# Clinical Pathways

## Diabetic Ketoacidosis (DKA)

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Connecticut Children's

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# What is a Clinical Pathway?

An evidence-based guideline that decreases unnecessary variation and helps promote safe, effective, and consistent patient care.

# Objectives of Pathway

- Establishing a clear, unambiguous, written protocol, adapted to our local circumstances, for appropriate triage and management of mild-moderate DKA.
- Building consensus within all experts who are involved in DKA management to provide highest quality care standard

# Why is Pathway Necessary?

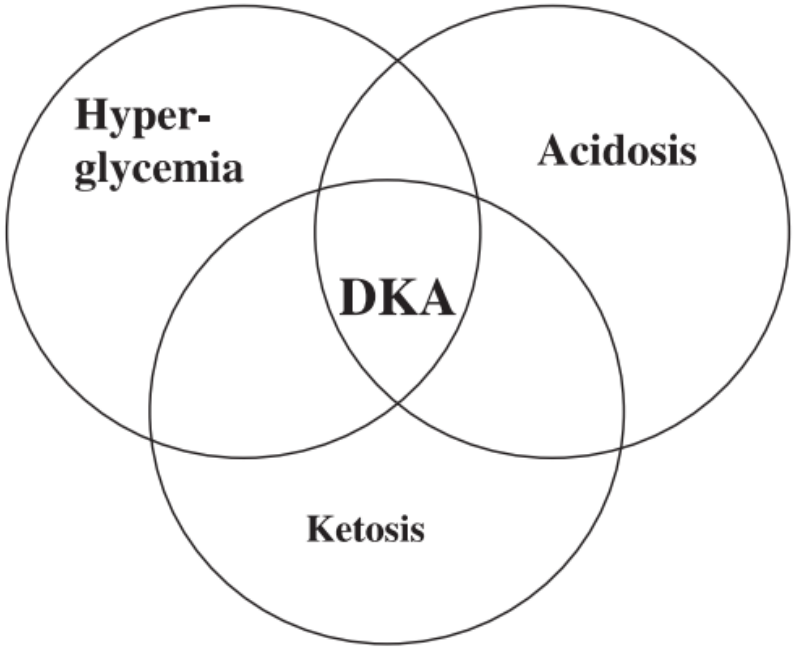
- DKA can have potentially fatal complications.
- Consistent and meticulous monitoring and treatment guidelines should be followed to carefully correct the metabolic derangement, while avoiding complications of therapy.
- Levels of monitoring and treatment vary based on a patient's initial presentation
- The pathway provides consistent guidelines for care after a patient has been stabilized, and to help them transition back to their routine home care when ready.

# Background: DKA Definition

- Hyperglycemia: Blood glucose (BG) > 11mmol/L (~200mg/dL)
- Venous pH < 7.3 OR Bicarbonate <15 mmol/L
- Ketonemia and ketonuria
  - Blood β-hydroxybutyrate (BOHB) concentration ≥3 mmol/L
  - Urine ketones are typically ≥2+ (‘moderate or large’) positive

# Background: DKA Definition

Other Hyperglycemic States
- Uncontrolled DM
- HHS
- Stress hyperglycemia




**Other Metabolic Acidotic States**
- Lactic acidosis
- Hyperchloremic acidosis
- Salicylism

**Other Ketotic States.**
- Ketotic hypoglycemia
- Alcoholic ketosis
- Starvation ketosis
- Isopropyl alcohol
- Hyperemesis

Kitabchi AE, Nyenwe EA. Hyperglycemic crises in diabetes mellitus: diabetic ketoacidosis and hyperglycemic hyperosmolar state. Endocrinol Metab Clin North Am 2006; 35:725–51.

# Clinical manifestations of DKA

Click the link to see Kussmaul breathing

- Dehydration
- Tachypnea; deep sighing (Kussmaul) respiration
- Nausea, vomiting, and abdominal pain that may mimic an acute abdominal condition
- Confusion, drowsiness, progressive obtundation and loss of consciousness

# DKA risk is increased in:

- Children who omit insulin
- Children with poor metabolic control or previous episodes of DKA
- Gastroenteritis with persistent vomiting and inability to maintain hydration
- Children with psychiatric disorder
- Children with difficult or unstable family circumstances
- Peripubertal and adolescent girls
- Children with limited access to medical services
- Insulin pump therapy

★In Children with established diabetes with recurrent DKA, insulin omission or failure to follow sick day or pump failure management guidelines accounts for almost *all* episodes.

# DKA Morbidity and Mortality

- In population studies, the mortality rate from DKA in children is 0.15–0.30% and may be decreasing.
- Cerebral injury is the major cause of mortality and morbidity
- Cerebral edema accounts for 60–90% of all DKA deaths
- From 10–25% of survivors of cerebral edema have significant residual morbidity.
- Children without overt neurological symptoms during DKA treatment may have subtle evidence of brain injury, particularly memory deficits, after recovery from DKA.

# DKA Morbidity and Mortality: Other complications

- Hypokalemia
- Hypocalcemia, hypomagnesemia
- Severe hypophosphatemia
- Hypoglycemia
- Other central nervous system complications include dural sinus thrombosis, basilar artery thrombosis, intracranial hemorrhage, and cerebral infarction
- Venous thrombosis
- Pulmonary embolism
- Sepsis
- Rhinocerebral or pulmonary mucormycosis
- Aspiration pneumonia
- Pulmonary edema
- Acute respiratory distress syndrome (ARDS)
- Pneumothorax, pneumomediastinum, and SC emphysema
- Rhabdomyolysis
- Ischemic bowel necrosis
- Acute renal failure
- Acute pancreatitis

# Cerebral Edema: Risk Factors

- Potential risk factors at diagnosis or during treatment of DKA:
  - Greater hypocapnia at presentation after adjusting for degree of acidosis
  - Increased serum urea nitrogen at presentation
  - Severe acidosis at presentation
  - Bicarbonate treatment for correction of acidosis
  - A marked early decrease in serum effective osmolality
  - An attenuated rise in serum sodium concentration or an early fall in glucose-corrected sodium during therapy
  - Greater volumes of fluid given in the first 4 hours
  - Administration of insulin in the first hour of fluid treatment

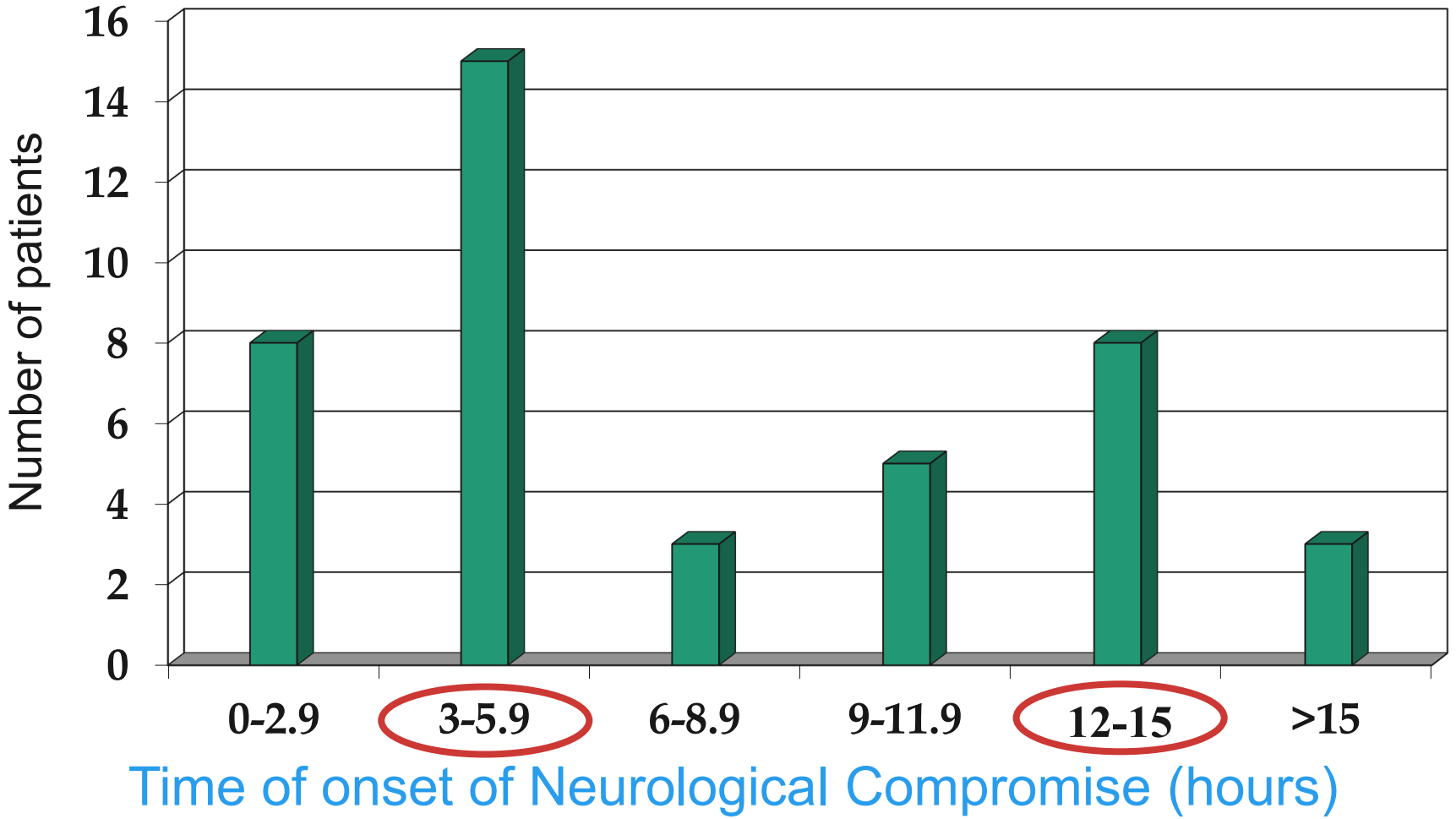
# Cerebral Edema: Signs and Symptoms

- Headache and slowing of heart rate
- Change in neurological status (restlessness, irritability, increased drowsiness, and incontinence)
- Specific neurological signs (e.g., cranial nerve palsies, papilledema)
- Rising blood pressure
- Decreased O2 saturation

# Cerebral Edema: Diagnostic Criteria

- Abnormal motor or verbal response to pain
- Decorticate or decerebration posture
- Cranial nerve palsy (especially III, IV, and VI)
- Abnormal neurogenic respiratory pattern (e.g., grunting, tachypnea, Cheyne–Stokes respiration, apneusis)

# Cerebral Edema: Timing of Onset




**Muir A, et al, Diab Care. July 2004**

# Cerebral Edema: Treatment

- Treatment should be initiated as soon as the condition is suspected
- Decrease the rate of maintenance fluids
- Hyperosmotic therapies: Mannitol or Hypertonic Saline per pathway guidelines
- Increase the head of bed to 30 degrees
- Intubation as necessary

# Cerebral Edema: Imaging

- *After* treatment for cerebral edema has been started cranial imaging may be considered as with any critically ill patient with encephalopathy or acute focal neurologic deficit
- The primary concern leading to imaging is whether the patient has a lesion requiring emergency neurosurgery
  - (e.g., intracranial hemorrhage) or a lesion that may necessitate anticoagulation (e.g., cerebrovascular thrombosis)

# Glasgow Coma Scale (GCS)

- An important tool for monitoring for cerebral edema

**Modified Glasgow Coma Scale for Infants and Children**

| | Child | Infant | Score |
|---|---|---|---|
| Eye opening | Spontaneous<br>To speech<br>To pain only<br>No response | Spontaneous<br>To speech<br>To pain only<br>No response | 4<br>3<br>2<br>1 |
| Best verbal response | Oriented, appropriate<br>Confused<br>Inappropriate words<br>Incomprehensible sounds<br>No response | Coos and babbles<br>Irritable cries<br>Cries to pain<br>Moans to pain<br>No response | 5<br>4<br>3<br>2<br>1 |
| Best motor response* | Obeys commands<br>Localizes painful stimulus<br>Withdraws in response to pain<br>Flexion in response to pain<br>Extension in response to pain<br>No response | Moves spontaneously and purposefully<br>Withdraws to touch<br>Withdraws to response in pain<br>Abnormal flexion posture to pain<br>Abnormal extension posture to pain<br>No response | 6<br>5<br>4<br>3<br>2<br>1 |

*If patient is intubated, unconscious, or preverbal, the most important part of this scale is motor response. Motor response should be carefully evaluated.

# DKA Clinical Pathway

The DKA Clinical Pathway is divided into 5 phases of care:

1) Transport Algorithm
2) Emergency Room Algorithm
3) PICU Management Algorithm
4) Med/Surg Management Algorithm
5) DKA Resolution and Ongoing Management Algorithm

The first 3 phases of care focus on identification and initial acute management

The last 2 phases of care are for patients who have stabilized and when DKA resolves

We will review each phase of care in the following slides.

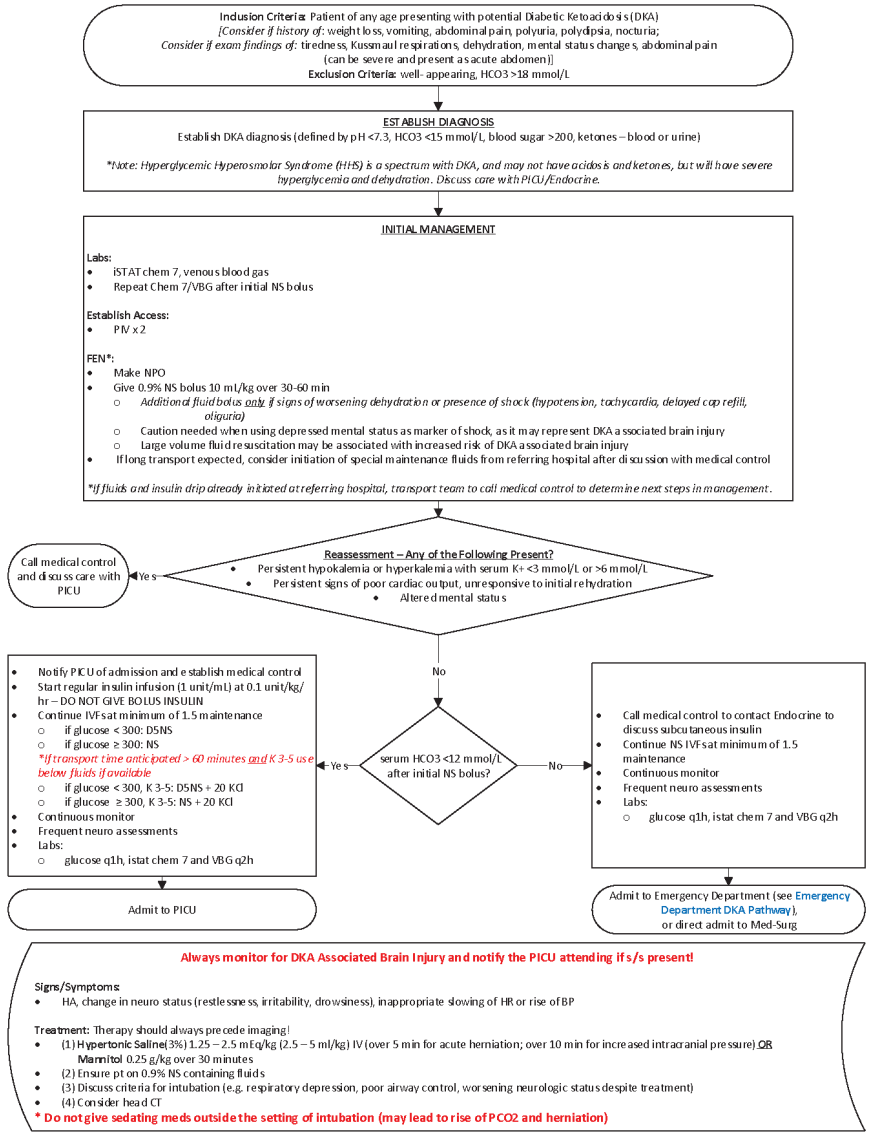
# DKA – Transport Algorithm

- The purpose of the Transport Algorithm is to provide guidance for teams transporting patients with suspected DKA to CT Children's Medical Center.
- The main objectives are early identification and initial stabilization.

