DIABETIC KETOACIDOSIS (DKA) MANAGEMENT IN PREGNANCY

AIMS

To provide clinical staff with the information to be able to manage diabetic ketoacidosis appropriately.

Staff shall be able to:

- Define hyperglycaemia in pregnancy
- Distinguish between hyperglycaemia, diabetic ketoacidosis and hyperosmolar hyperglycaemic state
- Respond appropriately when blood glucose results are abnormal

The Physician on call MUST be notified of all women admitted with suspected DKA BEFORE extensive management plans have been made or started.

BACKGROUND

In the absence of prompt diagnosis and treatment DKA can be life threatening to both the mother and the fetus

Diabetic ketoacidosis is:

- A life threatening metabolic complication of absolute insulin deficiency
- Characterised by the triad of:
  - Hyperglycaemia
  - Ketonaemia from fatty acid metabolism
  - Metabolic acidosis.

The resulting hyperglycaemia results in loss of water and electrolytes, hyperosmolality and fluid depletion.

Although more commonly associated with Type 1 diabetes, DKA can also occur in Type 2 or gestational diabetes in the context of severe illness such as sepsis, insulin disruption, myocardial infarction or medication administration (e.g. corticosteroids).

As a general rule:

- Stabilise maternal condition
- Continue close fetal surveillance
- Consider delivery if despite aggressive therapy fetal status does not improve or maternal condition continues to deteriorate.

DIAGNOSIS

The diagnosis of diabetic ketoacidosis is made on the basis of a compatible history (including polyuria, polydipsia, vomiting, abdominal pain, weight loss, dehydration, precipitating infection or event) and:

- Hyperglycaemia, typically BSL>13mmol/L but may be lower or normal in pregnancy
- Metabolic acidosis (pH<7.30) with high anion gap
- Presence of ketones in urine or serum

The most common precipitants for DKA are:

- Omission or inadequate dosing of insulin
- Infection (pneumonia, UTI, gastroenteritis, viral)
- Hyperemesis
- Medical/surgical intercurrent illness such as pancreatitis
- Steroid induced hyperglycaemia after administration for fetal lung maturation
- β2 agonists (eg. salbutamol, terbutaline) for tocolysis can cause and further aggravate DKA.

Remember, in addition to the usual symptoms and signs of DKA, pregnant women can also present with non-specific abdominal pain and/or contractions.

The differential diagnosis includes acute pancreatitis, alcoholic ketoacidosis, appendicitis, cystitis, hyperosmolar coma, lactic acidosis, salicylate toxicity and septic shock.

ASSESSMENT

Initial investigation for diabetic ketoacidosis should include;

1. BSL (laboratory and fingerpick): Check hourly
2. Arterial blood gases
3. Urine and serum ketone level (blood β – ketone testing can be done using the Optium meter)
4. Urea and electrolytes
5. Considering the precipitating cause/s and manage as appropriate. These could include:
    - Newly diagnosed Type 1 diabetes or Type 1 with missed insulin doses
    - Insufficient insulin for intercurrent illness, eg.
        - infection (consider CXR, MSU, blood cultures, meningism)
        - ischaemic event, eg. AMI (may be silent, check ECG), CVA, ischaemic bowel, gangrene
        - acute abdomen, eg. pancreatitis, peritonitis
        - drugs (alcohol, glucocorticoids, sympathomimetics)

TREATMENT

The Medical Registrar or Diabetes Physician must be contacted regarding the management of DKA.

All patients with DKA should be monitored in a high dependency unit (AMAU) or labour and birth suite. The duty anaesthetist must be informed of all admissions to labour and birth suite if the patient is in DKA.

Consider

1. Urinary catheter (if not producing urine after 3 hours)
2. Arterial line
3. Nasogastric tube (if drowsy/vomiting)

TRANSFER TO AN ICU MAY BE REQUIRED IF

- Severe ketoacidosis (pH < 7.0)
- Altered consciousness
- Poor response to acute resuscitation
- More intensive monitoring anticipated (eg. K+, intercurrent illness)

VOLUME EXPANSION

The treatment of DKA includes correction of dehydration (typical water deficits are 5-10 L), hyperglycaemia and electrolyte imbalance, (the most dangerous of which is hypokalaemia) combined with treatment of the provocative illness and frequent maternal monitoring. Aim to replace total volume loss in 24-36 hours, with approximately 50% of the resuscitation fluid being administered in the first 8-12 hours.

