Government of Western Australia
Department of Health

FIONA STANLEY hospital

Guideline

Adult Diabetic Ketoacidosis

Reference #: FSH-END-GUI-0001

Scope

Site	Service/Department/Unit	Disciplines
Fiona Stanley Hospital	Hospital Wide	Medical and Nursing

This guideline should NOT be used in children (<18 years) even if they have DKA.

Seek specialist advice.

This guideline can be used in pregnancy. Refer to specific section.

Cardiac monitoring must be available during the management of patients following this protocol when intravenous potassium chloride is administered at a rate of greater than 10mmol/hour.

1. Introduction

Diabetic Ketoacidosis (DKA) as a complex disorder, commonly seen in patients with Type 1 diabetes (although patients with type 2 diabetes and rarely Gestational Diabetes may also be affected), and can be life threatening if not treated properly and promptly.

Primary abnormalities are profound insulin deficiency, reduced uptake of glucose by muscle cells, accelerated glucose production from glycogen by liver cells and increased conversion of free fatty acids into ketone bodies in the liver. These processes manifest as extreme hyperglycaemia, ketonaemia, ketonuria, acidosis, dehydration and electrolyte imbalance.

These guidelines are for the treatment of adults with DKA.

Seek advice from senior clinician or diabetes specialty unit in cases of uncertainty.

2. Definitions

Diabetic Ketoacidosis	A triad of hyperglycaemia, ketosis and metabolic acidosis that develops in the setting of insulin deficiency.

3. Guideline

Staff must adhere to the following guideline when managing an adult patient with Diabetic Ketoacidosis (DKA).

The guideline must be adapted to the clinical situation where necessary.

All management must be recorded in Adult Diabetic Ketoacidosis (DKA) Guidelines and Management Record (MR 836), see appendix 1.

3.1. Diagnosis criteria

- Glucose: >11mmol/L or known diabetes
- Bicarbonate: <18mmol/L and/or venous pH <7.35*
- Ketones: >3mmol/L or urine ketones >2+

NB: The standard of care is the analysis of venous bicarbonate. Arterial blood gases should only be considered in patients with impaired consciousness.

3.2. Resolution criteria

- Resolution of ketonaemia (<0.6mmol/L). This should occur within 24 hours
- Correction of acidosis (venous bicarbonate >18mmol/L)
- Patient is eating and drinking normally
- Treatment/resolution of underlying or precipitating cause (where appropriate)
- Discharge planning including planned diabetes review post-discharge.

3.3. New principles for the management of DKA

- Aim to correct the cause of the acidosis, i.e. the ketonaemia.
- Insulin is given as a standard dose per kg until ketones are cleared (<0.6mmol/L).
- **Aim to cease high-dose fixed rate insulin infusion as soon as ketones are cleared and convert to subcutaneous insulin. If intravenous insulin is still required (e.g. when patient is not yet eating or drinking), medical staff should convert the patient to variable rate intravenous insulin infusion with dextrose as per adult or obstetric intravenous insulin infusion protocol found on MR835 or MR835B.**
- Monitor bedside capillary ketones and glucose with appropriate equipment.
- Use sodium chloride 0.9% for resuscitation, not colloid.
- Continue usual subcutaneous basal insulin in addition to IV insulin or start basal insulin at outset if patient is newly diagnosed.

- Give sodium chloride 0.9% and dextrose 10% together if ketones are still present (>0.6mmol/L) and glucose is <14mmol/L.
- Where available, ensure the patient receives early diabetes specialist team review and plans for appropriate post-discharge follow-up.

3.4. Essential assessment to determine the severity of DKA

The following assessment must be carried out to determine the severity of the patient's DKA:

- Blood ketones
- Blood glucose
- Venous bicarbonate
- Venous (or arterial) pH
- Potassium - beware of initial low K+, if <3.5mmol/L, call for senior medical advice immediately
- Serum osmolality
- Creatinine
- Blood pressure (BP)
- Glasgow Coma Scale (GCS).

