Diabetic Ketoacidosis and Diabetic Ketosis Non-Acidosis

**Definition:**
Diabetic Ketoacidosis (DKA) is the leading cause of morbidity and mortality in children with type 1 diabetes. The cause of DKA is a deficiency of insulin, with resultant unabated gluconeogenesis and lipolysis and impaired muscle glucose utilization. This generates hyperglycemia and ketosis associated with osmotic diuresis with water and electrolyte losses and metabolic acidosis.

**Incidence:**
The frequency of DKA differs between established type 1 diabetes and new onset diabetes. The risk of DKA in established type 1 diabetes is 1-10% per patient per year. In North America frequencies range from approximately 15-70% for DKA at onset of diabetes. DKA at diagnosis is more common in younger children (<2yr of age).

The incidence of clinically overt cerebral edema in national population studies is 0.5-0.9% and the mortality rate is 21-24%. Up to 20% of cases of cerebral edema occur before initiating therapy, but generally it develops in the first 12 hours of treatment. Mental status abnormalities occur in approximately 15% of children treated for DKA.

**Etiology:**
DKA results from deficiency of circulating insulin and increased levels of the counter regulatory hormones: catecholamines, glucagon, cortisol and growth hormone. Severe insulin deficiency occurs in previously undiagnosed type 1 diabetes mellitus and when patients on treatment deliberately or inadvertently do not take insulin, especially the long acting component of a basal-bolus regimen. Ketones accumulate because of increased lipolysis, increased ketogenesis and decreased ketone body utilization due to low insulin levels.

**Differential Diagnosis:**
- Metabolic acidosis
- Respiratory acidosis
- Septic shock
- Asthma
- Pneumonia
- Respiratory distress syndrome
- Salicylate toxicity
- Acute abdomen
- Gastroenteritis
- Hyperosmolar hyperglycemic non-ketotic coma

**Guideline Inclusion Criteria:**
Pediatric patients age ≥ 12 months with:
- Hyperglycemia
- Glucosuria
- Ketonuria

OR
Historical features suspicious of diabetes.

**Biochemical Criteria for the diagnosis of DKA:**
- Venous pH < 7.3
- HCO₃ < 18
- Hyperglycemia > 200 mg/dL
- AND Ketones in Urine

**Biochemical Criteria for diagnosis of Ketosis Non-acidosis:**
- Venous pH ≥ 7.3
- HCO₃ ≥ 18
- Hyperglycemia > 200 mg/dL
- AND
- Urine Ketones > Small
- β-HB > 1 mmol/L

**Guideline Exclusion Criteria:**
Age < 12 months
Ketosis Non-Acidosis Inpatient Exclusion Criteria:
- Age < 12 months
- Diabetic Ketoacidosis
- Cerebral Edema
- Hyperglycemia hyperosmolar state
- New onset diabetic
- Cystic Fibrosis

Ketosis Non-Acidosis ED Exclusion Criteria:
- Age < 12 months
- Diabetic Ketoacidosis
- Cerebral Edema
- Hyperglycemia hyperosmolar state
- New onset diabetic

Critical Points of Evidence

Evidence Supports
- Emergency assessment should follow Pediatric Advanced Life Support (PALS) guidelines.
- Monitoring of the clinical and biochemical response to treatment is necessary.
- Fluid replacement should begin before starting insulin therapy.
- Patients should be assessed for warning signs of cerebral edema.

Evidence Against
- Bicarbonate treatment is not recommended except for treatment of life-threatening hyperkalemia.
- Exceeding greater than two times maintenance fluid rate in 24 hours unless objective evidence of shock, excessive fluids may increase risk for cerebral edema.
- Computed Tomography findings of increased intracranial pressure often occur too late for effective intervention.

Practice Recommendations and Clinical Management

Patient Assessment
- Emergency assessment following PALS guidelines. (22-23)
  (Strong recommendation, low-quality evidence)

Assess neurologic stability, consider using Glasgow Coma Scale (GCS). (24)
  (Strong recommendation, low-quality evidence)

Assess for signs and symptoms of Cerebral Edema: (25)
- Severe headache
- Mental status changes (e.g., irritability, decreased cooperation, disorientation, decreased level of consciousness)
  - Many patients in DKA are lethargic, but this usually improves quickly on therapy.
- Bradycardia/hypertension/respiratory insufficiency (Cushing’s triad)
  - Be aware of the normal heart rate for the age.
  - The heart rate in a patient with DKA should decrease with IV fluid therapy, but not to below the normal range.
- Recrudescence of vomiting
  - Most patients in DKA are vomiting on presentation, but this should improve on therapy.
- One or both pupils fixed and dilated
- Papilledema
- Focal neurologic signs
- Polyuria secondary to diabetes insipidus or, conversely, oliguria secondary to syndrome of inappropriate antidiuretic hormone (SIADH)
- Coma
  (Strong recommendation, low-quality evidence)

