

“Treating Diabetic Ketoacidosis under COVID-19 Restrictions”

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Diabetic ketoacidosis is a serious and life-threatening condition which can be challenging to treat. We understand that many vets are currently having to navigate new ways of working due to COVID-19 restrictions and we hope this guide will be useful to you.

Definition: Diabetic ketoacidosis (DKA) is a severe complication of diabetes. It is seen in patients with hyperglycaemia, ketonuria/ketonaemia and concurrent acidosis.

Presentation and diagnosis: Patients with DKA will present critically ill. Clinical signs include lethargy, anorexia, vomiting and diarrhoea. Blood work will reveal hyperglycaemia, ketonaemia and acidosis. Urinalysis will reveal glucosuria and ketonuria. Ketones can be detected in the urine and blood using urine dipsticks.

These cases are complicated and require intensive management. If you do not have the facilities and team to manage these cases, and the owners have the finances, then referral should be strongly considered.

Treatment:

There are two things to focus on in your treatment plan:

- 1) Intravenous Fluid Therapy (IVFT) +/- phosphate +/- potassium +/- bicarbonate supplementation.
- 2) Insulin therapy.

IVFT

- Dehydration is a predominant feature in DKA. It is essential to place an IV and start IVFT as soon as possible.
- Blood pressure should be checked and monitored regularly if hypotensive.
- Patients have a high fluid requirement due to poorly controlled Diabetes Mellitus (DM) and as such fluid rates are high.
 - The exact amount will vary between patients and for hypotensive patients cautious use of fluid boluses is often required.
- The ideal fluid has not been established, however 0.9% saline is a good first choice due to the profound sodium deficit that is frequently present in these patients.
- **TIP:** If working as a skeleton team and using an infusion pump, set the volume to be infused to an amount which will prompt you to check the patient's hydration status and review IVFT rates regularly when the alarm sounds. Alternatively, set reminders on your phone to do this.
- Once the patient is no longer hypotensive and not requiring boluses of fluid, then supplementation can begin.
- **Potassium Supplementation**
 - It is essential to add potassium chloride (KCl). This is usually started at 30-40mmol KCl/L of fluids (based on the serum potassium concentration). KCl supplementation is required because insulin drives potassium intracellularly meaning the patient will be potassium deficient. If you do not have the luxury of measuring potassium, referral should be considered, but it is still advisable to supplement as this will inevitably be low in patients with DKA.
 - See Appendix 1 for further guidance on potassium supplementation.
- **Phosphate Supplementation**
 - Hypophosphatemia is commonly present, but treatment is not indicated unless serum phosphate concentration is $<0.48\text{mmol/L}$.

- Clinical signs are rare however haemolytic anaemia has been reported in cats.
- Potassium phosphate is generally administered as a continuous rate infusion (CRI) at the rate (0.01-0.06mmol/kg/hr) and duration depends on serum measurement. Repeat measurement should be performed twice daily.
- **Bicarbonate supplementation**
 - If acidosis is severe (pH <7), or plasma bicarbonate <8mEq/L then bicarbonate supplementation should be considered.
 - Bicarbonate therapy should not be administered if it is not possible to measure blood gases.
- The bicarbonate deficit in mEq can be estimated as below:

$$0.3 \times \text{BW (Kg)} \times \text{base excess}$$

e.g. For a 4Kg cat with base excess of -12 the bicarbonate deficit would be 14.4mEq.

Generally, $\frac{1}{4}$ to $\frac{1}{2}$ of the dose is administered slowly over 20-30minutes, blood gases are repeated and additional bicarbonate given as required.

Insulin

- Insulin therapy is usually delayed until at least 2 hours after fluid therapy has been started, so that hypoperfusion and electrolyte abnormalities are corrected first.
- Insulin may be administered as a constant rate infusion (CRI) intravenously or intermittently by intramuscular injection. VVS's Internal Medicine specialist prefers to use a CRI, as it is simpler and the least stressful method for the patient. It is also worth noting that although a CRI takes a little longer to prepare, once it is set up you don't have to do frequent IM injections which can be useful when working as a skeleton team.

