THE UNIVERSITY OF TEXAS MD Anderson Cancer Center
Making Cancer History®

Hyperglycemic Emergency Management (DKA/EDKA/HHS[1]) 2-Bag Method - Adult

Disclaimer: *This algorithm has been developed for MD Anderson using a multidisciplinary approach considering circumstances particular to MD Anderson's specific patient population, services and structure, and clinical information. This is not intended to replace the independent medical or professional judgment of physicians or other health care providers in the context of individual clinical circumstances to determine a patient's care.*

PRESENTATION

Patient presenting with polyuria, polydipsia, nausea/vomiting, or abdominal pain with or without history of diabetes mellitus

WORKUP/ASSESSMENT

- History and physical including use of insulin pump[2] and/or continuous glucose monitoring (CGM) device[3]
- Basic metabolic panel with total calcium, phosphorous, magnesium, c-peptide, venous or arterial blood gas, lactate, beta-hydroxybutyrate (BHB), and osmolality
  - Notify provider if bicarbonate < 15 mEq/L
- Point of care (POC) fingerstick glucose
- Consider hemoglobin A1c, hepatic panel, lipase, triglycerides, urine HCG if clinically indicated
- Diagnostic imaging, as clinically indicated
- Strict input and output hourly
  - Notify provider if urine output < 0.5 mL/kg/hour

DIAGNOSIS

- Assess[4] the following:
  - Hydration status
  - Electrolyte status
  - Blood glucose
  - Acidosis
  - Anion gap

Does the patient have DKA, EDKA, DKA with HHS, or HHS only[5]?

TREATMENT

Yes

- Admit to ICU
- NPO status
- Discontinue all previous insulin[6] and oral diabetes medications including insulin pump disconnection if applicable
- CGM device results should not be used for clinical decision making
- Initiate DKA/EDKA/HHS order set
- Consult Endocrinology-General Service
- Consult Diabetes Educator
- POC fingerstick glucose every hour
- Neuro checks every 4 hours
- Basic metabolic panel with total calcium every 4 hours for 24 hours then every 8 hours as indicated
- Phosphorus and magnesium every 8 hours as indicated
- If DKA, EDKA, **or** DKA with HHS[5]
  - BHB **and** venous or arterial blood gas every 8 hours as indicated
  - See Page 2 for DKA, EDKA, **or** DKA with HHS[5]
- If HHS Only:
  - Osmolality every 4 hours for 24 hours
  - See Page 4 for HHS Only

No

- Continue work up for further treatment or alternative diagnosis
  - Infection
  - Insulin omission (including new onset type 1 diabetes)
  - Ischemia (cardiac, central nervous system, gastrointestinal)
  - Intra-abdominal (biliary/pancreatitis)
  - Iatrogenic (antipsychotics, steroids, checkpoint inhibitors, SGLT-2 inhibitors)
  - Indiscretion (diet, non-adherence)
- Refer to Inpatient Hyperglycemia-Adult algorithm as indicated

NPO = nothing by mouth
SGLT = sodium-glucose cotransporter

[1] Diabetic ketoacidosis (DKA), euglycemic diabetic ketoacidosis (EDKA), and hyperosmolar hyperglycemic state (HHS)
[2] Refer to Managing Patients with Insulin Pumps (ATT3663)
[3] Refer to Guidelines for Patients with a Continuous Glucose Monitor (CGM) (#ATT3587)
[4] Continue to look for the underlying cause of events
[5] See Appendix A for Diagnostic Criteria
[6] Long acting insulin should be evaluated and ordered as indicated

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Hyperglycemic Emergency Management (DKA/EDKA/HHS) 2-Bag Method - Adult

DIAGNOSIS/MANAGEMENT

DKA, EDKA, or DKA with HHS[1]

- Administer crystalloid fluids[2,3] IV bolus as clinically indicated for volume repletion
- Initiate continuous intravenous (IV) fluid infusions utilizing 2-Bag Method based on potassium level
- Percent of each IV fluid infusion rate determined by POC glucose (see Appendix C)
- Bicarbonate administration is not recommended except for treatment of severe hyperkalemia (potassium level > 5.5 mmol/L), cardiovascular collapse or as an infusion only with severe acidosis (venous pH < 6.9)

Is potassium level ≤ 4.6 mmol/L?

