Adult Diabetic Ketoacidosis (DKA) Hyperosmolar Hyperglycemia State (HHS) Standard Orders

These orders are to be used as a guideline and do not replace sound clinical judgement and professional practice standards. Patient allergy and contraindications must be considered when completing these orders.

■Automatically activated (If not in agreement with an order cross out and initial). ☐ Requires a check (√) for activation

Allergies: ☐ **Unknown** ☐ **No** ☐ **Yes (describe)**_____ **Height (cm):** _____**Weight (kg):**_____

MEDICATION ORDERS

INITIAL IV Fluids

Severe deficit (Shock)

☐ 500mL 0.9% sodium chloride IV bolus every 15 minutes until MAP greater than 70 mmHg (prescriber to assess after each bolus)

☐ 250 mL 0.9% sodium chloride IV every 15 minutes for patients with *chronic renal failure* or *congestive heart failure* (prescriber to assess after each bolus)

Mild to moderate deficit

☐ 0.9% sodium chloride at 500 ml/hour for 4 hours, then 250 mL/hour for 4 hours

☐ 0.9% sodium chloride at _____ mL/hour for ____ hours.

MAINTENANCE IV Fluids (start after all boluses have been administered and patient is euvolemic – urinary output exceeds 50 mL/hour)

Patient's Corrected Sodium: *Current Sodium + [0.3 x (current Glucose – 5)] = _____ mmol/L*

Potassium (mmol/L)	Corrected Na less than 140 mmol/L	Corrected Na 140 mmol/L or greater
Less than 3.3	☐ 0.9% sodium chloride + 40 mmol/L KCl IV at _____mL/hour	☐ 0.45% sodium chloride* + 40 mmol/L KCl IV at ____ mL/hour
3.3 to 5.5	☐ 0.9% sodium chloride + 20 mmol/L KCl IV at _____mL/hour	☐ 0.45% sodium chloride + 20 mmol/L KCl IV at _____mL/hour
Greater than 5.5	☐ 0.9% sodium chloride IV at ____mL/hour (no potassium supplement)	☐ 0.45% sodium chloride IV at ____mL/hour (no potassium supplement)

* 0.45% sodium chloride + 40 mmol/L KCl prepared by pharmacy when available, nurse can prepare after hours accessing supply from pharmacy and + 20 mmol/L available at Regional Centres

☐ *When blood* ***glucose less than 14 mmol/L,*** change maintenance fluids to include 5% Dextrose solution at _____ mL/hour (suggested 125 mL/hour) as above to maintain plasma glucose of 12 to 14 mmol/L

INSULIN INFUSION (ensure potassium is over 3.3 mmol/L before starting insulin)

■ Insulin regular infusion at _____ units/hour IV (usual 0.1 units/kg/hour) **until glucose is less than 14 mmol/L**

■ Decrease insulin infusion rate to 0.05 units/kg/hour x ____kg = ____units/hour IV until resolution of ketoacidosis (anion gap 12 to 15 mEq/L) AND glucose between 12 to 14 mmol/L according to table below:

Glucose mmol/L	Insulin adjustment
Less than 7 mmol/L (anytime)	Consult prescriber
7 to 9.9	Decrease rate by 1 unit/hour
10 to 11.9	Decrease rate by 0.5 unit/hour
12 to 14	Maintain current rate
14.1 to 16	Increase rate by 0.5 unit/hour
16.1 to 18	Increase rate by 1 units/hour
Above 18	Consult prescriber

■ DO NOT stop insulin infusion if hypoglycemia develops.

GENERAL ORDERS

Immediate Management

■ Establish IV access, initiate IV fluids

☐ Continuous cardiac monitoring and hourly vital signs, neurochecks, ins and outs until DKA resolved

☐ Beta hydroxybutyrate

Initial Investigations

■ Bedside capillary blood glucose
■ CBC and differential
■ Chem-7 (Na, K, Cl, Total CO_2, BUN, glucose, Creatinine), Mg, PO_4, serum osmolality, anion gap, Serum Liver Function Tests, venous blood gas with lactate
■ Urine dipstick for ketones
☐ Urinalysis
☐ Hba1c (if not done within past 3 months)
☐ Serum HCG (women in childbearing years)
☐ Troponin
☐ CXR
☐ EKG
☐ Blood culture and sensitivity
☐ Urine culture and sensitivity
☐ Other_____

Ongoing Monitoring

☐ Admission to SCU once initial investigations have been completed and patient is stabilized
■ Bedside capillary blood glucose q1h until blood glucose less than 14 mmol/L, then decrease to q ___ hour
■ Chem-7, PO_4, Mg, Ca, serum osmolality, anion gap, venous blood gas q2h x ___h or until blood glucose is less than 14 mmol/L, then repeat blood work q ___ hour until anion gap is between 12-15, then discontinue.
■ Physician to reassess IV fluid & insulin q2h
■ Consider precipitating causes (see page 2)
■ **Notify prescriber if**
  - Glucose less than 7 mmol/L or above 18 mmol/L
  - Glucose decreases by greater than 5 mmol/h
  - Glucose remains unchanged or increases
  - Potassium less than 5.5 mmol/L
  - Sodium decreases by greater than 2 mmol/h
  - Sodium does not begin to trend downward after initial 6 hours

