hyperglycaemic Hyperosmolar State in Adults: Introduction

The Hyperglycaemic Hyperosmolar State (HHS) is a medical emergency of type 2 diabetes. HHS is associated with a significant morbidity and much higher mortality than DKA and must be diagnosed promptly and managed intensively. In addition to the significant metabolic derangements due to the hyperglycaemia and dehydration, patients often have additional medical or surgical co-morbidities which may have triggered HHS such as sepsis or ischaemia. These comorbidities must be diagnosed and appropriately managed. The clinical presentation of HHS may represent a new diagnosis of type 2 diabetes or as an acute complication of hyperglycaemia in known type 2 diabetes.

Consultation with appropriate regional / metropolitan hospital / MedStar is required.

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

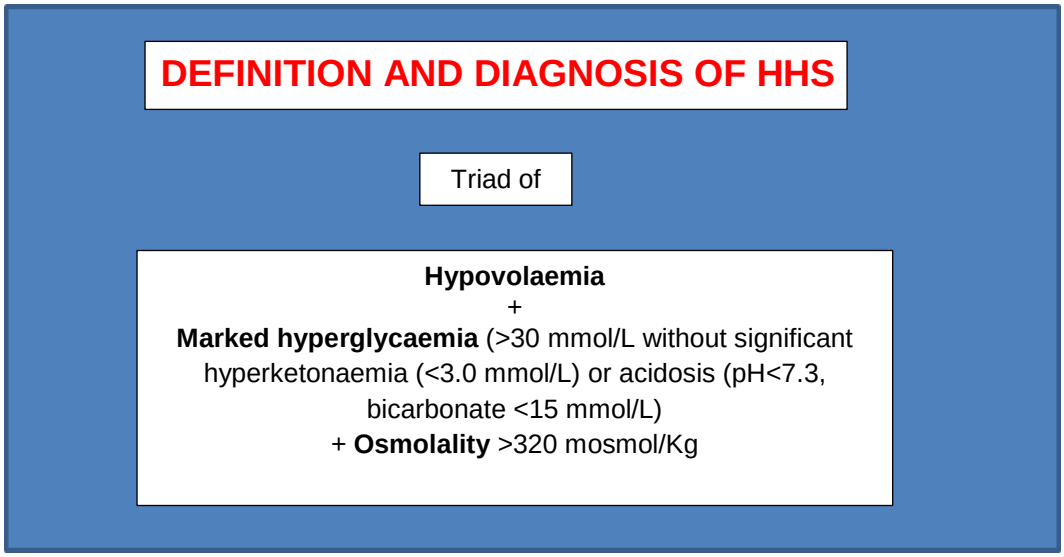
Severe cases will mandate retrieval to an appropriate regional or metropolitan hospital. Less severe cases may be able to be managed at larger country hospitals.

The following criteria must be met for local management;

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

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

Note - A mixed picture of Hyperglycaemic Hyperosmolar State and Diabetic Ketoacidosis may occur.



Assessment of severity

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

- Osmolality >350 mosmol/kg
- Sodium >160 mmol/L* (must calculate corrected sodium – see below)
- Venous/arterial pH <7.1
- Hypokalaemia (<3.5 mmol/L) or hyperkalaemia (>6 mmol/L) on admission
- Glasgow Coma Scale (GCS) <12 or abnormal
- 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
- Hypothermia
- Other serious co-morbidity – eg end stage kidney disease, heart failure or conditions that would warrant admission it HDU/ICU in their own right.

* Corrected Sodium:

$$\text{Sodium mmol/L} + \frac{(\text{glucose mmol/L} - 5.5)}{5.5} \times 1.6$$

Goal of treatment

The goals of treatment for HHS include;

- diagnosis and treatment of any underlying cause and to gradually and safely;
  - normalise the osmolality
  - replace fluid and correct dehydration without causing fluid overload
  - replace electrolyte losses, mainly potassium
  - normalise blood glucose.