*CLINICAL PATHWAY:*

# Diabetes Ketoacidosis (DKA) Transport Algorithm

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

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**Inclusion Criteria:** Patient of any age presenting with potential Diabetic Ketoacidosis (DKA)
*[Consider if history of*: weight loss, vomiting, abdominal pain, polyuria, polydipsia, nocturia;
*Consider if exam findings of:* tiredness, Kussmaul respirations, dehydration, mental status changes, abdominal pain (can be severe and present as acute abdomen)]
**Exclusion Criteria:** well- appearing, HCO3 >18 mmol/L

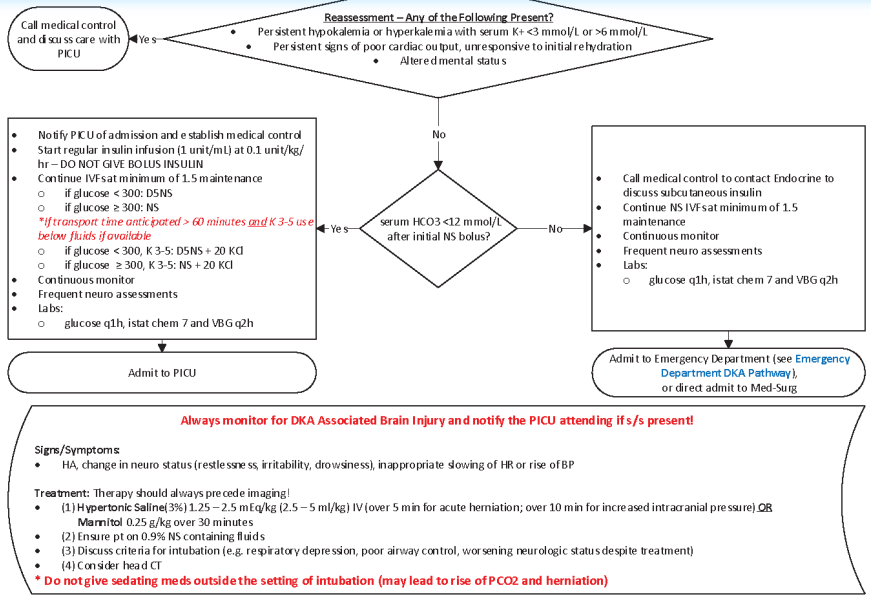
Labs:
- iSTAT chem 7, venous blood gas
- Repeat Chem 7/VBG after initial NS bolus

## ESTABLISH DIAGNOSIS

Establish DKA diagnosis (defined by pH <7.3, HCO3 <15 mmol/L, blood sugar >200, ketones – blood or urine)

**Note: Hyperglycemic Hyperosmolar Syndrome (HHS) is a spectrum with DKA, and may not have acidosis and ketones, but will have severe hyperglycemia and dehydration. Discuss care with PICU/Endocrine.*

- Those with a suspicion of DKA should be included. DKA should be suspected based on concerning components of the history and physical, as outlined above.
- Early identification is key.
- Once DKA is suspected, the diagnosis should be established based on specific criteria:
  - pH <7.3
  - HCO3 <15 mmol/L
  - Blood sugar >200
  - Ketones in the blood or urine

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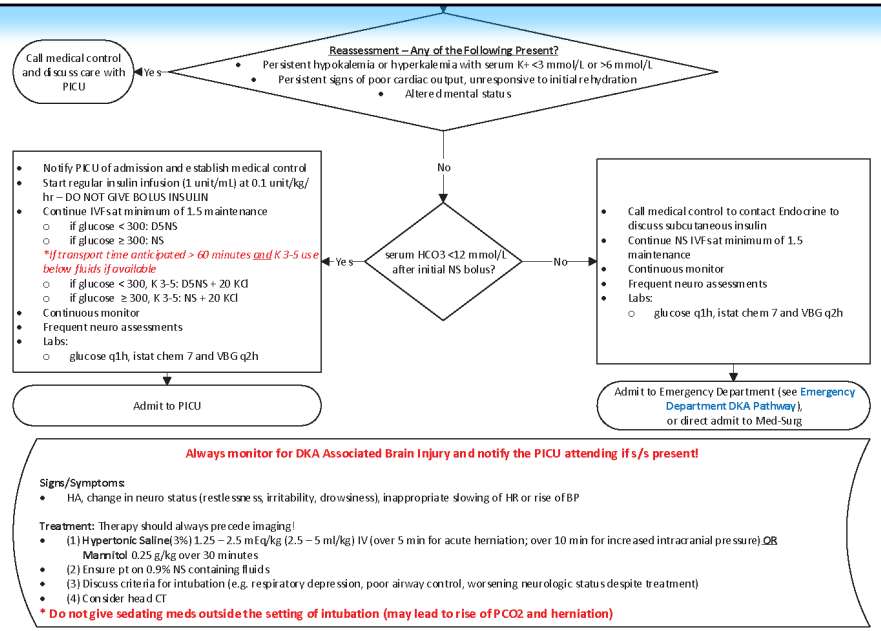
- Note that Hyperglycemic Hyperosmolar Syndrome (HHS) may present within the spectrum of suspected DKA. If this is present, it is important to discuss the diagnosis and management with the PICU and Endocrinology teams.

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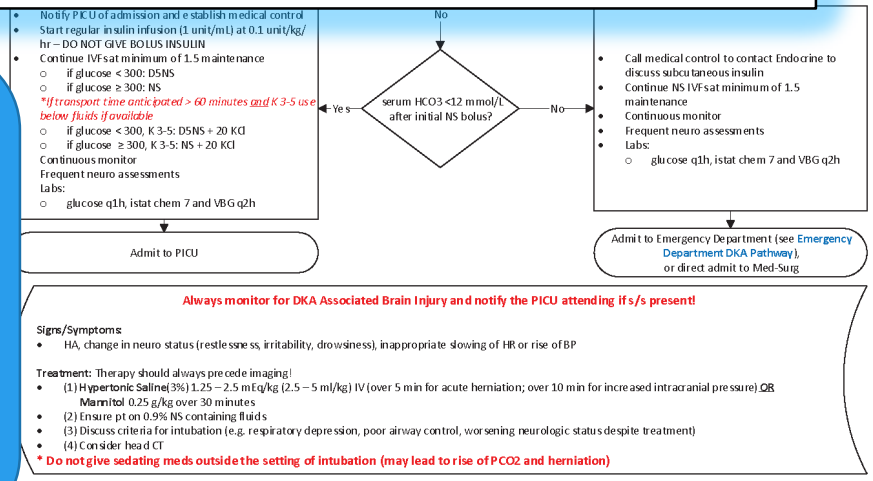
**Labs:**
- iSTAT chem 7, venous blood gas
- Repeat Chem 7/VBG after initial NS bolus

**Establish Access:**
- PIV x 2

**FEN*:**
- Make NPO
- Give 0.9% NS bolus 10 mL/kg over 30-60 min
  - *Additional fluid bolus <u>only</u> if signs of worsening dehydration or presence of shock (hypotension, tachycardia, delayed cap refill, oliguria)*
  - Caution needed when using depressed mental status as marker of shock, as it may represent DKA associated brain injury
  - Large volume fluid resuscitation may be associated with increased risk of DKA associated brain injury
- If long transport expected, consider initiation of special maintenance fluids from referring hospital after discussion with medical control

**If fluids and insulin drip already initiated at referring hospital, transport team to call medical control to determine next steps in management.*

- The initial management is focused on stabilization.
- Labs:
  - It is important to get “baseline” and repeat labs after the NS bolus is given.
- Access: 2 IV lines should be placed whenever possible





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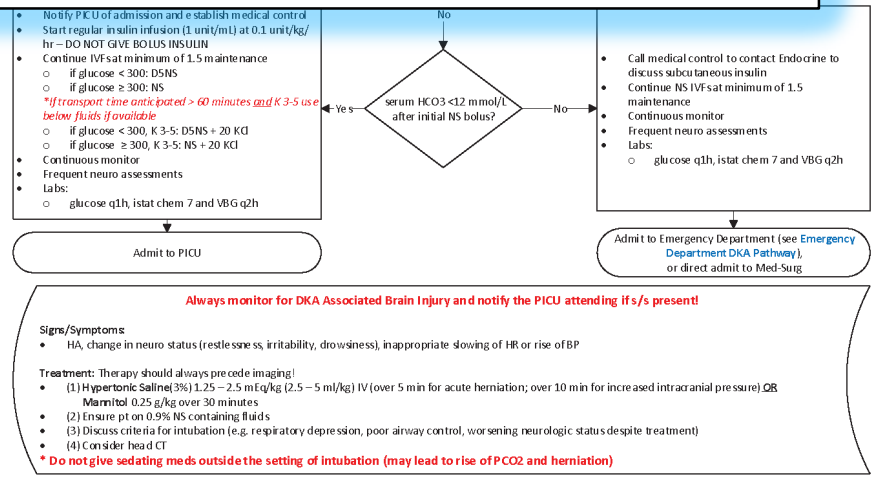
**If fluids and insulin drip already initiated at referring hospital, transport team to call medical control to determine next steps in management.*

- It is important to make the patient NPO and give a 0.9% NS bolus **10 ml/kg over 30-60 minutes.** Large volume fluid resuscitation may increase the risk of DKA associated brain injury.
- Additional fluid boluses should only be given if there is worsening dehydration or shock (as defined by hypotension, tachycardia, delayed cap refill and oliguria, not depressed mental status)

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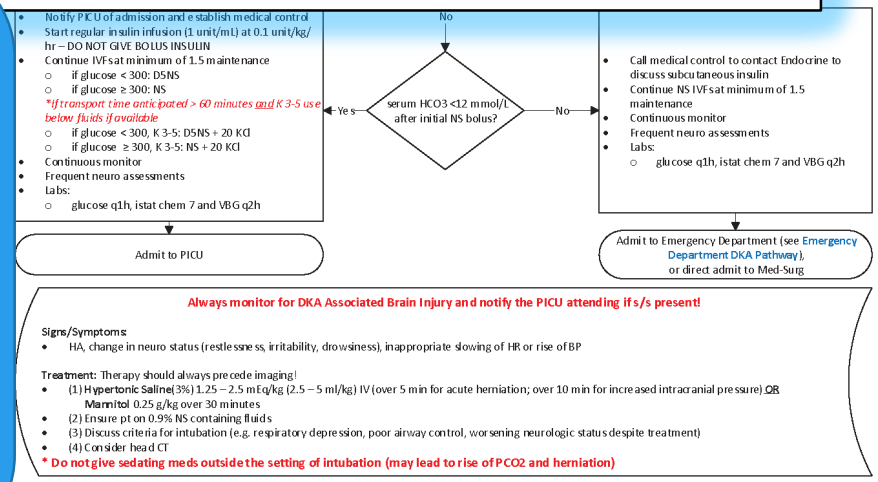
*t team to call medical control to determine next steps in management.*

- Transport Considerations:
  - If the patient was already started on fluids and an insulin drip at an outside hospital, call medical control to discuss with endocrinology.
  - If there is a longer transport expected, discuss starting special maintenance fluids with medical control.





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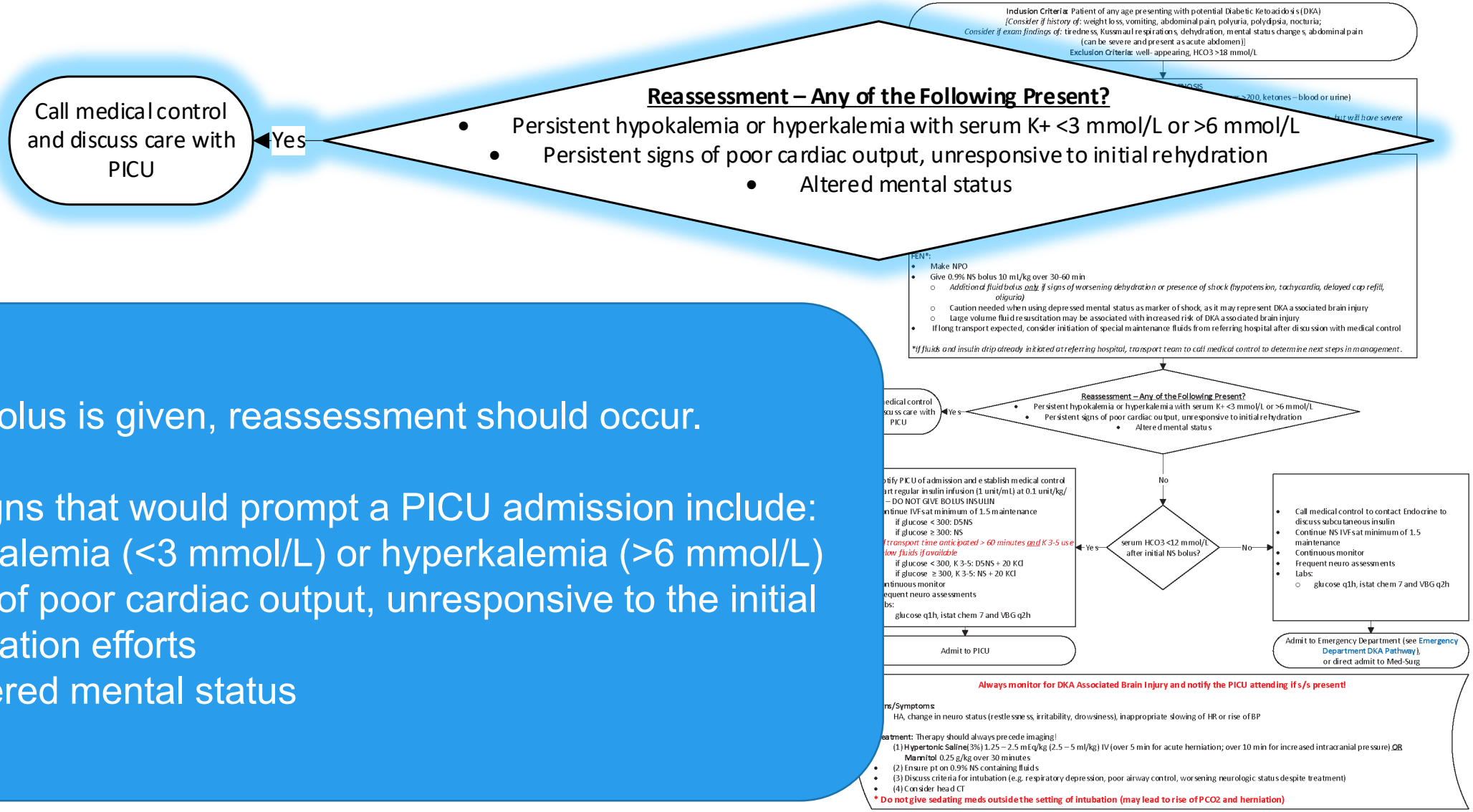


- After the bolus is given, reassessment should occur.
- Clinical signs that would prompt a PICU admission include:
  - Hypokalemia (<3 mmol/L) or hyperkalemia (>6 mmol/L)
  - Signs of poor cardiac output, unresponsive to the initial rehydration efforts
  - Or altered mental status

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- Additionally, a PICU admission should occur if there is a serum HCO3 <12 mmol/L present after the initial NS bolus
- If HCO3 <12 mmol/L, a regular insulin infusion should be given (NOT a bolus) and IVF should continue.
  - Guidelines for fluid type are given here.
- Frequent monitoring, including labs, are indicated.
- Once the patient arrives in the PICU, the PICU management algorithm should be followed.

