IWK Health

Diabetic Ketoacidosis (DKA)
Management 0 to 19 years
Emergency Department − Pediatrics HIGH ALERT

K07002307 Jun/7/2002 M
SCA,TEST Visit
ER0000145/12 **HCN:** 22222222
Van den Hof, TEST / TEST, Maureen
Dec/8/2012

Patient: _____

❑ Alert Record Reviewed ❑ No Allergies Known

❑ Allergies−Adverse Reactions−Cautions: _____

Age _____ Patient's Weight _____ kg Date of Patient's Weight _____

DIAGNOSIS: _____

Items preceded by a **bullet** (•) are active orders. Items preceded by a **checkbox** (❑) are only actioned if checked (√). Orders with a time stamp and initial will only be actioned once initialed.

Consult • Pediatric Diabetes/Endocrinology (Time:_____) **AND**

❑ PICU − *consider* if pH less than 7.1, under 5 years of age, hypotension, suspected cerebral edema (Time:_____)

Diet and Activity: • NPO • Bed rest ❑ Bathroom privileges ❑ Ice chips

Vital Signs / Monitoring

- Cardiorespiratory monitor
- HR, RR, BP, neurovitals including headache assessment and Glasgow Coma Scale (GCS) initially and q1h
- Assess for cerebral edema initially AND with any change in level of consciousness (LOC) (see page 2)
- Strict Ins & Outs
- Weight q12h

Investigations *Ward Clerk please enter orders* (RN record results on DKA flow sheet):

❑ urea, creatinine, urinalysis

❑ STAT Na, Cl, K, glucose, venous or capillary blood gas, serum osmolality x 1 then STAT ❑ q1h or ❑ q___h

❑ Bedside blood glucose q1h

❑ Bedside blood ketones initially then ❑ q2h OR ❑ urine ketones with each void

❑ Insert second IV as saline lock for ongoing bloodwork or use capillary blood sampling, if needed

❑ Other _____

Step 1: Initial Fluid Resuscitation − All Patients

❑ NaCl 0.9% _____ mL IV over 30 min (10 mL/kg, max 1000 mL or at maximum pump rate)

• Prescriber to reassess need for repeat bolus if persistent tachycardia or other signs of hypoperfusion

Time Initial Surname

_____ _____ _____ NaCl 0.9% _____ mL IV over 30 min (10 mL/kg, maximum 1000 mL)

Step 2a: Rehydration Fluids

- **Usual initial fluid is NaCl 0.9%. Calculate rate using table below**

Time Initial Surname

_____ _____ _____ NaCl 0.9% _____ mL/h IV

_____ _____ _____ NaCl 0.9% with 40 mmol KCL/liter _____ mL/h IV

_____ _____ _____ Dextrose 10% in NaCl 0.9% with 40 mmol KCl/liter _____ mL/h IV

Rehydration Table	
Weight	**mL/kg/h**
Less than 10 kg	6.5
10 to less than 20 kg	6
20 to less than 40 kg	5
Greater than 40 kg	4 (max 250 mL/h)

− Rehydrate with NaCl 0.9% until blood glucose less than 15 mmol/L OR when blood glucose is less than 25 mmol/L and is decreasing quickly by more than 5 mmol/L/h. Then change to dextrose 10% in NaCl 0.9%

− Add potassium (40 mmol/L) to IV fluid as soon as patient voids and serum potassium less than 5 mmol/L

− After 6 hours, consider decreasing to NaCl 0.45% if sodium rising and hyperchloremic

****SEE PAGE 2 FOR ONGOING ORDERS****

_____ _____ _____ _____

DATE (yyyy/MON/dd) Time (24hour/hh:mm) Prescriber Signature Printed Surname/Registration#

_____ _____ _____ _____

DATE (yyyy)/MON/dd Time (24hour/hh:mm) Verified By (Signature) Printed Surname

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Age _____ Patient's Weight _____ kg Date of Patient's Weight _____

ONGOING ORDERS

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Step 2b: Insulin

- **Discontinue all previous insulin orders and discontinue subcutaneous insulin pump**
- Do NOT start insulin until 1 hour AFTER IV fluids started
- Prime all new insulin tubing
- If glucose drops by more than 10 mmol/L after first hour of IV fluids, notify prescriber (Consider initial rate of 0.05 units/kg/h)
- If glucose drops by more than 5 mmol/L in 1 hour while on insulin infusion, notify prescriber
- **If glucose is less than 6 mmol/L stop insulin infusion temporarily and call prescriber**