Table 1: Severity Assessment of DKA

	Severity	
Parameter	**Mild to Moderate**	**Severe^**
Systolic blood pressure	>90 mmHg	<90 mmHg
Venous pH	7.1 – 7.35	<7.1
Capillary ketones	3 – 6 mmol/L	>6 mmol/L
Blood HCO_3	10 – 18 mmol/L	<10 mmol/L
Glasgow Coma Scale (GCS)	15	<15
Serum Potassium (K^+)	>3.5 mmol/L on admission	<3.5 mmol/L on admission

^ If any of the following is present, early senior medical officer advice must be sought for consideration of admission to critical care area

3.5. Initial management (1st hour – fluids / potassium / insulin)

3.5.1. Establish 2 large bore intravenous cannulas.

3.5.2. Administer 500-1000mL of sodium chloride 0.9% over 15 minutes if systolic BP is <90mmHg.

3.5.3. If systolic BP remains <90mmHg, repeat step 2 and call for senior medical officer advice. Septic shock and heart failure can be the potential causes and ICU involvement may be indicated.

3.5.4. If systolic BP is >90mmHg, prescribe sodium chloride 0.9% according to Table 2. Adjust the rate of fluid replacement according to the patient's age, fitness and dehydration state. Plan for fluid replacement and use clinical judgement.

3.5.5. Consider the use of urinary catheter if the patient does not pass urine for 2 hours or is incontinent.

3.5.6. Consider the use of nasogastric tube and the potential for aspiration if the patient's conscious state is impaired.

3.5.7. Consider the use of thromboprophylaxis in the elderly or "high risk" patient.

3.5.8. Look for and treat likely precipitants of DKA. This includes screening for infection and silent ischemia.

3.5.9. NB: White cell count is often elevated in DKA and does not reflect infection

3.5.10. Consider critical care (HDU/ICU) involvement if the patient is:

- In severe DKA (see table 1)
- Young (18-25 years old)
- Pregnant
- GCS <12
- In shock

3.6. Intravenous fluid and potassium management

Initial potassium is often normal or high, but the patient's total body potassium is low. Potassium levels will drop rapidly with fluid and insulin replacement, thus it is important to replace potassium early as low potassium can cause serious harm or death.

Cardiac monitoring must be in place during administration of 40mmol intravenous potassium chloride at a rate of 500mL/hour

- Add 10% dextrose at 125mL/hr if blood glucose level (BGL) <14mmol/L
- Increase 10% dextrose rate to 187mL/hr if BGL<5mmol/L
- Reduce sodium chloride 0.9% proportionately
- Reduce the rate of fluid replacement in the young (18-25), elderly or those with heart or renal failure

Table 2: Intravenous fluid and potassium infusion

Bag	Fluid	Potassium concentration by blood level			Sodium chloride 0.9% infusion rate	
		Greater than (>) 5.5 mmol/L	3.5-5.5 mmol/L	Less than (<) 3.5 mmol/L Senior review required	WITHOUT concurrent 10% dextrose (mL/hr)	WITH concurrent 10% dextrose (mL/hr)
1st	1L sodium chloride 0.9%	Nil	Nil	Nil	1000	875
2nd	1L sodium chloride 0.9%	Nil	40mmol	40mmol	500	375
		Cardiac monitoring must be available during the management of patients following this protocol when intravenous potassium chloride is administered at a rate of greater than 10mmol/hour.				
3rd	1L sodium chloride 0.9%	Nil	40mmol	40mmol	500	375
4th	1L sodium chloride 0.9%	Nil	40mmol	40mmol	250	125
5th	1L sodium chloride 0.9%	Nil	40mmol	40mmol	250	125
6th	1L sodium chloride 0.9%	Nil	40mmol	40mmol	167	125

Insulin Management

1. Add 50 units of Actrapid to 50mL of sodium chloride 0.9%.
2. Commence fixed rate intravenous insulin at 0.1units/kg/hour.
3. Prescribe subcutaneous basal insulin on day 1 (on Subcutaneous Insulin Order and Blood Glucose Monitoring Chart MR 834). Continue patient's usual subcutaneous basal (long-acting) insulin or commence subcutaneous basal insulin in newly diagnosed patient (see point 9).
4. Disconnect ALL continuous subcutaneous insulin infusion (CSII) pumps. DO NOT attempt to use the pump without specialist diabetes team input.

Important

5. Continue fixed rate insulin until ketones are cleared (<0.6mmol/L). Then, if patient is eating and drinking, convert to subcutaneous insulin (see below – Conversion to subcutaneous insulin). If the patient is not yet eating, change to adult intravenous insulin infusion protocol as per chart, MR835, with dextrose to avoid hypoglycaemia.

