**Hyperglycemic Emergency Management (DKA/HHS¹) - 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.

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**PATIENT PRESENTATION**

Patient with history of Type 1 or 2 Diabetes Mellitus OR presenting with polyuria, polydypsia, nausea/vomiting, or abdominal pain.

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**WORKUP/ASSESSMENT**

- History & physical
- Basic metabolic panel, serum calcium, phosphorus and magnesium every 4 hours
- Capillary blood glucose every hour
- Urine ketones
- Ionized calcium
- Diagnostic imaging as clinically indicated

**NOTE:** Interventions² for urinary output, pH, and serum bicarbonate.

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**Diagnosis of Hyperglycemic Emergency⁴,⁵?**

Yes
- Obtain Arterial blood gas
- Check urine ketones³
- Capillary blood glucose every hour
- Assess⁴ the following:
  - Hydration status
  - Electrolyte status
  - Glucose
  - Acidosis
  - Calculate Anion gap

No
- Continue to monitor hourly capillary blood glucose as per protocol (See Appendix A and B).

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¹ Diabetic Ketoacidosis (DKA) and Hyperosmolar Hyperglycemic State (HHS)
² 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.
  - If pH is less than 7 or if serum bicarbonate is less than 10 mEq/L, notify physician
  - If urine ketones are positive, send serum betahydroxy butyrate, start treatment pending results.
³ Continue to look for the underlying cause of events
⁴ 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.
⁵ HHS diagnostic criteria: serum glucose greater than 600 mg/dL, arterial pH greater than 7.3, bicarbonate greater than 15 mEq/L, and minimal ketonuria and ketonemia
Hyperglycemic Emergency Management (DKA/HHS\(^1\)) - Adult

**TREATMENT**

DKA/HHS\(^1\) Management

1. **Hydration**
   - Normal Saline IV fluid 1 Liter over 1 hour, then initiate continuous infusion to replete volume status\(^2\)

2. **Potassium (K\(^+\)) and initiation of insulin\(^3\)**
   - K\(^+\) less than 3.3 mEq/L
   - K\(^+\) 3.3-5.5 mEq/L
   - K\(^+\) greater than 5.5 mEq/L

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

**INTERVENTION**

- **Calculate corrected sodium**
- **Replete and recheck potassium per electrolyte replacement protocol.**
  - If protocol contraindicated, notify physician.
  - **Give IV bolus\(^4\) of regular insulin 0.15 units/kg and start IV infusion of regular insulin at 0.1 units/kg/hour**
- **Notify ICU team**
- **Stop Potassium**
- **Recheck Potassium in 1 hour and treat hyperkalemia as indicated**
- **Give IV bolus\(^4\) of regular insulin 0.15 units/kg**
- **Start IV infusion of regular insulin at 0.1 units/kg/hour AND**
- **Repeat serum K\(^+\) every 2 hours until less than 5.5 mEq/L**

**Additional fluids; 0.9% NaCl**

**When blood glucose is less than 250 mg/dL, change IVF to D5 0.45% NaCl and continue IVF at current rate**

**When blood glucose is less than 250 mg/dL, change IVF to D5 0.45% NaCl and continue IVF at current rate**

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

**No need to give bicarbonate**

**Consider bicarbonate (as per ICU team management\(^3\))**

**Treat with bicarbonate (as per ICU team management\(^3\))**

**Corrected Na\(^+\) less than 147 mEq/L**

**Corrected Na\(^+\) greater than or equal to 147 mEq/L**

**Additional fluids; 0.45% NaCl**

1. **Diabetic Ketoacidosis (DKA) and Hyperosmolar Hyperglycemic State (HHS)**
2. **Consider reduction for patients with CHF, end-stage liver or renal disease, or greater than 65 years old.**
3. **Refer to the ICU Adult Electrolyte Replacement Protocol Order Set**
4. **For insulin management with regular insulin bolus: usual dose 10-15 units for patients 70 to 100 kg**
5. **Calculation for corrected sodium: 0.016 x (measured glucose – 100) + measured Na = Corrected Sodium**

\(^1\)Diabetic Ketoacidosis (DKA) and Hyperosmolar Hyperglycemic State (HHS)
\(^2\)Consider reduction for patients with CHF, end-stage liver or renal disease, or greater than 65 years old.
\(^3\)Refer to the ICU Adult Electrolyte Replacement Protocol Order Set
\(^4\)For insulin management with regular insulin bolus: usual dose 10-15 units for patients 70 to 100 kg
\(^5\)Calculation for corrected sodium: 0.016 x (measured glucose – 100) + measured Na = Corrected Sodium
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

- Give long-acting insulin¹ subcutaneous times 1 dose.
- Notify Endocrine service

Blood or capillary glucose less than 250 mg/dL?