Consults

■ Dietary consult (start diet once anion gap is closed and nausea/vomiting has resolved)
■ Referral to Diabetes Education program

PRESCRIBER'S SIGNATURE: _____ PRINTED NAME: _____ Date _____ Time _____

Order Transcribed Date: _____Time: _____ Init_____ FAX/SCAN TO PHARMACY Date: _____Time: _____Init_____

MILD	MODERATE	SEVERE
pH 7.25 to 7.3 sBicarb 15 to 18 mEq/L	pH 7 to 7.24 sBicarb between 10 and 15 mEq/L	pH less than 7 sBicarb less than 10 mEq/L

SUSPECT DKA OR HHS IN ALL ILL PATIENTS WITH HYPERGLYCEMIA (usually):

DKA	HHS
Ketoacidosis	Minimal acid-base problem
Extracellular fluid volume (ECFV) contraction	ECFV contraction
Milder hyperosmolarity	Hyperosmolarity
Normal to high glucose	Marked hyperglycemia
May have decrease level of consciousness (LOC)	Marked decrease in LOC
Beware hypokalemia	Beware hypokalemia
Must use insulin	May need insulin
Absolute insulin deficiency plus increased glucagon	Relative insulin deficiency

PRECIPITATING FACTORS of DKA:

New diagnosis of diabetes	Insulin omission
Infection	Myocardial infarction
ECG changes may reflect hyperkalemia	Small increase in troponin may occur without overt ischemia
Thyrotoxicosis	Drugs
SGLT2 Inhibitors (canagliflozin, dapagliflozin, empagliflozin)	

COMPLICATIONS OF DKA:

Hyper/hypokalemia	ECFV overexpansion	Cerebral edema	Hypoglycemia	Pulmonary embolism
Aspiration	Hypocalcemia (if phosphate used)	Stroke	Acute renal failure	Deep vein thrombosis

TARGETS:

- Glucose 12 – 14 mmol/L
- pH greater than 7.3
- Anion gap less than 12 (resolution of ketoacidosis)
- Bicarbonate greater than 18 mmol/L

IV FLUID CONSIDERATIONS:

- Initial potassium replacement added to maintenance IV fluids if patient passing urine
- **Maximum rate of potassium infusion: 40 mmol/hour**
- Recommended fluid rate is 100 to 500 mL/hour to match urinary output, subsequent changes require a new order
- Routine replacement of bicarbonate and phosphorus is not recommended
- Initial Fluid requirements may be between 20 mL to 50 mL/kg depending on fluid deficit
- Use 0.45% NS if Corrected sodium is normal or high and rate of fall of effective plasma osmolality is less than 3 mmol/kg/h
- Use 0.9% NS if corrected sodium is low or rate of fall of effective plasma osmolality is 3 mmol/kg/h or greater
- Add D5W once plasma glucose reaches 14 mmol/L to maintain plasma glucose of 12-14 mmol/
- Give 20 – 40 mmol of potassium in each litre of IV fluid to keep serum potassium between 3.3 and 5.5 mmol/L

INSULIN INFUSION CONSIDERATIONS:

- Aim to decrease glucose by 2 – 3 mmol/L per hour
- After 1 hour, if glucose has not decreased by 2 mmol/L or greater, then double the rate of insulin infusion
- After 1 hour, if glucose has decreased by 4 mmol/L or greater, then decrease the rate of insulin infusion by half
- DO NOT stop insulin infusion if hypoglycemia develops. Insulin dependent diabetics are unable to move glucose into the cells without administration of insulin. Administration of dextrose without insulin can induce DKA.
  - If blood glucose is less than 4 mmol/L, give 50 mL of 50% dextrose and decrease insulin infusion to 0.5 units/hour (order on prescriber's order sheet)
  - If blood glucose decreased to 4 – 6.9 mmol/L, give 25 mL of 50% dextrose and decrease insulin infusion rate by half (order on prescriber's order sheet)
- Subcut insulin to be initiated when patient is tolerating diet; administer basal insulin at least 2 hours before insulin infusion is discontinued (order on prescriber's order sheet)

CALCULATIONS:

Anion gap (AG) = [Na] – [Cl + HCO_3]

Serum Osmolality = [Na+] x 2 + [glucose (mmol/L)] reported as mmol/kg

Effective Plasma Osmolality = [Na] x 2 + [Glucose (mmol/L)] reported as mmol/kg

CLINICAL PRACTICE GUIDELINES RECOMMENDATIONS:

- In adults with DKA or HHS, a protocol should be followed that incorporates the following principles of treatment fluid resuscitation, avoidance of hypokalemia, insulin administration, avoidance of rapidly falling serum osmolality and search for precipitating cause.
- Point-of-care capillary beta-hydroxybutyrate may be measured in the hospital or outpatient setting in adults with type 1 diabetes with CBG greater than 14 mmol/L to screen for DKA, and a beta hydroxybutyrate greater than 1.5 mmol/L warrants further testing for DKA. Negative urine ketones should not be used to rule out DKA.
- In adults with DKA, IV NS should be administered initially at 500 mL/h for 4 hours, then 250 mL/h for 4 hours with consideration of a higher initial rate (1 to 2 L/h) in presence of shock. For adults with HHS, IV fluid administration should be individualized.
- In adults with DKA, an infusion of short acting IV insulin of 0.1 units/kg/h should be used. The insulin infusion rate should be maintained until resolution of ketosis as measured by the normalization of the plasma anion gap. One the PG concentration falls to 14 mmol/L IV dextrose should be started to avoid hypoglycemia.
- Individuals treated with SGLT2 inhibitors with symptoms of DKA should be assessed for this condition even if BG is not elevated.