3.7. Ongoing management considerations

3.7.1. Measure capillary ketones and glucose hourly

3.7.2. Repeat venous blood gases (VBG) 1 hour after initial treatment and then 2 hourly until DKA is resolved

3.7.3. Aim to reduce ketones by 0.5mmol/hour

3.7.4. If ketones and glucose are not falling as expected, check all infusion lines

3.7.5. Bicarbonate is NOT helpful and is potentially dangerous. This should only be used in ICU.

3.8. Serious complications of DKA

Potassium – both hyperkalaemia and hypokalaemia are potentially life-threatening. The patient's potassium level must be monitored carefully. It is expected that K+ may decline with treatment. Seek advice from senior medical staff early when it occurs.

Hypoglycaemia – BGL can fall rapidly with DKA treatment. When this occurs, use additional glucose (10% dextrose when BGL <14mmol/L) rather than reducing insulin infusion.

Cerebral oedema – this can occur especially in younger patients. It is rare but has a high mortality rate. Seek specialist advice early.

Pulmonary oedema – it is uncommon but cautious fluid resuscitation is necessary if the patient also has cardiac or renal impairment.

3.9. Treatment of underlying precipitants

- NB: Elevated white cell count, fever and abdominal pain commonly occur in patients in DKA and don't necessarily indicate the presence of infection or intra-abdominal pathology.
- Careful examination and screening for underlying causes and regular monitoring and re-evaluation is necessary.
- Possible underlying causes include: sepsis (including lower limb cellulitis and meningitis); silent ischaemia; and toxins (alcohol).
- If infection is present, refer to FSH Antibiotic Guidelines.

3.10. Conversion to subcutaneous insulin

3.10.1. Once ketones have been cleared, convert patient from DKA protocol to alternative treatment plan.

3.10.2. For patients who are not yet eating and drinking or NOT yet eating and drinking normally, patient should continue on variable rate intravenous insulin protocol (as per chart, MR835).

NB: The insulin infusion rate will change. To determine the new insulin infusion rate, refer to the instructions as per INITIAL INFUSION RATE found in the Administration Guidelines on reverse of MR835. For newly diagnosed Type 1 DM, commence rate at I unit /hour.

3.10.3. For patient who are eating and drinking normally, they should be converted to subcutaneous insulin therapy. The guidelines are as follow:

For patients with known diabetes on multiple daily injections:

- Recommence usual bolus insulin with the patient's next meal.
- Cease IV insulin infusion 30 minutes after injection.
- Note: If no basal insulin has been given for >24 hours, aim to convert to subcutaneous insulin with evening meal and give usual basal dose OR convert at breakfast with half of the usual basal dose and then give remainder of the dose with the patient's evening meal.

For patients who are on CSII (insulin pump) therapy:

- Consider that the cause of DKA could be a result of pump failure; evaluate this prior to restarting the pump
- Seek advice from the Specialist Diabetes Team
- If appropriate, recommence pump when ketones are cleared and the patient is eating and drinking
- Cease IV insulin infusion 30 minutes after recommencing pump.

For patients with newly diagnosed type 1 diabetes:

- Commence basal insulin) on the day of admission.
- Start bolus insulin with the next meal.
- Cease IV insulin infusion 30 minutes after injection.
- Suggested starting doses:
  - Bolus (meal-time) insulin – 4 to 6 units of rapid-acting insulin analogue
  - Basal (once a day) insulin – 10 units Lantus or Levemir (NB: Levemir or Protaphane preferred in pregnancy).

3.11. DKA in Pregnant Women:

Pregnancy is a state of insulin resistance, accelerated starvation and respiratory alkalosis, especially in the late second and throughout the third trimester. Several hormones that are increased in pregnancy drive this e.g. human placental lactogen, prolactin, growth hormone and cortisol.

- Therefore pregnant women with diabetes are more prone to severe and rapidly progressive episodes of DKA at lower glycaemic levels and can even develop DKA with “normal” BGL levels (i.e. euglycemic DKA).
- Fetal mortality from maternal DKA is as high as 30% and complications include fetal hypoxia, acidosis, preterm delivery and neonatal intensive care unit admission.

In addition to usual care described above:

3.11.1. At presentation the endocrinology and obstetric teams should be consulted and neonatology made aware if delivery imminent.

