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

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PRESENTATION

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

- History and physical
- Basic metabolic panel, phosphorous, magnesium, and ionized calcium
  - Notify provider if serum bicarbonate < 15 mEq/L
- Point of care (POC) fingerstick glucose
- Urine ketones
  - If urine ketones are positive, send serum beta-hydroxybutyrate, and start treatment pending results
- Diagnostic imaging, as clinically indicated
- Strict input and output hourly
  - Notify provider if urine output < 0.5 mL/kg/hour

WORKUP/ASSESSMENT

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

- Yes
  - Obtain arterial blood gas and notify provider if pH ≤ 7.14 (see Page 2 for management recommendations)
- No
  - Assess the following:
    - Hydration status
    - Electrolyte status
    - Blood glucose
    - Acidosis
    - Anion gap

DIAGNOSIS/TREATMENT

- DKA or HHS
  - Admit to ICU
  - Initiate Step 1 of 2: DKA or HHS Hyperglycemia INITIATION order set
  - Consult Endocrinology-Diabetes
  - POC fingerstick glucose every hour
  - Serum sodium, potassium, chloride, and bicarbonate every 4 hours for 24 hours then every 8 hours as indicated
  - Calcium, BUN, creatinine, phosphorus, glucose, and magnesium every 8 hours as indicated
  - See Page 2 for DKA/HHS Management
- EDKA
  - Admit to ICU
  - Consult Endocrinology-Diabetes
  - POC fingerstick glucose every hour
  - Serum sodium, potassium, chloride, and bicarbonate every 4 hours for 24 hours then every 8 hours as indicated
  - Calcium, BUN, creatinine, phosphorus, glucose, and magnesium every 8 hours as indicated
  - See Page 4 for EDKA Management
- No DKA, HHS, or EDKA
  - Continue work up for further treatment or alternative diagnosis
  - Refer to Inpatient Hyperglycemia-Adult algorithm as indicated

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1 Diabetic ketoacidosis (DKA), hyperosmolar hyperglycemic state (HHS), and euglycemic diabetic ketoacidosis (EDKA)
2 Continue to look for the underlying cause of events
3 Diagnostic criteria:
   - DKA: blood glucose > 250 mg/dL, arterial pH < 7.3, serum bicarbonate < 15 mEq/L, and moderate ketonuria or ketonemia
   - HHS: blood glucose > 600 mg/dL, arterial pH > 7.3, serum bicarbonate > 15 mEq/L, and minimal ketonuria and ketonemia
   - EDKA: blood glucose ≤ 250 mg/dL, arterial pH < 7.3, serum 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., canagliflozin, dapagliflozin, empagliflozin, etoglisiflozin)
Hypermagnesemic Emergency Management (DKA/HHS/EDKA) - Adult

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TREATMENT

**DKA/HHS Management**

**Hydration**
1 liter\(^1\) of crystalloid fluids\(^2\) IV over 1 hour, then initiate continuous infusion to replete volume status

**Potassium and initiation of insulin\(^4\)**

- Potassium < 3.3 mEq/L
  - Calculate corrected sodium\(^3\)
  - Replete and recheck potassium per electrolyte replacement\(^7\) orders
  - Notify ICU/ACCC team if electrolyte replacement orders are contraindicated or not ordered

- Potassium 3.3-5.5 mEq/L
  - Give regular insulin 0.15 units/kg IV bolus\(^6,7\) and start regular insulin 0.1 units/kg/hour IV infusion\(^4,7\)

- Potassium > 5.5 mEq/L
  - Notify ICU/ACCC team
  - Stop all sources of potassium administration and treat hyperkalemia as clinically indicated
  - Give regular insulin 0.15 units/kg IV bolus\(^6,7\) and start regular insulin 0.1 units/kg/hour IV infusion\(^4,7\)
  - Repeat serum potassium every 2 hours until < 5.5 mEq/L

**pH**

- > 7.14
  - No need to give sodium bicarbonate

- 6.9 - 7.14
  - Consider sodium bicarbonate IV\(^8\) (as per ICU/ACCC team management)

- < 6.9
  - Treat with sodium bicarbonate IV\(^8\) (as per ICU/ACCC team management)

**Corrected sodium**

- Corrected sodium < 147 mEq/L
  - Additional crystalloid fluids\(^2\)
  - When blood glucose ≤ 250 mg/dL, see Page 3 for continued management

