## Revision History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date of Revision</th>
<th>Description of Revision</th>
<th>Revised By</th>
</tr>
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<tbody>
<tr>
<td>1.0</td>
<td>March 26, 2018</td>
<td>Completion of Topic</td>
<td>Fraulein Morales, Saifal Anwar</td>
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Important Information Before You Begin

The recommendations contained in this knowledge topic have been provincially adjudicated and are based on best practice and available evidence. Clinicians applying these recommendations should, in consultation with the patient, use independent medical judgment in the context of individual clinical circumstances to direct care. This knowledge topic will be reviewed periodically and updated as best practice evidence and practice change.

The information in this topic strives to adhere to Institute for Safe Medication Practices (ISMP) safety standards and align with Quality and Safety initiatives and accreditation requirements such as the Required Organizational Practices. Some examples of these initiatives or groups are: Health Quality Council Alberta (HQCA), Choosing Wisely campaign, Safer Healthcare Now campaign etc.

Guidelines

This Topic is based on the following guidance:

- Diabetes Canada Clinical Practice Guidelines on Diabetic Ketoacidosis (DKA)

Keywords

- Diabetic Ketoacidosis (DKA)
- Hyperosmolar hyperglycemic State (HHS)
- Hyperglycemia
Diabetic Ketoacidosis, Adult - Inpatient Order Set

Order Set Restrictions: Excludes pregnant population  
Order Set Keywords: Diabetic Ketoacidosis (DKA), Hyperosmolar hyperglycemic State (HHS), and Hyperglycemia

Admit, Discharge
- Admit to Service ____________ under care of Dr ____________
- Anticipated Date of Discharge _______________

Diet
- NPO
- Diabetic Diet
- Other: ____________

Patient Care

Activity
- Activity as Tolerated
- Fall Prevention Risk Assessment

Vital Signs
- Vital Signs every 30 minutes x 2; then every hour x 4; then every 2 hours x 24 hours; and then Authorized Prescriber to reassess
- Vital Signs every ______ hour(s)
- Orthostatic vitals every _______ hour(s)

Intake and Output
- Intake and Output every 8 hours, continue until intravenous therapy discontinued
- Intake and Output every ______ hour(s)

Consider Foley catheter insertion if clinically indicated
- Foley Catheter- Insert
- Foley Catheter- Reassess daily

Monitor
Consider if severe hyper/hypokalemia with ECG changes, suspected acute coronary syndrome as precipitating cause or as per physician discretion
- Bedside Cardiac Monitoring

Point of Care Testing
POCT glucose, i.e. capillary blood glucose, may be inaccurate if a patient is critically ill. Use non-POCT, non-capillary glucose to assess accuracy prior to reliance on POCT glucose. See POCT glucose procedure for details and other potential interferences.

- Blood Glucose Monitoring – POCT every 1 hour while on IV insulin infusion or until anion gaps is normalized
Blood Glucose Monitoring – POCT every ______ hour

Respiratory Care
- O2 Therapy – Titrate to Saturation to maintain SpO2 between 92-96%
- O2 Therapy – Titrate to Saturation to maintain SpO2 between 88-92%
- Notify Authorized Prescriber if oxygen requirement increase by greater than 2L

Laboratory Investigations

Hematology
- Complete Blood Count (CBC) with differential

Chemistry
- Electrolytes (Na, K, Cl, CO2)
- Creatinine
- Glucose Random
- Beta-Hydroxybutyrate
- Serum Osmolality
- Lactate
- Calcium (Ca)
- Albumin
- Magnesium (Mg)
- Phosphate
- Lipase
- Beta HCG
- Troponin
- CK
- Hemoglobin A1C

Blood Gases
- Arterial Blood Gas

Urine Tests
- Urine Osmolality Random
- Urinalysis Random
- Urine Bacterial Culture

Therapeutic Drug Monitoring and Toxicology - If clinically indicated
- Acetaminophen
- Ethanol (Blood Alcohol)
- Ethylene Glycol
- Isopropanol
- Methanol
- Salicylate
Repeating Labs
- Electrolytes (Na, K, Cl, CO2) and serum osmolality every 2 hours x 4; then every 4 hours until anion gap has normalized
- Venous Blood Gas every 2 hours x 4, then every 4 hours until anion gap and HCO3 have normalized
- Complete Blood Count (CBC) with differential daily