Consider assessment for patients at high risk for cerebral edema complications:
- Age < 24 months
- GCS < 13 after volume resuscitation
- Presenting pH < 7.15
- Presenting HCO₃ < 5 mEq/L
- Presenting PCO₂ < 10 mmHg
- Presenting BUN > 30 mg/dL
- Calculated serum osmolality > 350 [2 x Na + (glucose/18) + (BUN/2.8)]
- Corrected Na < 140 mEq/L or decreasing at 2 hour labs
- Patient received IV bicarbonate or insulin bolus
- Patient received > 40 mL/kg total initial volume replacement (include fluids received prior to arrival to DCMC)

For questions concerning this pathway, Click Here
Last Updated March 7, 2016
• Developmental delay or any condition that compromises communication
• Abnormal neurological exam after volume resuscitation
• Other organ system dysfunction
• History of Cerebral Edema
• Intractable vomiting
• Glucose > 800 ml/dL

Assess for clinical signs of DKA. \(^{(26)}\)
• Dehydration
• Tachycardia
• Tachypnea
• Deep, sighing (Kussmaul) respiration; breath has the smell of acetone
• Nausea, vomiting
• Abdominal pain that may mimic an acute abdominal condition
• Confusion, drowsiness, progressive reduction in level of consciousness and, eventually, loss of consciousness.
• Polyuria/polydipsia

Laboratory Testing
Beta-hydroxybuterate (ß-HB) should be measured immediately for all patients. ß-HB should be monitored every four hour for patients being treated for DKA and monitored every two hours for patients being treated for ketosis non-acidosis to monitor response to treatment. \(^{(27-34)}\)

(Strong recommendation, high-quality evidence)

Blood glucose should be measured immediately for all patients. Routine monitoring for ketosis non-acidosis patients is recommended.

Blood glucose should be rechecked after initial fluid resuscitation. Hemoglobin A1C should be measured to assist in diagnosis. \(^{(25, 35)}\)

(Strong recommendation, low-quality evidence)

Basic Metabolic Panel (BMP) should be measured to assist in diagnosis. Routine monitoring for DKA and ketosis non-acidosis patients is recommended at least every four hours. \(^{(25)}\)

Magnesium, Phosphorous, and Calcium should be measured to assist in diagnosis. Magnesium and phosphorous should be measured every eight to twelve hours. \(^{(25)}\)

(Strong recommendation, low-quality evidence)

Urinalysis with micro should be ordered as a diagnostic test. Consider urinalysis with culture in febrile patients or if patient history is suggestive of infection.

(Strong recommendation, low-quality evidence)

Routine monitoring of urine ketones is recommended for ketosis non-acidosis patients. \(^{(25)}\)

(Strong recommendation, high-quality evidence)

Imaging
Cranial computed tomography scan should be obtained to rule out other possible intracerebral causes of neurologic deterioration after treatment for cerebral edema especially in patients with herniation or signs of herniation. \(^{(36-39)}\)

(Strong recommendation, low-quality evidence)

Management
Fluid resuscitation should begin immediately and may need to be repeated until tissue perfusion is adequate. \(^{(25)}\)

(Strong recommendation, moderate-quality evidence)

Patient intake and outtake should be closely monitored and recorded. \(^{(25)}\)

Diabetes Ketoacidosis Management in the Emergency Department:
• Suspend insulin pump, if applicable to patient.

Initial fluid resuscitation with normal saline. \(^{(25)}\)

(Strong recommendation, moderate-quality evidence)
Prompt admission to PICU for any patient at high risk for cerebral edema, showing signs of herniation, or meeting insulin drip requirements.  
(Strong recommendation, low-quality evidence)

Routine monitoring of neurologic status, vital signs, and blood glucose is recommended.  
(Strong recommendation, low-quality evidence)

Patient should be placed on Cardio-respiratory Monitor and Pulse Oximeter.  
(Strong recommendation, low-quality evidence)

Bicarbonate administration is not recommended except for treatment of life-threatening hyperkalemia.  
(Strong recommendation, high-quality evidence)

Diabetes Ketoacidosis Management in the Pediatric Intensive Care Unit:  
Routine monitoring of neurologic status, vital signs, and blood glucose is recommended.  
(Strong recommendation, low-quality evidence)

Patient should be placed on Cardio-respiratory Monitor and Pulse Oximeter.  
(Strong recommendation, low-quality evidence)

Bicarbonate administration is not recommended except for treatment of life-threatening hyperkalemia.  
(Strong recommendation, high-quality evidence)

IV fluid resuscitation should be maintained to expand volume, as required to restore peripheral circulation. “Two-bag” system is recommended to enable faster response time in making IV fluid therapy changes.  
(Strong recommendation, low-quality evidence)

If the Potassium is < 5.5 mEq/dL and patient is voiding well include potassium replacement therapy as part of fluid resuscitation.  
(Strong recommendation, low-quality evidence)

The rate of fluid administration should not exceed 2 times the usual daily maintenance requirement.  
(Strong recommendation, low-quality evidence)

