

BCCH DIABETIC KETOACIDOSIS NURSING PROTOCOL

Diabetic ketoacidosis (DKA) involves a combination of hyperglycemia, acidosis, and ketones. It is diagnosed when (1) the blood glucose is ≥ 11 mmol/L; (2) capillary pH is ≤ 7.3 and/or capillary bicarbonate is ≤ 15 mmol/L; and (3) ketones are present in the blood and/or urine (see below). It usually takes days to develop DKA, but it can take hours in children with acute illness, insulin omission, or insulin pump site problems.

Causes of DKA Include:

- undiagnosed type 1 diabetes
- insulin omission or manipulation
- inadequate insulin dosing and monitoring during periods of increased insulin needs: (illness, infection, major stress, puberty, pregnancy)
- insulin pump misuse or infusion site disconnection, kinking or failure

Signs and Symptoms of DKA Include:

- polyuria
- polydipsia
- dehydration
- weight loss
- lethargy
- nausea, vomiting and abdominal pain
- fruity or acetone-smelling breath
- flushed face
- confusion
- hyperventilation and Kussmaul breathing (rapid, deep, sighing mouth-breathing)
- \uparrow heart rate and \uparrow respirations, and possibly \downarrow blood pressure

Acute dehydration must be treated with IV fluid replacement. Overhydration, correcting the hyperglycemia too quickly, the use of insulin in the first 1-2 hours of fluid therapy, and the use of bicarbonate have been implicated in causing cerebral edema in DKA, which can be fatal. Hydration should be cautious, according to the DKA Protocol, and the blood glucose should not fall below 15 mmol/L for the first 12-24 hours.

NURSING MANAGEMENT OF DKA IN THE EMERGENCY ROOM

1. Patient should be kept NPO.
2. Weight is needed for rehydration calculations. The ER physician will estimate the degree of dehydration and the fluids required, using the DKA Protocol.
3. Baseline neurovital signs.
4. Apply pulse oximetry and cardiac monitor; O₂ via mask if saturation is low.
5. Initial bloodwork: glucose, sodium, potassium, chloride, bicarbonate, osmolality, urea, creatinine, calcium, phosphorus, capillary blood gas and serum ketones/ β -hydroxybutyrate (where available); and urine for ketones and glucose. Bloodwork can be done with the IV start. If IV start is difficult, call the Lab to do a stat finger sample rather than waiting for the IV line to be initiated.
6. Measure blood glucose with hospital meter. If labwork is done at the same time, a drop from the lab sample may be used to do this. If the meter reads "HI", the blood glucose is ≥ 27.8 mmol/L, and the physician may request that labwork be drawn to obtain the actual blood glucose level.
7. Start one large-bore IV line. Three infusions will be Y'd into this line.
8. At the physician's discretion, moderately to severely dehydrated patients may receive a 5-10 mL/kg normal saline (NS, 0.9% NaCl) bolus over 30-60 minutes. This may be repeated, but should total <30 mL/kg.
9. In the first 1-2 hours of DKA management, the desired fluid is NS (NS + 40 mmol KCl/L may be used if the serum potassium level is initially low and the patient is urinating). The ER physician will calculate the rate of this from the DKA Protocol.
10. NOTE THAT INSULIN IS NO LONGER GIVEN IN THE FIRST 1-2 HOURS OF DKA MANAGEMENT.
11. Set up the "two-bag system". This consists of two IV bags (**A** and **B**) with equal electrolyte concentration, one containing no dextrose, the other 10-12.5% dextrose. They are administered simultaneously. The concentration of dextrose is easily changed by adjusting the proportions of the two bags contributing to the total rate. The total rate is determined by the child's degree of dehydration,

according to the DKA Protocol. The insulin infusion (**Bag C**) will eventually be Y'd into these bags (see below).