Sodium Chloride 0.9%

- Use for initial resuscitation
- Consider
  - 1-2 L in the first hour
  - 500-1000 mL/hour over the next 2-4 hours

Insulin infusion

- If the patient is already on long acting insulin, this should be continued.
- 50 units Neutral insulin **Actrapid®** in 500 mL 0.9% sodium chloride (ie. 0.1 units/mL) via infusion pump; flush and discard the first 20 mL
- Commence the infusion at **60 mL/hr** (ie. 6 units per hour). An Insulin bolus may be given if recommended by the physician.
- **Repeat ABG's** at 2-4 hours to check acidosis is being corrected, according to the discretion of the physician.
  *(Venous Blood Gases may be acceptable with less severe acidosis – check that the bicarbonate is rising)

Potassium (K+)

Patients with DKA may be depleted in total body potassium despite normal or even elevated potassium on presentation. Initially the potassium may be high due to acidosis but will fall rapidly when acidosis is corrected. The key to adequate potassium replacement is regular monitoring (1-2 hourly). An arterial line is recommended and arterial blood gas can give rapid information on the potassium level

- Potassium < 3.5, give 10 mmol/L potassium chloride (KCL) per hour IV. Recheck every 1-2 hours. If higher doses are required consider the insertion of a central line, cardiac monitoring and AMAU admission.
- Potassium = 3.5-5.5, give 20 mmol/L KCL over 1-2 hours IV. Recheck prior to any further administration.
- Potassium > 5.5, no replacement.

Bicarbonate

- Randomised trials outside pregnancy have not shown any benefit from bicarbonate therapy in patients with pH 6.9-7.1, although there are no studies in pregnancy.
- In pregnancy, the normal PH is 7.4-7.45, so a PH of 7 represents severe acidosis and bicarbonate may be considered. ***Patients in this situation should be considered for transfer to an Intensive Care Unit, or considered for delivery.***

Phosphate

Not usually indicated. May be considered if severe hypophosphataemia (< 0.35 mmol/L) +/- cardiorespiratory depression.

10% Dextrose

- Commence at 40 mL/hour when BGL < 10 mmol/hour to be run concurrently with 0.9% sodium chloride (as needed to restore euvolaemia).
- Check the BGL and ketones hourly.
- If the capillary ketones are not falling by 0.5 mmol/L/hour, increase the insulin by 1 unit/hour.
- If the blood glucose continues to fall below 7.0 within the first hour, consider increasing the dextrose infusion rate to 80mL/ hour and contact the physician

IV Infusions are to be ceased only when

- acidosis is corrected (ie. blood ketones < 0.5)
  and
- the patient is able to eat normally (to allow the safe recommencement of subcutaneous insulin)

NB. If patient normoglycaemic or becomes hypoglycaemic with IV insulin, ***do not cease the insulin infusion until acidosis is corrected*** (extra dextrose and/or an increase in the dextrose infusion rate can be administered).

Conversion to subcutaneous insulin

Once the ketones have been cleared and if the patient is eating and drinking normally, the patient should be transferred to subcutaneous insulin therapy by the diabetes team

For patients with known diabetes on multiple daily injections

- Recommence the usual bolus insulin with the patient's next meal
- Cease infusions:
  - Half an hour after rapid onset S/C insulin given
  - Basal insulin must be arranged with diabetes team prior to cessation of insulin infusion
  - ***5-10 minutes*** after the administration of fast acting analogs (Novorapid, Humalog, Apidra)

For patients who are on CS11 (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 physician
- If appropriate, recommence the pump when the ketones have cleared and the patient is eating and drinking.
- Cease the insulin infusion 30 minutes after recommencing pump.