3.11.2. Women who meet criteria for severe DKA or have sepsis should be managed in ICU.

3.11.3. Continuous fetal monitoring should be considered

3.11.4. The timing of delivery needs to be individualized based on multiple factors including gestational age, maternal condition (whether the mother is responding to aggressive therapy or deteriorating) and fetal condition (whether the fetal heart rate pattern is improving or deteriorating).

3.11.5. Glucocorticoids and betamimetics should be avoided during DKA as they will worsen hyperglycemia. If women remain at high risk of preterm delivery glucocorticoids for fetal lung maturation should be considered after resolution of the maternal metabolic derangement.

3.11.6. Whilst evidence is limited in DKA in pregnancy it should be noted that pregnancy induces a respiratory alkalosis and a pH of <=7.0 represents severe acidosis and bicarbonate may be considered in an ICU setting.

4. Related Policy and Procedure Documents

SMHS Blood Glucose Level Inpatient Management Clinical Practice Standards

5. Related Standards

NSQHS

Standard 1 – Governance for Safety and Quality in Health Service Organisations

1.5.2 Actions are taken to minimise risks to patient safety and quality of care.

1.8.2 Early action is taken to reduce the risks for at-risk patients.

1.8.3 Systems exist to escalate the level of care when there is an unexpected deterioration in health status.

Standard 4 – Medication Safety

4.11.1 The risk for storing, prescribing, dispensing and administration of high-risk medicines are regularly reviewed.

6. Monitoring

Compliance against this policy will be evaluated with routine incident review processes.

7. References

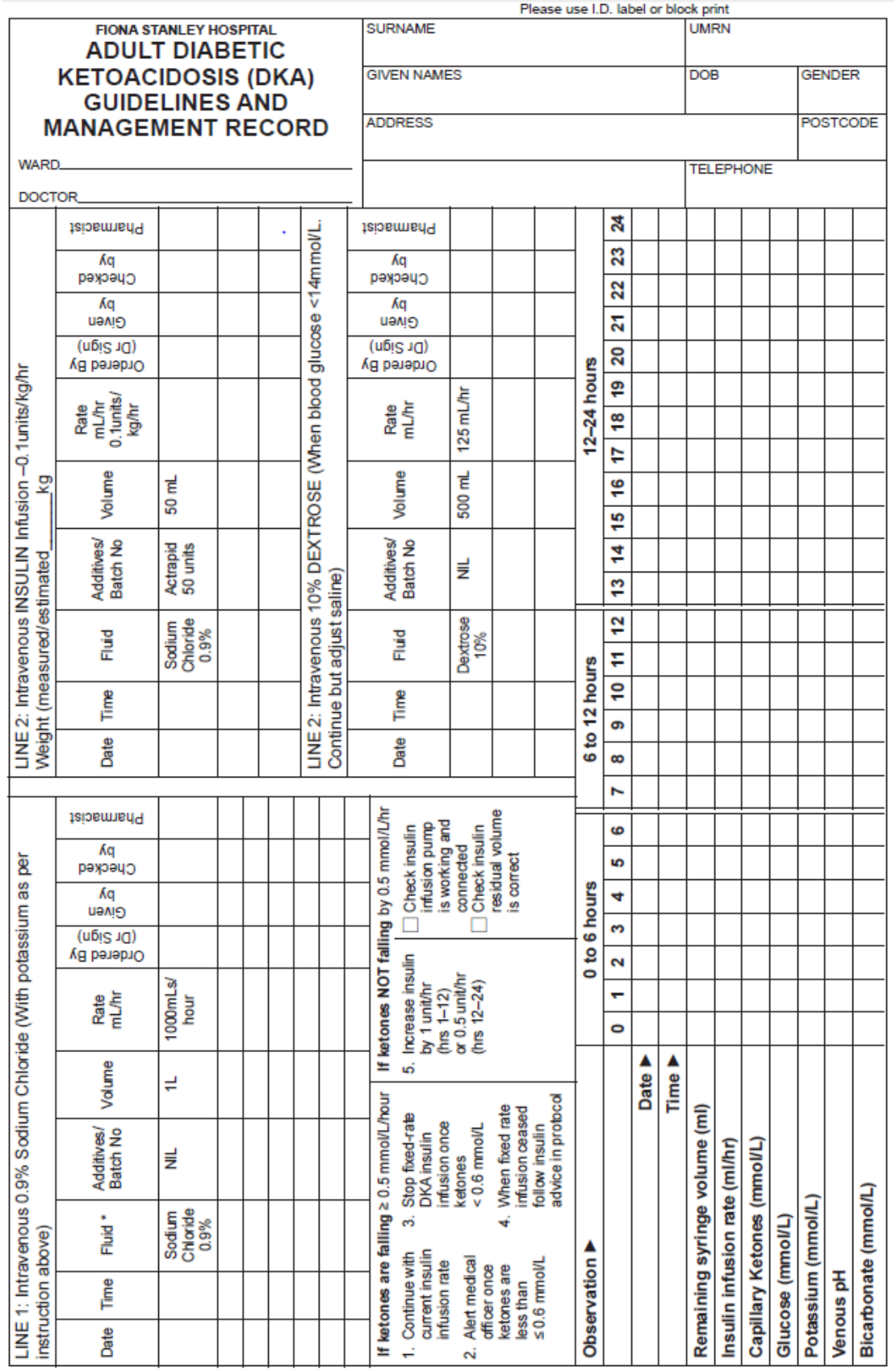
1. Garrsion, E et al (2014). Inpatient management of women with gestational and pregestational diabetes in pregnancy- review and expert opinion. Curr Diab Rep 14:457.
2. Savage, MW et al (2010). The Management of Diabetic Ketoacidosis in Adults. London, Joint British Diabetes Societies Inpatient Care Group. Retrieved from: https://www.diabetes.org.uk/Documents/About%20Us/Our%20views/Care%20recs/Joint%20British%20Diabetes%20Societies%20Inpatient%20Care%20Group%20-%20The%20Management%20of%20Diabetic%20Ketoacidosis%20in%20Adults%20-%20Guidelines.pdf
3. The King Edward Memorial Hospital DKA in pregnancy clinical guideline.
4. The Royal Women's Hospital - Melbourne DKA in pregnancy clinical guideline.