Insulin therapy should be started after starting fluid resuscitation.  
(Strong recommendation, high-quality evidence)

Regular insulin at 0.05 – 0.1 units/kg/hour in normal saline IV until ß-HB < 1 mmol/L is recommended.  
(Strong recommendation, high-quality evidence)

Ketosis Non-acidosis Management:  
Routine (every hour) monitoring of vital signs is recommended.  
(Strong recommendation, low-quality evidence)

Cardio-respiratory Monitor recommended for patients treated in the Emergency Department.  
(Strong recommendation, low-quality evidence)

IV Fluid should be administered with components and rates based on consultation with endocrinologist.  
(Strong recommendation, low-quality evidence)

If corrected Na is less than to 140 mEq/L maintenance fluids should contain normal saline.  
(Strong recommendation, low-quality evidence)

If corrected Na is greater than or equal to 140 mEq/L maintenance fluids should contain ½ normal saline.  
(Strong recommendation, low-quality evidence)

Alternating carbohydrate-free and carb-containing fluids may be necessary depending on the patient’s tolerance for PO and glucose levels.  
(Strong recommendation, low-quality evidence)

For questions concerning this pathway,  
Click Here  
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Insulin should be administered to patients based on the patient’s home correction for hyperglycemia, every two hours.  
(Strong recommendation, low-quality evidence)

Patients with moderate to large ketones defined as urine ketones ≥40 or ß-HB ≥ 2 mmol/L, should receive additional insulin with a dose of 0.1 units/kg subcutaneous. 
(Strong recommendation, low-quality evidence)

Insulin should not be given more frequently than every 2 hours. 
(Strong recommendation, high-quality evidence)

Cerebral Edema Management: 
Protect airway; intubation may be necessary for the patient with impending respiratory failure.  
(Strong recommendation, moderate-quality evidence)

Fluid rate should be reduced by one-third.  
(Strong recommendation, moderate-quality evidence)

Patients head should be elevated to 30°. 
(Strong recommendation, moderate-quality evidence)

Hypertonic saline (3%) should be administered 5-10 mL/kg over 30 minutes.  
(Strong recommendation, moderate-quality evidence)

Mannitol should be administered over 20 minutes and repeated if there is no initial response after 30 minutes to 2 hours. 
(Strong recommendation, moderate-quality evidence)

Hyperosmolar agents should be readily available at the patient’s bedside.  
(Strong recommendation, high-quality evidence)

Consults/Referrals: 
Endocrinology should be notified when a patient is suspected of having DKA.

Endocrinology should be consulted for diagnosis of DKA or Ketosis Non-acidosis and during treatment.

PICU Attending should be consulted STAT if the patient is high risk for cerebral edema or exhibiting signs of herniation.

PICU Attending should be consulted/notified as soon as the patient is determined to meet DKA criteria and if any of the following occur:
- Glucose < 80 mg/dL
- Glucose falling > 100 mg/dL/Hour
- Urine output < 1mL/kg/hour over 2 hours OR negative fluid balance
- Intractable vomiting
- Change in mental status (including severe or increasing headache)

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Last Updated March 7, 2016
Patient Disposition

Admission Criteria

Pediatric Intensive Care Unit:
- Patients that meet biochemical criteria for DKA.
- Patients with suspected or definite Cerebral Edema.
- Patients with hemodynamic instability.

Inpatient:
Patients that meet biochemical criteria for Ketosis Non-acidosis and any of the following:
- Ketones large to moderate OR β-HB > 2 mmol/L 2 hours after initiation of treatment in the emergency department
- Not tolerating PO 2 hours after initiation of treatment in the emergency department
- Psychosocial issues that necessitate inpatient treatment

Discharge Criteria

Inpatient
Patient should have all of the following:
- β-HB decreasing or < 0.6 mmol/L
  Discuss w/endocrinology for β-HB 0.6 - 1.9 mmol/L
- Patient is tolerating PO

Emergency Department
Patient should have all of the following:
- Urinary ketones are negative to trace OR β-HB decreasing or < 0.6 mmol/L
  Discuss w/endocrinology for β-HB 0.6 - 1.9 mmol/L
- Blood glucose < 200 ml/dL OR decreasing
  AND
- Patient is tolerating PO

Follow-Up Care

Inpatient Discharge Instructions
  Diabetic Ketosis Sick Day Plan
  Consult Endocrinology

Emergency Department Discharge instructions
  Diabetic Ketosis Sick Day Plan
  Consult Endocrinology

Outcome Measures

Emergency department & hospital length of stay
Emergency department & hospital readmission rate
Rate of hospital admissions

Addendums
Diabetic Ketosis – Sick Day Plan
Diabetes Ketoacidosis Emergency Department Evaluation Pathway
Evidence Based Outcome Center