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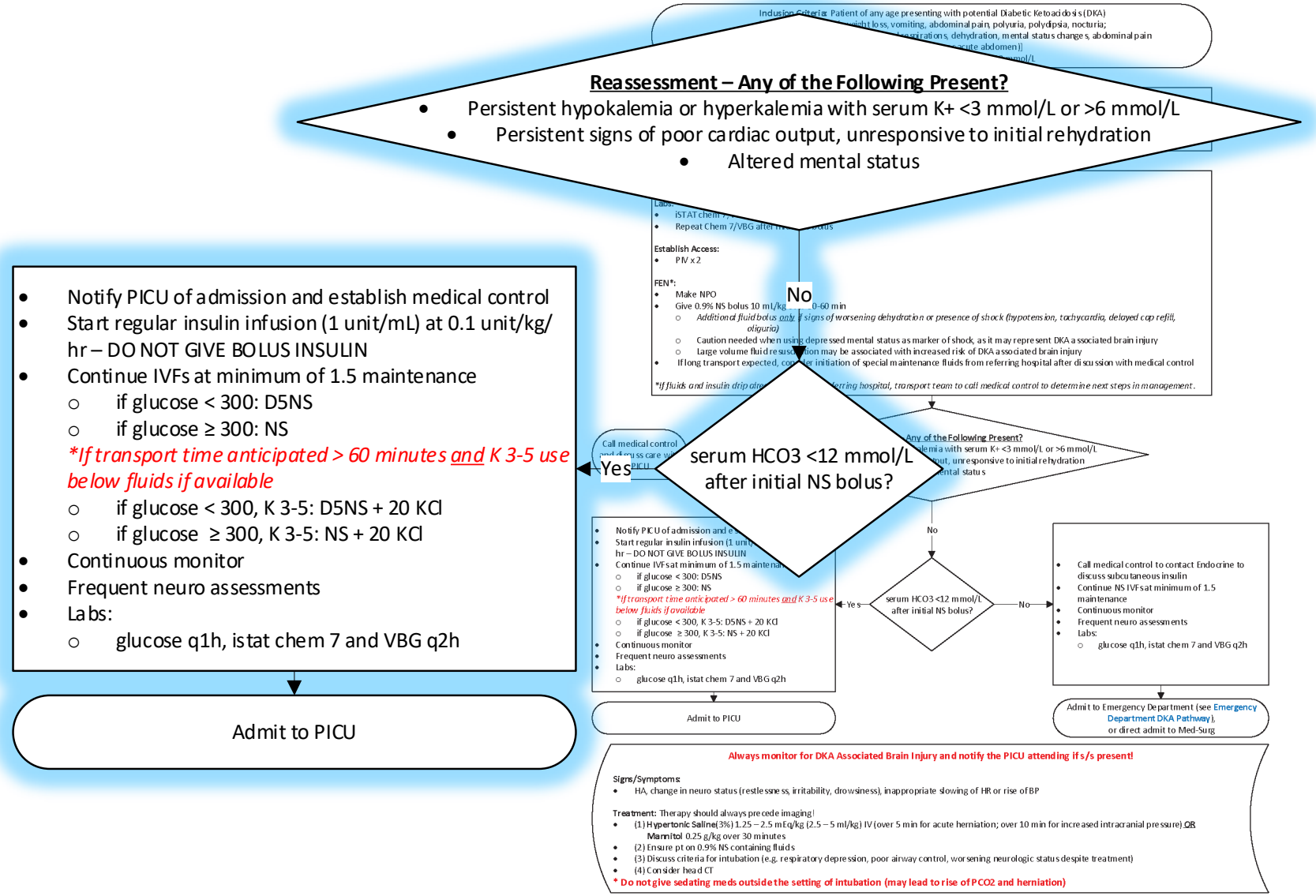


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- If none of the PICU criteria are met, subcutaneous insulin may be considered and IVF should be started/maintained, with frequent neuro and lab assessments.
- Admission may occur through the Emergency Department or as a direct admit to the Med-Surg Units, in which the appropriate algorithm should be followed.

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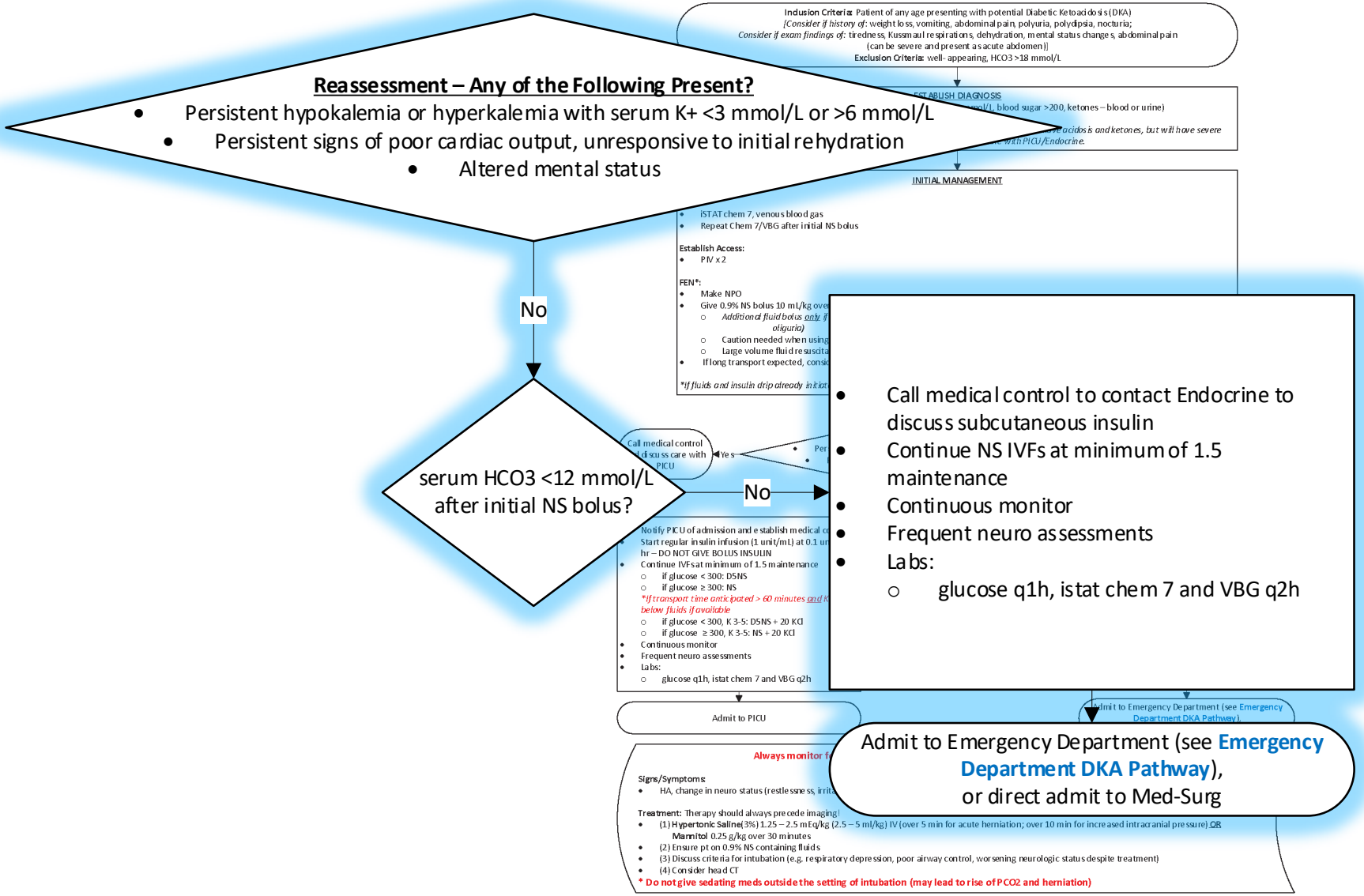


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**Always monitor for DKA Associated Brain Injury and notify the PICU attending if s/s present!**

**Signs/Symptoms:**

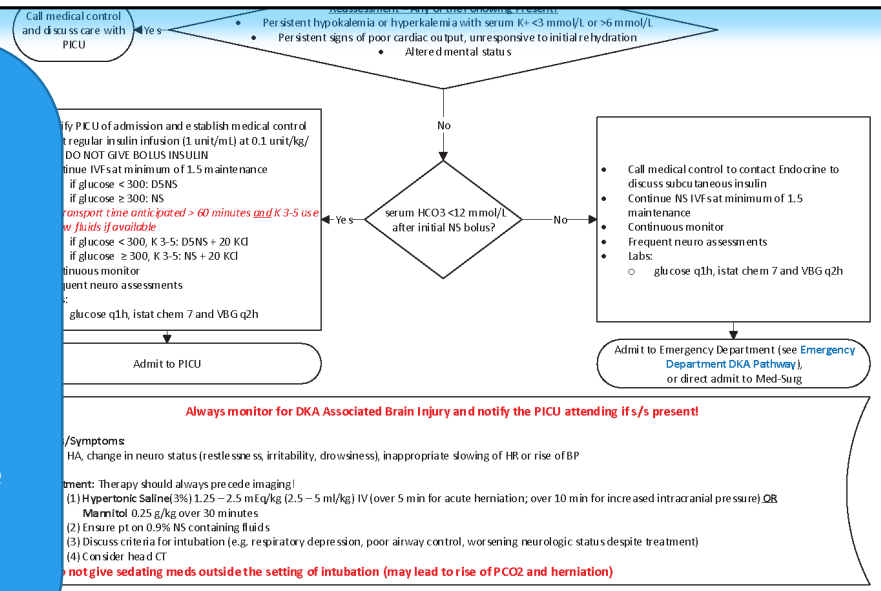
- HA, change in neuro status (restlessness, irritability, drowsiness), inappropriate slowing of HR or rise of BP

**Treatment:** Therapy should always precede imaging!

- (1) **Hypertonic Saline**(3%) 1.25 – 2.5 mEq/kg (2.5 – 5 ml/kg) IV (over 5 min for acute herniation; over 10 min for increased intracranial pressure) **OR** **Mannitol** 0.25 g/kg over 30 minutes
- (2) Ensure pt on 0.9% NS containing fluids
- (3) Discuss criteria for intubation (e.g. respiratory depression, poor airway control, worsening neurologic status despite treatment)
- (4) Consider head CT

*** Do not give sedating meds outside the setting of intubation (may lead to rise of PCO2 and herniation)**

- At all times, clinicians should monitor for DKA associated brain injury and notify the PICU attending if present.
- Treatment should always precede imaging.
- Note the doses of hypertonic saline or mannitol, as these were updated in 2022 to reflect the latest management guidelines.
- It is important to avoid sedating medications as it may lead to a rise of PCO2 and herniation!

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# DKA – Emergency Room Algorithm

- The purpose of the Emergency Room Algorithm is to quickly establish the diagnosis of DKA and provide initial management considerations.
- The point of entry into this algorithm is if a patient presents with suspected DKA in the emergency room, or if they were transported from an outside hospital.
- This algorithm is similar to the Transport Algorithm, but provides additional interventions.

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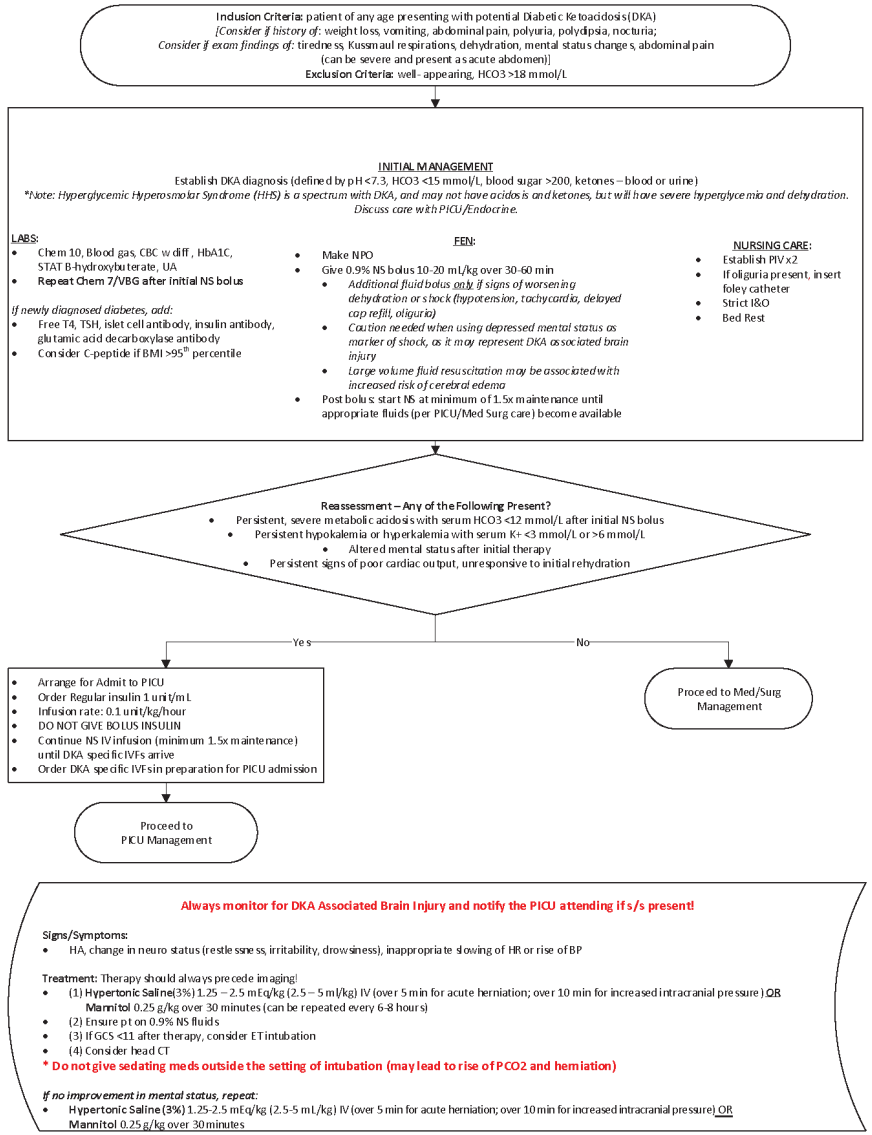


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- Early identification is key.
- Once DKA is suspected, the diagnosis should be established based on specific criteria:
  - pH <7.3
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  - Blood sugar >200
  - Ketones in the blood or urine

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**Exclusion Criteria:** well- appearing, HCO3 >18 mmol/L

## INITIAL MANAGEMENT

Establish DKA diagnosis (defined by pH <7.3, HCO3 <15 mmol/L, blood sugar >200, ketones – blood or urine)
**Note: Hyperglycemic Hyperosmolar Syndrome (HHS) is a spectrum with DKA, and may not have acidosis and ketones, but will have severe hyperglycemia and dehydration. Discuss care with PICU/Endocrine.*

**LABS:**

- Chem 10, Blood gas, CBC w diff , HbA1C, STAT B-hydroxybuterate, UA
- **Repeat Chem 7/VBG after initial NS bolus**

*If newly diagnosed diabetes, add:*

- Free T4, TSH, islet cell antibody, insulin antibody, glutamic acid decarboxylase antibody
- Consider C-peptide if BMI >95$^{th}$ percentile

**FEN:**

- Make NPO
- Give 0.9% NS bolus 10-20 mL/kg over 30-60 min
  - *Additional fluid bolus only if signs of worsening dehydration or shock (hypotension, tachycardia, delayed cap refill, oliguria)*
  - *Caution needed when using depressed mental status as marker of shock, as it may represent DKA associated brain injury*
  - *Large volume fluid resuscitation may be associated with increased risk of cerebral edema*
- Post bolus: start NS at minimum of 1.5x maintenance until appropriate fluids (per PICU/Med Surg care) become available

**NURSING CARE:**

- Establish PIV x2
- If oliguria present, insert foley catheter
- Strict I&O
- Bed Rest

**Always monitor for DKA Associated Brain Injury and notify the PICU attending if s/s present!**

Signs/Symptoms:

- HA, change in neuro status (restlessness, irritability, drowsiness), inappropriate slowing of HR or rise of BP

Treatment: Therapy should always precede imaging!

