

My Meter Says "HI" --- Now What?

Chlodys Johnstone, PA-C

Disclosures

- None

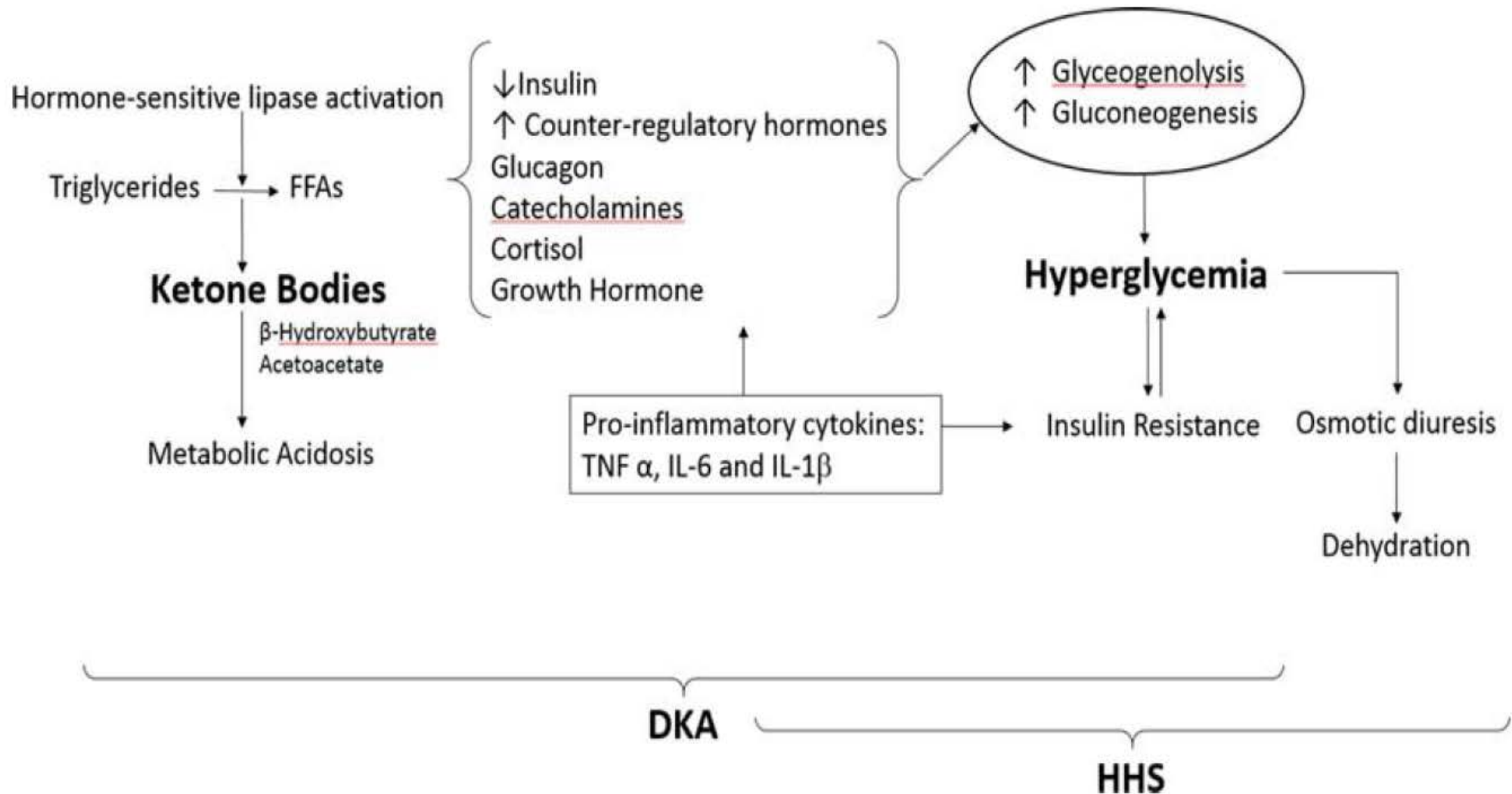
Objective

Upon completion of this activity participants will be able to identify two types of diabetic emergencies presenting with hyperglycemia.

Triaging Hyperglycemia

Can this be dealt with in outpatient setting or does the warrant a trip to the ER/hospitalization?

Is this diabetic ketoacidosis or hyperosmolar hyperglycemic state?



