Hyperglycemic Emergency Management (DKA/HHS\(^1\)) - 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.

**PATIENT PRESENTATION**

Patient presenting with polyuria, polydipsia, nausea/vomiting, or abdominal pain with or without history of Type 1 or 2 diabetes mellitus

**WORKUP/ASSESSMENT**

- History and physical
- Basic metabolic panel, calcium, phosphorus and magnesium every 4 hours
- Capillary blood glucose every hour
- Urine ketones\(^2\)
- Ionized calcium
- Diagnostic imaging as clinically indicated

Note: Interventions\(^3\) for urinary output and serum bicarbonate

Is serum bicarbonate < 15 mEq/L or respiratory rate > 16 breaths per minute?

- Yes
  - Obtain arterial blood gas\(^4\)
  - Capillary blood glucose every hour
  - Assess\(^5\) the following:
    - Hydration status
    - Electrolyte status
    - Blood glucose
    - Acidosis
    - Calculate anion gap

- No
  - Continue work up for further treatment or alternative diagnosis

Does patient have a diagnosis of hyperglycemic emergency\(^6\)?

- Yes
  - Initiate Step 1 of 2: DKA or HHS Hyperglycemia INITIATION order set
  - Consult Endocrinology
  - See Page 2 for DKA/HHS Management

- No

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\(^1\) Diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic state (HHS)

\(^2\) If urine ketones are positive, send serum beta-hydroxybutyrate, and start treatment pending results

\(^3\) Interventions:
- Strict input and output hourly for a total of 4 hours and notify physician if urine output is less than 0.5 mL/kg/hour
- Notify physician if serum bicarbonate < 15 mEq/L

\(^4\) Notify physician if pH < 7.2

\(^5\) Continue to look for the underlying cause of events

\(^6\) Diagnostic criteria:
- DKA: blood glucose > 250 mg/dL, arterial pH < 7.3, bicarbonate < 15 mEq/L, and moderate ketonuria or ketonemia [Note: Blood glucose may be lower than expected in patients on SGLT-2 inhibitors (e.g., empagliflozin, canagliflozin)]
- HHS: blood glucose > 600 mg/dL, arterial pH > 7.3, bicarbonate > 15 mEq/L, and minimal ketonuria and ketonemia
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**DKA/HHS Management**

**TREATMENT**

- **Hydration**
  - 0.9% sodium chloride 1 liter IV over 1 hour, then initiate continuous infusion to replete volume status

- **Potassium and initiation of insulin**
  - Potassium < 3.3 mEq/L
    - Replete and recheck potassium per electrolyte replacement protocol. If protocol contraindicated or not ordered, notify physician.
  - Potassium 3.3-5.5 mEq/L
    - Give regular insulin 0.15 units/kg IV bolus and start regular insulin 0.1 units/kg/hour IV infusion

- **pH**
  - > 7.14
    - No need to give sodium bicarbonate
  - 6.9 - 7.14
    - Consider sodium bicarbonate IV (as per ICU team management)
  - < 6.9
    - Treat with sodium bicarbonate IV (as per ICU team management)

**INTERVENTION**

- **Corrected sodium**
  - Corrected sodium < 147 mEq/L
    - Calculate corrected sodium
  - Corrected sodium ≥ 147 mEq/L

- **Additional fluids of 0.9% sodium chloride**
  - When blood glucose ≤ 250 mg/dL, change IVF to D5 0.45% sodium chloride to infuse at current rate

- **Potassium**
  - Potassium > 5.5 mEq/L
    - Notify ICU team
    - Stop all sources of potassium administration and treat hyperkalemia as clinically indicated
    - Give regular insulin 0.15 units/kg IV bolus and start regular insulin 0.1 units/kg/hour IV infusion
    - Repeat serum potassium every 2 hours until < 5.5 mEq/L

- **Sodium bicarbonate IV**
  - Treat with sodium bicarbonate IV (as per ICU team management)

**Additional fluids of 0.45% sodium chloride**

- Recheck potassium every 4 hours
- See Appendix A for insulin titration

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1 Consider reduction for patients with heart failure, end-stage liver or renal disease, or > 65 years old
2 Calculation for corrected sodium = 0.016 x (measured glucose – 100) + measured sodium
3 Prime all insulin tubing with 25 units of insulin from bag and do not administer via manifold
4 Refer to the Critical Care Adult PRN Electrolyte Replacement Orders
5 For insulin management with regular insulin bolus: Usual dose 10-15 units for patients 70-100 kg
6 Consider reducing insulin dose for patients with liver dysfunction/failure or renal disease
**INSULIN TITRATION**

- **Insulin titration**
  - Is blood glucose ≤ 250 mg/dL?
    - Yes: Continue to monitor capillary blood glucose every hour and titrate insulin infusion per Appendix A
    - No: De cape it below

**LONG ACTING INSULIN MANAGEMENT**

- **Initiation of long-acting insulin**
  - Notify Endocrinology
  - Endocrinology to dose long-acting insulin