Others
- Blood Cultures
- Other: ____________

Diagnostic Investigations - Order imaging studies if there is clinical concern for a precipitating cause of DKA
- Chest X-ray 2: PA & Lateral (GR Chest, 2 Projections)
- Electrocardiogram - 12 lead
- Other: ____________

Intravenous Therapy
- Intravenous Cannula – Insert: Initiate IV

Intravenous Fluid Replacement – Initial Resuscitation

Severe Dehydration/Hypovolemic Shock
- IV Bolus: 0.9% NaCl infusion IV 1000 mL over 1 hour
- IV Bolus: 0.9% NaCl infusion IV 2000 mL over 1 hour

Mild or Moderate Dehydration
- IV Bolus: 0.9% NaCl infusion IV 500 mL over 1 hour for ______ hours and then at 250 mL/hour for ______ hours

Intravenous Fluids Replacement Once Euvolemic – Potassium Added
*If plasma corrected Sodium (Corrected plasma [Na+] = Measured [Na+] + [3/10 × ([Glucose (mmol/L)] − 5)]) is more than 135 and if plasma osmolality is falling less than 3 mmol/kg/hour; choose the following intravenous solution.*

For potassium chloride supplementation – see Potassium Replacement orders below

Reassess fluid rate and type every 2 hours depending on hydration status, serum sodium and serum osmolality.

- 0.45% NaCl infusion IV (add potassium chloride supplementation as per potassium replacement orders) at 250 mL/hour; reassess fluids every 2 hour
- IV Fluid (other): ____________ infusion IV (add potassium chloride supplementation as per potassium replacement orders) at _____ mL/hour
**Medications**

**Potassium Replacement**  
*Adjust potassium chloride supplementation based on most recent electrolyte results*

- **If Serum potassium is less than 3.3 mmol/L:**
  - HOLD insulin infusion until serum potassium is GREATER than 3.3 mmol/L

  *Must choose ONE below:*
  - Choose IV solution with potassium chloride 40 mmol/L (maximum rate is 10 mmol/hour in peripheral line)
  - potassium chloride 10 mmol in sterile water 100 mL IV over 1 hour ; give 3 doses
  - potassium chloride (liquid) _____ mmol PO every ______ hour(s) for ______ day(s)
  - potassium chloride (1500 mg tab = 20 mmol) ______ mmol PO every ______ hour(s) for ______ day(s)

- **If Serum potassium is 3.3 – 5.5 mmol/L:**
  - Choose IV solution with potassium chloride 20 mmol/L
  - Choose IV solution with potassium chloride 40 mmol/L (maximum rate is 10mmol/hour in peripheral line)

- **If Serum potassium is greater than 5.5 mmol/L OR if urine output is less than 30 mL/hour:**
  - HOLD potassium chloride in IV solution

**Sodium Bicarbonate**  
*Consider ONLY if blood pH is less than 7.0 on Arterial Blood Gas or Venous Blood Gas despite fluid resuscitation and potassium replacement.*

- sodium bicarbonate 50 mmol in 50 mL D5W IV once, infuse over 1 hour

  *Reassess need for repeat infusion*
  - Repeat arterial blood gas or venous blood gas 1 hour after IV sodium bicarbonate

**Magnesium**  
*If clinically indicated, infuse over 2 or 4 hours*

- magnesium sulphate 2 g in 100 mL 0.9% NaCl IV once, infuse over 2 hours
- magnesium sulphate 4 g in 200 mL 0.9% NaCl IV once, infuse over 4 hours

**Phosphate**  
*Not recommended unless serum phosphate concentration below 0.32 mmol/L, cardiac dysfunction, anemia, or respiratory depression. If needed use:*

- Sodium phosphate (15 mmol phosphate, 20 mmol sodium) in D5W 100 mL over 4 hours x 1 dose

**Insulin Therapy Infusion**

- HOLD insulin infusion if serum potassium is less than 3.3 mmol/L *(Immediate potassium chloride correction required)*
- Initiate insulin as soon as serum potassium is more than 3.3 mmol/L, and repeat electrolytes every 2 - 4 hours
Notify Authorized Prescriber if blood glucose is less than 7 mmol/L at anytime