Other goals include prevention of:

- arterial or venous thrombosis
- other potential complications eg cerebral oedema/central pontine myelinolysis
- foot ulceration.

Principles

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

- measure or calculate osmolality (2Na+ **+** glucose **+** urea) frequently to monitor treatment response
- use IV 0.9% sodium chloride solution as the principal fluid to restore circulating volume and reverse dehydration. Only switch to 0.45% sodium chloride solution if the osmolality is not declining despite adequate positive fluid balance
- an initial rise in sodium is expected and is not in itself an indication for hypotonic fluids. Thereafter, the rate of fall of plasma sodium should not exceed 10 mmol/L in 24 hours
- the fall in blood glucose should be no more than 5 mmol/L/hr. Insulin infusion should be commenced once the blood glucose is no longer falling with IV fluids alone (usually after first 3 hours of IV fluids) OR immediately if there is significant blood ketone levels (3β-hydroxy butyrate greater than 1 mmol/L). Use the Intravenous Actrapid Infusion HHS / Type 2 Protocol – Adult. (Actrapid is the **insulin of choice** for IV infusion)

At any time, 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 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.
8) pressure risk score (including careful assessment of feet) on admission (within 8 hrs) using Braden pressure ulcer risk assessment (Appendix 1) and regular re-assessment.

Treatment Plan – Part A

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, advice critical care should be sort 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

- commence IV 0.9% sodium chloride – 1 litre to run over 1 hour
  - consider more rapid replacement if Systolic BP <90 mmHg
  - caution in the elderly where too rapid rehydration may precipitate heart failure but insufficient may fail to reverse acute kidney injury
- ONLY IF there is significant blood ketones (greater than 1.0 mmol/L) commence Intravenous Actrapid Infusion HHS / Type 2 Protocol - Adult (0.05 units/kg/hr)
- clinical assessment of the patient:
  - does the history suggest sepsis/vascular event or a recent change in medication?
  - assess the degree of dehydration
  - examine for a source of sepsis or evidence of vascular event
  - mental state assessment
- assess pressure risk score (within 8 hrs of admission) use Braden Scale assessment (Appendix 1)
  - ensure heels are off-loaded
  - ensure daily foot checks
- ongoing investigations
  - venous plasma blood glucose on admission then 6-8 hourly & capillary blood glucose hourly
  - hourly blood glucose (BG)
  - hourly Na+, K+, urea and calculated osmolality (2Na+ **+** glucose **+** urea) for the first 6 hours, then 2 hourly if, fall of osmolality by 3-8 mosmol/kg/hr
  - urea and electrolytes hourly for first 6 hours
  - venous blood gas 6-8 hourly
  - blood ketones and lactate 12 hourly
  - full blood count daily
  - blood cultures as clinically indicated
  - ECG on admission and continuous cardiac monitoring for patients requiring IV potassium replacement >10mmol/hour
  - CXR on admission
  - urinalysis and culture on admission
  - CRP (if infection suspected) daily
  - chart osmolality / glucose / sodium
  - maintain continuous pulse oximetry
  - maintain continuous cardiac monitoring
- insert urinary catheter to monitor hourly urine output and calculate fluid balance
- commence DVT prophylaxis
- consider IV antibiotics if sepsis identified or suspected.

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

Treatment Plan - B

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

The aim within this time period is to:

1) to achieve a gradual decline in osmolality (3-8 mosmol/kg/hr)
   - using 0.9% normal saline aim to give a further 0.5 – 1 L/hr depending on clinical assessment of dehydration/risk of precipitating heart failure and fluid balance (target is to achieve positive fluid balance of 2-3 L by 6 hours)
   - measure glucose, urea and electrolytes hourly and calculate osmolality
     - if plasma Na+ increasing but osmolality declining at appropriate rate, continue 0.9% sodium chloride
     - if plasma Na+ increasing AND osmolality increasing (or declining at less than 3 mosmol/kg/hr), switch to 0.45% sodium chloride at same rate
     - if osmolality falling at rate exceeding 8 mosmol/kg/hr consider reducing infusion rate of IV fluids and/or insulin (if already commenced)
     - consider using arterial or CVC blood for hourly glucose testing to reduce finger trauma
2) if blood glucose falling less than 5 mmol/L per hour check fluid balance
     - if positive balance inadequate, increase rate of infusion of 0.9% sodium chloride
     - if positive fluid balance adequate, commence Intravenous Actrapid Infusion HHS / Type 2 Protocol - Adult (Attachment 2).
3) avoidance of hypoglycaemia
     - aim to keep blood glucose 10-15 mmol/L in first 24 hours
     - if blood glucose falls below 15 mmol/L commence 5% glucose at 125 ml/hr AND continue 0.9% sodium chloride solution
4) vital signs and GCS monitored hourly
5) hourly fluid balance record (minimum urine output 0.5 ml/kg/hr).

Note - Insulin infusion is usually started after at least 3 hours of IV fluids (unless mixed HHS + DKA picture)

6) to 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 transfer to an appropriate regional or metropolitan hospital. Less common in HHS than DKA but monitoring and replacement is essential

Potassium level in first 24hr (mmol/L)	**Potassium replacement**
Over 5.5	Nil
4.5 – 5.5	20 mmol
3.5 – 4.5	30 mmol
Below 3.5	consultation with emergency physician/endocrinologist. Transfer to suitably equipped and staffed HDU or emergency department (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 if needed.*
- *The maximum rate on the ward is 10mmol K+/hour. If a higher concentration or rate is required, consultation with emergency physician or endocrinologist is required and consideration for transfer to suitably equipped and staffed HDU or ED.*
- *An infusion plump 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*

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 hourly; sodium and calculated osmolality 2 hourly if meeting criteria
   > take appropriate action (as outlined in B. time 60 minutes to 6 hours above)
2) continue IV fluid replacement to achieve positive fluid balance of 3-6 litres by 12 hours
   > hourly fluid balance chart
3) assess for complications of treatment eg fluid overload, cerebral oedema, central pontine myelinolysis (eg deteriorating conscious level)
4) avoid hypoglycaemia
   > aim to keep blood glucose 10-15 mmol/L in first 24 hours
   > if blood glucose falls below 15 mmol/L commence 5% glucose at 125 ml/hr AND CONTINUE 0.9% sodium chloride solution
5) 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

The aim within this time period is to:

1) ensure continuing improvement of clinical and biochemical parameters
   > continue charting blood glucose hourly. Measurement of sodium and calculated osmolality can be reduced to 4 hourly if improvement maintained (if not continue, 2 hourly)
   > do not expect biochemistry to have normalised by 24 hr (sodium and osmolality are likely to be raised)
   > take appropriate action (as outlined in B. time 60 minutes to 6 hours above)
2) continue IV fluid replacement to achieve remaining replacement of estimated fluid losses within next 12 hours (3-6 litres) – this will be dependent on factors such as initial degree of dehydration/body weight etc and MOST IMPORTANTLY the response to treatment so far. Therefore:
   > maintain accurate fluid balance chart (1 hourly), plotting osmolality and make appropriate adjustments to fluid replacement rates
3) continue IV insulin with or without 5% glucose solution to maintain blood glucose 10-15 mmol/L
   > adjust insulin infusion rate as per Intravenous Actrapid Infusion HHS / Type 2 Protocol - Adult (Appendix 2).
4) assess for complications of treatment eg fluid overload, cerebral oedema, central pontine myelinolysis (eg deteriorating conscious level)
5) continue treatment of any underlying precipitant

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

Treatment Plan - E

24 hours to Day 3

Expectation: patient should be steadily recovering, beginning to eat and drink, and biochemistry back to normal.