**Inclusion Criteria**
- Hyperglycemia &/or Glucosuria &/or Ketonuria
- Historical features suspicious of diabetes

**PALS and ISPAD Assessments**
- Vital Signs: Temp, Heart rate (HR), Respiratory rate (RR), and Blood pressure (BP)
- Notify MD if Cushing’s Triad is present (↓ HR, ↑ BP, widening pulse pressure)
- Cardiorespiratory monitoring
- Altered mental status
- Young age

**Assess Neurologic Stability & Risk of Cerebral Edema**
Consider Assesment for patients at high risk for cerebral edema complications
- Glasgow Coma Scale (GCS)

**Initial Diagnostic Labs:**
- Consider expanding labs for high risk for cerebral edema complications
- Notify Endocrinologist on Call
- Hemoglobin A1C
- Phosphorous
- VBG, CBG, OR ABG with lytes/Ca
- Magnesium
- BMP
- Urinalysis with micro*
- Quantitative Beta hydroxybutyrate – STAT (B-HB)
- *Consider urinalysis with culture if febrile

**Clinical Signs**
- Dehydration
- Vomiting
- Kussmaul breathing
- Abdominal tenderness
- Lethargy
- Mental status changes
- Smell of ketones (fruity smell)

**Signs Suggestive of DKA**
- Polyuria/Polydipsia
- Fatigue
- New onset enuresis
- Nausea/vomiting
- Nocturia
- Headache
- Weight loss
- Confusion
- Abdominal pain
- New Candida infection

**Initial Fluid Resuscitation**
- 20 mL/kg NS Bolus over 30 minutes | 1 L Max
- Then 2X Maintenance IV Fluids
- Consider adjustments based on fluid given prior to arrival at DCMC.
- **High risk for Cerebral Edema**
  - Consider having Hypertonic Saline (3%) available at the bedside: 5-10 mL/kg over 30 minutes

**Cerebral Edema Treatment Pathway**
- YES
- Signs of herniation
  - Bradycardia/hypertension/respiratory insufficiency
  - Anisocoria (Unequal pupil size)
  - Unresponsiveness

**Ketosis Non-acidosis Pathway**
- YES
  - **High risk of cerebral edema**
  - YES
  - Severe headache
  - Recurrent vomiting
  - History of Cerebral Edema
  - Depressed mental status

**Initiate ED Orderset:**
- ADMIT to PICU
  - Cardio-respiratory Monitor and Pulse Oximeter
  - Vital signs with neuro check Q 1 Hour
  - Intake and output recorded
  - Blood sugar by glucometer Q 1 Hour
  - Suspend insulin pump if applicable to patient
  - Consult Endocrinology

Consider a single dose of long-acting insulin (insulin glargine or insulin detemir), after consult w/ Endocrinology, if transport to PICU is expected to be > 60 minutes.

**Notify PICU attending for any of the following:**
- Glucose < 80 mg/dL
- Glucose falling > 100 mg/dL/Hour
- Urine output < 1mL/kg/hour over 2 hours OR negative fluid balance
- Intractable vomiting
- Change in mental status (including severe or increasing headache)

**ADMIT to PICU**

**Hyperglycemia hyperosmolar state**
- Consult Endocrinology Manage Off Pathway

**Meets DKA Definition**
1) pH < 7.3
2) Hyperglycemia > 200 Mg/dL
3) AND Ketones in Urine
   OR
   High risk for complications
   *CONSULT ENDOCRINOLOGY*

**Recheck Glucose after Initial Fluid Resuscitation**

**Meets Ketosis Non-Acidosis Definition**
1) pH > 7.3
2) Hyperglycemia > 200 Mg/dL
3) AND Urine Ketones > Small OR B-HB > 1
*CONSULT ENDOCRINOLOGY*

**IV Fluids**
- If patient is high risk for cerebral edema use NS
  - Corrected Sodium level > 140 mEq/L: ½ NS
  - Corrected Sodium level < 140 mEq/L: NS

Corrected Sodium = Measured sodium + 0.016 * (Serum glucose - 100)

For questions concerning this pathway, Click Here
Last Updated March 7, 2016
Diabetes Ketoacidosis Intensive Care Unit Management Pathway
Evidence Based Outcome Center

Inclusion Criteria
1. pH < 7.3 AND HCO₃ < 18
2. Hyperglycemia > 200 mg/dl AND
3. Urine Ketones present

Exclusion Criteria
- Age < 12 months
- Cardiac/Oncology
- Vital signs q1hr
- Respiratory Monitor
- Ondansetron (Zofran) 0.1 mg/kg Max: 4 mg dose IV prn q12hr
- Famotidine (Pepcid) 0.5 mg/kg/dose Max: 20 mg dose q12hr

Fluids
- 1.5 x maintenance | Max: 4L/m2 in 24hr
- Start regular insulin:
  - 1 unit/ml in normal saline IV
  - Infuse at 0.05 – 0.1 units/kg/hour
- Order long-acting insulin sub-Q: qPM
  - insulin glargine or insulin detemir
  - Consult Endocrinology for dose