- **Insulin, regular 1 unit/mL IV** at: ❑ **0.1 units/kg/h**
  ❑ **0.05 units/kg/h** (consider if less than 5 years, hypokalemia or severe DKA) ❑ _____ **units/kg/h**

Ongoing Fluid Orders: Sodium Management

- AFTER first 6 hours, consider reducing sodium to NaCl 0.45% if measured sodium rising and patient hyperchloremic

Time	Initial	Surname	
_____	_____	_____	D10W + NaCl 0.45% + KCl 40 mmol/L at _____ mL/hour IV
_____	_____	_____	Other: _____ at _____ mL/hour IV

Suspected Cerebral Edema

Suspect cerebral edema if GCS less than 14 and / or irritability in younger children; and / or Cushing's triad (increased BP, decreased HR, decreased RR) or severe or worsening headache

- Raise head of bed to 30 degrees
- Move to the resuscitation area (if in ED) and notify most responsible prescriber
- One to one nursing
- Call PICU and Endocrinology if not already consulted
- MD to assess perfusion status. If no signs of hypoperfusion, run IV fluids at 60% of initial rehydration rate

Time	Initial	Surname	
_____	____	_____	Other:_____ at _____ mL/h IV

Fluid Rates in Suspected Cerebral Edema
(60% of ususal rehydration rate)

Weight	mL/kg/hour
Less than 10 kg	3.9
10 to Less than 20 kg	3.6
20 to Less than 40 kg	3
Greater than 40 kg	2.4 (max 250 mL/h)

Consider

Time	Initial	Surname	
____	_____	_____	**NaCl 3% (hypertonic saline)**____ mL (5 mL/kg, MAX 250 mL) IV over 10 minutes ***OR***
____	_____	_____	mannitol _____ grams (0.5 to 1 gram/kg) IV over 15 minutes

DATE (yyyy/MON/dd)	Time (24hour/hh:mm)	Prescriber Signature	Printed Surname/Registration#
DATE (yyyy/MON/dd)	Time (24hour/hh:mm)	Verified By (Signature)	Printed Surname

Patient: _____

❑ Alert Record Reviewed ❑ No Allergies Known

❑ Allergies−Adverse Reactions−Cautions: _____

Age _____ Patient's Weight _____ kg Date of Patient's Weight _____

DIAGNOSIS: _____

Items preceded by a **bullet** (•) are active orders. Items preceded by a **checkbox** (❑) are only actioned if checked (√). Orders with a time stamp and initial will only be actioned once initialed.

Transfer Orders from ED to Inpatient Care Area

Diet
- NPO

❑ Ice chips

Activity
- Bedrest

❑ Bathroom privileges

Vital Signs / Monitoring
- Cardiorespiratory monitor
- HR, RR, BP, neurovitals including headache assessment and Glasgow Coma Scale (GCS) q1h
- Assess for cerebral edema initially on transfer AND with any change in level of consciousness (LOC) (see page 2)
- Strict Ins & Outs
- Weight q12h

Investigations *Ward Clerk please enter orders* (RN record results on DKA flow sheet):
- Electrolyte, glucose, venous / capillary blood gas, urea, creatinine, serum osmolality
  ❑ q1h ❑ q2h ❑ q4h
- Bedside blood glucose q1h
- Bedside blood ketones initially then ❑ q2h OR ❑ urine ketones with each void

Insulin
- **Insulin, regular 1 unit/mL IV** at:
  - ❑ **0.1 units/kg/h**
  - ❑ **0.05 units/kg/h** (consider if less than 5 years, hypokalemia or severe DKA)
  - ❑ _____ **units/kg/h**

IV Fluid
- _____ at _____ mL/h IV

DATE (yyyy/MON/dd)	Time (24hour/hh:mm)	Prescriber Signature	Printed Surname/Registration#
DATE (yyyy)/MON/dd	Time (24hour/hh:mm)	Verified By (Signature)	Printed Surname

ED and Early Management of Pediatric Diabetic Ketoacidosis (DKA) Algorithm

**Adapted with permission from TREKK for IWK Health Centre*

Recognition of DKA:

DKA can occur in existing or new onset type 1 or type 2 diabetes

Diagnostic criteria: Diabetes (random blood glucose greater than or equal to 11.1 mmol/L) + Ketonuria + Acidosis

Clinical Features: Polyuria, polydipsia, weight loss, dehydration, Kussmaul breathing, headache, decreased level of consciousnes, abdominal pain, vomiting

Alert Pediatric Referral Centre

DKA Severity:

	Mild	Moderate	Severe
pH	7.2 to 7.29	7.1 to 7.19	less than 7.1
HCO_3	10 to 14	5 to 9	less than 5