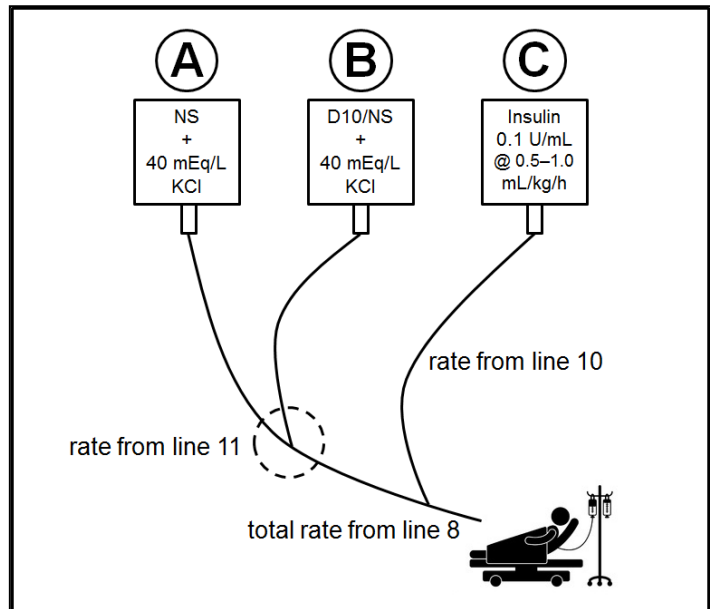
In the "two-bag system", **Bag A** is generally NS + 40 mEq/L KCl, and **Bag B** is usually D12.5/NS + 40 mEq/L KCl (or D10/NS + 40 mEq/L KCl if D12.5/NS is not available). The BCCH Pharmacy has prepared a "recipe book" for preparing these solutions from available IV solutions, which is available from the *Parenteral Drug Manual* on the C&W Intranet and on Endocrinology's website (see below). The following solutions should also be available pre-made in the Emergency Room and on 3F for after-hours use:

- NS + 40 mEq/L KCl
- D12.5/NS + 40 mEq/L KCl
- $\frac{1}{2}$ NS + 40 mEq/L KCl
- D12.5/ $\frac{1}{2}$ NS + 40 mEq/L KCl

EXAMPLE OF THE "TWO-BAG SYSTEM"

Example: IV rate from protocol line 11 = 100 mL/h
(this does not include insulin infusion rate)
rate Bag A + rate Bag B = 100 mL/h

rate Bag A no dextrose (mL/h)	rate Bag B D10 (mL/h)	final dextrose concentration (%)
100	0	D0
80	20	D2
60	40	D4
40	60	D6
20	80	D8
0	100	D10



after: Grinberg A et al, *Journal of Pediatrics* 1999;134(3):376-378.

12. Insulin is started 1-2 hours after initial DKA fluid management is begun. To prepare the insulin infusion, 50 units (0.5 mL) of short-acting insulin regular (Humulin® R or Novolin® Toronto) is added to a 500-mL bag of NS (or to D10/NS, if ordered). This is a concentration of 0.1 units/mL. The insulin is drawn up in a tuberculin syringe with a 1½-inch needle so that the insulin is injected past the plastic port of the IV bag. **Do not use an insulin syringe.** Mix fluid continually while injecting, to prevent the insulin from settling in the port. Flush the tubing with 50 mL of the insulin solution to saturate insulin binding sites. **This procedure requires a double-check.** The insulin infusion (**Bag C**) is Y'd into the lowest port on the IV, closest to the patient and is usually run at 0.5-1 mL/kg/hr (which is 0.05-0.1 units/kg/hr). An insulin bolus is never given. This dose of insulin is required to reverse the ketosis. As the blood glucose approaches 15 mmol/L, or if it is dropping too rapidly, the total rate of the insulin infusion will remain the same, but the rate of the no-dextrose IV will be decreased, and the rate of the high-dextrose IV will be increased by the same amount.
13. According to BCCH Nursing Policy, the IV bag is changed every 24 hours, and the tubing is changed every 96 hours.
14. The insulin infusion is discontinued once the blood pH returns to normal and the patient is ready to switch to SQ insulin. This is usually within 24-36 hours. Pharmacy prepares a new insulin infusion bag every 24 hours. The tubing is replaced every 96 hours, as per BCCH Nursing Policy and Procedure Manual PT-004 (*Parenteral and Infusion Therapy: Initiating or Changing an Infusion*), available on the C&W Intranet.
15. Depending on the patient's progress, the solutions may eventually (e.g. after 6-12 hours) be changed to ½NS + 40 mEq/L KCl and D10-12.5/½NS + 40 mEq/L KCl.