Yes

- 2-Bag Method (see Appendix C):
  - Bag 1: 0.45% NS with KCl 20 mEq/L
  - Bag 2: D10/0.45% NS with KCl 20 mEq/L
- Recommended total IV fluid infusion rate is 150-500 mL/hour

Is potassium level < 3.3 mmol/L?

Yes

Replete and recheck potassium[4,5] to achieve potassium level ≥ 3.3 mmol/L

No

No

- 2-Bag Method (see Appendix C):
  - Bag 1: 0.45% NS
  - Bag 2: D10/0.45% NS
- Recommended total IV infusion rate is 150-500 mL/hour
- Consider administering regular insulin 0.1 units/kg IV bolus (maximum 10 units) if potassium level > 5 mmol/L
- Stop all sources of potassium administration and treat hyperkalemia as clinically indicated
- Repeat potassium level every 2 hours until level ≤ 4.6 mmol/L
  - Consider adding potassium to IV fluids when potassium level ≤ 4.6 mmol/L

- Initiate IV insulin infusion at 0.1 units/kg/hour[6,7] (maximum initial infusion dose of 15 units/hour)
- Initiate long-acting insulin: glargine 0.125 unit/kg (maximum dose of 15 units) subcutaneous every 12 hours[8]
  - Notify Endocrinology-General Service if glucose < 100 mg/dL prior to administration **or** if dose not given for any reason
- Monitor potassium and electrolytes every 4-8 hours as clinically indicated[5]
  - Remove potassium from IV fluids if potassium level > 4.6 mmol/L
- Reassess hydration status and adjust total IV fluid rate as clinically indicated

See Page 3 for evaluation

CVAD = central venous access device
D10 = dextrose 10%
NS = normal saline [sodium chloride (NaCl)]
KCl = potassium chloride
KPO_4 = potassium phosphate
PIV = peripheral intravenous line

[1] See Appendix A for Diagnostic Criteria
[2] Consider reduction for patients with heart failure, end-stage liver or renal disease, or age > 65 years
[3] Crystalloid IV fluids include 0.9% sodium chloride, plasmalyte, or lactated ringers (see Appendix B)
[4] For patients with acute kidney injury, estimated glomerular filtration rate (eGFR) < 45 mL/minute/1.73 m^2, end stage renal disease, or anuric, consider reducing potassium replacement by 50%
[5] Refer to the Critical Care Adult PRN Electrolyte Replacement Orders via CVAD, PIV
[6] Consider reducing insulin dose for patients with renal or liver dysfunction/failure
[7] Round infusion dose to nearest 0.1 units/hour
[8] If eGFR < 45 mL/minute/1.73 m^2 **or** age > 70 years, reduce glargine dose to 0.1 units/kg subcutaneous every 12 hours

Hyperglycemic Emergency Management (DKA/EDKA/HHS) 2-Bag Method - Adult

EVALUATION FOR RESOLUTION

DKA, EDKA, <u>or</u> DKA with HHS[1]

pH > 7.3
<u>and</u>
anion gap ≤ 12
<u>and</u>
either bicarbonate ≥ 18 mEq/L
or
BHB < 0.6 mmol/L?

Yes → Has patient received long-acting insulin within prior 12 hours?

- Yes →
  - Discontinue IV insulin infusion
  - Notify Endocrinology-General Service for any adjustments to maintenance insulin regimen
  - Advance diet as tolerated
  - Discontinue DKA/EDKA/HHS order set and order maintenance fluids and labs as needed
- No →
  - Initiate long-acting insulin: glargine 0.125 unit/kg subcutaneous every 12 hours[2] **<u>and</u>**
  - Discontinue IV insulin infusion no sooner than 2 hours after administration of long-acting insulin
  - Notify Endocrinology-General Service for any adjustments to maintenance insulin regimen
  - Advance diet as tolerated
  - Discontinue DKA/EDKA/HHS order set and order maintenance fluids and labs as needed