Fayfman M, Pasquel FJ, Umpierrez GE. Management of hyperglycemic crises: Diabetic ketoacidosis and hyperglycemic hyperosmolar state. *Med Clin North Am.* 2017;101:587-606.

Table 4. Number and rate of hospitalizations among adults aged ≥ 18 years with diagnosed diabetes for selected causes, United States, 2014

Cause of hospitalization	No. in thousands	Crude rate per 1,000 persons with diabetes (95% CI)
Diabetes as any listed diagnosis	7,155	327.2 (311.3–343.1)
Major cardiovascular disease	1,539	70.4 (66.8–73.9)
Ischemic heart disease	400	18.3 (17.3–19.3)
Stroke	251	11.5 (10.9–12.1)
Lower-extremity amputation	108	5.0 (4.7–5.2)
Diabetic ketoacidosis	168	7.7 (7.3–8.1)

CI = confidence interval.

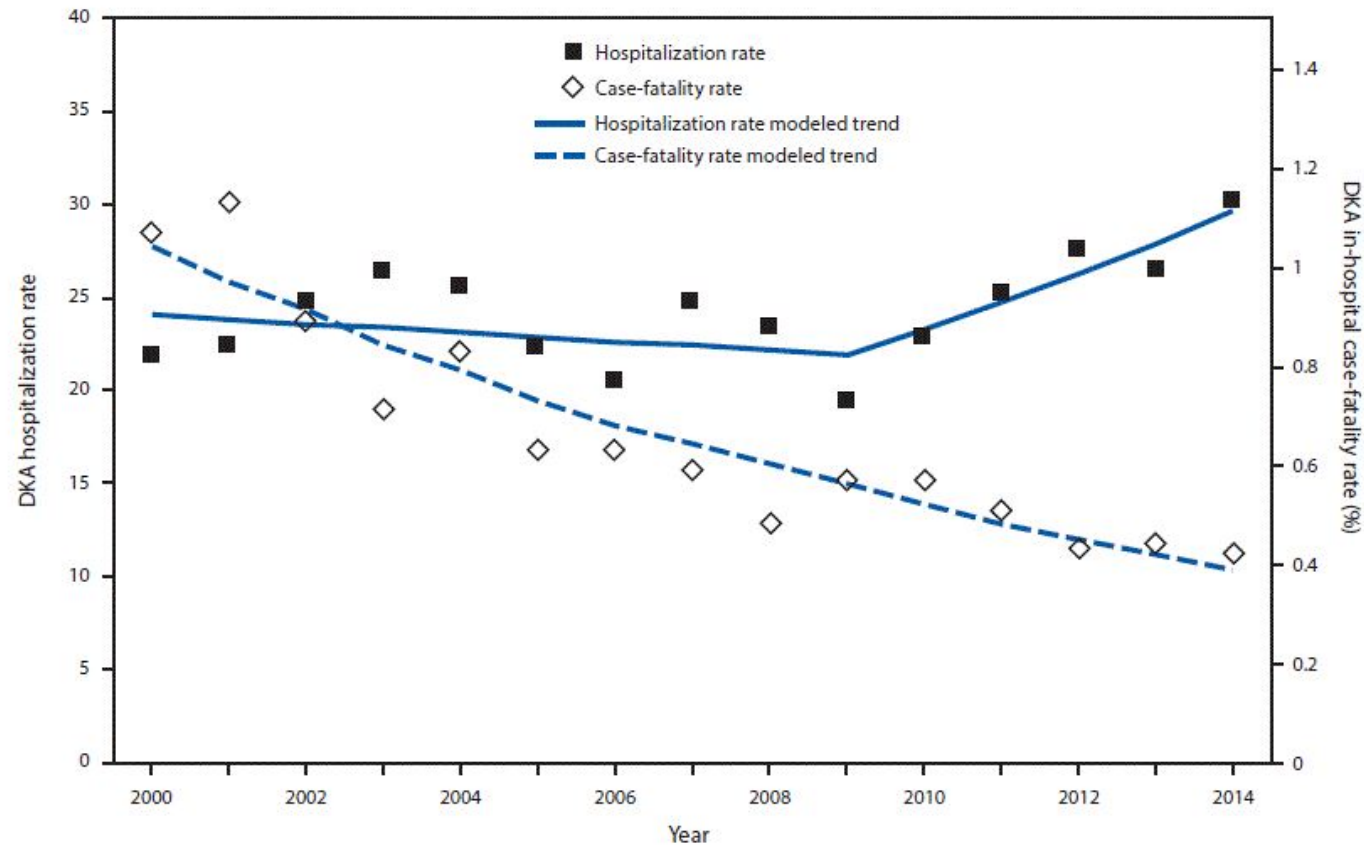
Data source: United States Diabetes Surveillance System.