1) ensure that clinical and biochemical parameters are improving or have normalised
   > continue IV fluids until eating and drinking normally
2) convert to appropriate subcutaneous insulin when biochemically stable
   a. ensure that if the patient had been on insulin before admission, the basal insulin has been on board for at least 4 hours before IV is discontinued, or the usual oral hypoglycaemic agents have been reintroduced.
   b. to transfer to basal bolus subcutaneous insulin:
      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
      iii. 50% of TDD is given in three divided doses at mealtimes (rapid acting insulin)
   c. if pre-mixed insulin (twice a day) is chosen:
      i. 2/3 of TDD is given at breakfast and 1/3 is given at the evening meal.
   d. the fasting BGL reflects adequacy of long-acting insulin.
3) continue blood glucose monitoring QID as per CHSA Blood Glucose Monitoring Chart. Subsequent insulin dose adjustments may be necessary based on capillary blood glucose levels.
4) encourage early mobilisation
5) daily urea and electrolytes
6) remove catheter when clinically appropriate
7) assess for signs of fluid overload or cerebral oedema
8) assess for evidence of continuing sepsis
9) daily foot checks
10) continue DVT prophylaxis until day of discharge.

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

After care

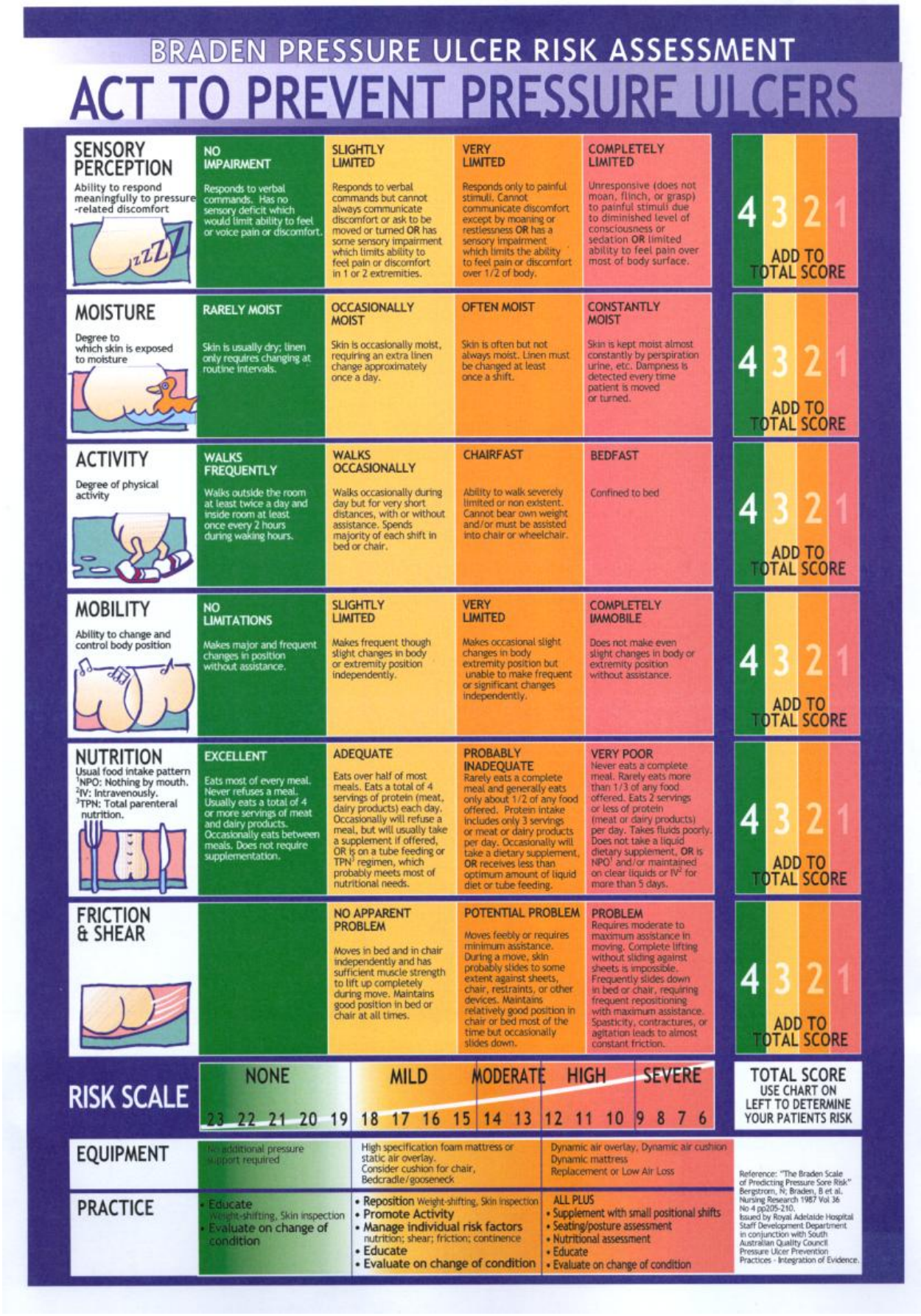
Most patients should go home on subcutaneous insulin (the regime being determined by their circumstances).