Yes
- Notify ICU/EC Team and change IVF to D5 0.45% NaCl and continue IVF at current rate
- Decrease insulin infusion rate by 50%
- Titrate insulin infusion per Appendix B
- Continue to monitor capillary blood glucose every hour and titrate insulin infusion per Appendix A

No

BMI less than 30
- 0.15 units/kg
- Consider reducing dose in patients with End Stage Liver Failure

BMI equal to or greater than 30 or someone who is on more than 1 unit/kg/day insulin dose at home
- 0.2 units/kg
- Consider reducing dose in patients with End Stage Liver Failure

EGFR less than 60 mL/minute/1.73 m² or age greater than 70 years
- 0.1 units/kg
- Consider reducing dose in patients with End Stage Liver Failure

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

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¹Diabetic Ketoacidosis (DKA) and Hyperosmolar Hyperglycemic State (HHS)
²Prime all insulin tubing with 25 units of insulin from bag and do not use a manifold.
³Discontinue insulin drip 2 hours after insulin glargine administration.
**APPENDIX A: Glucose Insulin Drip Management**

<table>
<thead>
<tr>
<th>Glucose level</th>
<th>Intervention</th>
<th>Recheck glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>decreased less than 50 mg/dL</td>
<td>double infusion rate</td>
<td>1 hour post change</td>
</tr>
<tr>
<td>decrease by 50-100 mg/dL</td>
<td>continue current rate</td>
<td>1 hour post change</td>
</tr>
<tr>
<td>decreased greater than 100 mg/dL</td>
<td>decrease rate by half</td>
<td>1 hour post change</td>
</tr>
</tbody>
</table>

Note: Once glucose is less than 250 mg/dl, notify ICU team AND change IV fluids to D5 0.45% NaCl

**APPENDIX B: Blood Glucose and Insulin Drip Titration**

1. Decrease insulin continuous IV infusion rate by 50% of current dose
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 serum glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 70 mg/dL</td>
<td>1. Stop infusion, notify physician, AND give 25 mL D50W IV push</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>2. Restart infusion at ½ the previous rate when glucose is greater than 180 mg/dL on 1 measurement</td>
<td></td>
</tr>
<tr>
<td>70-90 mg/dL</td>
<td>1. Stop infusion</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>2. Restart infusion at ½ the previous rate when glucose is greater than 180 mg/dL on 1 measurement</td>
<td></td>
</tr>
<tr>
<td>91-120 mg/dL</td>
<td>1. Decrease infusion rate by ½ current rate</td>
<td>1 hour</td>
</tr>
<tr>
<td>121-140 mg/dL</td>
<td>1. Decrease infusion rate by 1 unit/hour</td>
<td>1 hour</td>
</tr>
<tr>
<td>141-180 mg/dL</td>
<td>1. No change</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>2. If no changes are needed for 3 consecutive measurements, decrease</td>
<td></td>
</tr>
<tr>
<td></td>
<td>monitoring to every 4 hours</td>
<td></td>
</tr>
<tr>
<td>181-200 mg/dL</td>
<td>1. If glucose increasing, increase infusion rate by 1 unit/hour</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>2. If glucose decreasing or the same, continue current rate</td>
<td></td>
</tr>
<tr>
<td>201-250 mg/dL</td>
<td>1. If glucose increasing, increase infusion rate by 1.5 units/hour</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>2. If glucose decreasing or the same, continue current rate</td>
<td></td>
</tr>
<tr>
<td>251-300 mg/dL</td>
<td>1. If glucose increasing, increase infusion rate by 2 units/hour</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>2. If glucose decreasing or the same, continue current rate</td>
<td></td>
</tr>
<tr>
<td>301-350 mg/dL</td>
<td>1. If glucose increasing, bolus 10 units of Regular Insulin IV push AND</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>increase infusion rate by 2 units/hour</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. If glucose decreasing or the same, continue current rate</td>
<td></td>
</tr>
<tr>
<td>greater than 350 mg/dL</td>
<td>1. If glucose increasing, bolus 15 units of Regular Insulin IV push AND</td>
<td>1 hour</td>
</tr>
<tr>
<td></td>
<td>increase infusion rate by 2 units/hour</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. If glucose decreasing or the same, continue current rate</td>
<td></td>
</tr>
</tbody>
</table>

Diabetic Ketoacidosis (DKA) and Hyperosmolar Hyperglycemic State (HHS)
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SUGGESTED READINGS


This practice consensus algorithm is based on majority expert opinion of the Hyperglycemic Emergency Management work group at the University of Texas MD Anderson Cancer Center. It was developed using a multidisciplinary approach that included input from the following:

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