Emergency Department Visits

In 2014, a total of 14.2 million emergency department visits were reported with diabetes as any listed diagnosis among adults aged 18 years or older (Table 5), including:

- 245,000 for hypoglycemia (11.2 per 1,000 persons with diabetes).
- 207,000 for hyperglycemic crisis (9.5 per 1,000 persons with diabetes).

FIGURE. Age-adjusted diabetic ketoacidosis hospitalization rate per 1,000 persons with diabetes and in-hospital case-fatality rate — United States, 2000–2014*



Abbreviation: DKA = diabetic ketoacidosis.

* Symbols indicate observed points; lines indicate modeled trends. All modeled trend lines were significant at a p-value of <0.05.

Benoit SR, Zhang Y, Geiss LS, Gregg EW, Albright A. Trends in diabetic ketoacidosis hospitalizations and in-hospital mortality- United States, 2000-2014. *MMWR Morb Mortal Wkly Report* 2018;67:362-365.

Case 1

60 yo M w/ hx of T2DM and HFrEF from ICM secondary to CAD s/p MI now with a LVAD and ICD presents to regularly scheduled cardiology clinic follow-up. At the appointment patient's only complaint is discharge of ICD with associated dizziness the day prior. Labs drawn prior to appointment come back as follows:

WBC 8.40 k/uL, Hemoglobin 12.5 g/dL, Hematocrit 35.5%

Glucose 826 mg/dL, BUN 40 mg/dL, Cr 2.04 mg/dL, Na 117 mmol/dL, K 3.1 mmol/L, Cl 72 mmol/L, CO₂ 29 mmol/L, AG 16 mmol/L, Ca 9.2 mg/dL, AST 28 U/L, ALT 22 U/L, Alk Phos 66 U/L, Bili: 7.4 g/dL, Albumin level 3.6 g/dL, eGFR 34

The primary team wants to admit the patient due to AKI and recent shock per ICD. You are consulted for glycemic management recommendations.

The primary team is asking what else you want ordered? Does this patient have HHS?

Case 2

19 yo M with hx of T1DM diagnosed at age 12 calls clinic after-hours and reports meter level reading HI in setting of hours of N/V. Pt states he was feeling well at bedtime w/ BG 190 then he awoke at 4 am and began vomiting. He has daughter at home with viral illness.

What questions do you want ask?

What are you using to check you blood sugar?

- Meter
- Sensor/continuous glucose monitor
- In DKA BG often greater than 250 mg/dL, notably euglycemic DKA occurs
- In HHS BG often greater than 600 mg/dL

What have your blood sugars been running?

- Helps determine if hyperglycemia is acute vs. chronic
- DKA tends to be associated with a more acute onset
- HHS tends to be a slower onset

Are you taking your diabetes medications?

- Thorough medications history for oral agents and/or insulin
- Assess for barriers to adherence-regimen complexity, cost, etc.
- Assess for malfunctions in equipment used to deliver insulin and potential human errors in administration
- Assess for integrity of insulin and/or medications given- expiration dates, heat/cold exposure
- Assess for additional medications that may influence BG

Recent illnesses?

- Illness- UTI, PNA, Pancreatitis, CVA, MI
- Poor fluid intake
- Drugs and medications- SGLT2, glucocorticoids, atypical antipsychotics, sympathomimetic agents, cocaine

Symptoms?