Insulin
- 1.5 x maintenance | Max: 4L/m2 in 24hr
- Start regular insulin:
  - 1 unit/ml in normal saline IV
  - Infuse at 0.05 – 0.1 units/kg/hour
- Order long-acting insulin sub-Q: qPM
  - insulin glargine or insulin detemir
  - Consult Endocrinology for dose

Fluid titration
1. Total fluid rate 1.5 x maintenance
   - While patient is acidic maintain NPO status
   - If Potassium (K+) < 5.5 mEq/dl AND patient is voiding well discontinue normal saline and initiate two bag system

Assess Neurologic Stability & Risk of Cerebral Edema: q1hr
- High Risk for Cerebral Edema: Decrease insulin AND consider hypertonic saline (3%)

Labs:
- Blood glucose by glucometer: q2hr
- VBG w/lytes, CBG w/lytes OR ABG w/lytes: q2hr
- Serum B-Hb: q4hr
- BMP: q4-q12hr
- Magnesium & Phosphorus: q8-q12hr
- Additional Labs
  - Serum Osmolality (OSM) – If patient is high risk for Cerebral Edema, glucose is increasing, or high initial OSM
  - Urinalysis with micro, Urine Culture, or Throat Culture – If patient history supports

Monitoring:
- Vital signs q1hr
- Cardio-respiratory monitor, pulse oximeter, strict I & Os including po intake

Other medication:
- Famotidine (Pepcid) 0.5 mg/kg/dose Max: 20 mg dose q12hr
- Ondansetron (Zofran) 0.1 mg/kg Max: 4 mg dose IV prn q12hr
- Long-acting insulin (insulin glargine or insulin detemir): Contact Endocrinology for dose

Fluid titration based on serum glucose:

<table>
<thead>
<tr>
<th>Serum glucose (mg/dL)</th>
<th>Fluid titration</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 – 200</td>
<td>100% = _____ ml/hr</td>
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<tr>
<td>201 – 250</td>
<td>66% = _____ ml/hr</td>
</tr>
<tr>
<td>Greater than 250</td>
<td>33% = _____ ml/hr</td>
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If glucose greater than 300 but is falling greater than 100 mg/dl per hour, start fluids as follows and resume fluid titration as above once serum glucose less than or equal to 200 mg/dl

For questions concerning this pathway, Click Here
Last Updated April 18, 2016
**Risks for Cerebral Edema:**
- New-onset diabetes
- History of prolonged DKA (several days)
- Extended history of poor diabetic control leading to chronic hyperosmolality
- Age < 5
- Moderate-to-severe acidosis (serum pH < 7.2)
- Elevated BUN
- Provision of > 4L/M2/day of fluids
- Excessive swings of serum glucose, plasma osm., and serum pH
- Variable rate of fluid replacement
- Rate of decrease of serum glucose >100 mg/dL/hour
- Failure of serum Na to increase as serum glucose decreases
- Rapidly decreasing plasma osmolality or critically low plasma osmolality during the first 24 hours of therapy
- Osmolality may be calculated as: 
  \[ \text{Posm} = 2\text{[Na]} + \frac{\text{[Glucose]}}{18} + \frac{\text{[BUN]}}{2.8} \]
- In general, it is sufficient to monitor serum Na and glucose, rather than explicitly calculate osmolality

**Signs of Cerebral Edema**
- Severe headache
- Mental status changes (e.g., irritability, decreased cooperation, disorientation, decreased level of consciousness)
  - Many patients in DKA are lethargic, but this usually improves quickly on therapy.
- Bradycardia/hypertension/respiratory insufficiency (Cushing’s triad)
  - Be aware of the normal heart rate for the age.
  - The heart rate in a patient with DKA should decrease with IV fluid therapy, but not to below the normal range.
- Recrudescence of vomiting
  - Most patients in DKA are vomiting on presentation, but this should improve on therapy.
- One or both pupils fixed and dilated
- Papilledema
- Focal neurologic signs
- Polyuria secondary to diabetes insipidus or, conversely, oliguria secondary to syndrome of inappropriate antidiuretic hormone (SIADH)
- Coma

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**Initiate treatment as soon as the condition is suspected and in the following order!**

**Call PICU and Endocrinology**

**Airway Protection**
Intubation *may* be necessary for the patient with impending respiratory failure or GCS < 8, sustained hyperventilation has been associated with poor outcome.

**Maneuvers and IV Fluids**
- Reduce the rate of fluid administration by one-third.
- Elevate the head of the bed and keep head positioned midline

**Hyperosmolar Therapy**
- **Hypertonic saline (3%),** 5–10 mL/kg over 30 minutes
- **AND/OR**
- **Mannitol** 0.5–1 g/kg IV over 20 minutes and repeat if there is no initial response in 30 minutes to 2 hours

**After Treatment Care and Considerations**
- Consult Neurosurgery regarding possible ICP monitor
- After treatment for cerebral edema has been started, a cranial CT scan should be obtained to rule out other possible intracerebral causes of neurologic deterioration (≈10% of cases), especially thrombosis or hemorrhage, which may benefit from specific therapy.