- (1) Hypertonic Saline(3%) 1.25 – 2.5 mEq/kg (2.5 – 5 ml/kg) IV (over 5 min for acute herniation; over 10 min for increased intracranial pressure) OR Mannitol 0.25 g/kg over 30 minutes (can be repeated every 6-8 hours)
- (2) Ensure pt on 0.9% NS fluids
- (3) If GCS <11 after therapy, consider ET intubation
- (4) Consider head CT

*** Do not give sedating meds outside the setting of intubation (may lead to rise of PCO2 and herniation)**

*If no improvement in mental status, repeat:*

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*[Consider if history of*: weight loss, vomiting, abdominal pain, polyuria, polydipsia, nocturia;
*Consider if exam findings of:* tiredness, Kussmaul respirations, dehydration, mental status changes, abdominal pain (can be severe and present as acute abdomen)]
**Exclusion Criteria:** well- appearing, HCO3 >18 mmol/L

## INITIAL MANAGEMENT

Establish DKA diagnosis (defined by pH <7.3, HCO3 <15 mmol/L, blood sugar >200, ketones – blood or urine)
**Note: Hyperglycemic Hyperosmolar Syndrome (HHS) is a spectrum with DKA, and may not have acidosis and ketones, but will have severe hyperglycemia and dehydration. Discuss care with PICU/Endocrine.*

**LABS:**

- Chem 10, Blood gas, CBC w diff , HbA1C, STAT B-hydroxybuterate, UA
- **Repeat Chem 7/VBG after initial NS bolus**

*If newly diagnosed diabetes, add:*

- Free T4, TSH, islet cell antibody, insulin antibody, glutamic acid decarboxylase antibody
- Consider C-peptide if BMI >95$^{th}$ percentile

**FEN:**

- Make NPO
- Give 0.9% NS bolus 10-20 mL/kg over 30-60 min
  - *Additional fluid bolus only if signs of worsening dehydration or shock (hypotension, tachycardia, delayed cap refill, oliguria)*
  - *Caution needed when using depressed mental status as marker of shock, as it may represent DKA associated brain injury*
  - *Large volume fluid resuscitation may be associated with increased risk of cerebral edema*
- Post bolus: start NS at minimum of 1.5x maintenance until appropriate fluids (per PICU/Med Surg care) become available

**NURSING CARE:**

- Establish PIV x2
- If oliguria present, insert foley catheter
- Strict I&O
- Bed Rest

**Always monitor for DKA Associated Brain Injury and notify the PICU attending if s/s present!**

Signs/Symptoms:

- HA, change in neuro status (restlessness, irritability, drowsiness), inappropriate slowing of HR or rise of BP

Treatment: Therapy should always precede imaging!

- (1) Hypertonic Saline(3%) 1.25 – 2.5 mEq/kg (2.5 – 5 ml/kg) IV (over 5 min for acute herniation; over 10 min for increased intracranial pressure) OR Mannitol 0.25 g/kg over 30 minutes (can be repeated every 6-8 hours)
- (2) Ensure pt on 0.9% NS fluids
- (3) If GCS <11 after therapy, consider ET intubation
- (4) Consider head CT

*** Do not give sedating meds outside the setting of intubation (may lead to rise of PCO2 and herniation)**

*If no improvement in mental status, repeat:*

- Hypertonic Saline (3%) 1.25-2.5 mEq/kg (2.5-5 mL/kg) IV (over 5 min for acute herniation; over 10 min for increased intracranial pressure) OR Mannitol 0.25 g/kg over 30 minutes

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*CLINICAL PATHWAY:*

# Diabetes Ketoacidosis (DKA) Emergency Room Algorithm

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

- Labs include a more thorough evaluation than the Transport Algorithm, and are listed here.

**Inclusion Criteria:** patient of any age presenting with potential Diabetic Ketoacidosis (DKA)
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## INITIAL MANAGEMENT

Establish DKA diagnosis (defined by pH <7.3, HCO3 <15 mmol/L, blood sugar >200, ketones – blood or urine)
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- Chem 10, Blood gas, CBC w diff , HbA1C, STAT B-hydroxybuterate, UA
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**NURSING CARE:**

- Establish PIV x2
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Signs/Symptoms:

- HA, change in neuro status (restlessness, irritability, drowsiness), inappropriate slowing of HR or rise of BP

Treatment: Therapy should always precede imaging!

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- Make the patient NPO and give 0.9% NS bolus **10-20 ml/kg over 30-60 minutes** as a large volume fluid resuscitation may be associated with an increased risk of cerebral edema.
- Repeat boluses should only be given if worsening dehydration or shock (hypotension, tachycardia, delayed cap refill, oliguria; not depressed mental status)
- After the initial bolus is given, repeat chem7/VBG and start NS at minimum of 1.5x maintenance until more appropriate fluids are available in PICU/Med Surg.

*CLINICAL PATHWAY:*

# Diabetes Ketoacidosis (DKA) Emergency Room Algorithm

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

**Inclusion Criteria:** patient of any age presenting with potential Diabetic Ketoacidosis (DKA)
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**NURSING CARE:**
- Establish PIV x2
- If oliguria present, insert foley catheter
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- Bed Rest

**Always monitor for DKA Associated Brain Injury and notify the PICU attending if s/s present!**

Signs/Symptoms:
- HA, change in neuro status (restlessness, irritability, drowsiness), inappropriate slowing of HR or rise of BP

Treatment: Therapy should always precede imaging!
- (1) Hypertonic Saline(3%) 1.25 – 2.5 mEq/kg (2.5 – 5 ml/kg) IV (over 5 min for acute herniation; over 10 min for increased intracranial pressure) OR Mannitol 0.25 g/kg over 30 minutes (can be repeated every 6-8 hours)
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- Nursing care is outlined here.
- 2 PIV lines should be established, and foley catheter inserted if oliguria is present.

*CLINICAL PATHWAY:*
# Diabetes Ketoacidosis (DKA) Emergency Room Algorithm

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**Inclusion Criteria:** patient of any age presenting with potential Diabetic Ketoacidosis (DKA)
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**NURSING CARE:**
- Establish PIV x2
- If oliguria present, insert foley catheter
- Strict I&O
- Bed Rest

**Always monitor for DKA Associated Brain Injury and notify the PICU attending if s/s present!**

Signs/Symptoms:
- HA, change in neuro status (restlessness, irritability, drowsiness), inappropriate slowing of HR or rise of BP

Treatment: Therapy should always precede imaging!
- (1) Hypertonic Saline(3%) 1.25 – 2.5 mEq/kg (2.5 – 5 ml/kg) IV (over 5 min for acute herniation; over 10 min for increased intracranial pressure) OR Mannitol 0.25 g/kg over 30 minutes (can be repeated every 6-8 hours)
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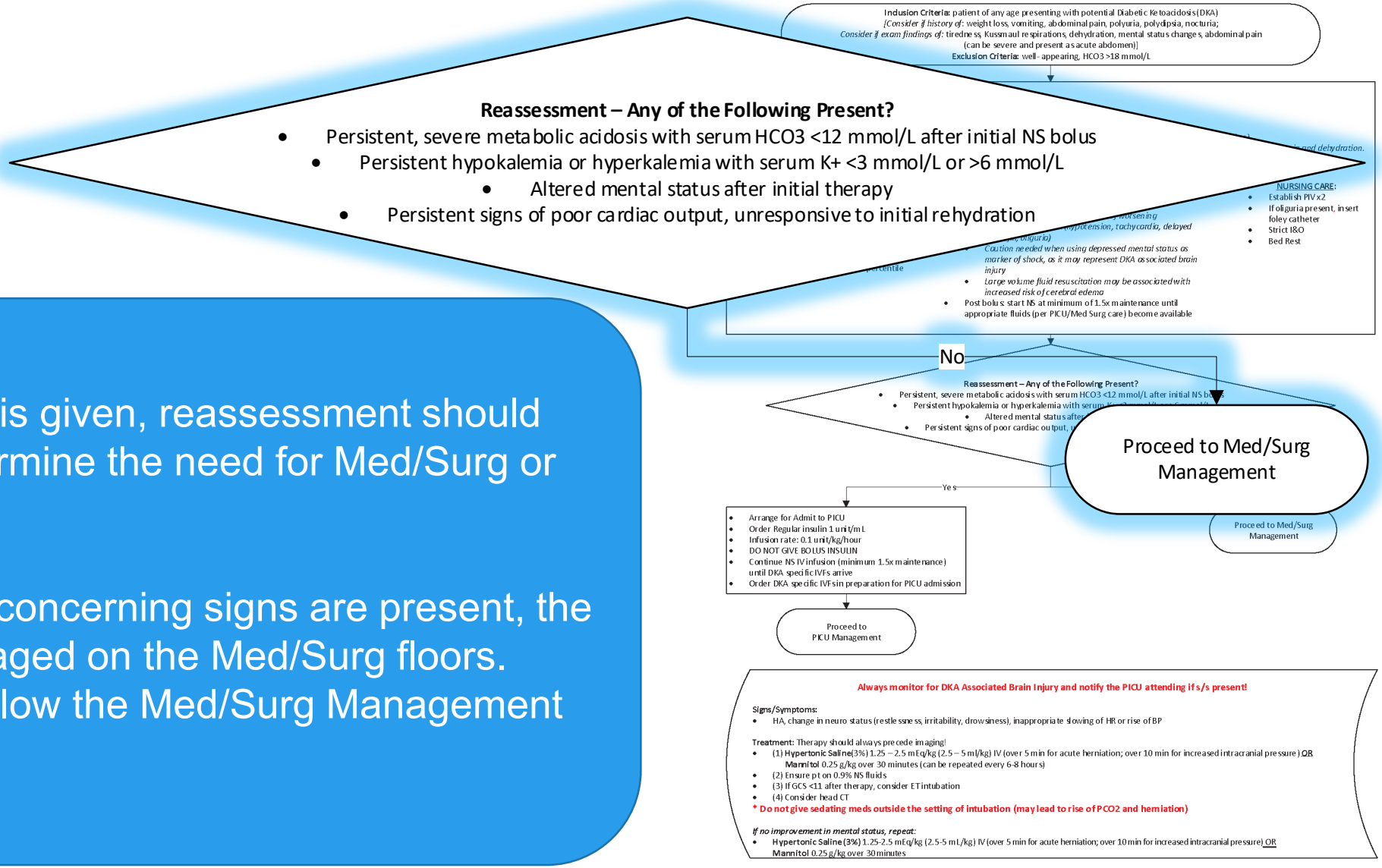
*CLINICAL PATHWAY:*

# Diabetes Ketoacidosis (DKA) Emergency Room Algorithm

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

- After the initial care is given, reassessment should occur. This will determine the need for Med/Surg or PICU management.
- If none of the listed concerning signs are present, the patient can be managed on the Med/Surg floors. Clinicians should follow the Med/Surg Management Algorithm.

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- If any of these concerning signs are present, then the patient should be admitted to the PICU.
- While awaiting PICU admission, regular insulin infusion should be ordered/started (NOT the bolus)
- NS IV infusions should be continued until DKA specific IVF arrives. These DKA specific IVF should be ordered to in preparation for PICU admission.
- Once admitted to the PICU, follow the PICU Management Algorithm.

*CLINICAL PATHWAY:*

# Diabetes Ketoacidosis (DKA) Emergency Room Algorithm

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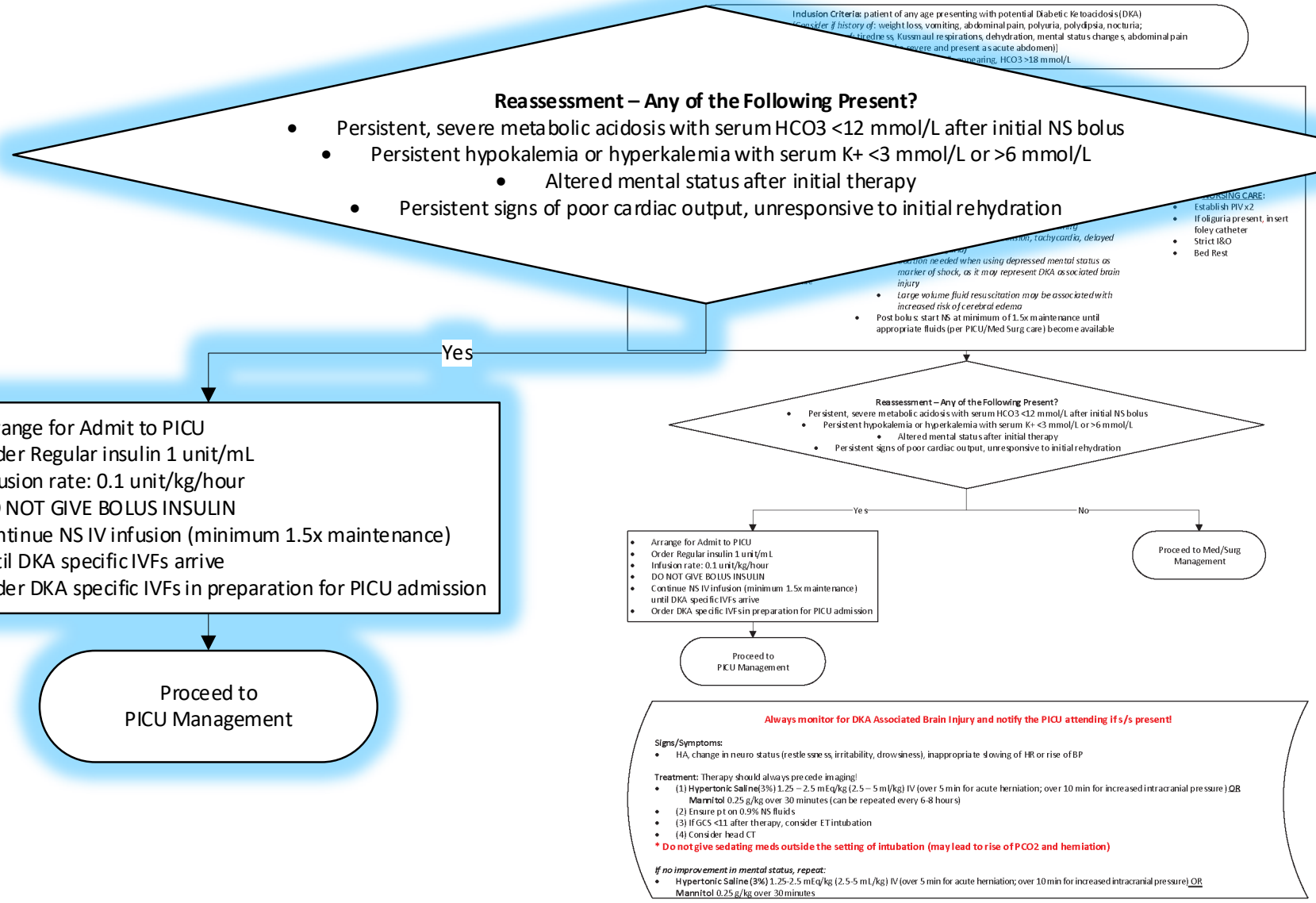


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*CLINICAL PATHWAY:*
# Diabetes Ketoacidosis (DKA) Emergency Room Algorithm

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

**Always monitor for DKA Associated Brain Injury and notify the PICU attending if s/s present!**

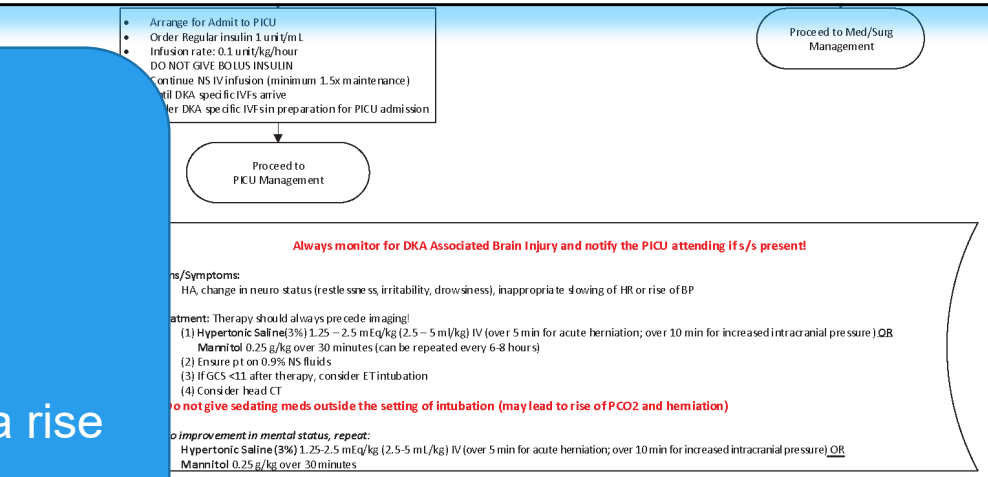
**Signs/Symptoms:**
- HA, change in neuro status (restlessness, irritability, drowsiness), inappropriate slowing of HR or rise of BP

**Treatment:** Therapy should always precede imaging!
- (1) **Hypertonic Saline**(3%) 1.25 – 2.5 mEq/kg (2.5 – 5 ml/kg) IV (over 5 min for acute herniation; over 10 min for increased intracranial pressure) **OR** **Mannitol** 0.25 g/kg over 30 minutes (can be repeated every 6-8 hours)
- (2) Ensure pt on 0.9% NS fluids
- (3) If GCS <11 after therapy, consider ET intubation
- (4) Consider head CT

*** Do not give sedating meds outside the setting of intubation (may lead to rise of PCO2 and herniation)**

***If no improvement in mental status, repeat:***
- **Hypertonic Saline (3%)** 1.25-2.5 mEq/kg (2.5-5 mL/kg) IV over (over 5 min for acute herniation; over 10 min for increased intracranial pressure) OR **Mannitol** 0.25 g/kg over 30 minutes

- At all times, clinicians should monitor for DKA associated brain injury and notify the PICU attending if present.
- Treatment should always precede imaging.
- Note the doses of hypertonic saline or mannitol, as these were updated in 2022 to reflect the latest management guidelines.
- It is important to avoid sedating medications as it may lead to a rise of PCO2 and herniation!