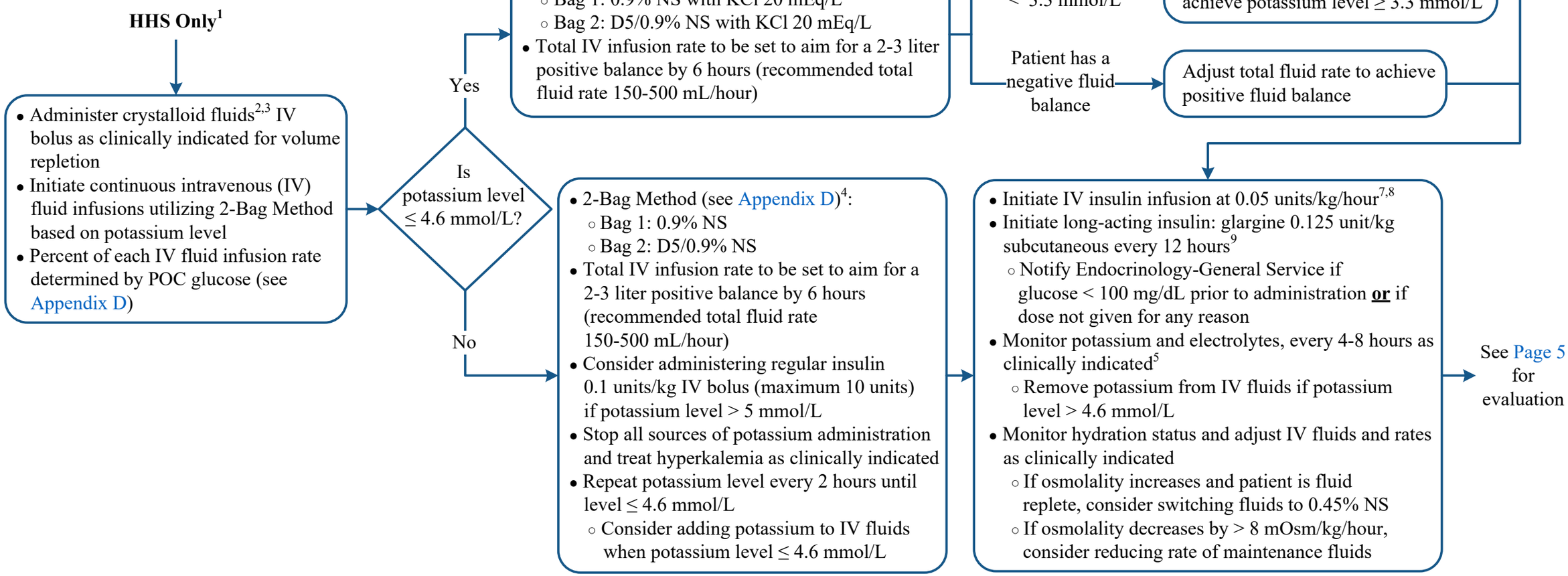
No → Continue treatment per Appendix C

FOLLOW UP TREATMENT

[1] See Appendix A for Diagnostic Criteria
[2] If eGFR < 45 mL/minute/1.73 m^2 **<u>or</u>** age > 70 years, reduce glargine dose to 0.1 units/kg subcutaneous every 12 hours

Hyperglycemic Emergency Management (DKA/EDKA/HHS) 2-Bag Method - Adult

DIAGNOSIS/MANAGEMENT



[1] See Appendix A for Diagnostic Criteria
[2] Consider reduction for patients with heart failure, end-stage liver or renal disease, or age > 65 years
[3] Crystalloid IV fluids include 0.9% sodium chloride, plasmalyte, or lactated ringers (see Appendix B)
[4] For patients with corrected sodium > 147 mmol/L, consider use of 0.45% NS and D5/0.45% NS as base fluids
[5] For patients with acute kidney injury, eGFR < 45 mL/minute/1.73 m^2, end stage renal disease, or anuric, consider reducing potassium replacement by 50%
[6] Refer to the Critical Care Adult PRN Electrolyte Replacement Orders via CVAD, PIV
[7] Consider reducing insulin dose for patients with renal or liver dysfunction/failure
[8] Round infusion dose to nearest 0.1 units/hour
[9] If eGFR < 45 mL/minute/1.73 m^2 **or** age > 70 years, reduce glargine dose to 0.1 units/kg subcutaneous every 12 hours