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For questions concerning this pathway, [Click Here]

Last Updated March 7, 2016
**EXCLUSION CRITERIA**
- Age < 12 months
- Diabetic Ketoacidosis
- Cerebral Edema
- Hyperglycemia
- hyperosmolar state
- Cystic Fibrosis
- New onset diabetic

**Inclusion Criteria**
1) pH > 7.3 OR HCO₃ ≥ 18
2) Hyperglycemia > 200 Mg/dl
3) AND Urine Ketones > Small OR β-HB > 1

**TIME: 0 Initial Insulin Dose**

**Moderate to Large Ketones**
- (> 40 on Urine Ketones or β-HB > 2 mmol/L)

**Insulin Administration:**
- Insulin aspart (Novolog): 0.1 units/kg SQ once
- AND
- Home correction for hyperglycemia:
  - (typically 1 unit per X > Y, ex. 1 unit per 50mg/dl > 150mg/dl)

**IV Fluids:**
- Infuse IVF at 2 times maintenance rate

**TIME: 90 Minutes After Initial Insulin Dose**

**IV fluids Reduce to maintenance**
- Encourage water intake

Consider meals or 30 gram snacks (Possible Sources of Snacks)
- The dose of insulin for the meal is based on the patient’s insulin to carbohydrate ratio at home. This dose should be given at patients regularly scheduled 2hr interval.
- Do not give insulin more frequently than every 2 hrs.

**TIME: 120 Minutes After Initial Insulin Dose**

**Give insulin according to the patients insulin to carbohydrate ratio (ICR)**
- AND consider 30 gram snack (Possible Sources of Snacks)

**Discharge Criteria: Consult Endocrinology**
- Urinary ketones are trace to negative
- OR
- β-HB decreasing or < 0.6 mmol/L
- (Consult Endo: β-HB 0.6 - 1.9 mmol/L)
- Blood glucose < 200 mg/dl OR decreasing
- AND
- Patient is tolerating PO

**DISCHARGE INSTRUCTIONS**
- Use ED Diabetic Ketosis Sick Day Plan
- Consult Endocrinology

**Small to Trace Ketones**
- (<40 on Urine Ketones or β-HB < 2 mmol/L)

**Insulin Administration:**
- Home correction for hyperglycemia:
  - (typically 1 unit per X > Y, ex. 1 unit per 50mg/dl > 150mg/dl)

**IV Fluids:**
- Infuse IVF at 2 times maintenance rate

**IV fluids Reduce to maintenance**
- Encourage water intake

**TIME: 90 Minutes After Initial Insulin Dose**

**Order Quantitative β-hydroxybutyrate – STAT and VBG Labs**

**Administer Zofran: 0.1 mg/kg | Max 4 mg**
- AND
- Continue IV Fluids at 2 times maintenance

**Glucose < 200 mg/dl OR rapidly decreasing**
- Change IV Fluids
- D10 %NS at maintenance
- AND
- ½ NS or NS at maintenance

**Tolerating PO?**
- YES
- NO

**Tolerating PO?**
- YES
- NO

**Disposition**
- Picu admission criteria:
  - pH < 7.3 AND HCO₃ < 18
  - Hyperglycemia > 200 Mg/dl
  - Corrected Na > 150
  - AND Ketones in Urine
- Inpatient Admission Criteria:
  - Ketones Large to Moderate OR β-HB > 2 mmol/L
  - Not Tolerating PO
  - Psycho social issues that necessitate inpatient treatment

**For questions concerning this pathway, Click Here**

Last Updated March 7, 2016
Ketosis Non-Acidosis Inpatient Treatment Pathway
Evidence Based Outcome Center

**Ketosis Non-Acidosis Criteria**
1. pH ≥ 7.3 or HCO3 ≥ 18
2. AND Urine Ketones > Small OR β-HB > 1

**EXCLUSION CRITERIA**
- Age < 12 months
- Diabetic Ketoacidosis
- Cerebral Edema
- Hyperglycemia
- Hyperosmolar State
- New onset diabetes

**Glucose > 200 mg/dL:**
- Start IVF + sodium chloride + potassium 🌊 @ 2 x maintenance (max fluid rate = 250 ml/hr)

**Glucose ≤ 200 mg/dL:**
- D10 IVF + sodium chloride + potassium 🌊 @ maintenance
  - PLUS -
  - Non-dextrose containing IVF 🌊 @ maintenance (max fluid rate = 250 ml/hr)
  - Continue labs 🧐 and monitoring 🌊
  - Administer insulin every 2 hours (amount of insulin is determined by serum beta-hydroxybutyrate) 🌊
  - Offer small sips of water

