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

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

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\(^3\) the following:
  - Hydration status
  - Electrolyte status
  - Blood glucose
  - Acidosis
  - Calculate anion gap

No

- 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

- Continue work up for further treatment or alternative diagnosis

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

\(^1\) 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 < 0.5 mL/kg/hour
- Notify physician if serum bicarbonate < 15 mEq/L
- Notify physician if pH < 7.2

\(^4\) 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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**TREATMENT**

- **DKA/HHS Management**
  - **Hydration**
    - 0.9% sodium chloride 1 liter\(^1\) IV over 1 hour, then initiate continuous infusion to replete volume status
  - **Potassium and initiation of insulin\(^3\)**
    - Potassium < 3.3 mEq/L
      - Potassium 3.3-5.5 mEq/L
        - Potassium > 5.5 mEq/L
          - > 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** < 147 mEq/L
  - Additional fluids of 0.9% sodium chloride
    - Corrected sodium ≥ 147 mEq/L
      - Additional fluids of 0.45% sodium chloride

- **Corrected sodium** ≥ 147 mEq/L
  - Give regular insulin 0.15 units/kg IV bolus\(^5,6\) and start regular insulin 0.1 units/kg/hour IV infusion\(^5,6\)
  - Recheck potassium and electrolytes every 4 hours
  - See Appendix A for insulin titration

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

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**Insulin Titration**

1. **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
       - **Is blood glucose ≤ 250 mg/dL?**

   - **Decrease insulin infusion rate by half**
   - **Notify ICU/EC Team to:**
     - Initiate Step 2 of 2: DKA or HHS (glucose ≤ 250 mg/dL) order set and discontinue Step 1 of 2
     - Change IVF to D5 0.45% sodium chloride to infuse at current rate
   - **Titrate insulin infusion per Appendix B**
   - **Notify Endocrinology if insulin infusion is stopped**

2. **Is eGFR < 60 mL/minute/1.73 m² or age > 70 years?**
   - Yes
     - **Insulin glargine 0.1 units/kg subcutaneously**
   - No
     - **BMI < 30**
       - **Insulin glargine 0.15 units/kg subcutaneously**
     - **BMI ≥ 30 or taking more than 1 unit/kg/day insulin at home**
       - **Insulin glargine 0.2 units/kg subcutaneously**

   - **eGFR = estimated glomerular filtration rate**

   1. **Prime all insulin tubing with 25 units of insulin from bag and do not administer via manifold**
   2. **Consider reducing insulin dose for patients with liver dysfunction/failure**

**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
    - **Discontinue insulin infusion 2 hours after long-acting insulin administration**
  - No
    - **BMi < 30**
      - **Insulin glargine 0.15 units/kg subcutaneously**
    - **BMI ≥ 30 or taking more than 1 unit/kg/day insulin at home**
      - **Insulin glargine 0.2 units/kg subcutaneously**
## 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 &lt; 50 mg/dL or increased by any amount and remains &gt; 250 mg/dL</td>
<td>Double infusion rate</td>
<td>1 hour post change</td>
</tr>
<tr>
<td>Decreased by 50-100 mg/dL and remains &gt; 250 mg/dL</td>
<td>Continue current rate</td>
<td>1 hour</td>
</tr>
<tr>
<td>Decreased by &gt; 100 mg/dL and remains &gt; 250 mg/dL</td>
<td>Decrease rate by half, Notify Endocrinology, if infusion stopped</td>
<td>1 hour post change</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 ≤ 250 mg/dL) order set and discontinue Step 1 of 2
  - Change IVF to D₅ 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

**Note:** Check capillary glucose 1 hour after initiating Step 2 insulin infusion and titrate per parameters below.

<table>
<thead>
<tr>
<th>Glucose Level</th>
<th>Intervention</th>
<th>Recheck Glucose</th>
</tr>
</thead>
</table>
| ≤ 100 mg/dL at one time | • Decrease infusion rate by half  
• Recheck capillary glucose in 1 hour | 1 hour |
| > 70 mg/dL | • Stop infusion, give D5W 25 mL IV push, and notify Endocrinology  
• Recheck capillary glucose every hour until glucose is > 180 mg/dL and restart infusion at half the previous rate when glucose > 180 mg/dL on 1 measurement | 1 hour |
| 70-90 mg/dL | • Stop infusion, notify Endocrinology  
• Recheck capillary glucose every hour until glucose is > 180 mg/dL and restart infusion at half the previous rate when glucose > 180 mg/dL on 1 measurement | 1 hour |
| 91-120 mg/dL | • Decrease infusion rate by half of the current rate and recheck capillary glucose in 1 hour  
• If infusion stopped, notify Endocrinology and recheck capillary glucose every hour until glucose is > 180 mg/dL. Restart infusion at half the previous rate when glucose > 180 mg/dL on 1 measurement. | 1 hour |
| 121-140 mg/dL | • Decrease infusion rate by 1 unit/hour and recheck capillary glucose in 1 hour  
• If infusion stopped, notify Endocrinology and recheck capillary glucose every hour until glucose is > 180 mg/dL. Restart infusion at half the previous rate when glucose > 180 mg/dL on 1 measurement. | 1 hour |
| 141-180 mg/dL | • No change in Insulin infusion rate and recheck capillary glucose in 1 hour. If no change in infusion rate needed for 3 consecutive hours, decrease glucose monitoring to every 2 hours.  
• If infusion stopped, notify Endocrinology and recheck capillary glucose every hour until glucose is > 180 mg/dL. Restart infusion at half the previous rate when glucose > 180 mg/dL on 1 measurement. | 1 hour |
| 181-200 mg/dL | • If glucose increasing, increase infusion rate by 1 unit/hour and recheck capillary glucose in 1 hour  
• If glucose decreasing or the same, continue current rate and recheck capillary glucose in 1 hour | 1 hour |
| 201-250 mg/dL | • If glucose increasing, increase infusion rate by 1.5 units/hour and recheck capillary glucose in 1 hour  
• If glucose decreasing or the same, continue current rate and recheck capillary glucose in 1 hour | 1 hour |
| 251-300 mg/dL | • If glucose increasing, increase infusion rate by 2 units/hour and recheck capillary glucose in 1 hour  
• If glucose decreasing or the same, continue current rate and recheck capillary glucose in 1 hour | 1 hour |
| 301-350 mg/dL | • If glucose increasing, bolus 10 units of regular insulin IV push AND increase infusion rate by 2 units/hour. Recheck capillary glucose in 1 hour.  
• If glucose decreasing or the same, continue current rate and recheck capillary glucose in 1 hour | 1 hour |
| > 350 mg/dL | • If glucose increasing, bolus 15 units of regular insulin IV push AND increase infusion rate by 2 units/hour. Recheck capillary glucose in 1 hour.  
• If glucose decreasing or the same, continue current rate and recheck capillary glucose in 1 hour | 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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