- Corrected sodium ≥ 147 mEq/L
  - Additional fluids of 0.45% sodium chloride

**INTERVENTION**

- When blood glucose ≤ 250 mg/dL, see Page 3 for continued management

ACCC = Acute Cancer Care Center

1 Consider reduction for patients with heart failure, end-stage liver or renal disease, or age > 65 years; consider additional fluids as indicated for continued volume repletion
2 Crystalloid IV fluids include 0.9% sodium chloride or plasmalyte
3 Calculation for corrected sodium = 0.016 x (measured glucose – 100) + measured sodium
4 Prime all insulin tubing with 25 units of insulin from bag
5 Refer to the Critical Care Adult PRN Electrolyte Replacement Orders via CVC, PIV
6 For insulin management with regular insulin bolus: Usual dose 10-15 units for patients 70-100 kg
7 Consider reducing insulin dose for patients with liver dysfunction/failure or renal disease
8 Sodium bicarbonate should NOT be initiated until serum potassium ≥ 3.3 mEq/L

Department of Clinical Effectiveness V5

Approved by the Executive Committee of the Medical Staff on 04/19/2022

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### DIAGNOSIS

**DKA/HHS**

- **Is blood glucose ≤ 250 mg/dL?**

  - Yes
  - No

### TREATMENT

- Decrease insulin infusion rate by half
- ICU/ACCC Team to:
  - Discontinue Step 1 of 2
  - Initiate Step 2 of 2: DKA/HHS/EDKA (glucose ≤ 250 mg/dL) order set
  - Change IVF to D5/0.45% sodium chloride to infuse at current rate
  - Initiate long-acting insulin: glargine 0.125 unit/kg subcutaneous every 12 hours¹ ²
- Titrate insulin infusion per Appendix B
- Notify Endocrinology-Diabetes if insulin is stopped

- Change IVF to D5/0.45% sodium chloride to infuse at current rate
- Initiate long-acting insulin: glargine 0.125 unit/kg subcutaneous every 12 hours
- Continue to monitor capillary blood glucose every hour and titrate insulin infusion per Appendix A

### EVALUATION

- **Is anion gap ≤ 12**
- **and serum bicarbonate ≥ 18 mEq/L?**

  - Yes
  - No

#### Notes

1. Consider reducing insulin dose for patients with liver dysfunction/failure
2. If estimated glomerular filtration rate (eGFR) < 60 mL/minute/1.73 m² or age > 70 years, reduce glargine dose to 0.1 units/kg subcutaneous every 12 hours
3. See Appendix C
Hyperglycemic Emergency Management (DKA/HHS/EDKA) - Adult

DIAGNOSIS

- Hydration:
  - 1 liter\(^1\) of crystalloid fluids\(^2\) IV over 1 hour, then
  - Initiate D5/0.45% sodium for maintenance fluids\(^3\)
- Potassium management:
  - Replete and recheck potassium per electrolyte replacement\(^4\) orders
  - Notify ICU/ACCC team if electrolyte replacement orders are contraindicated or not ordered
  - Do not initiate insulin until potassium \(\geq 3.3\) mEq/L
- pH management:
  - pH 6.9 – 7.14: consider sodium bicarbonate IV\(^5\) as per ICU/ACCC Team
  - pH < 6.9: treat with sodium bicarbonate IV\(^5\) as per ICU/ACCC Team
  - Recheck blood gas hourly for pH and bicarbonate until pH \(\geq 7.2\)
  - If initiated, consider discontinuing sodium bicarbonate IV when pH \(\geq 7.14\)
- Insulin management: ICU/ACCC team to:
  - Initiate Step 2 of 2: DKA/HHS/EDKA (glucose \(\leq 250\) mg/dL) order set with an initial insulin infusion rate of 0.1 unit/kg/hour\(^6,7\)
  - Initiate long-acting insulin: glargine 0.125 unit/kg subcutaneous every 12 hours\(^6,8\)

TREATMENT

- Intravenous fluids include 0.9% sodium chloride or plasmalyte
- Consider increasing dextrose to 10% if patient is experiencing hypoglycemia and persistent anion gap metabolic acidosis. See Appendix C.
- Refer to the Critical Care Adult PRN Electrolyte Replacement Orders via CVC, PIV
- Sodium bicarbonate should NOT be initiated until serum potassium \(\geq 3.3\) mEq/L
- Consider reducing insulin dose for patients with liver dysfunction/failure
- Prime all insulin tubing with 25 units of insulin from bag
- If estimated glomerular filtration rate (eGFR) \(\times 60\) mL/minute/1.73 m\(^2\), or age \(> 70\) years, reduce glargine dose to 0.1 units/kg subcutaneous every 12 hours

EVALUATION

- Titrate insulin infusion per Appendix B
- Notify Endocrinology-Diabetes if insulin is stopped

Is anion gap \(\leq 12\) and serum bicarbonate \(\geq 18\) mEq/L? 