**Glucose ≤ 200 mg/dL:**
- Offer water or diet soda
- Start IVF + sodium chloride + potassium 🌊 to keep total hourly fluids (po + IV) to 2 x maintenance (max fluid rate = 250 ml/hr)
- Continue labs 🧐 and monitoring 🌊
- Administer insulin every 2 hours (amount of insulin is determined by serum beta-hydroxybutyrate) 🌊
- Offer small sips of water

**IV Fluids**
- Sodium content:
  - Corrected Sodium level ≥ 140 mEq/L: ¼ NS
  - Corrected Sodium level < 140 mEq/L: NS
- Corrected Sodium = Measured sodium + 0.016 * (Serum glucose - 100)

**Potassium Content:**
- K < 4: ADD 30 meq/L KCl and 30meq/L Kphos
- K – 5.5: ADD 20 meq/L KCl and 20 meq/L Kphos
- K > 5.5: NO potassium

**β-HB < 0.6**
STOP Pathway, Discontinue IVF; Assess discharge criteria, Resume routine home diabetes care

**New Admits and PICU Transfers**
Assess Inclusion, Exclusion, and PICU Criteria
Consult Endocrinology

**IF glucose < 100 mg/dL STOP Protocol**
CALL Endocrinology for further instructions

**Disposition**

**PICU Admission Criteria:**
- Altered mental status
- pH < 7.3 AND HCO3 < 18
- Corrected Na ≥ 150
- Hemodynamic instability

**IMC Admission Criteria:**
- β-HB > 3 mmol/L after 12 hours on protocol

**Discharge Criteria:**
- Discuss Endocrinology
- β-HB < 0.6 mmol/L
- Consider β-HB 0.6 - 1.9 mmol/L
- Patient is tolerating PO

For questions concerning this pathway, [Click Here]
Last Updated April 18, 2016
Assessment for patients at high risk for cerebral edema complications

- Age < 24 months
- GCS < 13 after volume resuscitation
- Presenting pH < 7.15
- Presenting HCO₃ < 5 mEq/L
- Presenting PCO₂ < 10 mmHg
- Presenting BUN > 30 mg/dL
- Calculated Serum osmolality > 350 [2 x Na + (glucose/18) + (BUN/2.8)]
- Corrected Na < 140 mEq/L or decreasing at 2 hour labs
- Patient received IV bicarbonate or insulin bolus
- Patient received > 40 mL/kg total initial volume replacement (include fluids received prior to arrival to DCMC)
- Developmental delay or any condition that compromises communication
- Abnormal neurological exam after volume resuscitation
- Other organ system dysfunction
- History of Cerebral Edema
- Intractable vomiting
- Glucose > 800 mg/dL

Hyperglycemic Hyperosmolar State (HHS) criteria

Hyperglycemic hyperosmolar state (HHS), also referred to as hyperosmolar nonketotic coma, may occur in young patients with T2DM, but rarely in T1DM subjects.

Criteria for HHS include:
- plasma glucose concentration >33.3 mmol/L (600 mg/dL)
- arterial pH >7.30
- serum bicarbonate >15 mmol/L
- small ketonuria, absent to mild ketonemia
- effective serum osmolality >320 mOsm/kg
- stupor or coma

Possible sources of snacks

<table>
<thead>
<tr>
<th>Snack</th>
<th>Volume</th>
<th>CHO</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Saltine Crackers</td>
<td>1 Pkg (2 crackers)</td>
<td>4 grams</td>
<td>Graham Crackers</td>
<td>1 Pkg (3 crackers)</td>
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</tr>
<tr>
<td>Jello Snacks</td>
<td>1 Pkg (8oz)</td>
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For questions concerning this pathway, Click Here
Last Updated March 7, 2016
Diabetic Ketosis – Sick Day Plan

SICK DAY PLAN WITH SMALL, MODERATE, OR LARGE KETONES

- Please rest for the remainder of your illness. If you have moderate or large ketones in your urine, you should not exercise, even if you feel well.

- Return to the emergency room for chest pain, confusion, vomiting that does not stop with medication or if you are concerned about your child and do not feel able to care for them.

- Drink lots of fluids: 8 ounces of caffeine free, sugar free liquids every 30 minutes.

- Check for ketones with all urine, or check for blood ketones every two hours until ketones are negative.

- Check blood sugar every two hours until you are no longer having ketones in your blood or urine.

- If you normally give insulin injections at home, do not stop giving insulin. Give your normal home correction of rapid insulin (Novolog, Humalog, or Apidra) every 2 hours with rapid insulin (Novolog, Humalog, or Apidra). Give your normal carbohydrate coverage for meals. Do not forget to give your normal dose of long acting insulin (i.e. Lantus or Levemir) in addition to other management.

- If you are on an insulin pump at home, please be sure to change your pump site, reservoir/cartridge, fill with new insulin, and reconnect the pump to the new site. Continue with your normal home insulin pump settings as well as correction and coverage. It is OK to resume basal rate through the pump, but if ketones remain small to large, correction dose should be given by pen or syringe (not your pump).