- Polydipsia, polyuria
- HHS- Neurologic alterations including obtundation, seizure, hemiparesis
- DKA- Abdominal pain, nausea, vomiting, and SOA
- Weight changes

Labs

- If triaging via phone call ask if urine ketone strips available
- If in healthcare facility check CMP, beta hydroxybutyric acid, plasma osmolality, ABG, CBC, A1c, EKG
- If suspecting infection consider checking UA, chest x-ray, blood cultures, respiratory panel, flu screen, rapid strep screen or culture, comp GI panel, monospot

Table 1—Diagnostic criteria for DKA and HHS

	DKA			HHS
	Mild (plasma glucose >250 mg/dl)	Moderate (plasma glucose >250 mg/dl)	Severe (plasma glucose >250 mg/dl)	Plasma glucose >600 mg/dl
Arterial pH	7.25–7.30	7.00 to <7.24	<7.00	>7.30
Serum bicarbonate (mEq/l)	15–18	10 to <15	<10	>18
Urine ketone*	Positive	Positive	Positive	Small
Serum ketone*	Positive	Positive	Positive	Small
Effective serum osmolality†	Variable	Variable	Variable	>320 mOsm/kg
Anion gap‡	>10	>12	>12	Variable
Mental status	Alert	Alert/drowsy	Stupor/coma	Stupor/coma

*Nitroprusside reaction method. †Effective serum osmolality: $2[\text{measured Na}^+ (\text{mEq/l})] + \text{glucose (mg/dl)}/18$. ‡Anion gap: $(\text{Na}^+) - [(\text{Cl}^- + \text{HCO}_3^- (\text{mEq/l}))]$. (Data adapted from ref. 13.)

Exam

- HEENT: Dry mucus membranes, fruity or acetone breath
- Cardiovascular: Tachycardia
- Lungs/ Respiratory: Tachypnea
- Skin: Dry, poor turgor
- Neuro: Lethargy, confusion

Clinical Features of Hyperglycemic Emergencies

Condition	Symptoms	Signs	Presentation
DKA	Polydipsia	Hypothermia	Acute onset (hours-days)
	Polyuria	Tachycardia	More common in T1D than T2D
	Weakness	Tachypnea	
	Weight loss	Kussmaul breathing	
	Nausea	Ileus	
	Vomiting	Acetone breath	
	Abdominal pain	Altered sensorium	
HHS	Polydipsia	Hypothermia	Insidious onset (days-weeks)
	Polyuria	Hypotension	Older age
	Weakness	Tachycardia	More common in T2D than T1D
	Weight loss	Altered sensorium	

Fayfman M, Pasquel FJ, Umpierrez GE. Management of hyperglycemic crises: Diabetic ketoacidosis and hyperglycemic hyperosmolar state. *Med Clin North Am.* 2017;101:587-606.

Case 1

60 yo M w/ hx of T2DM and ICM secondary to CAD s/p MI now with a LVAD and ICD presents to regularly scheduled cardiology clinic follow-up. Labs come back as follows:

WBC 8.40 k/uL, Hemoglobin 12.5 g/dL, Hematocrit 35.5%

Glucose 826 mg/dL, BUN 40 mg/dL, Cr 2.04 mg/dL, Na 117 mmol/dL, K 3.1 mmol/L, Cl 72 mmol/L, CO₂ 29 mmol/L, AG 16 mmol/L, Ca 9.2 mg/dL, AST 28 U/L, ALT 22 U/L, Alk Phos 66 U/L, Bili: 7.4 g/dL, Albumin level 3.6 g/dL, eGFR 34

Plasma osmolality: 297 mOsm/kg

Case 1 continued

Vitals: Temp 97.7F, HR-has LVAD, BP- has LVAD but Doppler MAP was 74, RR 14, SpO2 on RA 95%

ROS: 14 pt ROS negative with exception of bilateral lower extremity edema and dry mouth

Exam:

Gen: Pleasant male, ambulating in room w/ wife at side, NAD

HEENT: NCAT, anicteric sclera, EOMI, mucus membranes dry

Neck: No appreciable thyromegaly or lymphadenopathy

CV: LVAD hum

Resp: CTAB, normal respiratory effort on room air

Abd: Soft, NTND, BS positive

Ext: Bilateral LE with edema, stasis changes LLE, onychomycosis of toenails bilaterally

Skin: No apparent rashes or lesions

Neuro: Awake, alert and oriented x 4, interactive, moves all limbs spontaneously

Psych: Appropriate affect, mood

Case 2

19 yo M with hx of T1DM diagnosed at age 12 calls clinic after-hours and reports meter level reading HI in setting of hours of N/V. Pt states he was feeling well at bedtime w/ BG 190 then he awoke at 4 am and began vomiting. He has daughter at home with viral illness.

What questions do you want ask?