All **patients known to have type 2 diabetes** prior to admission should have their usual medication therapy reviewed. Assess HbA1c to evaluate pre-admission diabetes control for those with known type 2 diabetes. The HbA1c level will inform any changes to meet medication needs post discharge insulin.

In **patients where the admission represented a new diagnosis of type 2 diabetes**, post insulin medication needs will need consideration.

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.

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



Recommended by the CHSA LHN Preventing & Managing Pressure Injuries Working Group, 2014

INTRAVENOUS ACTRAPID INFUSION

HHS / TYPE 2

PROTOCOL - ADULT

(MR-INF-B)

Hospital: .....

Affix patient identification label in this box

UR Number: .....

Surname: .....

Given name: .....

Second given name: .....

D.O.B: __ __ / __ __ / __ __ __ __ Sex: .....

BGL Frequency

☐ Hourly ☐ 2 Hourly*

*(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.)

Dr's Name: .....

Signature: ..... **Pager No:** .....

Review need for IV Insulin infusion daily before 12 pm. If continuing, rewrite on a new page.

Target BGL range:

Adult Inpatient 7 to 10 mmol/L

20..... Day/Month																								
Time																								
BGL Record (mmol/L)	20																							
If patient remains in	15																							
column 3 for four measurements, and still has not achieved target, call MO	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 HHS/TYPE 2

Column 1	
BGL	Units/hr
BGL < 4.0 means Hypoglycaemia	
<6.4	Off
6.5 - 7.9	0.5
8.0 - 9.9	1.0
10.0 - 11.4	1.5
11.5 - 12.9	2.0
13.0 - 14.9	3.0
15.0 - 16.4	3.0
16.5 - 17.9	4.0
18.0 - 20.0	5.0
>20.0	6.0

Column 2	
BGL	Units/hr
BGL < 4.0 means Hypoglycaemia	
<6.4	Off
6.5 - 7.9	1.0
8.0 - 9.9	2.0
10.0 - 11.4	3.0
11.5 - 12.9	4.0
13.0 - 14.9	5.0
15.0 - 16.4	6.0
16.5 - 17.9	7.0
18.0 - 20.0	8.0
>20.0	12.0

Column 3	
BGL	Units/hr
BGL < 4.0 means Hypoglycaemia	
<6.4	Off
6.5 - 7.9	2.0
8.0 - 9.9	4.0
10.0 - 11.4	5.0
11.5 - 12.9	6.0
13.0 - 14.9	8.0
15.0 - 16.4	10.0
16.5 - 17.9	12.0
18.0 - 20.0	14.0
>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%					

INTRAVENOUS ACTRAPID INFUSION STANDARD PROTOCOL - ADULT MR-INF-B

Adopted with permission from Northern Adelaide Local Health Network

Page 1 of 2

Adapted from the *Intravenous Actrapid Infusion Standard protocol – Adult, Northern Adelaide Local health Network*.

Notes page

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

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