



BOTTOM LINE RECOMMENDATIONS:

Diabetic Ketoacidosis (DKA)

Diabetic ketoacidosis (DKA) is a serious complication seen in patients with Type 1 (or increasingly Type 2) diabetes. Up to 1.0% of episodes of DKA may be complicated by cerebral edema and be associated with significant morbidity and mortality. Metabolic derangements associated with DKA are treated with fluid resuscitation, insulin infusion and close monitoring of neurological, metabolic and fluid status. New fluid resuscitation guidelines included in this Bottom Line Recommendation are based on the recently published PECARN FLUID trial¹. Episodes of pediatric DKA **must** be treated according to a published [pediatric-specific protocol](#) in close communication with a pediatric diabetes specialist.

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

- » Acidosis - pH <7.3 or HCO₃ <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, HCO₃ 10-14) and MODERATE DKA (pH 7.10-7.19, HCO₃ 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**.
 - » A recent randomized controlled trial did NOT find a difference in incidence of cerebral edema between pediatric DKA patients treated with a standard or rapid fluid protocol using isotonic or hypotonic IV fluid¹.
 - » **ALL** pediatric DKA patients (**EXCLUDING** those presenting with signs of cerebral edema) should receive a 10 mL/kg (MAX 1000 mL) bolus of **0.9% NS IV** over 30 minutes and their perfusion should be assessed.
 - » Patients with tachycardia or other signs of hypoperfusion (capillary refill time >2 sec, cool extremities) after their first fluid bolus should receive another 10 mL/kg 0.9% NS IV (MAX 1000mL) over 30 min. Reassess perfusion after each bolus and repeat bolus if persistent hypoperfusion. Discuss further fluid management with Pediatric Referral Centre.
 - » After the initial bolus(es), aim to replace the estimated fluid deficit over 36 hours. **TOTAL** IV fluid rates may be calculated using the weight-based rehydration table below, which replaces the fluid deficit (and maintenance requirements) over 36 hours.
 - » See [TREKK DKA PedsPac](#) for more information.

Rehydration Table (Total IV Fluids)	
Weight:	mL/kg/hr
5 – <10 kg	6.5
10 - <20 kg	6
20 - <40 kg	5
≥40 kg	4 (max 250 mL/hr)

- » **0.9% NS** is the initial IV fluid of choice, potassium is added as per published [pediatric-specific protocol](#).
 - » 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, HCO₃ <5)** is treated as described above for mild/moderate DKA. In addition:
 - » 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)
- » Greater acidosis (lower pCO₂, lower pH)
- » New onset diabetes
- » Longer duration of symptoms
- » Sick appearance
- » More severe evidence of dehydration (increased hematocrit, increased urea)

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

- » Headache, vomiting
- » Confusion, **GCS <14**, acute deterioration in mental status during treatment
- » Irritability in young children (not consolable by their caregiver)

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



- » **DO NOT** use IV bolus of insulin
- » **DO NOT** use early IV insulin infusion (within 1st hour of administration of IV fluids)
- » **DO NOT** use sodium bicarbonate to treat acidosis

» TREAT SUSPECTED CEREBRAL EDEMA

- » Manage ABCs.
- » Elevate the head of the bed.
- » If there is evidence of hypoperfusion (tachycardia, capillary refill > 2 sec, cool extremities), then give **0.9% NS 10 mL/kg IV** bolus over 30 min and repeat x 1 if hypoperfusion persists. Discuss further fluid management with pediatric diabetes specialist.
- » If there is no evidence of hypoperfusion, restrict IV fluid by giving 60% of rate from weight-based rehydration table on previous page.
- » 3% NS (5 mL/kg IV over 15 min) and/or Mannitol (0.5-1 gm/kg IV over 20 min).
- » 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).
- » Head CT (not required prior to transport; should be done at Pediatric Referral Centre).

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**.
- » Patients may be discharged home following resolution of acidosis (HCO₃⁻ ≥18), identification and treatment of any underlying cause of the DKA episode (i.e. infection) and arrangement of close follow-up with a **pediatric diabetes specialist**.

CRITERIA FOR HOSPITAL ADMISSION:

- » All but very mild DKA patients are admitted to hospital for treatment and close monitoring.

CRITERIA FOR TRANSFER TO CHILDREN'S HOSPITAL INTENSIVE CARE:

- » Severe DKA (**pH <7.10, HCO₃⁻ <5**) with or without signs of cerebral edema (headache, vomiting, GCS < 14, 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 healthcare 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. The TREKK Network is not liable for any damages, claims, liabilities, costs or obligations arising from the use of this document including loss or damages arising from any claims made by a third party. The TREKK Network also assumes no responsibility or liability for changes made to this document without its consent. This summary is based on:

- 1) Kuppermann et al. [Clinical trial of fluid infusion rates for pediatric diabetic ketoacidosis](#). New England Journal of Medicine 2018; 378(24);2275-2287.
- 2) Diabetes Canada. [Clinical practice guidelines: Type 1 Diabetes in children and adolescents](#). Available online: <http://guidelines.diabetes.ca/cpg>. Accessed June 06, 2018.
- 3) Wolfsdorf JI, Glaser N, Agus M, Fritsch M, Hanas R, Rewers A, Sperling MA, Codner E. [Diabetic Ketoacidosis and Hyperglycemic Hyperosmolar State: A Consensus Statement from the International Society for Pediatric and Adolescent Diabetes](#). *Pediatr Diabetes*. 2018 Jun 13. [Epub ahead of print].

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