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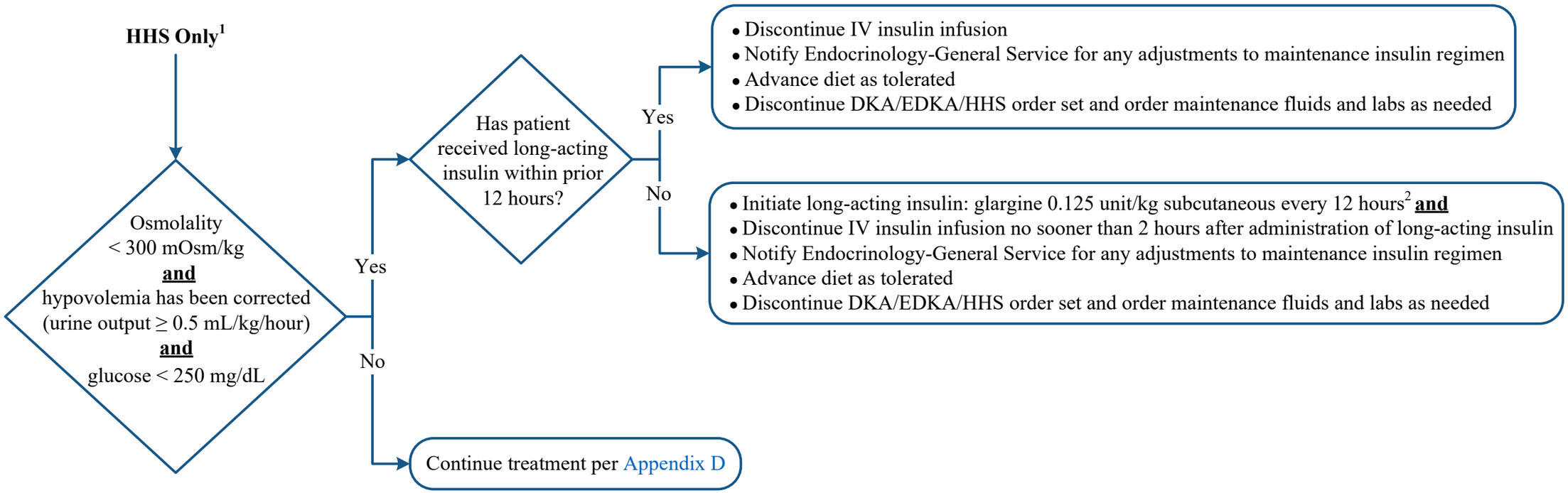
Hyperglycemic Emergency Management (DKA/EDKA/HHS) 2-Bag Method - Adult

EVALUATION FOR RESOLUTION



FOLLOW UP TREATMENT

- Discontinue IV insulin infusion
- Notify Endocrinology-General Service for any adjustments to maintenance insulin regimen
- Advance diet as tolerated
- Discontinue DKA/EDKA/HHS order set and order maintenance fluids and labs as needed

- Initiate long-acting insulin: glargine 0.125 unit/kg subcutaneous every 12 hours[2] **and**
- Discontinue IV insulin infusion no sooner than 2 hours after administration of long-acting insulin
- Notify Endocrinology-General Service for any adjustments to maintenance insulin regimen
- Advance diet as tolerated
- Discontinue DKA/EDKA/HHS order set and order maintenance fluids and labs as needed

[1] See Appendix A for Diagnostic Criteria
[2] If eGFR < 45 mL/minute/1.73 m^2 **or** age > 70 years, reduce glargine dose to 0.1 units/kg subcutaneous every 12 hours

Hyperglycemic Emergency Management (DKA/EDKA/HHS) 2-Bag Method - Adult

APPENDIX A: Diagnostic Criteria

	Blood Glucose	pH[1]	Bicarbonate	BHB	Osmolality
DKA	> 250 mg/dL	< 7.3	< 15 mEq/L	> 3 mmol/L	< 320 mosm/kg
EDKA	≤ 250 mg/dL	< 7.3	< 15 mEq/L	> 3 mmol/L	< 320 mosm/kg
DKA with HHS[2]	> 600 mg/dL	< 7.3	< 15 mEq/L	> 3 mmol/L	≥ 320 mosm/kg
HHS[2] Only	> 600 mg/dL	≥ 7.3	≥ 15 mEq/L	≤ 3 mmol/L	≥ 320 mosm/kg