- For blood glucose less than 70, give 15 grams of juice by mouth and recheck your blood glucose in 15 minutes. Please repeat this until blood sugar is over 70. Always have Glucagon available for severe low blood glucose levels.

- Call the diabetes care line (512–628–1830) tomorrow morning (_____/_____) to discuss your child’s management, or if you have any questions or concerns.

- Call the diabetes care line (512–628–1830) for a high or low blood sugar that is sustained, if sugars do not respond to your normal management, or if your ketones are getting more severe on two consecutive checks. If after clinic hours please call MedLink (512-323-5465) and tell them that you have a very sick diabetic child to have the on-call doctor paged.
Today in the emergency department, it was found that your child has ketones in his or her blood or urine. Ketones are made when the body is unable to use glucose for energy and has to burn fat. Missing insulin does, infections, the flu, or even a cold can cause the body to not use insulin or glucose correctly and instead burn fat for energy. When this occurs, ketones can build up dangerously in the blood and urine. Always test for ketones when your child has:

- Any Illness
- Unexplained blood sugar above 300
- Diarrhea, nausea, or vomiting
- Fever of 100.4°F (38°C) oral or 101.4°F (38.5°C) rectal or higher

Based on the tests done in the emergency department today, it does not appear that your child has or diabetic ketoacidosis or DKA. DKA is a dangerous condition that is often caused by the body having a lack of insulin. This can happen if your child misses taking his or her insulin injections, or if your child gets an infection. Symptoms of ketoacidosis include:

- Nausea and vomiting
- Stomach cramps
- Rapid, deep breathing
- Fruity-smelling breath
- Blurred vision

Even though your child does not currently have ketoacidosis, he or she may develop this problem if his or her illness worsens. Ketoacidosis is very serious. If you are concerned that your child is getting sicker, please discuss with the endocrinologist on call, or bring your child back to the emergency department immediately.

Our healthcare team has discussed your child’s case with the endocrinologist on call today, and we have decided as a team that it is safe for you to care for your child’s ketosis at home today. Please see the sick-day plan below for further details.

Other notes:

- **Stick to your usual diet and meal plan if your child can eat.** This will help regulate your child’s blood sugar and keep him or her from becoming dehydrated.

- **If your child can’t eat,** have him or her sip fruit juices, soft drinks with sugar, or ice cubes made from juice or sugar water. Or try gelatin, frozen juice bars, or low-fat ice cream. If you were given medicine for nausea to use at home (i.e. Zofran/ondansetron) please use this as needed to help with nausea and vomiting.

- **Make sure your child drinks plenty of water.** Your child has to stay hydrated.

- **Test blood sugar often.** Test as often as indicated in the sick-day plan. And continue checking your child’s blood sugar even if he or she isn’t eating. A rise in hormones can cause the blood sugar level to rise. That means insulin must still be injected to keep your child safe and his or her blood sugar in the target range.

- **Do not skip insulin.** ALWAYS continue giving insulin. Adjust the amount of insulin you give your child according to the sick-day plan. But do NOT skip insulin, even if your child is vomiting. Skipping insulin could lead to DKA Call your child’s doctor if you aren’t sure how much insulin you should give your child.
Sick Day Supplies to have in your house:

- Sugar free fluids - diet soda, sugar-free Jell-O and popsicles, broth
- Fluids with sugar - regular soda, Gatorade, popsicles, Jell-O
- Hard candy - peppermints, Lifesavers
- Glucose gel or tablets
- Medicines - for fever, cough, diarrhea
- Medicine for nausea - Zofran
- Glucagon Emergency Kit

Always keep emergency phone numbers on hand when away from home or traveling.

Diabetes Office Line: 512-628-1830

Medlink: 512-323-5465- ask for the pediatric endocrinologist on call

- Dr. Susan Nunez
- Dr. Rajani Prabhakaran
- Dr. Shona Rabon
- Dr. Stephanie Tacquard
- Dr. Joshua Smith
- Dr. Bonnie Goldsmith
EBOC Project Owner: Joshua Smith, MD

Approved by the Diabetes Management Evidence-Based Outcomes Center Team

Revision History
Date Approved: March 7, 2016
Next Review Date: March 7, 2018

Diabetes Management EBOC Team:
Joshua Smith, MD
Sujit Iyer, MD
Michael Gardiner, MD
Eric Higginbotham, MD
Lynn Thoreson, DO
Melissa Cossey, MD
Hayley Harris, MD
Patricia Aldridge, MD
Carolyn Ragsdale, PharmD
Thanh Ngo, PharmD
Diane Taylor, RN
Denita Lyons, RN
Patrick Boswell

EBOC Committee:
Sarmistha Hauger, MD
Mark Shen, MD
Deb Brown, RN
Robert Schlechter, MD
Levy Moise, MD
Sujit Iyer, MD
Tory Meyer, MD
Nilda Garcia, MD
Meena Iyer, MD
Michael Auth, DO
Stephen Pont, MD

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