Hyperosmolar Hyperglycemic State (HHS)
Consider if:
- Glucose greater than or equal to 33 mmol/L; HCO_3 greater than 15
- Minimal acidosis/ketosis; negative or trace urine ketones
- Osmolality greater than or equal to 330 mOsm/L

Discuss with Pediatric Referral Centre

Initial Management:

- Assess ABCs, vital signs (including BP) + neurovitals (GCS, pupils)
- Rapid bedside glucose, *bedside blood ketones
- O_2 10 to 15 Lpm non−rebreather mask (if signs of shock)

- IV access x 2 lines (consider intraosseous if unsuccessful)
- Serum glucose, electrolytes, venous gas, urea, creatinine, serum osmolality
- Urinalysis for glucose, ketones; bladder catheterization if needed

- Consider other investigations
  - − Obtain cultures (e.g. blood, urine, throat) if clinical evidence of infection
  - − ECG for baseline assessment of K+ status (if delay in obtaining serum K+)

CAUTION!
Intubation and ventilation are ***high−risk procedures*** for DKA patients, and should never be undertaken without consultaion with your pediatric referral centre or transport team

Signs of CEREBRAL EDEMA?

- GCS less than 14 and/or irritability in younger children. And/or Cushing's triad: ↑ BP, ↓HR, ↓ RR

YES

Cerebral Edema Management

- Call Pediatric Referral Centre
- Assess and manage ABCs
- Bed rest, elevate head of bed to 30°
- If hypoperfused (tachycardia, cap refill greater than 2 sec, cool extremities), give 10 mL/kg NaCl 0.9% bolus over 30 minutes; reassess after bolus and repeat x 1 if persistent hypoperfusion. Discuss further fluid management with Pediatric Referral Centre.
- Run IV fluids at 60% of rate outlined in Rehydration Table
- NaCl 3% (5 mL/kg IV over 10 minutes) OR Mannitol (0.5 to 1 g/kg IV over 15 minutes)
- Start insulin infusion 0.1 units/kg/hour IV after 1 hour of IV fluids
- Head CT not required prior to transport

NO

Fluid Resuscitation (Based on recent evidence)

Administer 10 mL/kg NaCl 0.9% bolus over 30 minutes

Peristent tachycardia, or other signs of hypoperfusion (cap refill greater than 2 sec or cool extremities)?

NO

Rehydration Table: Total IV Fluids

Weight	mL/kg/hour
5 to less than 10 kg	6.5
10 to less than 20 kg	6
20 to less than 40 kg	5
greater than or equal to 40 kg	4 (MAX 250 mL/h)

YES

Repeat 10 mL/kg NaCl 0.9% bolus over 30 min. Reassess after each bolus and repeat if persistent hypoperfusion. Discuss with Pediatric Referral Centre

Pediatric Referral Centre Discussion

CONSIDERATION OF:
- Difficult vascular access
- Additional treatment of cerebral edema
- Airway management
- Ongoing fluid management

IV Fluids and Insulin

- Rehydrate with IV NaCl 0.9% until **glucose less than 15 mmol/L or decreases by greater than 5 mmol/L/hour once the glucose is less than 25 mmol/L.** Then change to **D10W/NaCl 0.9%**
- Add 40 mmol/L KCl into IV fluid (if K+ less than 5 mmol/L and patient has voided in ED)
- Start insulin **infusion 0.1 units/kg/hour IV after 1 hour of IV fluids**

NEVER use IV insulin bolus
NEVER administer sodium bicarbonate

Ongoing Monitoring Until Transfer

- Q 1 hour: Blood glucose, Fluid ins and outs, Neurovitals (GCS, pupils), HR and BP
- Q 2 to 4 hours: Electrolytes and venous gas, Monitor ECG for T−wave changes

Dedicate one IV line to use as saline lock for serial bloodwork

Adapted from: A PedsPacs TREKK Resource. Published: Dec. 2018
Version 1.0.

Ongoing Management: Pediatric DKA Algorithm

Refer to TREKK Pediatric DKA Algorithm for Initial Management

IWK Health Centre

DKA: Monitoring

Ongoing Monitoring (until resolution of acidosis)

- **q1h:** HR, BP, bedside glucose, neurovitals, fluid ins and outs
  - *If any decline in GCS, go to DKA with suspected cerebral injury*
- **q1 to 2h x 2 then q1 to 4h:**
  - Blood gas, glucose (BG), Na, K, Cl, urea, creatinine, osmolality, urine or blood ketones
- Calculate anion gap and measure bedside blood ketones to assess acidosis and guide weaning of insulin infusion

To distinguish ongoing DKA from hyperchloremic acidosis:

	Anion gap	Blood ketones
DKA	greater than 12	greater than 1 mmol/L
Hyperchloremic acidosis	less than or equal to 12	less than 1 mmol/L

DKA: Ongoing Fluid Management

RATE: Fluid Resuscitation Table (from TREKK DKA Algorithm)

Weight	less than 10 kg	10 kg to less than 20 kg	20 kg to less than 40 kg	40 kg or more
mL/kg/h	6.5	6	5	4 (MAX 250 mL/h)

3 principal elements of IV fluids to consider:

a) *Saline concentration:*

- FIRST 6 HOURS: **NaCl 0.9%**
- AFTER 6 HOURS: consider changing to solution containing NaCl 0.45% (to reduce the risk of hyperchloremic acidosis)
- Note measured sodium should rise, if not keep NaCl 0.9%

b) *Potassium*

- Add KCl only after patient voids and serum K less than 5 mmol/L
- At least **40 mmol/L KCl** is typically required
- Optional 50:50 mix of 20 mmol/L KCl plus 20 mmol/L Kphos

Note: Patients in DKA are at high risk of HYPOkalemia. Frequent monitoring and attention to serum K is essential. If HYPOkalemia persists despite maximum rate of K replacement (60 mmol/L in peripheral IV), then the insulin infusion rate should be reduced. Also consider oral supplements.

c) *Dextrose*

ADD D5W or D10W to NaCl 0.9% or NaCl 0.45% when

- Blood glucose less than 15 mmol/L **OR**
- Blood glucose decreasing greater than 5 mmol/L/hour

Insulin

- Dilute 50 units of regular humulin insulin in 50 mL NaCl 0.9% for 1 unit/mL. Flush tubing with 5 mL of insulin solution
- **Dose: 0.1 units/kg/hour****
  - Continue this dose until DKA corrected (pH greater than 7.30, HCO_3 greater than 15 mmol/L, bedside blood ketones less than 1 mmol/L and/or anion gap less than or equal to 12)
  - Target glucose of 8 to 14 mmol/L

  Note: Patients in DKA are at risk of persistent hyperchloremic metabolic acidosis. Blood ketones & anion gap are better indicators of DKA correction than pH and HCO_3 alone
- Convert to subcutaneous insulin once DKA is corrected and patient able to tolerate oral fluids. If this occurs between usual meal insulin times, ↓ insulin infusion by 25 to 50% every 1 to 2 hours to keep blood glucose in target range until insulin is due
- Discontinue insulin infusion and IV fluids 30 minutes after subcutaneous rapid acting insulin is given

***In very young patients, those with HYPOkalemia, or correcting acidosis but inability to maintain BG with D12.5% solution, consider rates of insulin 0.05 units/kg/hour*

DKA with Suspected Cerebral Injury

Recognition:

- May be clinically apparent at presentation, or develop within first 12 to 24 hours of treatment
- Risk factors for cerebral injury:
  - Greater acidosis (lower pH and pCO_2)
  - More severe dehydration
  - Young age (less than 5 years)
  - New onset diabetes

Warning signs:

- Headache, irritability or altered behaviour, somnolence, decreasing level of consciousness
- Abnormal vital signs and blurred disc margins are LATE signs
- Immediate management is essential if cerebral injury is suspected. CT head is not helpful in acute management and should be deferred

Immediate Management – High Suspicion of Cerebral Injury

- Move to place of intensive monitoring, call emergency response team if available; RN and MD at bedside.
- Assess and support ABCs. The need for intubation is RARE (see Page 1)
- Initiate intensive monitoring
- Raise head of bed to greater than 30°
- Give NaCl 3% 5 mL/kg IV over 10 minutes. *If only one IV line, hold maintenance fluids during NaCl 3% infusion*. Alternative: Mannitol 0.5 to 1 g/kg IV over 15 minutes
- Consult PICU

Ongoing Monitoring

- Cardiorespiratory monitor, more frequent neurovitals
- Biochemical monitoring as for DKA
- Consider head imaging once stable

Ongoing Fluid Management

- Refer to page 1 for initial guidelines
- Provide fluid boluses if needed for perfusion, **THEN**
- Adjust IV fluids to 60% or to maintain normal BP, but avoid overhydration
- Fluid choice:
  - **NaCl 0.9%** OR **D10W/NaCl 0.9%** + **40 mmol/L KCL** (as pr glucose criteria on Page 1)
- Potassium – as per DKA

Insulin

- Dose 0.05 to 0.1 units//kg/hour

Adapted from CPEG Pediatric DKA Algorithm Version 8: June 20, 2019 and TREKK Resource.