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# DKA – PICU Management Algorithm

- The purpose of the PICU algorithm quickly establish DKA diagnosis, stabilize the patient with DKA specific IVF and insulin and provide close monitoring of the patient's status.

*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis PICU Management

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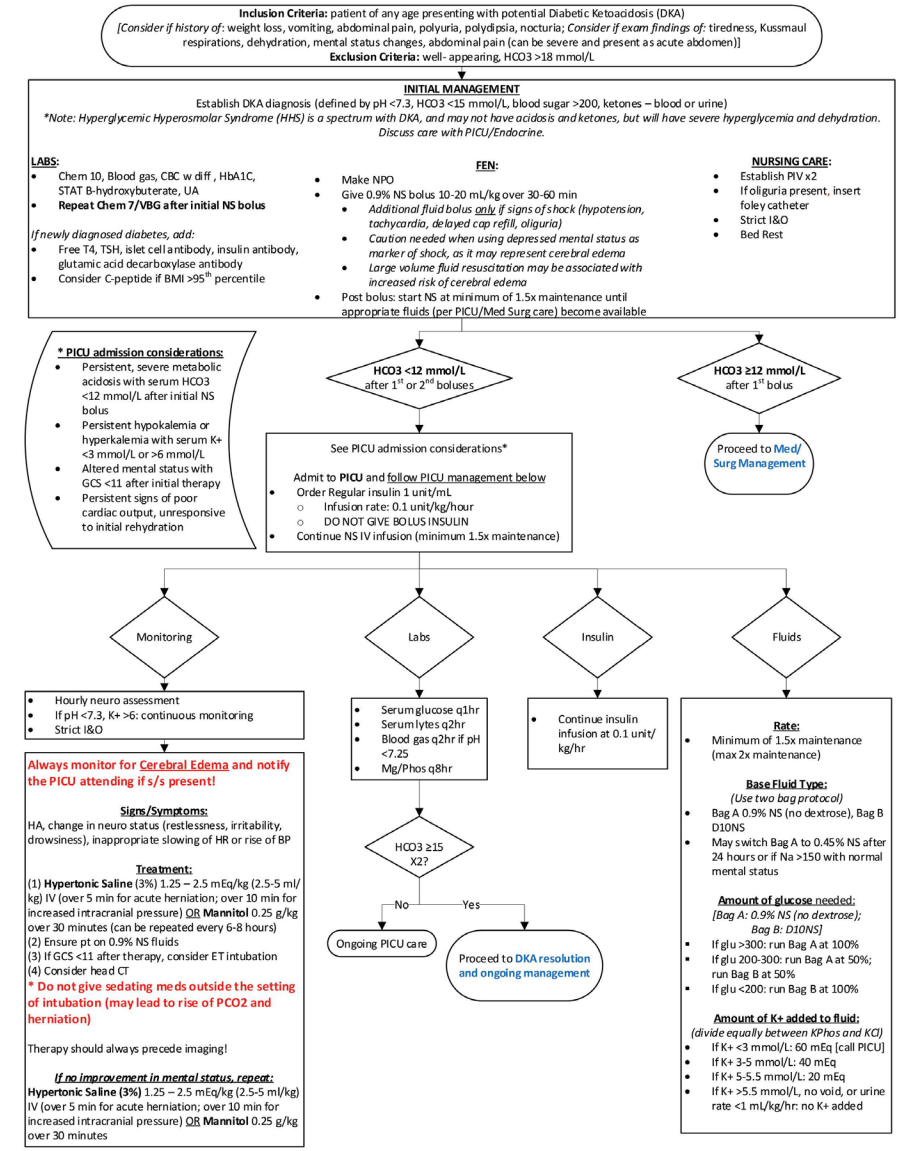


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*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis PICUM Management

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

**Inclusion Criteria:** patient of any age presenting with potential Diabetic Ketoacidosis (DKA)
*[Consider if history of*: weight loss, vomiting, abdominal pain, polyuria, polydipsia, nocturia; *Consider if exam findings of:* tiredness, Kussmaul respirations, dehydration, mental status changes, abdominal pain (can be severe and present as acute abdomen)]
**Exclusion Criteria:** well- appearing, HCO3 >18 mmol/L

## INITIAL MANAGEMENT

Establish DKA diagnosis (defined by pH <7.3, HCO3 <15 mmol/L, blood sugar >200, ketones – blood or urine)
**Note: Hyperglycemic Hyperosmolar Syndrome (HHS) is a spectrum with DKA, and may not have acidosis and ketones, but will have severe hyperglycemia and dehydration. Discuss care with PICU/Endocrine.*

**LABS:**

- Chem 10, Blood gas, CBC w diff , HbA1C, STAT B-hydroxybuterate, UA
- **Repeat Chem 7/VBG after initial NS bolus**

*If newly diagnosed diabetes, add:*

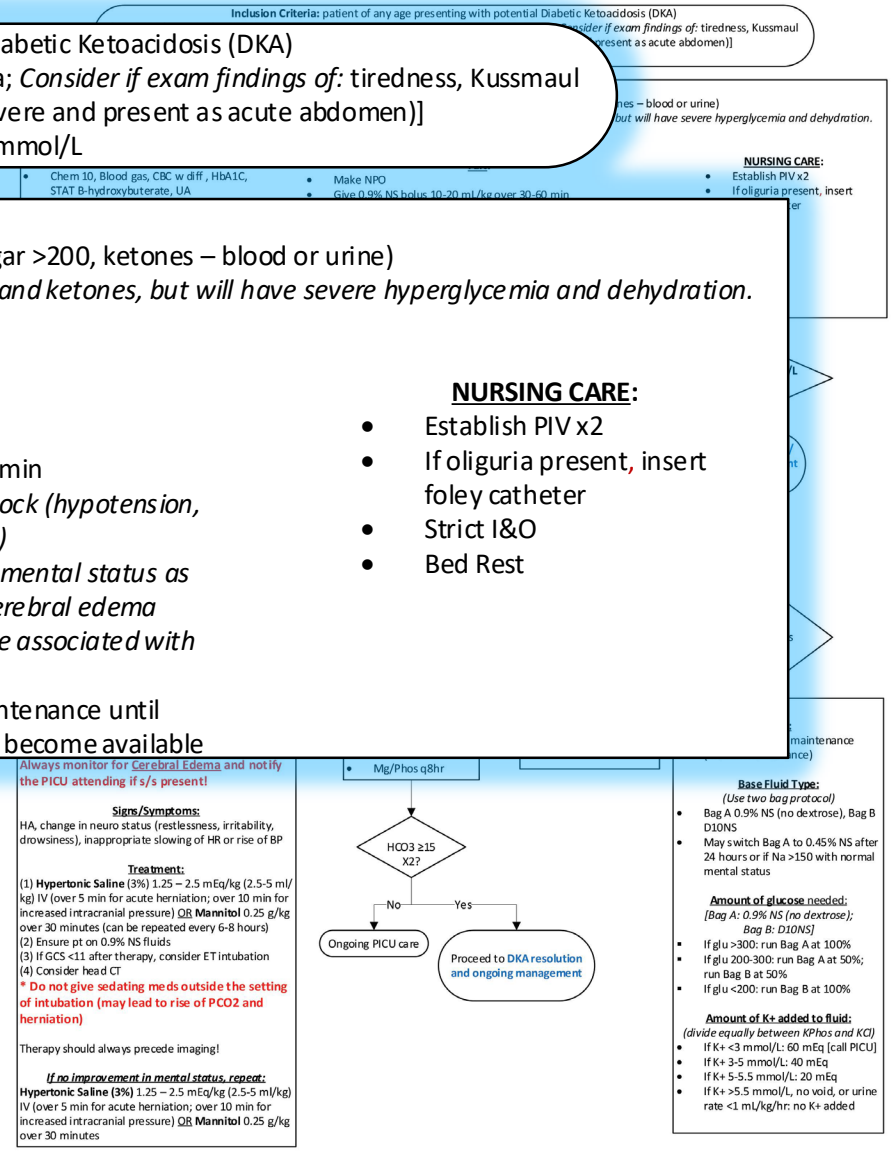
- Free T4, TSH, islet cell antibody, insulin antibody, glutamic acid decarboxylase antibody
- Consider C-peptide if BMI >95$^{th}$ percentile

**FEN:**

- Make NPO
- Give 0.9% NS bolus 10-20 mL/kg over 30-60 min
  - *Additional fluid bolus only if signs of shock (hypotension, tachycardia, delayed cap refill, oliguria)*
  - *Caution needed when using depressed mental status as marker of shock, as it may represent cerebral edema*
  - *Large volume fluid resuscitation may be associated with increased risk of cerebral edema*
- Post bolus: start NS at minimum of 1.5x maintenance until appropriate fluids (per PICU/Med Surg care) become available

**NURSING CARE:**

- Establish PIV x2
- If oliguria present, insert foley catheter
- Strict I&O
- Bed Rest




- Inclusion criteria and initial management boxes are the same as the Emergency Room algorithm.
- The focus is on laboratory monitoring, NPO status, and 0.9% NS bolus 10-20 ml/kg over 30-60 min and post-bolus IVF initiation.

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*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis PICU Management

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**Inclusion Criteria:** patient of any age presenting with potential Diabetic Ketoacidosis (DKA)

## INITIAL MANAGEMENT

Establish DKA diagnosis (defined by pH <7.3, HCO3 <15 mmol/L, blood sugar >200, ketones – blood or urine)

**Note: Hyperglycemic Hyperosmolar Syndrome (HHS) is a spectrum with DKA, and may not have acidosis and ketones, but will have severe hyperglycemia and dehydration. Discuss care with PICU/Endocrine.*

**LABS:**

- Chem 10, Blood gas, CBC w diff , HbA1C, STAT B-hydroxybuterate, UA
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**NURSING CARE:**

- Establish PIV x2
- If oliguria present, insert foley catheter
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The patient is admitted to the PICU if there is:

- Persistent and severe metabolic acidosis with serum HCO3 <12 mmol/L after the initial NS bolus is given
- Persistent hypokalemia (<3 mmol/L) or hyperkalemia (>6 mmol/L)
- Altered mental status with GCS <11 after initial therapy
- Persistent signs of poor cardiac output, unresponsive to initial rehydration

*** PICU admission considerations:**

- Persistent, severe metabolic acidosis with serum HCO3 <12 mmol/L after initial NS bolus
- Persistent hypokalemia or hyperkalemia with serum K+ <3 mmol/L or >6 mmol/L
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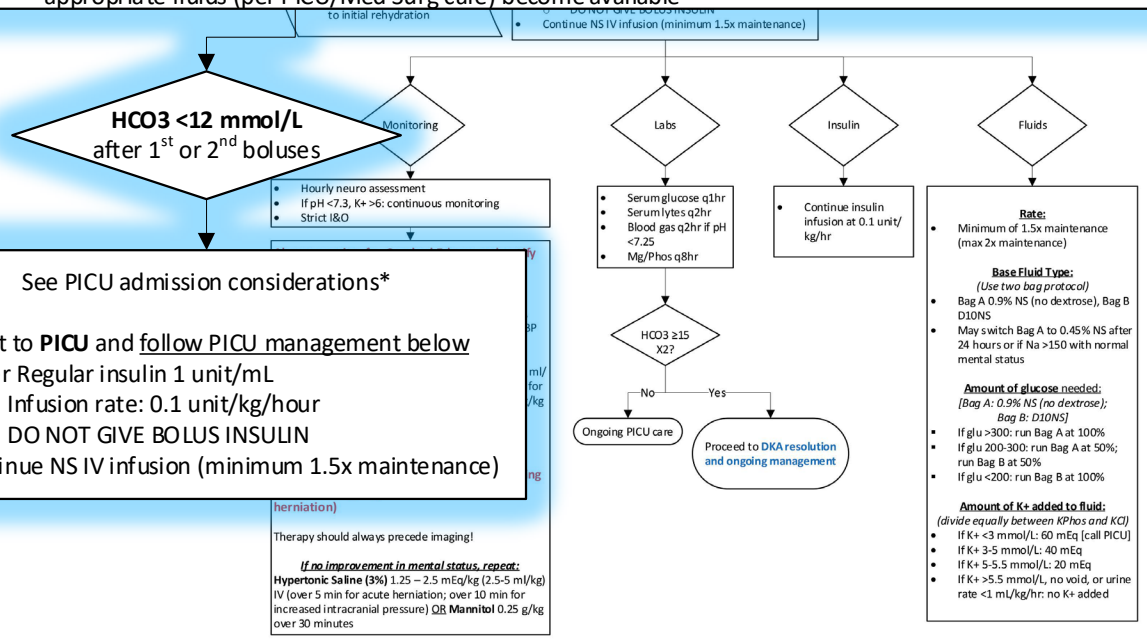


See PICU admission considerations*

Admit to **PICU** and follow PICU management below

- Order Regular insulin 1 unit/mL
  - Infusion rate: 0.1 unit/kg/hour
  - DO NOT GIVE BOLUS INSULIN
- Continue NS IV infusion (minimum 1.5x maintenance)

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*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis PICU Management

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Regular insulin infusion should be ordered (NOT the bolus insulin) and NS IV infusions at minimum of 1.5x maintenance should be continued until the DKA specific fluids arrive

**Inclusion Criteria:** patient of any age presenting with potential Diabetic Ketoacidosis (DKA)

## INITIAL MANAGEMENT

Establish DKA diagnosis (defined by pH <7.3, HCO3 <15 mmol/L, blood sugar >200, ketones – blood or urine)

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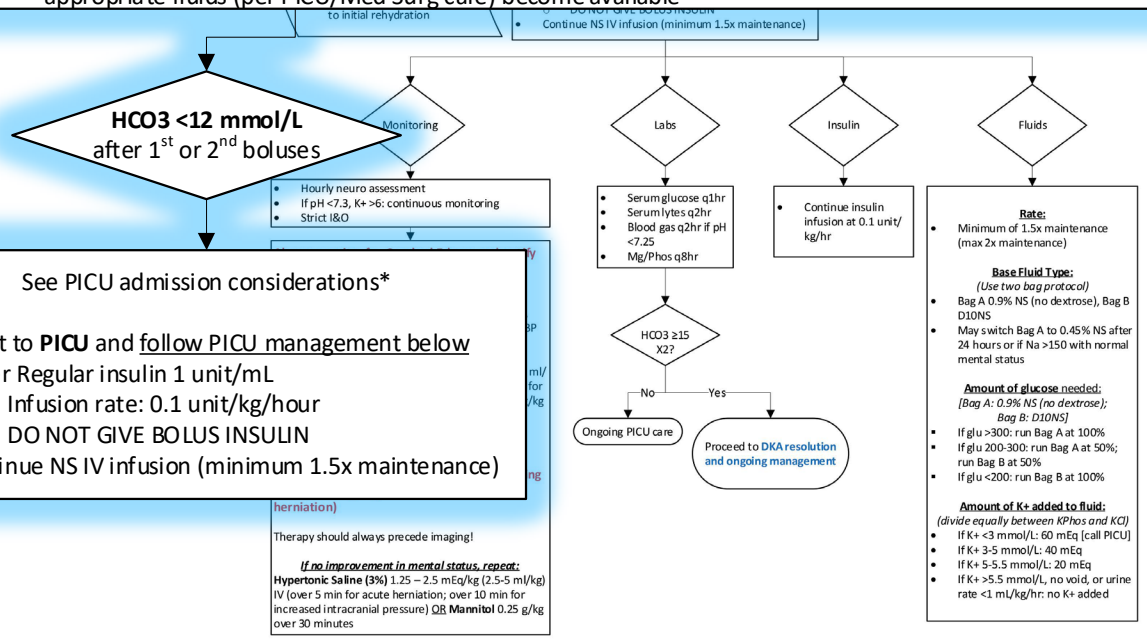


