HOWARD COUNTY GENERAL HOSPITAL JOHNS HOPKINS MEDICINE	Howard County General Hospital **Patient Care Services, Nursing** **Critical Care, Adult**	*Policy Number*	ICU038
		Effective Date	02/09/2023
		Approval Date	02/06/2023
	Subject **Critical Care Management of Adult Patients with Diabetic Ketoacidosis (DKA) and Hyperosmolar Hyperglycemic State (HHS)**	*Page*	1 of 5
		Supersedes Date	N/A

This document applies to the following Participating Organizations:

Howard County General Hospital, Inc.

Keywords: anion gap, diabetes, diabetic emergency, diabetic ketoacidosis, DKA, Insulin Infusion, IV insulin

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I. PURPOSE

A. To provide standards of care for the assessment, management, and requirements of care for patients diagnosed with diabetic ketoacidosis (DKA) or hyperosmolar hyperglycemic state (HHS).

B. To ensure standard guidelines for the management of patients with DKA and HHS.

II. DEFINITIONS

DKA	Diabetic Ketoacidosis (DKA) is an acute complication with a rapid onset that occurs in patients during a diabetic emergency. It is a life-threatening complication which can occur amongst patients with either type 1 (T1D) or type 2 diabetes (T2D). It occurs when there is insufficient insulin to stop the breakdown of fats (lipolysis) as a source of fuel for the body. Consequently, there is a massive buildup of fatty acids, which then get converted into ketones. Although blood sugars are usually very elevated in DKA, in rare cases glucose levels can be normal (i.e., euglycemic DKA, such as in pregnancy, alcoholism, or SGLT2 inhibitor use). If left unchecked, DKA can progress to severe acidosis and dehydration, as well as profound electrolyte and fluid shifts, potentially resulting in coma or death.
CHF	Congestive heart failure
ESRD	End stage renal disease

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HHS	Hyperosmolar Hyperglycemic State (HHS) is an acute hyperglycemic crisis which includes hyperosmolality and severe dehydration without ketoacidosis. This occurs when glucose production and release into the blood is increased or glucose uptake by the cells is decreased. Therefore, cells do not receive glucose and the liver will respond by converting glycogen to glucose for release into the blood. When the excess glucose remains in the serum, osmosis causes fluid shifts. If the cycle continues, this can result in a coma or death. This often occurs in patients with T2D, but can also rarely occur among patients with T1D
POCT	Point of Care Testing - using a glucose meter and finger prick sample
SGLT2 Inhibitors	Abbreviation for sodium-glucose cotransporter-2 inhibitors. These are a class of medications used to lower high blood glucose levels in people with type 2 diabetes. They are sometimes called gliflozins.
T1D	Type 1 Diabetes Mellitus
T2D	Type 2 Diabetes Mellitus

III. SCOPE

Applicable to all licensed personnel within the adult nursing departments.

IV. POLICY

A. All patients receiving intravenous insulin should have 2 intravenous (IV) sites established. The first IV site is used for the delivery of the insulin (set as the primary infusion). This continuous drip should not be interrupted except for appropriate titrations per authorized provider orders. A secondary infusion should NOT be connected to the insulin tubing. Staff are to ensure there is a designated label on the distal tubing when the patient is receiving more than one infusion.

B. The authorized prescriber will order ALL INSULIN through Adult ED/ICU Diabetic Ketoacidosis (DKA) and Hyperglycemic Hyperosmolar Syndrome (HHS) Focused order set (includes goal, starting infusion dose, and bolus dose if needed). *Side Note: bolus dose is not necessary per ADA recommendations.

C. The patient must be weighed in kilograms.

D. Endocrinology must be consulted.

E. Ensure medications such as SGLT2 inhibitors (e.g, Jardiance, Farxiga [both on formulary], or Invokana or Steglatro [both non-formulary]) are discontinued during hospital stay. Provide “at-home education” on these medications, such as when to hold if the patient is nauseous or NPO as it can drive patients into a ketotic state.

