

Prevention of Diabetic Ketoacidosis (DKA) in Insulin Pump Therapy

Diabetic ketoacidosis (DKA) is a complication of diabetes that can result in death. DKA happens when there is not enough insulin and Blood Glucose (BG) cannot be used as an energy source, so the BG rise quickly. The body then starts to burn fat for energy, leading to a build-up of acids in the blood called ketones. People on an insulin pump are at a higher risk for DKA because they are not using long acting insulin. DKA can develop in as few as 2-4 hours if the insulin infusion is interrupted or boluses are missed.

There is a higher chance of developing DKA in pregnancy which can cause harmful effects to mother and baby, including possible fetal death. Pregnant women become less sensitive to insulin causing the body to not use insulin as well. Insulin doses then increase throughout the pregnancy. Therefore, the infusion site may need to be changed more often, even as often as every day in the last month of pregnancy, because more insulin is flowing through the infusion site.

1. Know when more insulin might be needed

- Illness or emotional stress
- Nausea, vomiting or diarrhea
- Infections (dental or other)
- Injury or day surgery
- Missed insulin bolus
- Pump malfunction
- Infusion failure (site, tubing, kinked cannula, etc.)
- Pregnancy

2. Take action

- Check blood glucose more often and always before bed.
- Use the following guidelines to help correct high BG and prevent DKA.
- Keep a DKA safety kit stocked (fresh insulin, syringe or pen, ketone strips, meter).
- Follow your clinic's guidelines for sick day management (this may include increasing the size of boluses or using temporary increased basal rates).
- Inspect pump, insulin cartridge and tubing connections before bed each night.
- Contact your diabetes team if help is needed; some teams have 24 hour phone help.

If blood ketones 0.6 mmol/L or more, or urine ketones over trace, give a correction that is 50% more than what the bolus calculator recommends using insulin pen or syringe. Calculate 1.5 times correction dose like this:

$$1.5 \times \frac{(\text{current blood glucose} - \text{target blood glucose})}{(\text{insulin sensitivity factor or correction factor})} = \text{X units of insulin}$$

3. Go to the emergency department if any of these happen:

- Blood ketones 3 mmol/L or greater, or urine ketones reading moderate to large (40 mg/dL or more, 2+ or more).
- Signs of DKA (nausea, vomiting, stomach pain, trouble breathing or deep/rapid breathing, fruity-smelling breath, muscle weakness).
- Signs of dehydration (dry mouth or skin, cracked lips, sunken eyes, drowsiness, dizziness, feeling faint, pounding heartbeat).
- Vomiting and unable to keep fluids down for 4 hours (child vomits more than 2 times in 4 hours with ketones greater than trace or 0.6 mmol/L).
- Blood Glucose above 14.0 mmol/L with Blood Ketones 0.6 mmol/L or more, urine ketones above 5mg/dl, or above trace after 2 corrections with no improvement.
- Pump failure with no plan to replace insulin and unable to reach your diabetes team.

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Test for ketones with any of the following:

- Blood glucose greater than 14.0 mmol/L
- Symptoms of DKA (nausea, vomiting, abdominal pain, lightheadedness, fruity smelling breath, shortness of breath) regardless of blood sugar level
- Illness
- Signs of dehydration (dry mouth, tongue or cracked lips)

- **If Blood ketones are 3 mmol/L or greater or urine ketones moderate to large (40 mg/dL or more, 2+ or more) give 1.5 X correction by pen or syringe and go to the emergency department.**

Follow These Guidelines

| Blood ketones 0.5 mmol/L or less Urine ketones negative/trace (5 mg/dL or less) | Blood ketones are 0.6 mmol/L or more Urine ketones above trace (above 5 mg/dL) |
|--|---|
| <ol style="list-style-type: none"> 1. Take usual correction bolus with pump. 2. Drink: 125-250 ml (1/2-1 cup) calorie free fluids every hour 3. Troubleshoot* 4. Recheck blood glucose in 2 hours. If: <ul style="list-style-type: none"> • 14 mmol/L or less, give bolus corrections with pump every 2-4 hours until BG is in target. • More than 14 mmol/L, retest ketones 5. If first correction didn't bring glucose below 14 mmol/L: <ul style="list-style-type: none"> • Correct again using pen or syringe. If on a hybrid closed loop pump, switch to manual mode first. Stay in manual mode for at least 4 hours after the last injection by pen or syringe. • Change infusion set, reservoir, tubing, site and insulin. | <ol style="list-style-type: none"> 1. Take 1.5X correction by pen or syringe. (If on a hybrid closed loop pump, switch to manual mode first. Stay in manual mode for at least 4 hours after the last injection by pen or syringe.) 2. Change infusion set, cartridge/reservoir, tubing, site and insulin. 3. Drink 125-250 ml (1/2-1 cup) calorie free fluids every hour 4. Troubleshoot* 5. Recheck blood glucose in 2 hours If blood glucose is: <ul style="list-style-type: none"> • 14 mmol/L or less, give bolus corrections with pump every 2-4 hours until BG is in target. • greater than 14 mmol/L retest ketones and repeat steps 1 to 5. |
| <p>See other side of this handout for more reasons to go to emergency department.</p> | |

***Troubleshooting:**

- **Blood glucose readings** – Verify glucose sensor readings with fingerpoke glucose meter readings before making insulin decisions. Do not rely on CGM readings alone.
- **Infusion site** – Check that cannula is not in longer than 3 days, site not irritated or infected, connections are tight, site is not damp (tunneling)
- **Tubing** – Check that tubing was primed, no blood clots, leaks or large bubbles
- **Insulin** – consider using a new vial or lot; consider replacing all basal and bolus insulin with injections according to the instructions from your diabetes team.
- **Pump** – Check bolus history basal rate settings, temporary basal rates; call the pump company if pump not working properly or help is needed to find pump settings.

This material is designed for information purposes only. It should not be used in place of medical advice, instruction and/or treatment. If you have specific questions, please consult your doctor or appropriate healthcare professional.