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*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis PICUM Management

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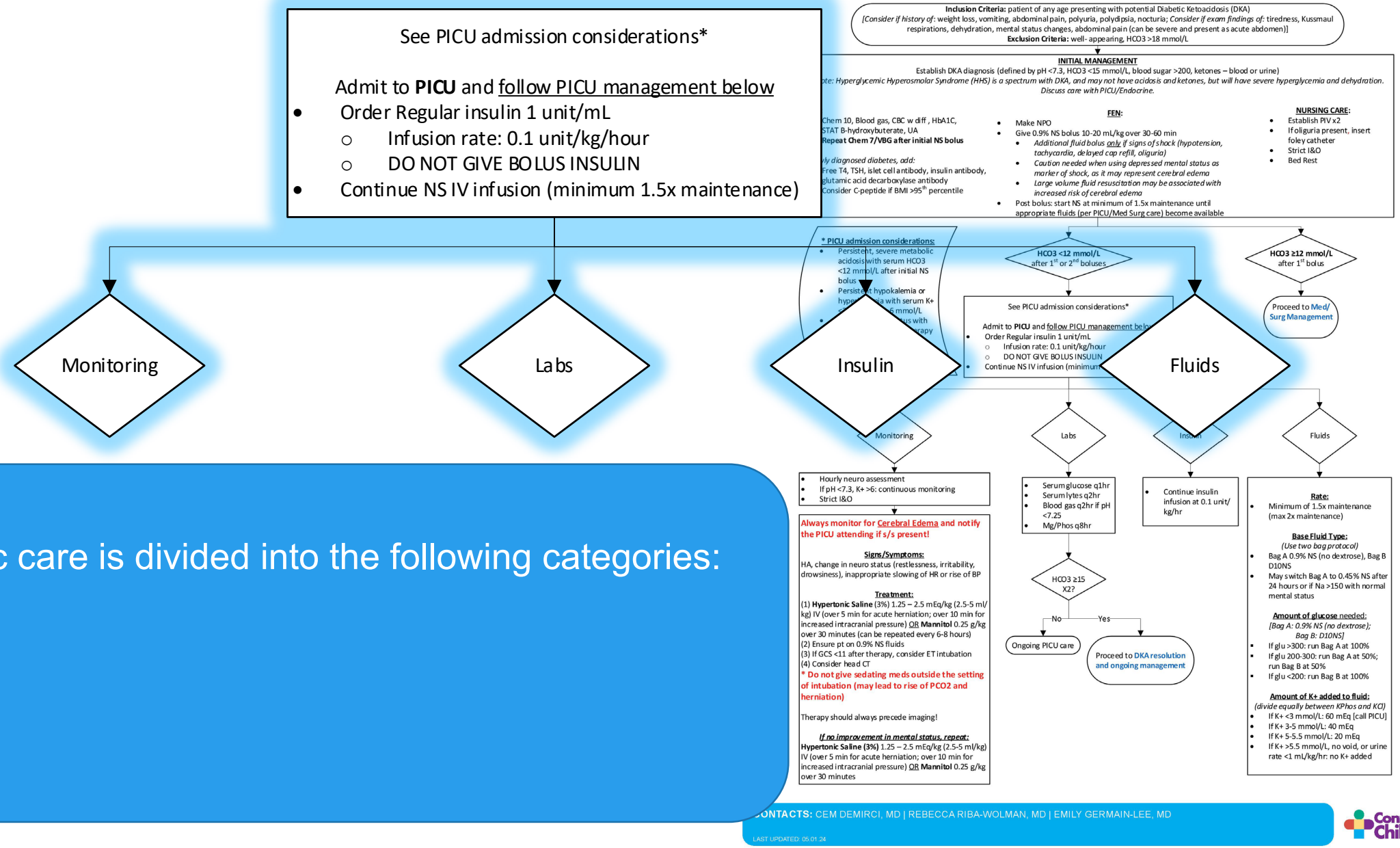
See PICU admission considerations*

Admit to **PICU** and <u>follow PICU management below</u>

- Order Regular insulin 1 unit/mL
  - Infusion rate: 0.1 unit/kg/hour
  - DO NOT GIVE BOLUS INSULIN
- Continue NS IV infusion (minimum 1.5x maintenance)




PICU specific care is divided into the following categories:

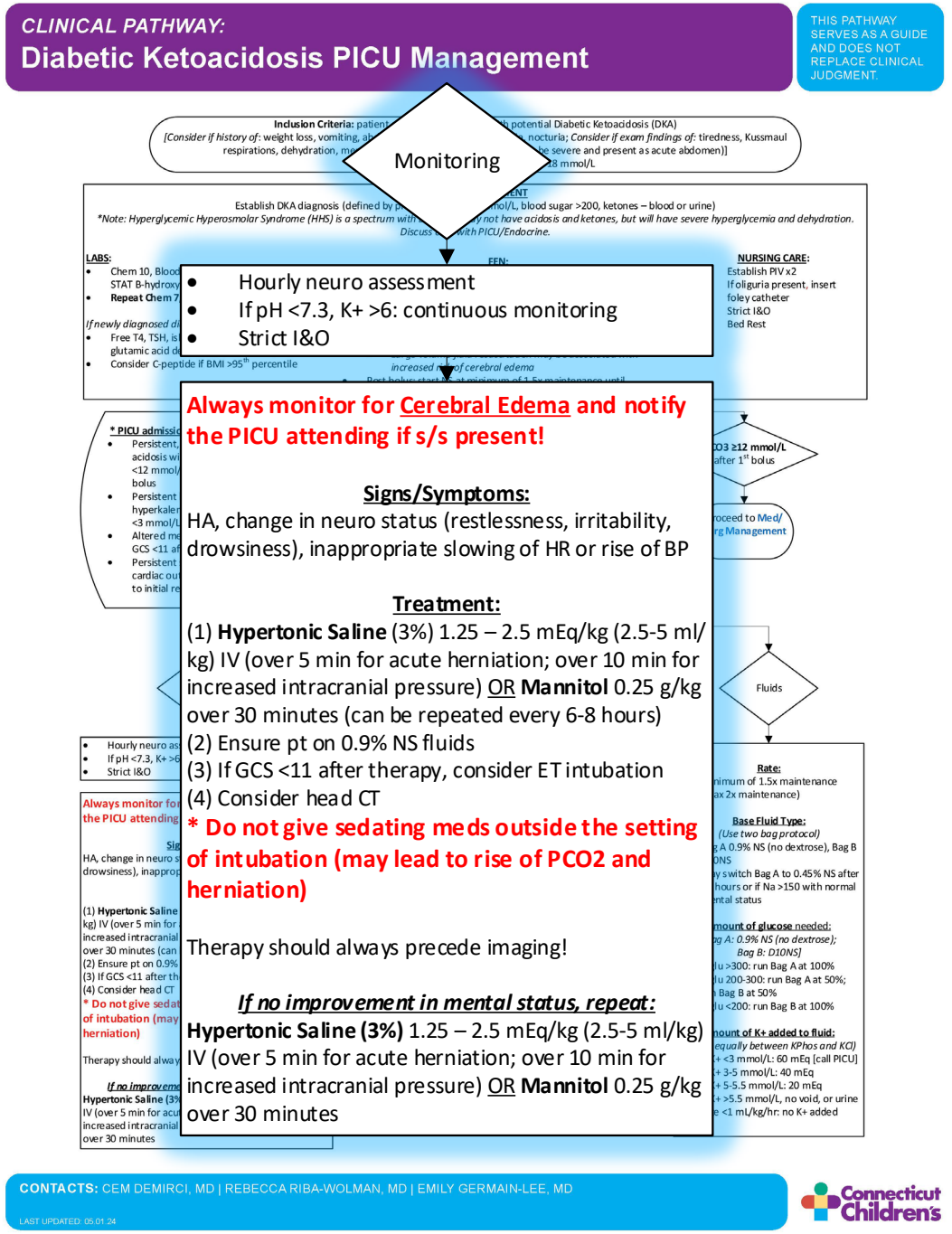
- Monitoring
- Labs
- Insulin
- Fluids

**CONTACTS:** CEM DEMIRCI, MD | REBECCA RIBA-WOLMAN, MD | EMILY GERMAIN-LEE, MD

LAST UPDATED: 05.01.24

- Clinical monitoring in the PICU includes hourly neuro assessments, with continuous monitoring if pH >7.3 and K+ >6 mmol/L

- As always, clinicians should monitor for DKA associated brain injury and notify the PICU attending if present.
- Treatment should always precede imaging.
- Note the doses of hypertonic saline or mannitol, as these were updated in 2022 to reflect the latest management guidelines.
- If there is no improvement in the patient's mental status, then hyptertonic saline or mannitol can be repeated.
- It is important to avoid sedating medications as it may lead to a rise of PCO2 and herniation!

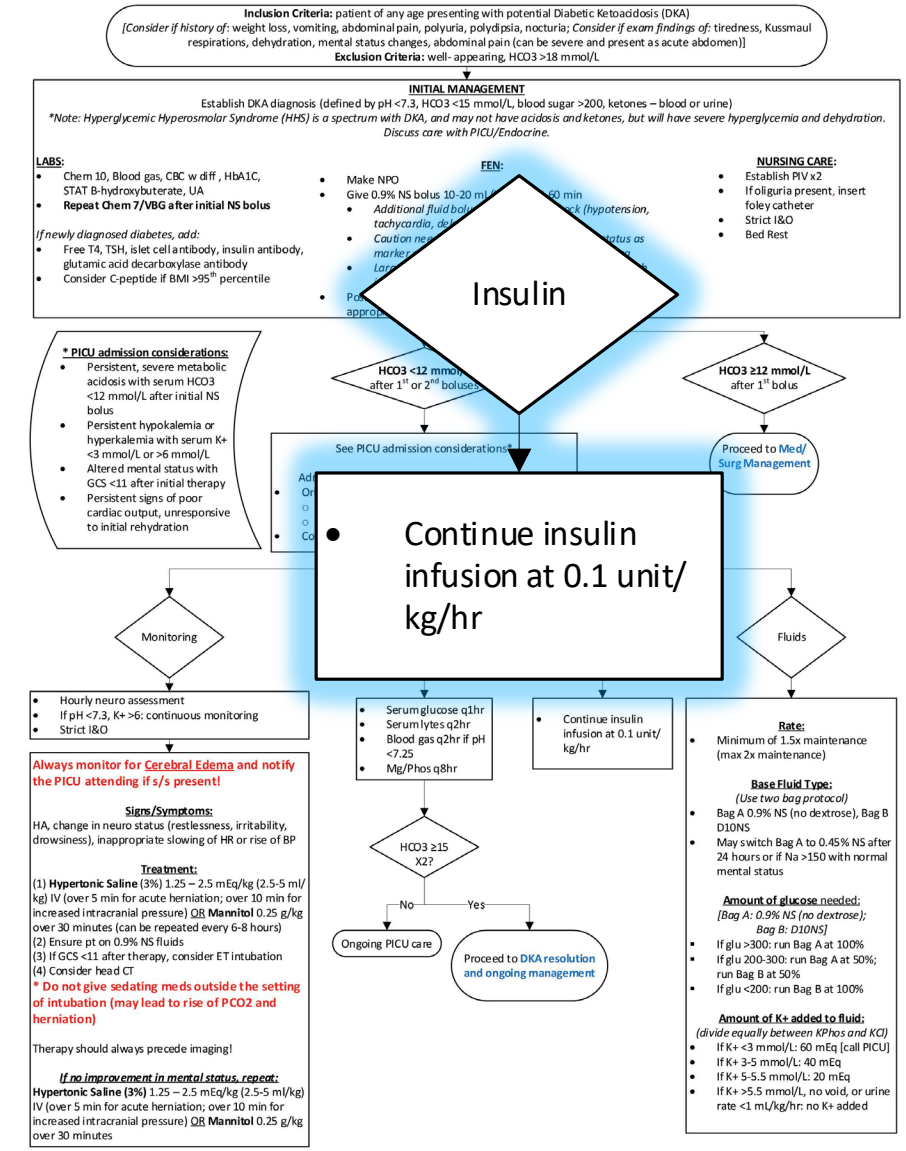


- Insulin infusions should be continued. Boluses are not ordered at this time.