CRI Neutral Insulin Protocol:

- Neutral insulin (e.g. hypurin) is added to 0.9% NaCl and administered at 0.05 IU/kg/hr.
 - A solution can be made up by adding 25IU of neutral insulin to a 500ml bag of 0.9% NaCl.
 - This will result in a concentration of 0.05 IU of neutral insulin/ml.
 - Insulin will bind to the plastic tubing in drip lines and as such fluid should be run through the line to allow 30-50ml to be expelled and discarded, so that a more consistent solution reaches the patient once administration begins.
 - The infusion can then be started at 1ml/kg/hr to deliver the desired daily dose.
- The rest of the fluid requirements, and potassium supplementation are provided in a separate bag, so that these can be adjusted independently. If phosphate and / or bicarbonate are supplemented, these should also be added to their own bags.
- Individual bags are used so that the rates can be controlled separately and adjusted accordingly. If you have a 3-way stopcock then all these fluids can run into the same IV catheter. If not, use Y-connectors and place 2 IV lines.
- Blood glucose should be measured every 1-2hours.
- Continue with insulin therapy, aiming for a glucose concentration of 8-15mmol/L.
- If the glucose falls to less than 8mmol/L *reduce* the insulin CRI rate by 50% and replace the potassium supplemented fluids with one containing 5% glucose, 0.9%NaCl and KCl.
- If the glucose falls to less than 4mmol/L *stop* the insulin CRI and replace the potassium supplemented fluids with one containing 5% glucose, 0.9%NaCl and KCl.
- To make a 5% glucose solution add 100ml of 50% dextrose to a 1L bag of fluids.

IM Neutral Insulin Protocol

- Initially 0.2IU soluble insulin is given IM.
- Blood glucose (BG) is repeated every 1-2hours and repeated intramuscular injections (0.1IU) are given as required.
 - The aim is a glucose concentration of 8-15mmol/L.
- If the glucose falls to less than 8mmol/L *continue* the insulin doses and replace the potassium supplemented fluids with one containing 5% glucose, 0.9%NaCl and KCl. The administered rate will depend on the patient's hydration status.
- If the glucose falls to less than 4mmol/L, *stop* giving insulin and replace the potassium supplemented fluids with one containing 5% glucose, 0.9%NaCl and KCl.
- To make a 5% glucose solution add 100ml of 50% dextrose to a 1L bag of fluids.
- BG should be checked every 1-2hours to allow for monitoring and subsequent adjustment of the fluid rates.

For all Cases (whether Insulin CRI or IM)

- **Electrolytes**, the most important of which is potassium, should be checked every 4-6hr initially. If electrolytes cannot be measured then referral for ongoing treatment should be strongly considered. We would recommend talking to the centre you are referring to for advice on how much treatment / stabilisation to give before transferring the patient.
- Broad spectrum **antibiotics** (such as potentiated amoxicillin) may be initiated if there is a concern regarding underlying infection, particularly a urinary tract infection which may be contributing to the DKA.
 - Clinicians should be mindful of the need for responsible use of antimicrobials and should send samples for culture and sensitivity to ensure appropriate antimicrobial use wherever possible.

- Additional investigations such as thoracic radiographs, abdominal ultrasound and full blood work (including folate, cobalamin and fPLi) may also be required depending on the individual case and clinical signs.
- In some cases, parenteral feeding may be required either by placing a nasogastric tube or oesophageal feeding tube.
- Additional supportive care such as maropitant and mirtazapine may also be required. It is important to try and tempt cats to eat as soon as possible.
- Once DKA has resolved (with acidosis resolved and ketones negative in blood and urine), and the patient is eating normally their usual subcutaneous insulin can be restarted or in the case of a newly diagnosed patient, subcutaneous insulin therapy can be introduced.

Appendix 1

Serum Potassium	Volume to be added to 250ml of 0.9%NaCL or LRS
<2mmol/l	20mmol
2-2.5mmol/l	15mmol
2.5-3mmol/l	10mmol
3-3.5mmol/l	7mmol
3.5-5.5mmol/l	5mmol

Potassium supplemented fluids should be administered via fluid pumps. This is so that the rate of the infusion can be accurately monitored. The rate should not exceed 0.5mmol/kg/hr.

Specific Note re COVID-19

- This information sheet was published on 21/04/20. BVA and RCVS guidelines may be subject to regular change over the coming months. Please check for updates at:
BVA: <https://www.bva.co.uk/>
RCVS: <https://www.rcvs.org.uk/home/>
- DKA patients may require intensive nursing care and this often requires more than one staff member to be working in close proximity.
- Ensure that social distancing guidelines are maintained and/or that appropriate Personal Protective Equipment (PPE) is supplied to staff, to minimise transmission of COVID-19.
- If staffing levels or staff safety cannot be maintained to enable appropriate levels of care for the patient, then it may be necessary to consider alternative options, including referral
- Animal welfare should be a priority, but so should human safety in these challenging and unprecedented times. Look after yourself and your team, as well as your patient.

If you would like to speak to a VVS Specialist about any of your cases, please do not hesitate to contact us:

T: 020 7043 2283

E: admin@vvs.vet

VVS Specialists are here to help and can review clinical history and test results and advise you on your cases as and when you need support.

You may be working sole charge, but you are not alone.