- **Is eGFR < 60 mL/minute/1.73 m² or age > 70 years?**
  - Yes:
    - Insulin glargine 0.1 units/kg subcutaneously
  - No:
    - Insulin glargine 0.15 units/kg subcutaneously

- **BMI < 30**
  - Insulin glargine 0.15 units/kg subcutaneously

- **BMI ≥ 30**
  - Insulin glargine 0.2 units/kg subcutaneously

- **Discontinue insulin infusion 2 hours after long-acting insulin administration**

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**Hyperglycemic Emergency Management (DKA/HHS) - Adult**

**Department of Clinical Effectiveness V3**

Approved by the Executive Committee of the Medical Staff on 06/25/2019
### APPENDIX A: Blood Glucose Monitoring and Insulin Drip Management for Blood Glucose > 250 mg/dL

<table>
<thead>
<tr>
<th>Glucose Level</th>
<th>Intervention</th>
<th>Recheck Glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased by less than 50 mg/dL or increased by any amount</td>
<td>Double infusion rate</td>
<td>1 hour post change</td>
</tr>
<tr>
<td>And remains greater than 250 mg/dL</td>
<td>Continue current rate</td>
<td>1 hour</td>
</tr>
<tr>
<td>Decreased by 50-100 mg/dL and remains greater than 250 mg/dL</td>
<td>Decrease rate by half; Notify Endocrinology if infusion stopped</td>
<td>1 hour post change</td>
</tr>
<tr>
<td>Decreased by greater than 100 mg/dL and remains greater than 250 mg/dL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Once blood glucose is ≤ 250 mg/dL:
- Decrease insulin infusion rate by half and Notify ICU/EC Team:
  - Initiate Step 2 of 2: DKA or HHS (Glucose Less Than or Equal to 250 mg/dL) order set and discontinue Step 1 of 2
  - Change IVF to D₅ W_0.45% sodium chloride to infuse at current rate
- See Appendix B

### APPENDIX B: Blood Glucose Monitoring and Insulin Drip Titration for Blood Glucose ≤ 250 mg/dL

1. Decrease insulin continuous IV infusion rate by half of current dose (if not already done)
2. Titrate per parameters below:

<table>
<thead>
<tr>
<th>Glucose Level</th>
<th>Intervention</th>
<th>Recheck Glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 70 mg/dL</td>
<td>Stop infusion, notify Endocrinology, and give D_5W 25 mL IV push; Restart infusion at half the previous rate when glucose is greater than 180 mg/dL on 1 measurement</td>
<td>1 hour</td>
</tr>
<tr>
<td>70-90 mg/dL</td>
<td>Stop infusion, notify Endocrinology; Restart infusion at half the previous rate when glucose is greater than 180 mg/dL on 1 measurement</td>
<td>1 hour</td>
</tr>
<tr>
<td>91-120 mg/dL</td>
<td>Decrease infusion rate by half the current rate; Notify Endocrinology if infusion stopped</td>
<td>1 hour</td>
</tr>
<tr>
<td>121-140 mg/dL</td>
<td>Decrease infusion rate by 1 unit/hour; Notify Endocrinology if infusion stopped</td>
<td>1 hour</td>
</tr>
<tr>
<td>141-180 mg/dL</td>
<td>No change; If no changes are needed for 3 consecutive measurements, decrease monitoring to every 2 hours</td>
<td>1 hour</td>
</tr>
<tr>
<td>181-200 mg/dL</td>
<td>If glucose increasing, increase infusion rate by 1 unit/hour; If glucose decreasing or the same, continue current rate</td>
<td>1 hour</td>
</tr>
<tr>
<td>201-250 mg/dL</td>
<td>If glucose increasing, increase infusion rate by 1.5 units/hour; If glucose decreasing or the same, continue current rate</td>
<td>1 hour</td>
</tr>
<tr>
<td>251-300 mg/dL</td>
<td>If glucose increasing, increase infusion rate by 2 units/hour; If glucose decreasing or the same, continue current rate</td>
<td>1 hour</td>
</tr>
<tr>
<td>301-350 mg/dL</td>
<td>If glucose increasing, give regular insulin 10 units IV push and increase infusion rate by 2 units/hour; If glucose decreasing or the same, continue current rate</td>
<td>1 hour</td>
</tr>
<tr>
<td>&gt; 350 mg/dL</td>
<td>If glucose increasing, give regular insulin 15 units IV push and increase infusion rate by 2 units/hour; If glucose decreasing or the same, continue current rate</td>
<td>1 hour</td>
</tr>
</tbody>
</table>

Decrease greater than 100 mg/dL at one time: Decrease infusion rate by half the current rate | 1 hour |
SUGGESTED READINGS


This practice consensus statement is based on majority opinion of the Hyperglycemic Emergency Management work group at the University of Texas MD Anderson Cancer Center for the patient population. These experts included:

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