F. Baseline lab-work is required before the initiation of the insulin infusion therapy:
   1. Hemoglobin A1c (if there is no record of HgA1c from the last 90 days)
   2. Complete Metabolic Panel (CMP) - electrolytes are very important among these patients as potassium can be depleted very quickly
   3. Venous blood Gases (VBG) to analyse blood pH

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G. If the patient is able to tolerate a diet, a carbohydrate-controlled diet (60g) can be ordered. There is no contraindication for a DKA/HHS patient to have a diet ordered.
   1. If a DKA/HHS patient has a diet ordered, nutritional subcutaneous insulin Novolog (aspart) is to be ordered and administered AFTER the patient has consumed 50% or more of the meal.
   2. Allowing the patient to eat will treat or prevent starvation ketosis, thereby theoretically enabling the patient to close the anion gap faster and get off the insulin drip more rapidly.

H. Upon initiation of the insulin therapy, 2 registered nurses must verify the order in the medical record. Weight will be ordered by the authorized prescriber as “dosing weight”.

I. Follow-up/Serial Labs:
   1. Every 1 hour, blood glucose monitoring (via POCT) as ordered.
   2. BMP every 4 hours
   3. A repeat VBG is ordered/checked only if the patient has severe acidosis (e.g. pH <6.9) and the patient receives a bolus of sodium bicarb, or if ordered/instructed by the authorized provider.

J. Registered nurses will monitor lab results and initiate adjustments such as insulin infusion dose changes, fluid replacements including sodium bicarbonate, dextrose, and normal saline infusions, electrolyte replacement, and insulin drip titrations.

K. **Special note about potassium**: insulin can cause rapid drop in potassium levels by stimulating movement from the intravascular to intracellular space. Therefore, nurses should replete potassium as necessary (as per the prn orders).
   1. I**f the potassium is < 3.3 mEq/L**, the potassium MUST FIRST be aggressively repleted, BEFORE initiating an insulin infusion. Severe hypokalemia can potentially result in cardiac arrhythmia and even death.

L. Notify the authorized provider when:
   1. pH less than 7
   2. Serum Creatinine greater than 1.5 mg/dL or Creatinine Clearance is less than 30 mL/min
   3. Potassium less than 3.3 mEq/L or greater than 5.8 mEq/L
   4. Glucose less than 100 mg/dL

M. Insulin infusions are considered High Alert Medications (Refer to M-01.1 policy: Medication Administration). A second nurse must independently “double check” the patient identification, blood glucose level, infusion pump dose, weight programmed into the IV infusion pump (as appropriate), line attachments and medication concentration. The double independent check is completed and documented in the MAR with “Dual sign-off" when:
   1. Insulin infusion is initiated (New Bag)
   2. Bolus dose or re-bolus dose (Bolus from the Bag)
   3. Administration of dose changed (Rate/Dose Change)
   4. Care is handed off to another nurse (Hand-off)
   5. When the infusion is restarted after a hold/pause(Restart)

V. PROCEDURE

A. IV Insulin protocol orders (specific for patient diagnosis) are ordered by the authorized prescriber. All insulin infusions **MUST BE** ordered through the Adult ED/ICU Diabetic Ketoacidosis (DKA) and Hyperglycemic Hyperosmolar Syndrome (HHS) Focused order set.

B. Establishing the WEIGHT for insulin orders:
   a. The patient’s weight is obtained (in kilograms) and documented in the medical record.
   b. If the patient cannot be weighed, use the patient’s stated or estimated weight as appropriate.
   c. The provider will use the recorded weight in the record to determine the “dosing weight” for the patient.
   d. ALWAYS ensure the weight entered in the IV infusion pump matches the weight in order.

e. Please do not change the weight once the infusion has been initiated to maintain continuity until the completion of therapy.

C. Ordering and administering the BOLUS DOSE:
   a. The authorized provider will order the bolus (if appropriate for the patient).
   b. The registered nurse will administer the BOLUS dose from the bag using the IV infusion pump with a second registered nurse who performs an independent double check and dual sign in the MAR.
   c. Bolus doses are NOT TO BE DEFAULTED in the IV infusion pump— nurses must enter the dose based on the provider order.