[1] Arterial or venous
[2] With marked hypovolemia

Hyperglycemic Emergency Management (DKA/EDKA/HHS) 2-Bag Method - Adult

APPENDIX B: Crystalloid And Dextrose Containing Fluids

Fluids	Sodium (mEq/L)	Chloride (mEq/L)	Potassium (mEq/L)	Magnesium (mEq/L)	Dextrose (grams/L)	Buffer (mEq/L)	Osmolarity (mOsm/L)	Comments
Plasma	**140**	**103**	**4**	**2**	**N/A**	**Bicarbonate (25)**	**275-290**	
0.9% sodium chloride	154	154	N/A	N/A	N/A	N/A	308	Not preferred in patients with/or at risk for hyperchloremia and/or acute kidney injury
Plasma-Lyte A	140	98	5	3	N/A	Acetate (27)	294	Preferred for patients with low sodium bicarbonate and hyperchloremia. Monitor electrolytes, especially potassium and magnesium
Lactated Ringers	130	109	4	N/A	N/A	Lactate (28)	273	Contains calcium 3 mEq/L
D10/0.45% sodium chloride	77	77	N/A	N/A	100	N/A	660	Use in DKA, EDKA, **or** DKA with HHS
D10/0.45% with potassium chloride (KCl) 20 mEq[1]	77	77	20	N/A	100	N/A	694	
D5/0.9% sodium chloride	154	154	N/A	N/A	50	N/A	560	Use in HHS Only
D5/0.9% with potassium chloride (KCl) 20 mEq[1]	154	154	20	N/A	50	N/A	600	
D5/0.45% sodium chloride	77	77	N/A	N/A	50	N/A	406	Use in HHS Only if corrected sodium > 147 mmol/L **or** in DKA, EDKA, and DKA with HHS only if D10 is unavailable
D5/0.45% with potassium chloride (KCl) 20 mEq[1]	77	77	20	N/A	50	N/A	447	

[1] Consider potassium containing fluid if potassium level ≤ 4.6 mmol/L; adjust potassium content as clinically indicated for renal dysfunction

Hyperglycemic Emergency Management (DKA/EDKA/HHS) 2-Bag Method - Adult

APPENDIX C: DKA, EDKA, or DKA with HHS Blood Glucose Monitoring and Management Using 2-Bag Method

POC Glucose Level	IV Fluid Titration[1]		IV Insulin Infusion Management[3]	Recheck POC Glucose
	Bag 1 (0.45% NS with or without KCl[2])	Bag 2 (D10/0.45%NS with or without KCl[2])	• Initiate IV insulin infusion at 0.1 units/kg/hour (maximum initial infusion dose = 15 units/hour) • Consider reducing insulin dose for patients with renal or liver dysfunction/failure • Round infusion dose to nearest 0.1 units/hour	
In first hour			If glucose does not decrease by at least 75 mg/dL **and** POC glucose greater than 250 mg/dL, increase IV insulin infusion to 0.15 unit/kg/hour	1 hour
> 250 mg/dL	100% hourly IV fluid rate	0% hourly IV fluid rate	Notify ICU Team if glucose decreases by more than 100 mg/dL/hour for consideration to decrease IV insulin infusion dose by 50%[3]	
200-250 mg/dL	50% hourly IV fluid rate	50% hourly IV fluid rate		
150-199 mg/dL	30% hourly IV fluid rate	70% hourly IV fluid rate		
100-149 mg/dL	10% hourly IV fluid rate	90% hourly IV fluid rate		
70-99 mg/dL	0% hourly IV fluid rate	100% hourly IV fluid rate	• STOP IV INSULIN INFUSION • Give $D_{50}W$ 12.5 grams IV push, and notify Endocrinology-General Service and ICU Team • Recheck POC glucose every 15 minutes until ≥ 100 mg/dL ◦ If POC ≥ 100 mg/dL resume IV insulin infusion at 50% of previous IV insulin infusion dose[3] ◦ If POC < 100 mg/dL for 2 consecutive checks, notify Endocrinology-General Service and ICU Team for further adjustments[3]	15 minutes
< 70 mg/dL	0% hourly IV fluid rate	100% hourly IV fluid rate	• STOP IV INSULIN INFUSION • Give $D_{50}W$ 25 grams IV push, and notify Endocrinology-General Service and ICU Team • Recheck POC glucose every 15 minutes until ≥ 100 mg/dL ◦ If POC ≥ 100 mg/dL resume IV insulin infusion at 50% of previous IV insulin infusion dose[3] ◦ If POC < 100 mg/dL for 2 consecutive checks, notify Endocrinology-General Service and ICU Team for further adjustments[3]	
If pH > 7.3 **and** anion gap ≤ 12 **and** either bicarbonate ≥ 18 mEq/L or BHB < 0.6 mmol/L (resolution of DKA, EKDA, **or** DKA with HHS), notify ICU Team to initiate long acting insulin if indicated, discontinue order set, order maintenance fluids and labs as needed, and advance diet. Notify Endocrinology-General Service for any adjustments to maintenance insulin regimen.				