8. Disclaimer

Printed or personally saved electronic copies of this policy are considered uncontrolled. Refer to the FSH Policy hub for current controlled electronic policies.

9. Appendices

9.1. Appendix 1: Adult DKA Management Record



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FIONA STANLEY HOSPITAL

ADULT DIABETIC KETOACIDOSIS (DKA) GUIDELINES AND MANAGEMENT RECORD

WARD_____

DOCTOR_____

SURNAME | UMRN

GIVEN NAMES | DOB | GENDER

ADDRESS | POSTCODE

TELEPHONE

LINE 1: Intravenous 0.9% Sodium Chloride (With potassium as per instruction above)

Date	Time	Fluid *	Additives/ Batch No	Volume	Rate mL/hr	Ordered by (Dr Sign)	Given by	Checked by	Pharmacist
		Sodium Chloride 0.9%	NIL	1L	1000mLs/ hour				

If ketones are falling ≥ 0.5 mmol/L/hour

1. Continue with current insulin infusion rate
2. Alert medical officer once ketones are less than ≤ 0.6 mmol/L
3. Stop fixed-rate DKA insulin infusion once ketones < 0.6 mmol/L
4. When fixed rate infusion ceased follow insulin advice in protocol

If ketones NOT falling by 0.5 mmol/L/hr

5. Increase insulin by 1 unit/hr (hrs 1–12) or 0.5 unit/hr (hrs 12–24)

☐ Check insulin infusion pump is working and connected

☐ Check insulin residual volume is correct

LINE 2: Intravenous INSULIN Infusion –0.1units/kg/hr

Weight (measured/estimated_____kg

Date	Time	Fluid	Additives/ Batch No	Volume	Rate mL/hr 0.1units/ kg/hr	Ordered by (Dr Sign)	Given by	Checked by	Pharmacist
		Sodium Chloride 0.9%	Actrapid 50 units	50 mL					

LINE 2: Intravenous 10% DEXTROSE (When blood glucose <14mmol/L. Continue but adjust saline)

Date	Time	Fluid	Additives/ Batch No	Volume	Rate mL/hr	Ordered by (Dr Sign)	Given by	Checked by	Pharmacist
		Dextrose 10%	NIL	500 mL	125 mL/hr				

Observation ▶	0 to 6 hours							6 to 12 hours							12–24 hours															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24					
Date ▶																														
Time ▶																														
Remaining syringe volume (ml)																														
Insulin infusion rate (ml/hr)																														
Capillary Ketones (mmol/L)																														
Glucose (mmol/L)																														
Potassium (mmol/L)																														
Venous pH																														
Bicarbonate (mmol/L)																														