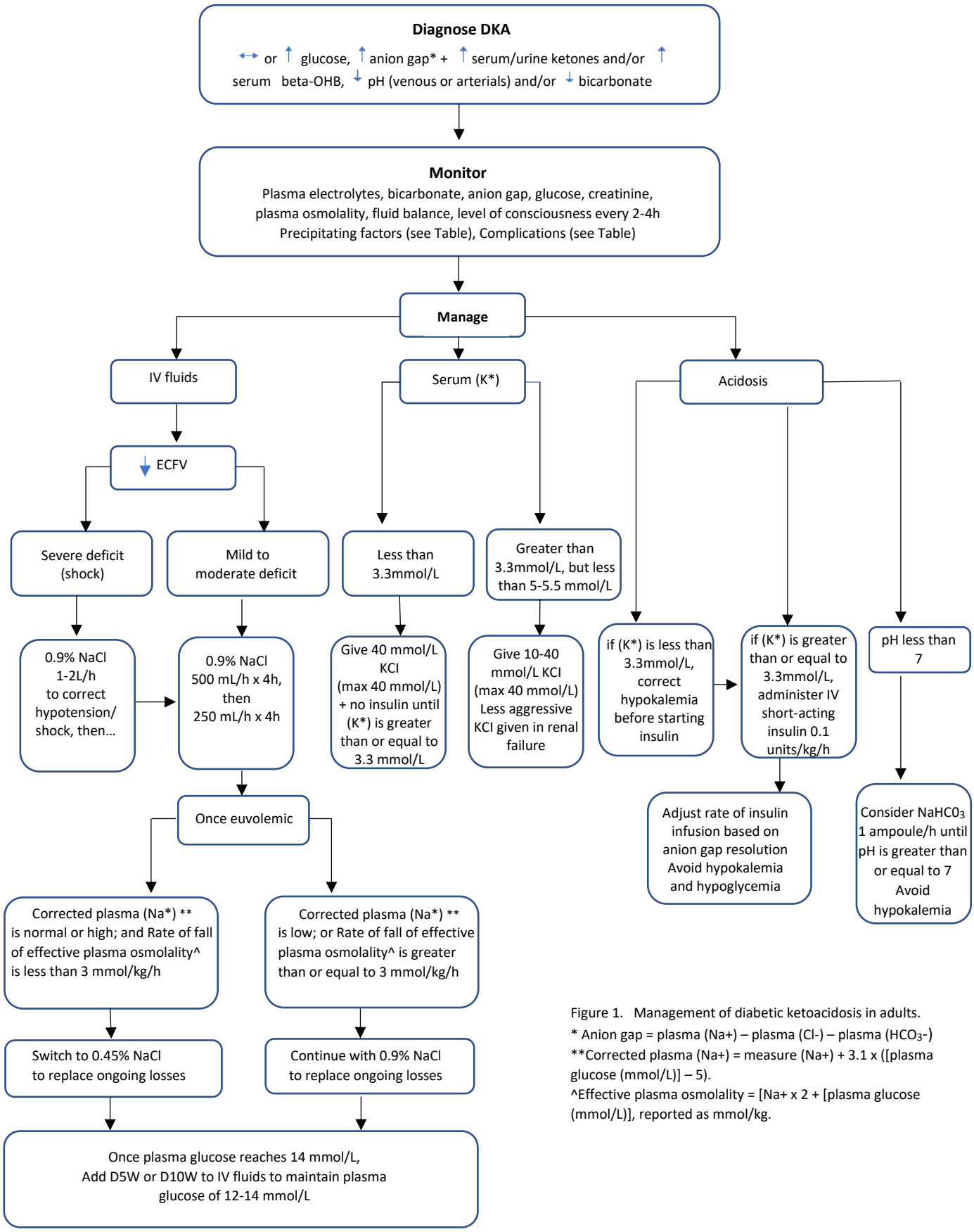

Figure 1. Management of diabetic ketoacidosis in adults.
* Anion gap = plasma (Na+) – plasma (Cl-) – plasma (HCO_3-)
**Corrected plasma (Na+) = measure (Na+) + 3.1 x ([plasma glucose (mmol/L)] – 5).
^Effective plasma osmolality = [Na+ x 2 + [plasma glucose (mmol/L)], reported as mmol/kg.

Hyperglycemic Emergencies in Adults *(Diabetes Canada Clinical Practice Guidelines Expert Committee 2018)*