[1] Titrate both IV fluids for a combined rate of 100%

[2] If potassium level ≤ 4.6 mmol/L: Add to BOTH bag 1 and 2: potassium chloride (KCl) 20 mEq/L; If potassium level > 4.6 mmol/L: Do NOT add potassium to bag 1 or 2

[3] IV insulin infusion dose reduction should only be made twice. Minimal IV insulin infusion dose for DKA, EDKA, **or** DKA with HHS is 0.025 units/kg/hour.

Approved by the Executive Committee of the Medical Staff on 08/20/2024

Hyperglycemic Emergency Management (DKA/EDKA/HHS) 2-Bag Method - Adult

APPENDIX D: HHS Only Blood Glucose Monitoring and Management Using 2-Bag Method

POC Glucose Level	IV Fluid Titration[1]		IV Insulin Infusion Management[4]	Recheck POC Glucose
	Bag 1 (0.9% NS with or without KCl[2,3])	Bag 2 (D5/0.9%NS with or without KCl[2,3])	• Initiate IV insulin infusion at 0.05 units/kg/hour (maximum initial infusion dose = 15 units/hour) • Consider reducing insulin dose for patients with renal or liver dysfunction/failure • Round infusion dose to nearest 0.1 units/hour	
In first hour			If glucose does not decrease by at least 75 mg/dL **and** POC glucose greater than 250 mg/dL, increase IV insulin infusion to 0.1 unit/kg/hour	1 hour
> 250 mg/dL	100% hourly IV fluid rate	0% hourly IV fluid rate	Notify ICU Team if glucose decreases by more than 100 mg/dL/hour for consideration to decrease IV insulin infusion dose by 50%[4]	1 hour
200-250 mg/dL	50% hourly IV fluid rate	50% hourly IV fluid rate		
150-199 mg/dL	30% hourly IV fluid rate	70% hourly IV fluid rate		
100-149 mg/dL	10% hourly IV fluid rate	90% hourly IV fluid rate		
70-99 mg/dL	0% hourly IV fluid rate	100% hourly IV fluid rate	• STOP IV INSULIN INFUSION • Give $D_{50}W$ 25 mL IV push, and notify Endocrinology-General Service and ICU Team • Recheck POC glucose every 15 minutes until ≥ 100 mg/dL ◦ If POC ≥ 100 mg/dL resume insulin infusion at 50% of previous IV insulin infusion dose[4] ◦ If POC < 100 mg/dL for 2 consecutive checks, notify Endocrinology-General Service and ICU Team for further adjustments[4]	15 minutes
< 70 mg/dL	0% hourly IV fluid rate	100% hourly IV fluid rate	• STOP IV INSULIN INFUSION • Give $D_{50}W$ 50 mL IV push, and notify Endocrinology-General Service and ICU Team • Recheck POC glucose every 15 minutes until ≥ 100 mg/dL ◦ If POC ≥ 100 mg/dL resume insulin infusion at 50% of previous IV insulin infusion dose[4] ◦ If POC < 100 mg/dL for 2 consecutive checks, notify Endocrinology-General Service and ICU Team for further adjustments[4]	
If osmolality < 300 mOsm/kg **and** hypovolemia has been corrected (urine output ≥ 0.5 mL/kg/hour) **and** glucose < 250 mg/dL (resolution of HHS Only), notify ICU Team to initiate long acting insulin if indicated, discontinue order set, order maintenance fluids and labs as needed, and advance diet. Notify Endocrinology-General Service for any adjustments to maintenance insulin regimen.				

[1] Titrate both fluids for a combined rate of 100%

[2] If potassium level ≤ 4.6 mmol/L: Add to BOTH bag 1 and 2: potassium chloride (KCl) 20 mEq/L; If potassium level > 4.6 mmol/L: Do NOT add potassium to bag 1 or 2

[3] For patients with corrected sodium > 147 mmol/L, consider use of 0.45% NS and D5/0.45% NS as base fluids

[4] Insulin infusion dose reduction should only be made one time. Minimal insulin infusion dose for HHS Only is 0.025 units/hour.

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MD Anderson Institutional Policy Attachment #ATT3663 – Managing Patients with Insulin Pumps

MD Anderson Institutional Policy Attachment #ATT3587 – Guidelines for Patients with a Continuous Glucose Monitor (CGM)

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