**For patients on Sodium-glucose co-transporter 2 (SGLT2) inhibitors SGLT2 and in DKA**

For patients on SGLT2 inhibitors with Blood Glucose less than 14 mmol/L refer to – **Ongoing Insulin Management – Start once blood glucose is LESS THAN 14 mmol/L for 2 consecutive readings** AND refer to **Intravenous Fluid Replacement Orders (Glucose less than 14 mmol/L)**

For patients on SGLT2 inhibitors with Blood Glucose equal to or greater than 14 mmol/L refer to - **Initial Insulin Management – When blood glucose is EQUAL to or GREATER than 14 mmol/L**

- **Hold SGLT2** (complete medication name, dose, route, frequency):

#### Initial Insulin Management – When blood glucose is EQUAL to or GREATER than 14 mmol/L

When glucose is less than 14 mmol/L for 2 consecutive readings, proceed to order section **Ongoing Management** for fluid, electrolytes and insulin replacement orders.

- **Regular insulin** (HumuLIN ®R) at ___________ units/hour IV infusion (mix 100 units of Humulin R in 100 mL D5W) and adjust based on every 1 hour capillary blood glucose results as follows:
  - If glucose decreases by 1 to 4 mmol/L, continue current insulin IV rate
  - If glucose fail to decrease on 2 consecutive readings, double insulin IV rate
  - If glucose decreases by more than 4 mmol/L, reduce insulin IV rate by half

#### Ongoing Insulin Management – Start once blood glucose is LESS THAN 14 mmol/L for 2 consecutive readings

The goals are to maintain glucose between 12-14 mmol/L until acidosis is reversed (when CO2 is or HCO3 are normalized and to continue insulin infusion until acidosis is resolved.

**Intravenous Fluid Replacement Orders (Glucose less than 14 mmol/L)**

If plasma corrected Sodium (Corrected plasma [Na+] = Measured [Na+] + [3/10 × ([Glucose (mmol/L)] − 5)] is more than 135 and if plasma osmolality is falling less than 3 mmol/kg/hour; choose the following intravenous solution

- **D5W – 0.45% NaCl infusion** (add potassium chloride supplementation as per potassium replacement orders)
- **D5W – 0.9% NaCl at _____ mL/hour** (add potassium chloride supplementation as per potassium replacement orders)
Insulin Infusion (Glucose less than 14 mmol/L)

- Decrease current insulin infusion rate by 50%, then adjust to maintain glucose at 12-14 mmol/L based on hourly glucose monitoring:

<table>
<thead>
<tr>
<th>Glucose (mmol/L)</th>
<th>Insulin Adjustment</th>
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<tbody>
<tr>
<td>Less than 7 (any time)</td>
<td>Hold insulin infusion and Contact Authorized Prescriber</td>
</tr>
<tr>
<td>7 - 9.9</td>
<td>Decrease rate by 1 unit/hour</td>
</tr>
<tr>
<td>10 - 11.9</td>
<td>Decrease rate by 0.5 units/hour</td>
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<tr>
<td>12 - 14</td>
<td>Maintain current rate</td>
</tr>
<tr>
<td>14.1 - 16</td>
<td>Increase rate by 1 unit/hour</td>
</tr>
<tr>
<td>Greater than 16</td>
<td>Increase rate by 2 units/hour</td>
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</tbody>
</table>

- Contact Authorized Prescriber to change insulin order or IV fluid orders if:
  - Glucose is out of range (12-14 mmol/L) for 2 consecutive readings
  - Subcutaneous Insulin should be started once acidosis is resolved (pH greater than 7.3, normalized anion gap and CO2, or HCO3) and when patient is tolerating oral diet (subcutaneous insulin to be initiated)

Subcutaneous Insulin Orders

Start basal insulin (long acting) two hours prior to stopping IV insulin infusion

- Continue IV insulin infusion for 2 hours post subcutaneous basal insulin and then discontinue IV insulin
- Continue home insulin (type/dose)______________________________
- Basal Bolus Insulin Therapy (BBIT) Order Set
- In-Hospital Orders for Self-Management of Insulin Pump Order Set
- Other(s)______________________________

Transitions and Referrals

- Consult Dietitian
- Consult Social Worker
- Consult/Referral to Diabetic Education Program/Health Care Team (resources as applicable)
- Other: ____________
## Baseline Analytics – Measure #1 Order Set Usage