PERINATAL COMPLICATIONS

The frequency and severity of perinatal complications is dependent upon the severity of the maternal condition at the time of presentation, adequacy of management, and the gestational age and condition of the fetus prior to onset of the DKA. The reported fetal mortality in recent years has ranged from 10-36%. Perinatal morbidity is high due to preterm delivery, hypoxia and acidosis

EFFECT OF DKA ON THE FETUS

The mechanism of fetal loss is not clear but believed to be due to:

- Massive osmotic diuresis and consequent dehydration, which leads to volume depletion and reduced utero-placental blood perfusion.
- Maternal acidemia is known to reduce placental blood flow with resultant fetal hypoxia.
- Maternal hypophosphatemia leads to altered red blood cell oxygen metabolism causing further fetal hypoxia.
- Fetal hyperinsulinemia resulting from maternal hyperglycaemia leads to increased fetal oxygen requirements by stimulating oxidative metabolic pathways, further aggravating the insult.
- Maternal hypokalaemia can potentially cause fetal hypokalaemia, leading to fatal arrhythmias.

MANAGEMENT OF DKA – FETAL MONITORING

- The mode and intensity of fetal monitoring will largely be influenced by the gestational age at the time of DKA and also by other pregnancy risk factors and past obstetric history.
- Decisions regarding the type and intensity of fetal surveillance at gestations under 28 weeks are difficult and should be individualised and made at a consultant level. The MFM consultant's opinion should be sought.
- Usually with gestations over 28 weeks, continuous fetal heart rate monitoring is recommended and should be commenced at the time of diagnosis and continued until the mother is stabilised with correction of the majority of metabolic derangements. It may sometimes be necessary to continue the CTG until the FHR abnormalities disappear and this may take 4-8 hours.

- **NB.** All modes of fetal testing will be influenced by the fetal hypoxemia and acidosis.
- FHR abnormalities, not uncommonly seen during an acute DKA episode are:
  - minimal or absent variability
  - absent accelerations
  - repetitive variable or late decelerations
- Consider an ultrasound scan to check fetal wellbeing, especially in very preterm gestations where CTG is more difficult to interpret and other situations where these findings may help with delivery decisions.
- USS findings are quite often abnormal and show:
  - abnormal biophysical profile
  - abnormal umbilical artery Doppler
  - abnormal middle cerebral artery Doppler with evidence of redistribution.
- The frequency and severity of fetal abnormalities are directly related to the severity and duration of the episode and appropriateness of its management.
- Most fetal abnormalities will usually improve after correction of the metabolic derangements and maternal stabilisation.
- The decision to continue the pregnancy or to proceed with delivery in the setting of DKA can be very challenging and should be made at the consultant level. The MFM consultant's opinion should be sought if possible. These decisions should take into consideration:
  - Gestational age of the fetus
  - Maternal status
  - Fetal status
  - Response to treatment
  - Background medical history of co-morbidities
  - Past obstetric history
- Resist the natural inclination to proceed with an urgent C-section for fetal heart rate abnormalities, prior to stabilisation of the maternal condition.
- DKA on its own is NOT an indication for urgent delivery as this increases both maternal morbidity and mortality and also leads to the delivery of a hypoxic, acidotic and usually preterm neonate.

DKA MANAGEMENT PROTOCOLS

Volume expansion (with potassium as per protocol)

Date	Time	Fluid	Additives/ Batch No.	Volume	Rate	Ordered by	Given by	Checked by
		N/Sal	NIL	1 L				
		N/Sal		1 L				

Insulin infusion (flush and discard first 20 mL)

Date	Time	Fluid	Additives/ Batch No.	Volume	Rate	Ordered by	Given by	Checked by
		N/Sal	Actrapid 50 units	500 mL	60 mL /hr			

Dextrose (to commence when BGL < 10)

Date	Time	Fluid	Additives/ Batch No.	Volume	Rate	Ordered by	Given by	Checked by
		10% dextrose		1 L	40 mL /hr			

DIABETIC KETOACIDOSIS MONITORING

Elapsed time (hr)	Date/ time	BGL (hourly)	Insulin rate (mL/hr)	Dextrose rate (mL/hr)	Insulin pump volume	Saline pump volume	Dextrose pump volume	PH/ pCO 2	Bicarb	Na+/K+	Urea/ Creat.	Blood ketones	Signature
0.5													
1													
1.5													
2													
2.5													
3													
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