*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis PICUM Management

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

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LAST UPDATED: 05.01.24

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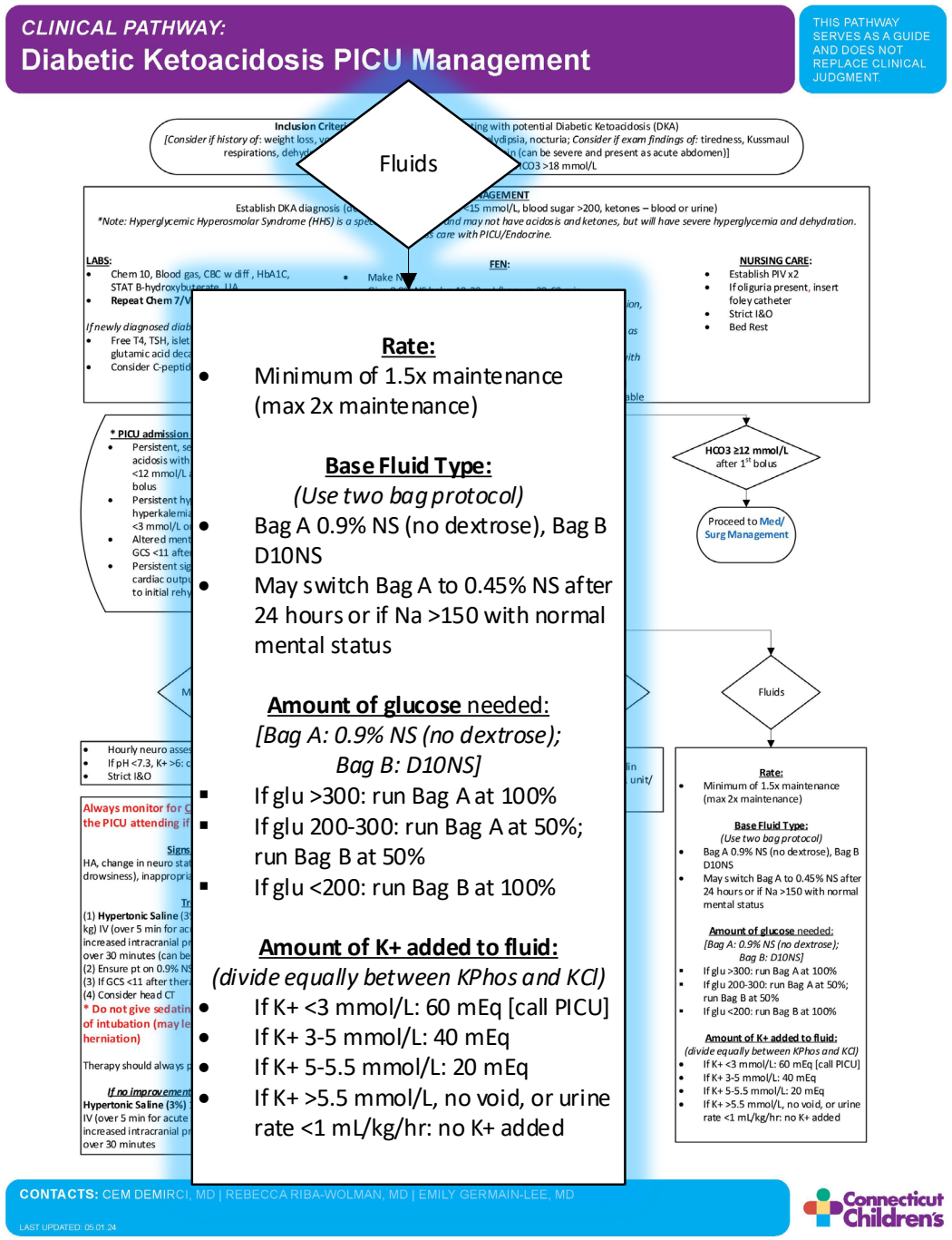
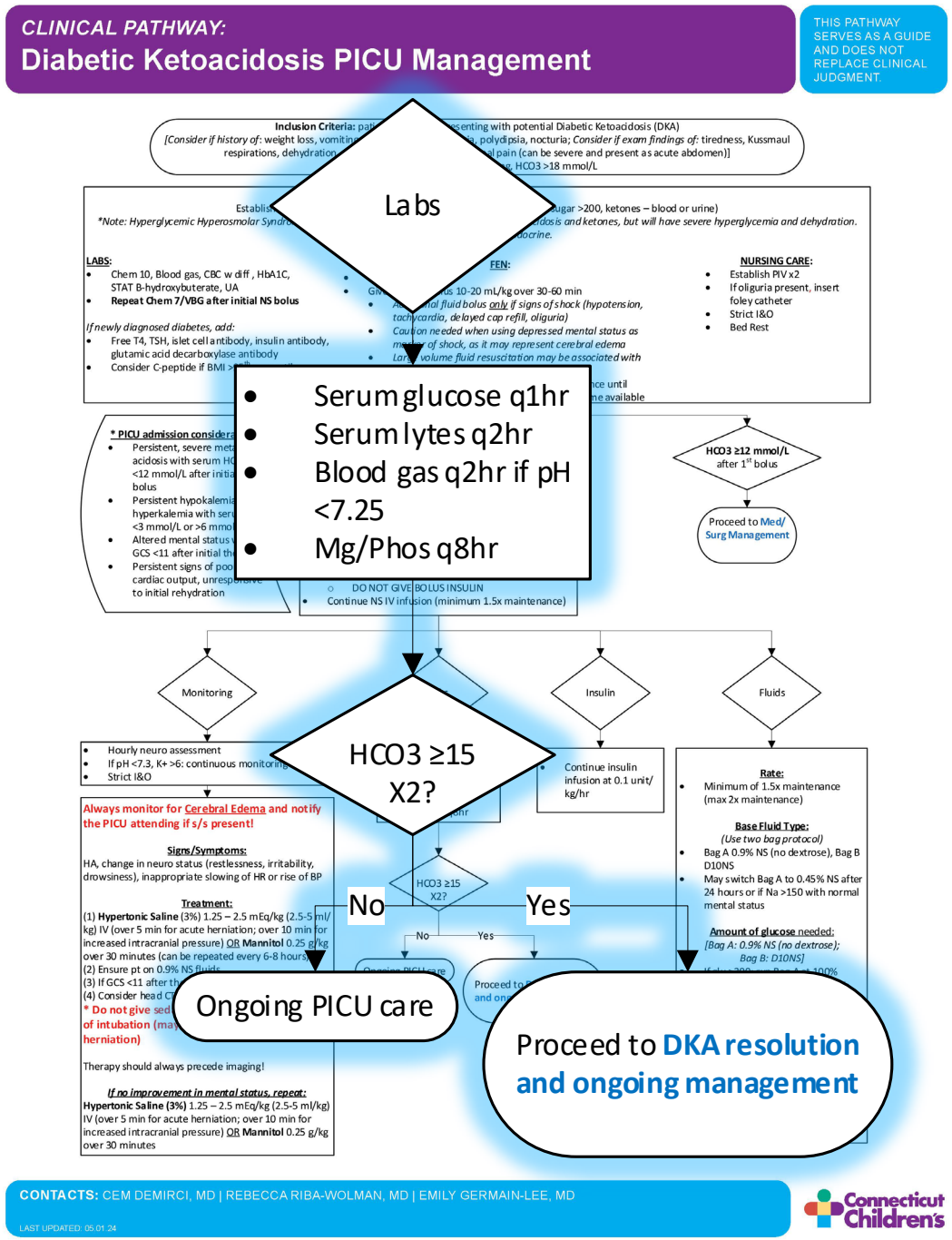
- DKA specific fluids are listed here.
- The rate is always a minimum of 1.5x maintenance rate with a max of 2x maintenance.
- The base fluid type utilizes a 2 bag protocol. Bag A is 0.9% NS and Bag B is D10NS. Bag A can be changed to 0.45% NS after 24 hours or sodium >150 with normal mentation
- The amount of glucose added to the fluids is based on the patient's glucose values and given via Bag B
- The amount of K+ added to the fluid will be divided equally between Kphos and KCl. The amount given depends on the patient's K values.



- Lab monitoring is listed here and includes hourly glucose checks, as well as lytes and blood gas.
- The HCO3 will ultimately determine if the patient stays in the PICU or is stable enough to transfer to the Med/Surg units and/or proceed to DKA resolution and ongoing management algorithm.



# DKA – Med/Surg Management Algorithm

- The purpose of the Med/Surg Algorithm is to provide ongoing management to a stabilized patient with DKA.

*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis (DKA) Med/Surg Management

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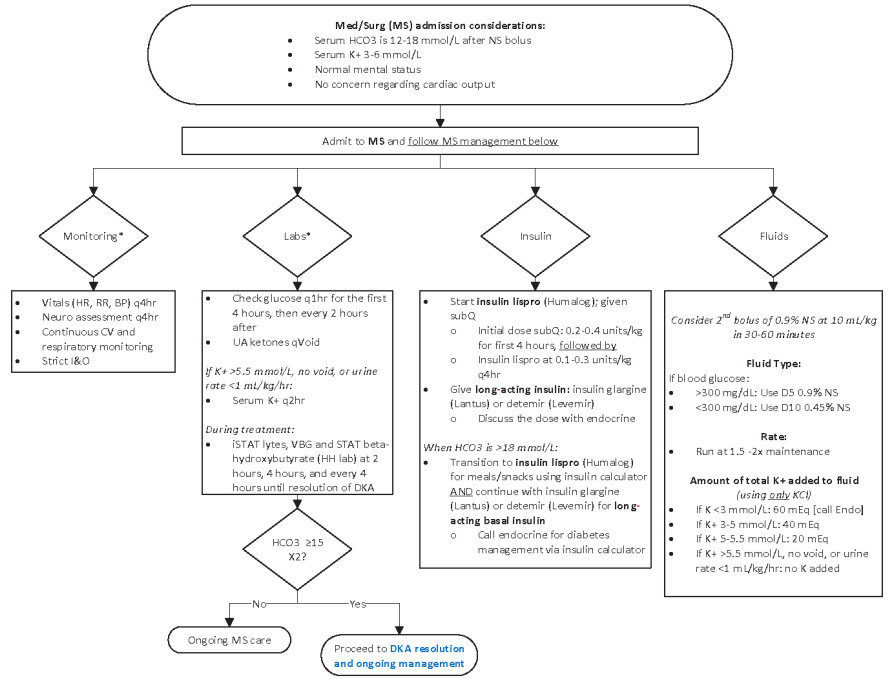


***Call Endocrinology anytime during assessment or treatment if patient develops:**

- Headache
- Altered mental status
- Poor circulation despite adequate hydration
- HCO3 level <12 mmol/L
- Hyperkalemia (K+ >6 mmol/L) or hypokalemia (K+ <3 mmol/L)

**CONTACTS:** CEM DEMIRCI, MD | REBECCA RIBA-WOLMAN, MD | EMILY GERMAIN-LEE, MD

LAST UPDATED: 01.19.23

*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis (DKA) Med/Surg Management

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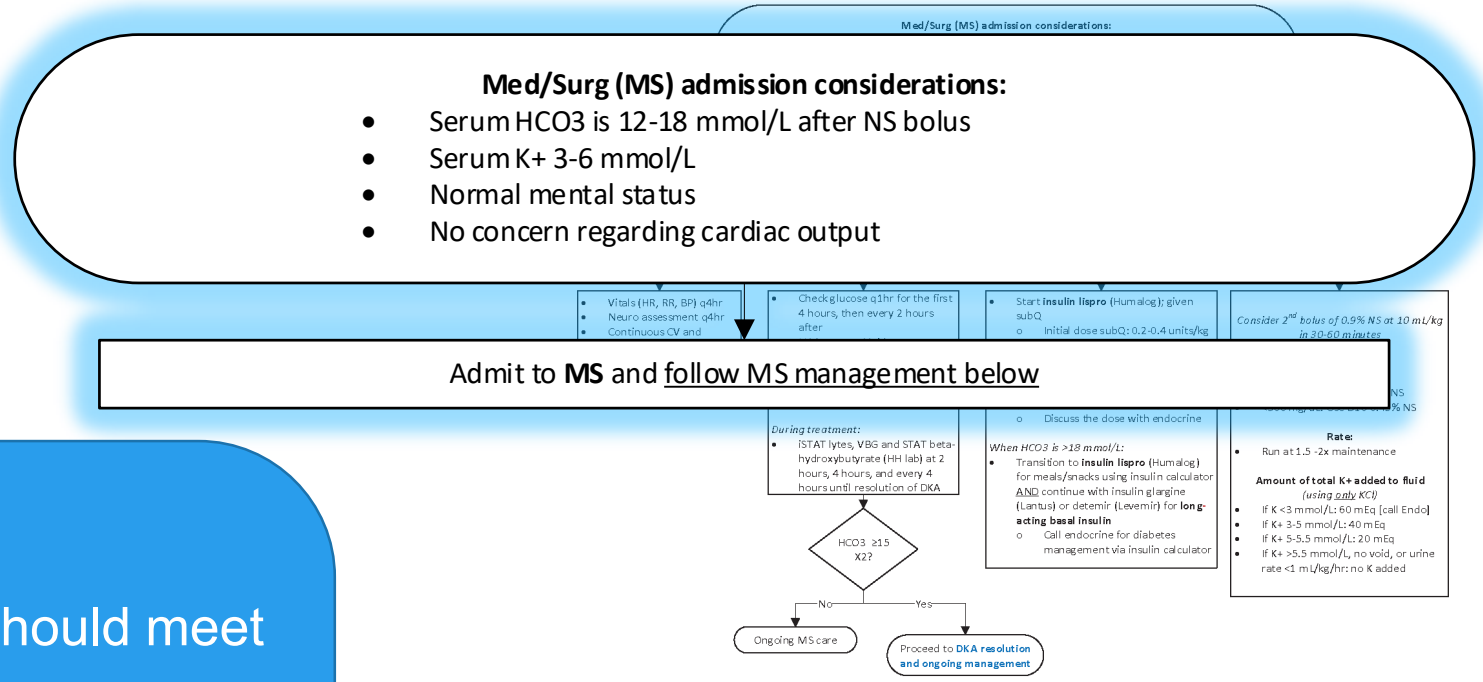


Patients appropriate for Med/Surg should meet the following criteria:

- Serum HCO3 is 12-18 mmol/L after the NS bolus is given
- Serum K+ is 3-6 mmol/L
- Mentation is normal
- There is no concern regarding cardiac output

***Call Endocrinology anytime during assessment or treatment if patient develops:**

- Headache
- Altered mental status
- Poor circulation despite adequate hydration
- HCO3 level <12 mmol/L
- Hyperkalemia (K+ >6 mmol/L) or hypokalemia (K+ <3 mmol/L)

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*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis (DKA) Med/Surg Management

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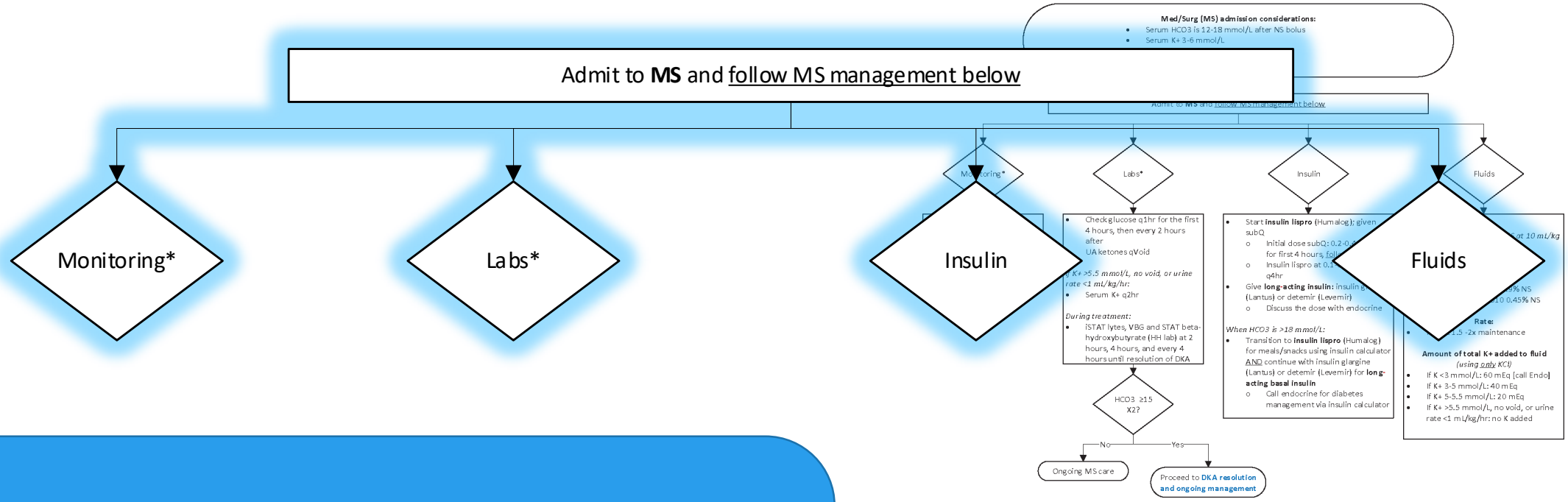


Med/Surg specific care is divided into the following categories:

- Monitoring
- Labs
- Insulin
- Fluids

***Call Endocrinology anytime during assessment or treatment if patient develops:**

- Headache
- Altered mental status
- Poor circulation despite adequate hydration
- HCO3 level <12 mmol/L
- Hyperkalemia (K+ >6 mmol/L) or hypokalemia (K+ <3 mmol/L)

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The insulin infusion can now be changed to the following:

- Insulin lispro (Humalog) given every 4 hours around the clock
- Long-acting insulin: Insulin glargine (Lantus), or detemir (Levemir)

Once HCO3 has improved further to >18 mmol/L, insulin can then be changed to:

- Insulin lispro (Humalog) with meals, and
- Long acting basal insulin

*CLINICAL PATHWAY:*

**Diabetic Ketoacidosis (DKA) Med/Surg Management**

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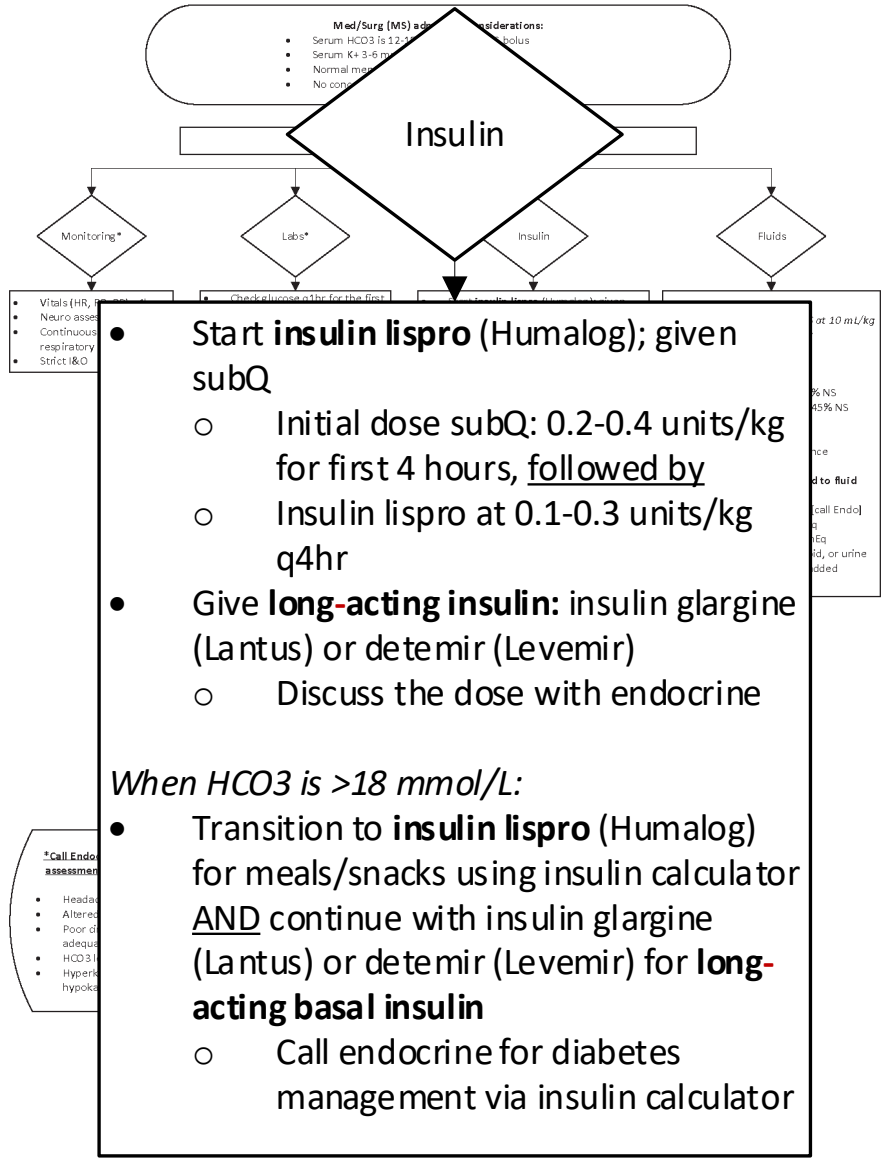


