Hyperglycemic Emergency Management (DKA/HHS) - Adult

This practice algorithm has been specifically developed for MD Anderson using a multidisciplinary approach and taking into consideration circumstances particular to MD Anderson, including the following: MD Anderson’s specific patient population; MD Anderson's services and structure; and MD Anderson’s clinical information. Moreover, this algorithm is not intended to replace the independent medical or professional judgment of physicians or other health care providers.

### PATIENT PRESENTATION

- Patient with history of Type 1 or 2 Diabetes Mellitus or presenting with polyuria, polydipsia, nausea/vomiting, or abdominal pain

### WORKUP/ASSESSMENT

<table>
<thead>
<tr>
<th>Serum bicarbonate less than 15 mEq/L or respiratory rate greater than 16 breaths per minute?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

**Note:** Interventions for urinary output, pH, and serum bicarbonate

### Diagnosis of hyperglycemic emergency?

**Yes**
- Consult Endocrinology service
- See Page 2 for DKA/HHS Management

**No**
- Continue workup for further treatment or alternative diagnosis

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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
4 If pH is less than 7 or if serum bicarbonate is less than 10 mEq/L, notify physician
5 Continue to look for the underlying cause of events
6 DKA diagnostic criteria: blood glucose greater than 250 mg/dL, arterial pH less than 7.3, bicarbonate less than 15 mEq/L, and moderate ketonuria or ketonemia
7 HHS diagnostic criteria: blood glucose greater than 600 mg/dL, arterial pH greater than 7.3, bicarbonate greater than 15 mEq/L, and minimal ketonuria and ketonemia

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**DKA/HHS Management**

**TREATMENT**

- **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\(^2\)**
  - Potassium less than 3.3 mEq/L
  - Potassium 3.3-5.5 mEq/L
  - Potassium greater than 5.5 mEq/L

- **pH**
  - Greater than 7.14
  - 6.9 - 7.14
  - Less than 6.9

**INTERVENTION**

- **Calculate corrected sodium\(^2\)**
  - Corrected sodium less than 147 mEq/L
  - Corrected sodium greater than or equal to 147 mEq/L

- **Additional fluids of 0.9% sodium chloride**

- **Additional fluids of 0.45% sodium chloride**

- **When blood glucose is less than or equal to 250 mg/dL, change IVF to D\(_5\) 0.45% sodium chloride to infuse at current rate**

- **Recheck blood gas hourly for pH and bicarbonate until pH reaches 7.2 or higher**

- **Notify ICU team**
  - Stop all sources of potassium administration and treat hyperkalemia as clinically indicated
  - Give regular insulin 0.15 units/kg IV bolus\(^3\) and start regular insulin 0.1 units/kg/hour IV infusion\(^3\)
  - Repeat serum potassium every 2 hours until less than 5.5 mEq/L.

- **Consider sodium bicarbonate (as per ICU team management)**

- **Recheck potassium and electrolytes every 4 hours**

- **See Page 3 for Insulin Titration**

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1. Consider reduction for patients with heart failure, end-stage liver or renal disease, or greater than 65 years old
2. Calculation for corrected sodium = 0.016 x (measured glucose + 100) plus measured Na
3. Prime all insulin tubing with 25 units of insulin from bag and do not use a manifold
4. Refer to the Critical Care Adult PRN Electrolyte Replacement Orders via CVC protocol
5. For insulin management with regular insulin bolus: usual dose 10-15 units for patients 70 to 100 kg
6. Consider reducing insulin dose for patients with end-stage liver or renal disease

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**INSULIN TITRATION**

- Insulin Titration
- Blood glucose less than or equal to 250 mg/dL?
  - Yes: Notify ICU/EC Team and change IVF to D$_5$ 0.45% sodium chloride to infuse at current rate; Decrease insulin infusion rate by half; Titrate insulin infusion per Appendix B
  - No: Continue to monitor capillary blood glucose every hour and titrate insulin infusion per Appendix A

**LONG ACTING INSULIN MANAGEMENT**

- Initiation of long-acting insulin once electrolytes are corrected and blood glucose levels between 150-250 mg/dL for 2 consecutive hours as per Appendix B
  - Yes: Notify Endocrinology service; Endocrinology to dose long-acting insulin
  - No: Insulin glargine 0.1 units/kg; Consider reducing dose in patients with end stage liver failure
  - eGFR less than 60 mL/minute/1.73 m$^2$ or age greater than 70 years?
    - Yes: Insulin glargine 0.15 units/kg; Consider reducing dose in patients with end stage liver failure
    - No: BMI less than 30
      - Yes: Discontinue insulin infusion 2 hours after long-acting insulin administration
      - No: BMI 30 or greater or taking more than 1 unit/kg/day insulin dose at home
        - Yes: Insulin glargine 0.2 units/kg; Consider reducing dose in patients with end stage liver failure

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1 Prime all insulin tubing with 25 units of insulin from bag and do not use a manifold.

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

APPENDIX A: Glucose Insulin Drip Management for Blood Glucose Greater Than 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></td>
<td></td>
</tr>
<tr>
<td>Decreased by 50-100 mg/dL and remains greater than 250 mg/dL</td>
<td>Continue current rate</td>
<td>1 hour post change</td>
</tr>
<tr>
<td>Decreased greater than 100 mg/dL and remains greater than 250 mg/dL</td>
<td>Decrease rate by half</td>
<td>1 hour post change</td>
</tr>
</tbody>
</table>

Once blood glucose is less than or equal to 250 mg/dL:
- Decrease insulin infusion rate by half and
- Notify ICU/EC team to change IV fluids to D, 0.45% sodium chloride and activate Appendix B Insulin Drip Management Orders

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APPENDIX B:

**Blood Glucose and Insulin Drip Titration for Blood Glucose Less Than or Equal to 250 mg/dL**

1. Decrease insulin continuous IV infusion rate by half of current dose (if not already done)
2. Once blood glucose is less than or equal to 250 mg/dL, start insulin drip titration

<table>
<thead>
<tr>
<th>Glucose Level</th>
<th>Intervention</th>
<th>Recheck Glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 70 mg/dL</td>
<td><em>Stop infusion, notify physician, and give D$_{50}$W 25 mL IV push</em>&lt;br&gt; 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&lt;br&gt; 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</td>
<td>1 hour</td>
</tr>
<tr>
<td>121-140 mg/dL</td>
<td>Decrease infusion rate by 1 unit/hour</td>
<td>1 hour</td>
</tr>
<tr>
<td>141-180 mg/dL</td>
<td>No change&lt;br&gt; 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&lt;br&gt; 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&lt;br&gt; 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, give regular insulin 10 units IV push and increase infusion rate by 2 units/hour&lt;br&gt; 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 15 units IV push and increase infusion rate by 2 units/hour&lt;br&gt; If glucose decreasing or the same, continue current rate</td>
<td>1 hour</td>
</tr>
<tr>
<td>Greater than 350 mg/dL</td>
<td>If glucose increasing, give regular insulin 25 units IV push</td>
<td>1 hour</td>
</tr>
<tr>
<td>Decrease greater than 100 mg/dL at one time</td>
<td>Decrease infusion rate by half the current rate</td>
<td>1 hour</td>
</tr>
</tbody>
</table>
SUGGESTED READINGS


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DEVELOPMENT CREDITS

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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