D. **Initiating Insulin Infusion**:
   a. Special "low sorbing" IV tubing is available for IV insulin infusion - prime the tubing with no waste. If this tubing is not available, use standard IV pump tubing and prime 25 mLs of insulin solution through the tubing prior to inserting into the pump channel and connecting to the patient. Ensure proper disposal of 25mLs of waster insulin solution. (Refer to Policy: Hazardous Drug Handling)
   b. The insulin infusion concentration is regular insulin 1 unit per 1 mL sodium chloride solution.
   c. The insulin infusion is to be administered through an IV infusion pump using the designated drug profile. Program the IV Pump with the dosing weight from the order and have a second RN verify the weight entered in the pump.
   d. IV tubing and insulin bags are changed every 24 hours.

E. Adjustments to the Insulin Infusion: see dose adjustments per order administration instructions.

F. Once the blood glucose reaches 250mg/dL, decrease the dose of the insulin and switch fluids to dextrose-containing.

G. If the blood glucose reaches below 150mg/dL, decrease the insulin dose again as per the order.

H. If the blood glucose reaches below 100mg/dL, pause (in the MAR) and the insulin infusion is stopped on the IV pump, but continue the dextrose-containing fluid (e.g., D5W1/2NS). Recheck the blood sugar in 15 minutes.

I. If the blood glucose reaches below 70mg/dL, confirm that the insulin infusion is "paused" (in MAR) & "stopped" on the IV infusion pump and that dextrose-containing fluids are running, contact the authorized prescriber, and initiate the hospital hypoglycemia management orders.

J. If the blood sugar rises (e.g., from 90 to 110mg/dL, or 145 to 155mg/dL), be sure to increase the insulin infusion dose accordingly as per the order.

K. **Stopping the insulin infusion**:
   1. For DKA: When the anion gap closes as per order, (e.g. anion gap less than or equal to 14 and serum CO2 greater than or equal to 17),administer long acting insulin; then two hours later stop the insulin infusion and IV fluids . If no long acting insulin is ordered, please contact the authorized prescriber .
   2. For HHS: confirm with the authorized provider when to stop the insulin infusion (because by definition the anion gap is already closed). Commonly the infusion is stopped once the glucose level is less than 250 mg/dL.

L. Congestive Heart Failure (CHF) or anuric End Stage Renal Disease (ESRD) patientsare at high risk of developing fluid overload and potentially pulmonary edema. Therefore, it is usually preferred to be more judicious with intravenous fluids. There is a specific order set for CHF and ESRD patients.
   a. Once the blood glucose reaches 250mg/dL or less, dextrose infusion may need to be run slower or stopped altogether.
   b. Consider Dextrose 10% (D10W) infusion at a lower rate (e.g, 75 ml/hr) instead of D5W with 0.45 NS (D5W1/2NS). Contact the authorized provider, if D10W(10%) is not ordered for the patient with CHF or ESRD and DKA.
   c. The authorized prescriber may choose to order half the typical rate or decrease the insulin drip rate in ESRD, as patients with chronic kidney disease have reduced insulin clearance (meaning that the insulin “hangs around longer in the patient”).

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VI. SUPPORTIVE INFORMATION

References

American Diabetes Association (2019). Position Statment: 15. Diabetes Care in the Hospital: Standards of Medical Care in Diabetes - 2020. Diabetes Care 2020:43 (Supplement_1):S193-S202 ADA - Diabetes Care in Hospitalized Patient

BMJ Best Practices - *Diabetes Ketoacidosis* (April 2022). https://bestpractice.bmj.com/topics/en-us/162

Tran T, et al. (2017) Review of Evidence for Adult Diabetic Ketoacidosis Management Protocols. *Front Endocrinol* (Lausanne). Jun 13;8:106.

VII. APPROVALS

Electronic Signature(s)	Date
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