NURSING CARE

- blood glucose by meter and/or lab every 30-60 minutes
- electrolytes, lab glucose, blood ketones, capillary gas every 2-4 hours as ordered
- record nursing results on DKA flowsheet
- neurovital signs every 15 minutes until stable, then hourly until discontinued
- close neurological observation and frequent rousing
- monitor for headache, abnormal respirations or behavioral changes
- NPO until rehydrated and glucose is stabilized
- ice chips may be allowed, at physician's discretion
- check urine for ketones with each void
- strict intake and output

MONITOR FOR CEREBRAL EDEMA

Cerebral edema occurs in ~0.5% of children presenting in DKA, and it has a mortality of ~25%. At highest risk are (1) children newly diagnosed with diabetes, (2) younger children, and (3) children with the greatest degree of dehydration and acidosis.

Symptoms include:

- headache
- inappropriate lowering of heart rate
- recurrence of vomiting
- changes in neurological status (restlessness, irritability, drowsiness, incontinence, cranial nerve palsies, altered pupillary reactivity, etc.)
- rising blood pressure
- oxygen desaturation

If you suspect cerebral edema, notify the physician immediately. Elevate the head of the bed. Be prepared to call the code team, and ensure that IV mannitol and/or 3% saline is ready at hand.

TRANSFER TO WARD

This may happen any time after the child is stabilized. An order should be sent to Pharmacy for intermediate-acting (Humulin® N or Novolin® NPH) and short-acting (Humulin® R or Novolin® Toronto) or rapid-acting (Humalog®, NovoRapid®, or Apidra®) insulin vials to be sent to the ward, in preparation for a switchover to SQ insulin. Nursing care continues as above until the insulin infusion is discontinued.

Subcutaneous insulin is started when acidosis is corrected and the child is ready to eat. The blood pH will be normal, and serum ketones (see below) will have normalized, but ketones will likely still be present in the urine. For short-acting insulin (Humulin® R or Novolin® Toronto), the insulin injection is given 20-30 minutes before breakfast or dinner, and the insulin infusion is turned off 30-60 minutes after the injection. For rapid-acting insulin (Humalog®, NovoRapid® or Apidra®), the insulin injection is given immediately before breakfast or dinner, and the insulin infusion is turned off 20-30 minutes after the injection. The physician may choose to continue the IV fluids for another 12-24 h to complete rehydration. Labwork will be discontinued once the child's pH and electrolytes have returned to normal.

For newly diagnosed children, diabetes education is initiated with the family as soon as possible. Children who are not newly diagnosed will need a reassessment of their diabetes management.

INTERNET LINKS

The following resources are all available from our [DKA Protocol webpage](#):

- [DKA Protocol Toolkit](#)
- [DKA Medical Protocol](#) (PLAIN PDF FORMAT)
- [DKA Medical Protocol](#) (FILLABLE PDF FORMAT)
- [DKA Nursing Protocol](#)
- [DKA Flowsheet](#)
- [DKA Sample Physician Order Sheet](#)
- [BCCH Recipes for Making DKA Solutions](#)
- [Blood Glucose and Insulin Record](#)
- [Glucose, Insulin and Fluid Management in DKA](#)

REFERENCES

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CORRELATION OF BLOOD AND URINE KETONES

Urine ketones		Blood ketones (β -hydroxybutyrate)
negative	<0.5 mmol/L	\leq 0.5 mmol/L
trace	0.5 mmol/L	0.6-0.9 mmol/L
small	1.5 mmol/L	1.0-1.4 mmol/L
moderate	4 mmol/L	1.5-2.4 mmol/L
large	8 mmol/L	2.5-2.9 mmol/L
very large	16 mmol/L	\geq 3.0 mmol/L