Yes
- Notify Endocrinology-Diabetes
- Discontinue insulin IV infusion no sooner than 2 hours after administration of long-acting insulin

No
- Discontinue insulin IV infusion no sooner than 2 hours after administration of long-acting insulin

1 Consider reduction for patients with heart failure, end-stage liver or renal disease, or age \(> 65\) years; consider additional fluids as indicated for continued volume repletion
2 Crystalloid IV fluids include 0.9% sodium chloride or plasmalyte
3 Consider increasing dextrose to 10% if patient is experiencing hypoglycemia and persistent anion gap metabolic acidosis. See Appendix C.
4 Refer to the Critical Care Adult PRN Electrolyte Replacement Orders via CVC, PIV
5 Sodium bicarbonate should NOT be initiated until serum potassium \(\geq 3.3\) mEq/L
6 Consider reducing insulin dose for patients with liver dysfunction/failure
7 Prime all insulin tubing with 25 units of insulin from bag
8 If estimated glomerular filtration rate (eGFR) \(\times 60\) 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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APPENDIX A: Blood Glucose Monitoring and Insulin Infusion 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</td>
<td>Double infusion rate</td>
<td>1 hour post change</td>
</tr>
<tr>
<td>And remains &gt; 250 mg/dL</td>
<td></td>
<td></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 and Notify Endocrinology-Diabetes, 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/ACCC Team:
  - Discontinue Step 1 of 2
  - Initiate Step 2 of 2: DKA/HHS/EDKA (glucose ≤ 250 mg/dL) order set
  - Change IVF to D5/0.45% sodium chloride to infuse at current rate
  - Initiate long-acting insulin: glargine 0.125 unit/kg subcutaneous every 12 hours
- See Appendix B

1See Appendix C
2Consider reducing insulin dose for patients with liver dysfunction/failure
3If estimated glomerular filtration rate (eGFR) < 60 mL/minute/1.73 m² or age > 70 years, reduce glargine dose to 0.1 units/kg subcutaneous every 12 hours
## APPENDIX B: Blood Glucose Monitoring and Insulin Infusion 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>
| Decrease > 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-Diabetes  
● Recheck capillary glucose every hour until glucose > 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-Diabetes  
● Recheck capillary glucose every hour until glucose > 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-Diabetes and recheck capillary glucose every hour until glucose > 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-Diabetes and recheck capillary glucose every hour until glucose > 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-Diabetes and recheck capillary glucose every hour until glucose > 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 |
Hyperglycemic Emergency Management
(DKA/HHS/EDKA) - Adult

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APPENDIX C: Crystalloid And Dextrose Containing Fluids

<table>
<thead>
<tr>
<th>Fluids</th>
<th>Sodium (mEq/L)</th>
<th>Chloride (mEq/L)</th>
<th>Potassium (mEq/L)</th>
<th>Magnesium (mEq/L)</th>
<th>Dextrose (grams/L)</th>
<th>Buffer (mEq/L)</th>
<th>Osmolarity (mOsm/L)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma</td>
<td>140</td>
<td>103</td>
<td>4</td>
<td>2</td>
<td>N/A</td>
<td>Bicarbonate (25)</td>
<td>275-290</td>
<td>Not preferred in patients with/or at risk for hyperchloremia and/or acute kidney injury</td>
</tr>
<tr>
<td>0.9% sodium chloride</td>
<td>154</td>
<td>154</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>308</td>
<td></td>
</tr>
<tr>
<td>Plasma-Lyte A</td>
<td>140</td>
<td>98</td>
<td>5</td>
<td>3</td>
<td>N/A</td>
<td>Acetate (27)</td>
<td>294</td>
<td>Preferred for patients with low sodium bicarbonate and hyperchloremia. Monitor electrolytes, especially serum potassium and magnesium</td>
</tr>
<tr>
<td>D5/0.45% with potassium chloride (KCl) 20 mEq</td>
<td>77</td>
<td>77</td>
<td>20</td>
<td>N/A</td>
<td>50</td>
<td>N/A</td>
<td>447</td>
<td>Consider in Step 2 of the DKA/HHS/EDKA for patients with serum potassium ≤ 5 mEq/L</td>
</tr>
<tr>
<td>D5/0.45% sodium chloride</td>
<td>77</td>
<td>77</td>
<td>N/A</td>
<td>N/A</td>
<td>50</td>
<td>N/A</td>
<td>406</td>
<td></td>
</tr>
<tr>
<td>D10/0.45% sodium chloride</td>
<td>77</td>
<td>77</td>
<td>N/A</td>
<td>N/A</td>
<td>100</td>
<td>N/A</td>
<td>660</td>
<td>Consider increasing dextrose to 10% if patient is experiencing hypoglycemia and persistent anion gap metabolic acidosis</td>
</tr>
</tbody>
</table>

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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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