Case 2 continued

- No ketone strips
- Home regimen is insulin glargine 25 u daily, insulin lispro 1 u:15 g CHO, and 1 u:30mg/dL over 130
- States taking less than 5 u of lispro daily
- Has been “stretching insulin” as has been over 12 m since last clinic visit and currently without insurance

Case 2 continued

POC BG 430, A1c: 16.3%, Urine ketone 160 mg/dL, urine glucose 1000 mg/dL

WBC 13.15 k/uL, Abs neutrophils 11.24 k/uL, Hemoglobin 13.1 g/dL, Hematocrit 44.6%

Glucose 462 mg/dL, BUN 11 mg/dL, Cr 0.92 mg/dL, Na 130 mmol/dL, K 5.0 mmol/L, Cl 97 mmol/L, CO₂ <4 mmol/L, AG Not calc mmol/L, Ca 8.0 mg/dL, AST 16 U/L, ALT 128 U/L, Alk Phos 128 U/L, Bili: 0.2 g/dL, Albumin level 3.8 g/dL, eGFR greater than 60

Mag 2.1 mg/dL, Phos 3.0 mg/dL, Plasma osmolality 306 mOSm/kg, Lactic acid 1.0 mmol/L, Beta-Hydroxybutyric acid 7.22 mmol/L

VBG: venous pH 6.94, CO₂ 20 mmHg, O₂ 39 mm HG, O₂ Sat 57%, Base deficit 26.8 mmol/L, Bicarb 4 mmol/L

Case 2

Vitals: Temp 98.6F, HR-137, BP-134/83, RR 45, SpO2 100%

ROS: +weight loss, +SOA, +nausea, +vomiting +polyuria

Exam:

Gen: Thin young male, laying in bed, ill appearing

HEENT: NCAT, anicteric sclera, mucus membranes appear dry

Neck: Trachea midline. No appreciable thyromegaly or lymphadenopathy

CV: Tachycardic with regular rhythm. No murmur auscultated.

Resp: Tachypneic, not speaking in full sentences

Abd: Soft, NTND, BS positive. Emesis basin at side containing bilious vomit

Ext: No cyanosis or edema. Feet without lesions.

Skin: No apparent rashes, no lesions

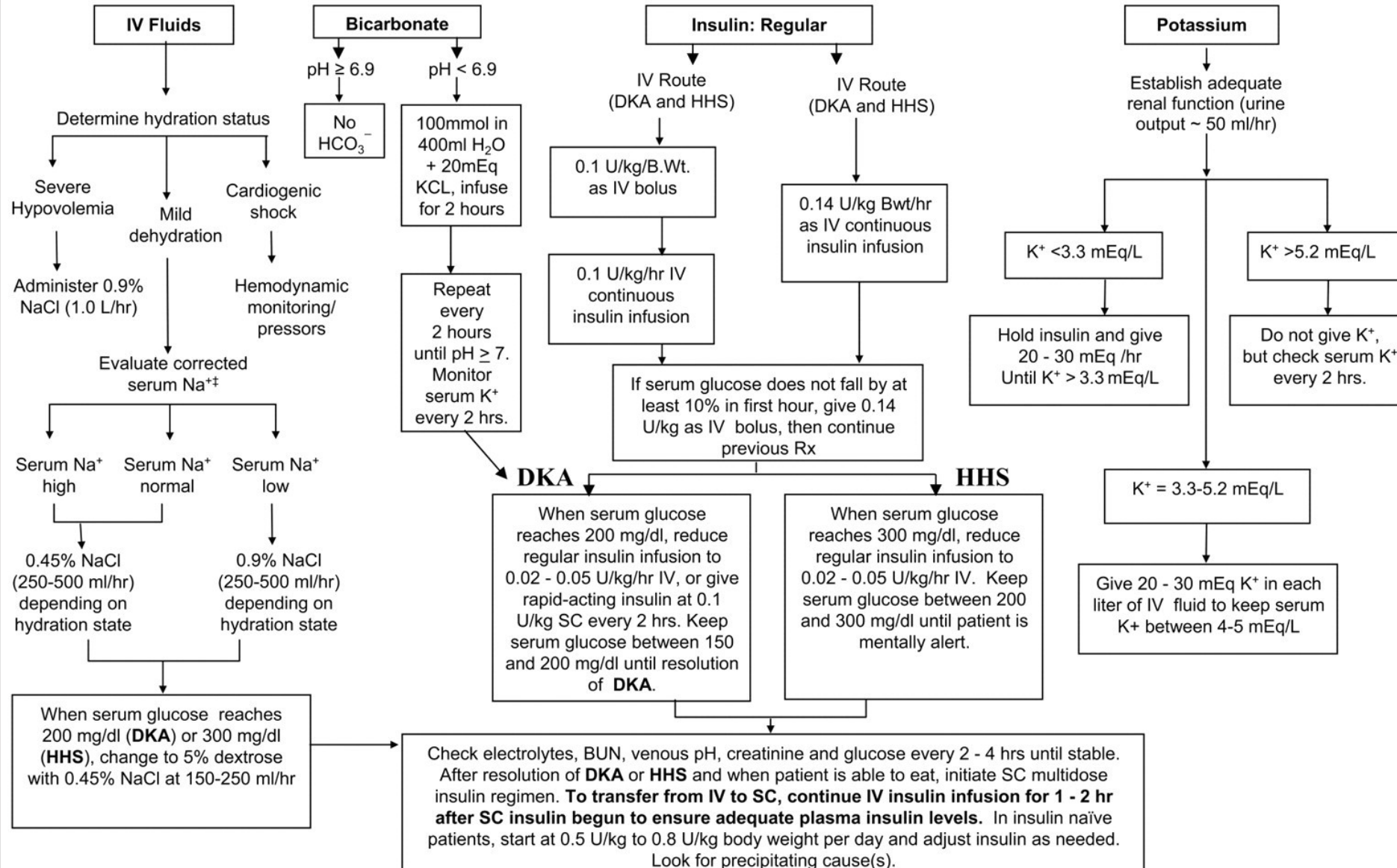
Neuro: Awake, alert and oriented x 4, interactive, moves all limbs spontaneously

