BOTTOM LINE RECOMMENDATIONS:

Diabetic Ketoacidosis (DKA)

In pediatric patients with Type 1 (or increasingly Type 2) Diabetes, **up to 1.5%** of episodes of DKA may be complicated by **cerebral edema.** Cerebral edema is associated with significant morbidity and mortality. Due to this risk, **pediatric DKA is treated differently than adult DKA.** The metabolic derangements associated with DKA are repaired slowly to prevent life-threatening shifts in fluids and electrolytes. Episodes of pediatric DKA **MUST** be treated according to a **published pediatric-specific protocol**[1] in close communication with a **pediatric diabetes specialist**. Contact the pediatric diabetes specialist or PICU at your pediatric referral site and your provincial medical transport service as required.

DIAGNOSE DKA IN PATIENTS WHO PRESENT WITH ALL THREE OF THE FOLLOWING:

- Acidosis **- pH < 7.3 or HCO_3 < 15 on venous or capillary blood gas**
- Moderate to large ketones on urine dipstick or routine urinalysis
- Diabetes (either new onset or existing) - **random serum glucose of > 11.1 mmol/L**

AT INITIAL ASSESSMENT, CHILDREN WITH:

- **MILD DKA (pH 7.20 - 7.29, HCO_3 10 - 14)** and **MODERATE DKA (pH 7.10 - 7.19, HCO_3 5 - 9)** are admitted to hospital for intravenous (IV) fluid therapy, IV insulin infusion and close monitoring. Rarely, older children with mild DKA may be treated using subcutaneous insulin and observation in the emergency department with **guidance from a pediatric diabetes specialist**.
  - **0.9% NaCl IV** boluses should only be used to treat decompensated shock (hypotension) and cardiovascular compromise
  - Large fluid boluses are potentially dangerous
  - Aim to replace the estimated fluid deficit evenly over 48 hours; fluid replacement should **not** exceed twice the maintenance rate of fluid requirements **(see published pediatric-specific protocol[1])**
  - **0.9% NaCl IV** is given initially to slowly treat dehydration; potassium is added as per **published pediatric-specific protocol[1]**
  - IV fluid composition is adjusted as per specific patient needs as metabolic derangements are repaired
  - Delay start of IV infusion of insulin (0.1 units/kg/hour) until 1 hour after IV fluid is started (not longer than 2 hours)
  - Patients are closely monitored with regular measurements of glucose, electrolytes (particular attention should be paid to hypokalemia) and venous or capillary blood gas
  - Boluses of IV insulin and the use of sodium bicarbonate are contraindicated as they increase the risk of cerebral edema
- **SEVERE DKA (pH < 7.10, HCO_3 < 5)** is treated as described above for mild/moderate DKA. As well:
  - These patients are usually admitted to PICU for treatment and monitoring. This decision should be made in consultation with pediatric diabetes and pediatric intensive care specialists.

CEREBRAL EDEMA MAY COMPLICATE ANY EPISODE OF DKA:

- **IDENTIFY PATIENTS AT RISK FOR CEREBRAL EDEMA**
  - Younger age **(< 5 years)**
  - New onset diabetes
  - Sick appearance
  - Greater acidosis **(lower pCO_2, lower pH)**
  - Longer duration of symptoms
  - More severe evidence of dehydration (increased hematocrit, urea, potassium)

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» **RECOGNIZE PATIENTS WITH CEREBRAL EDEMA AND CALL PICU/PROVINCIAL TRANSPORT SERVICE**

- » Headache, vomiting
- » Confusion, **GCS < 15**
- » Irritability in young children (not consolable by their caregiver)

» **AVOID MEDICAL INTERVENTIONS THAT MAY INCREASE THE RISK OF CEREBRAL EDEMA, INCLUDING:**

- » **DO NOT** use aggressive IV fluids (>50 ml/kg in the first 4 hours of treatment)
- » **DO NOT** use hypotonic IV fluids
- » **DO NOT** use IV bolus of insulin
- » **DO NOT** use early IV insulin infusion (within 1st hour of administration of fluids)
- » **DO NOT** use sodium bicarbonate to treat acidosis

» **TREAT CEREBRAL EDEMA**

- » Management of ABCs, restriction of IV fluid to maintenance, elevation of the head of the bed, Mannitol (0.5 - 1 gm/kg IV over 20 min) and/or 3% NaCl (5 - 10 ml/kg IV over 30 min)
- » A head CT should be performed, generally once the patient is stabilized at your pediatric referral site

CRITERIA FOR SAFE DISCHARGE HOME:

- » Rarely, older patients with very mild DKA may be treated in the emergency department with subcutaneous insulin and monitoring, in consultation with a **pediatric diabetes specialist**
- » These patients may be discharged home following resolution of acidosis and arrangement of close follow-up with a **pediatric diabetes specialist**

CRITERIA FOR HOSPITAL ADMISSION:

- » DKA requiring IV fluid, IV insulin infusion and close monitoring

CRITERIA FOR TRANSFER TO CHILDREN'S HOSPITAL INTENSIVE CARE:

- » Severe DKA **(pH < 7.10, HCO_3 < 5)** with or without signs of cerebral edema (headache, vomiting, decreased GCS, irritability)
- » Children **<5 years of age are at high risk of cerebral edema** and may be admitted to ICU for close observation depending on local practice

The purpose of this document is to provide health care professionals with key facts and recommendations for the diagnosis and treatment of DKA in children. This summary was produced by the DKA content advisor for the TREKK Network, Dr. Sarah Reid of the Children's Hospital of Eastern Ontario, and uses the best available knowledge at the time of publication. However, healthcare professionals should continue to use their own judgment and take into consideration context, resources and other relevant factors.

This summary is based on:

1) British Columbia Children's Hospital, *British Columbia's Children's Hospital Diabetic Ketoacidosis Protocol,* October 2015. (http://www.bcchildrens.ca/endocrinology-diabetes-site/documents/dkaprt.pdf)

2) Canadian Diabetes Association, *Clinical practice guidelines: Type 1 Diabetes in children and adolescents.* Can Journal of Diabetes 37:153-162 (2013).

3) Metzger DL. *Diabetic ketoacidosis in children and adolescents: An update and revised treatment protocol.* BCMJ 52(1):24-31 (2010).

4) Wolfsdorf JI et al. *ISPAD Clinical Practice Guidelines: Diabetic ketoacidosis and hyperglycemic hyperosmolar state.* Pediatric Diabetes 15(Suppl 20):154-179 (2014).

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