<table>
<thead>
<tr>
<th>Name of Measure</th>
<th>Definition</th>
<th>Rationale</th>
<th>Cited References</th>
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</thead>
<tbody>
<tr>
<td>Number of times order set Diabetic Ketoacidosis, Adult - Inpatient Order Set used</td>
<td>Number of times order set Diabetic Ketoacidosis, Adult - Inpatient is used. Overall, by zone, by sites, by domain (ED, Inpatient, etc.), and by units. Will be required on an ongoing basis with the ability to filter by location, time period, domain, etc.</td>
<td>Intended to measure how often the order set cited in the knowledge topic is being used, in what domain, and be for different lengths of time. May indicate areas with adoption issues or gaps in topic</td>
<td>Diabetes Canada Clinical Practice Guidelines on DKA American Diabetes Association guidelines</td>
</tr>
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**Rationale**

It is important to see how often the protocol is being used to determine if it improve outcome and reduce health care cost, and also to standardize care across the province.

## Analytics – Outcome Measure #2

<table>
<thead>
<tr>
<th>Name of Measure</th>
<th>Definition</th>
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<th>Cited References</th>
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</table>
| Compliance to clinical standards of CKT ie. Scoring tools, specific items/orders in the order set | The elements of the CKT for which it is important to measure compliance against specific items/orders in the order set are:  
- Compliance to fluid resuscitation, electrolyte replacement, initial insulin infusion rat, insulin use, hypoglycemia episodes, transition to subcutaneous insulin, time to resolution of DKA, Diabetes education and dietitian referrals  
- Practice pattern and compliance to the protocol can be measured eg, initial fluid resuscitation, when and how rapidly potassium is being replaced and insulin adjustments  | Measure compliance to specified clinical standards within the CKT To determine rate of compliance to Diabetes Canada Clinical Practice Guidelines regarding diabetic ketoacidosis management | Diabetes Canada Clinical Practice Guidelines on DKA American Diabetes Association guidelines |

**Rationale**

To determine rate of compliance to Diabetes Canada Clinical Practice Guidelines regarding diabetic ketoacidosis management.
### Analytics – Outcome Measure #3

<table>
<thead>
<tr>
<th>Name of Measure</th>
<th>Assessment of DKA treatment patterns and length of stay</th>
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<tbody>
<tr>
<td>Definition</td>
<td>Length of stay and incidence of re hospitalization with DKA post-acute management</td>
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</table>
| Rationale                        | Severity of DKA will affect length of stay and admission to ward vs I-Care vs ICU  
|                                  | The protocol might also help in finding the incidence of causes of DKA, and complications |
| Cited References                 | Diabetes Canada Clinical Practice Guidelines on DKA  
|                                  | American Diabetes Association guidelines                           |

### Relevant Clinical Knowledge Topics

- **Basal Bolus Insulin Therapy, Adult – Inpatient (BBIT)**
- **Diabetic Ketoacidosis, Adult – Emergency Department (DKA, Diabetes, Hyperglycemia, HHS)**
- **Insulin Pump Therapy, Pediatric and Adult – Acute Care**

### Relevant Guidelines, Procedures, Protocols, and Policies

- Insulin Pump In-Hospital Therapy – [ipumpit.ca](http://ipumpit.ca)
- **Basal Bolus Insulin Therapy Website**  
  (Note: BBIT is appropriate if patient requires subcutaneous insulin)  
  - [How to BBIT: An Educational Resource for Prescribers AHS Adult Subcutaneous Basal Bolus Insulin Therapy (BBIT)](http://how-to-bbit.ca)
- **AHS Glycemic Management Policy – Adult**  
  - [Procedure: Treatment of Hypoglycemia - Adult HCS-206-01](http://procedure.hcs-206-01)
  - [Procedure: Treatment of Hyperglycemia - Adult HCS-206-02](http://procedure.hcs-206-02)
  - [Resource: Glycemic Management Policy Suite FAQ](http://resource.gmpsuite-faq)
Acknowledgements

We would like to acknowledge the contributions of the clinicians who participated in the development of this topic. Your expertise and time spent are appreciated.

<table>
<thead>
<tr>
<th>Name</th>
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Additional Contributors
Thank you to all clinicians who participated in the colleague review process. Your time spent reviewing the knowledge topics and providing valuable feedback is appreciated.