Psych: Appropriate affect

Next Steps: Treatment

- If DKA/HHS patient, consider protocol based treatment
- If hyperglycemia without acute crisis, make plan for treatment and plan for f/u

Complete initial evaluation. Check capillary glucose and serum/urine ketones to confirm hyperglycemia and ketonemia/ketonuria. Obtain blood for metabolic profile. Start IV fluids: 1.0 L of 0.9% NaCl per hour.†



Most important step: Prevention

- Clear medication administration directions
- Assessment at clinical visits for barriers to care- cost, complexity of regimen
- Ensuring patients have tools to treat hyperglycemia- ketone strips, sick day rules
- Working as a clinical team- SW, pharmacists, nurses, providers, CDEs

References

1. Fayfman M, Pasquel FJ, Umpierrez GE. Management of hyperglycemic crises: Diabetic ketoacidosis and hyperglycemic hyperosmolar state. *Med Clin North Am.* 2017;101:587-606.
2. Benoit SR, Zhang Y, Geiss LS, Gregg EW, Albright A. Trends in diabetic ketoacidosis hospitalizations and in-hospital mortality- United States, 2000-2014. *MMWR Morb Mortal Wkly Report* 2018;67:362-365.
3. Center for Disease Control and Prevention. *National Diabetes Statistics Report, 2017.* Atlanta, GA: Centers for Disease Control and Prevention, US Department of Health and Human Service; 2017.
4. Kitabachi AE, Umpierrez GE, Murphy MB, et al.; American Diabetes Association. Hyperglycemic crisis in diabetes. *Diabetes Care.* 2004;27(Suppl. 1):S94-S102.
5. Kitabchi AE, Miles JM, Umpierrez GE, Fisher JN. Hyperglycemic crisis in adult patients with diabetes. *Diabetes Care.* 2009;32:1335-1343.
6. French EK, Donihi AC, Korytkowski MT. Diabetic ketoacidosis and hyperosmolar hyperglycemic syndrome: review of acute decompensated diabetes in adult patients. *BMJ.* 2019;365:l114.
7. Laffel LM, Limbert C, Phelan H, Virmani A, Wood J, Hofer SE. ISPAD Clinical Practice Consensus Guidelines 2018: Sick day management in children and adolescents with diabetes. *Pediatr Diabetes.* 2018;19(Suppl.27):193-204.
8. Pasquel FJ, Umpierrez GE. Hyperosmolar hyperglycemic state: A historic review of the clinical presentation, diagnosis, and treatment. *Diabetes Care.* 2014;37:3124-3131.