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LAST UPDATED: 01.19.23

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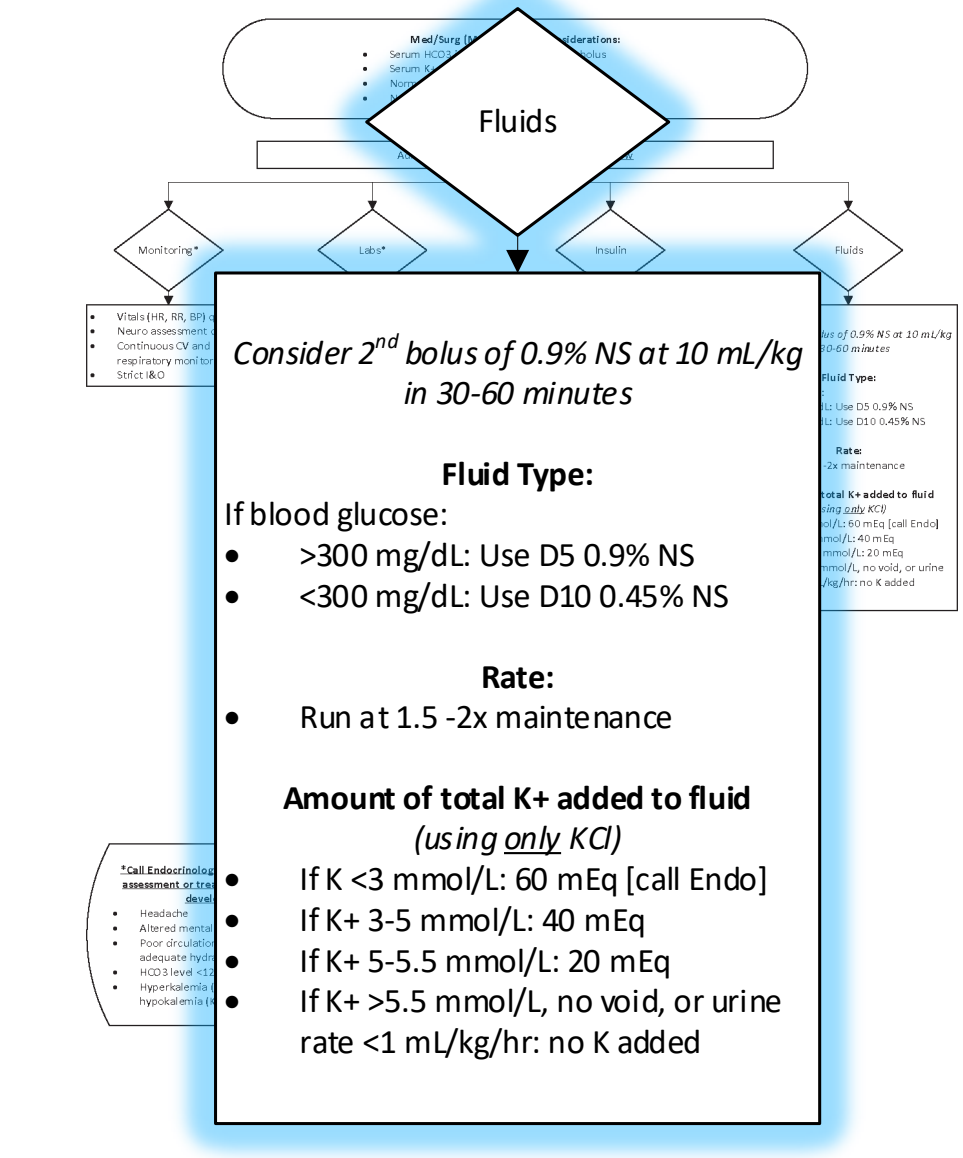
- When the patient is stabilized on the Med/Surg floors, a second bolus can be given.
- Fluids should be continued based on blood glucose level and K+ levels, using D5 or D10 fluids and KCl.
  - Note the difference in fluids from the PICU.
- The rate should be run at 1.5 – 2x maintenance.



- Monitoring includes vitals and neuro checks every 4 hours (note the decreased frequency compared to the PICU).

- Endocrinology should be contacted if there is any headache, altered mental status, or poor circulation despite adequate hydration.

*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis (DKA) Med/Surg Management

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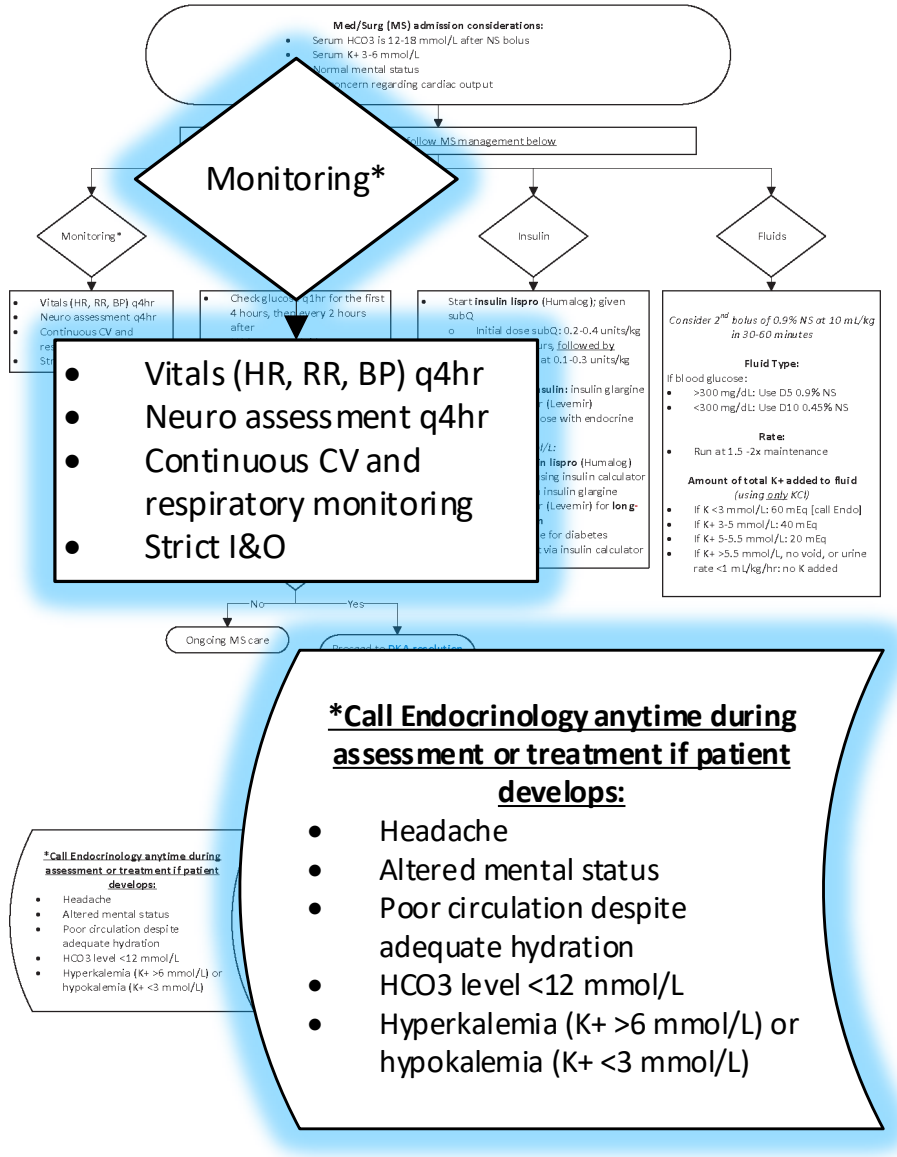


*Call Endocrinology anytime during assessment or treatment if patient develops:
- Headache
- Altered mental status
- Poor circulation despite adequate hydration
- HCO3 level <12 mmol/L
- Hyperkalemia (K+ >6 mmol/L) or hypokalemia (K+ <3 mmol/L)

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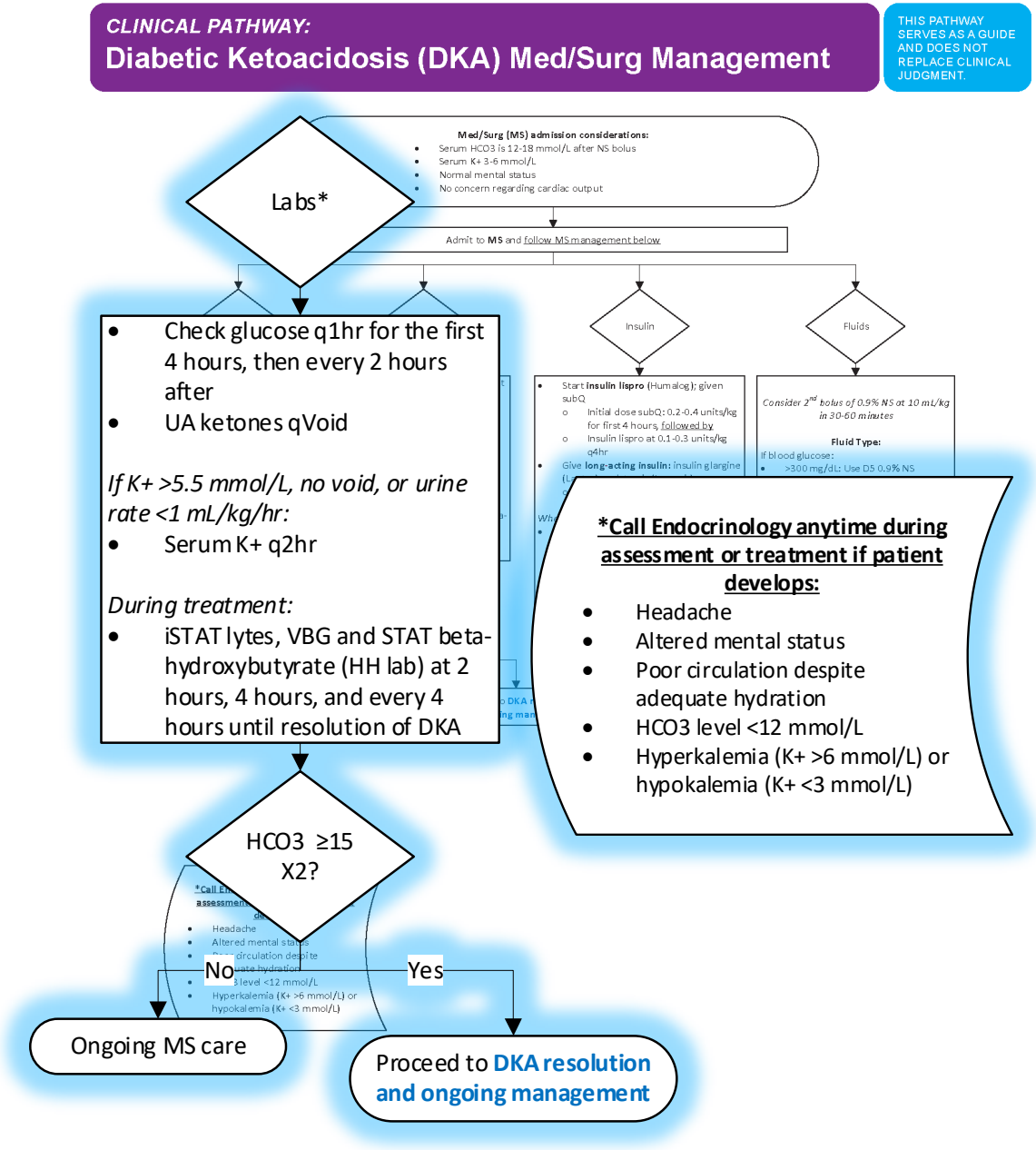
LAST UPDATED: 01.19.23

- Labs are monitoring frequently at first and then spaced out over time.
- Endocrinology should be notified if HCO3 drops to <12 mmol/L or there is hypokalemia (<3 mmol/L) or hyperkalemia (>6 mmol/L) at any time.
- HCO3 determines if the patient stays on ongoing Med/Surg management or if they proceed to the DKA resolution and ongoing management algorithm.



# DKA – Resolution and Ongoing Management Algorithm

- The purpose of the Resolution and Ongoing Management algorithm is to provide care once DKA is resolved and avoid further glucose and electrolyte imbalances.

*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis Resolution and Ongoing Management

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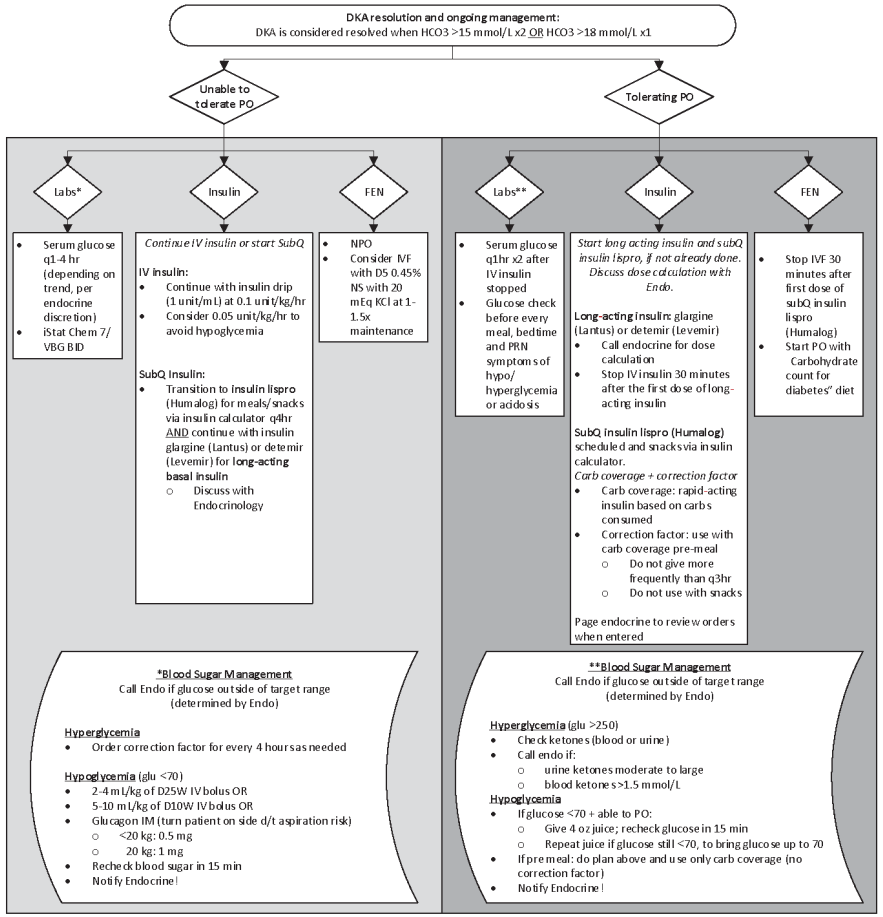


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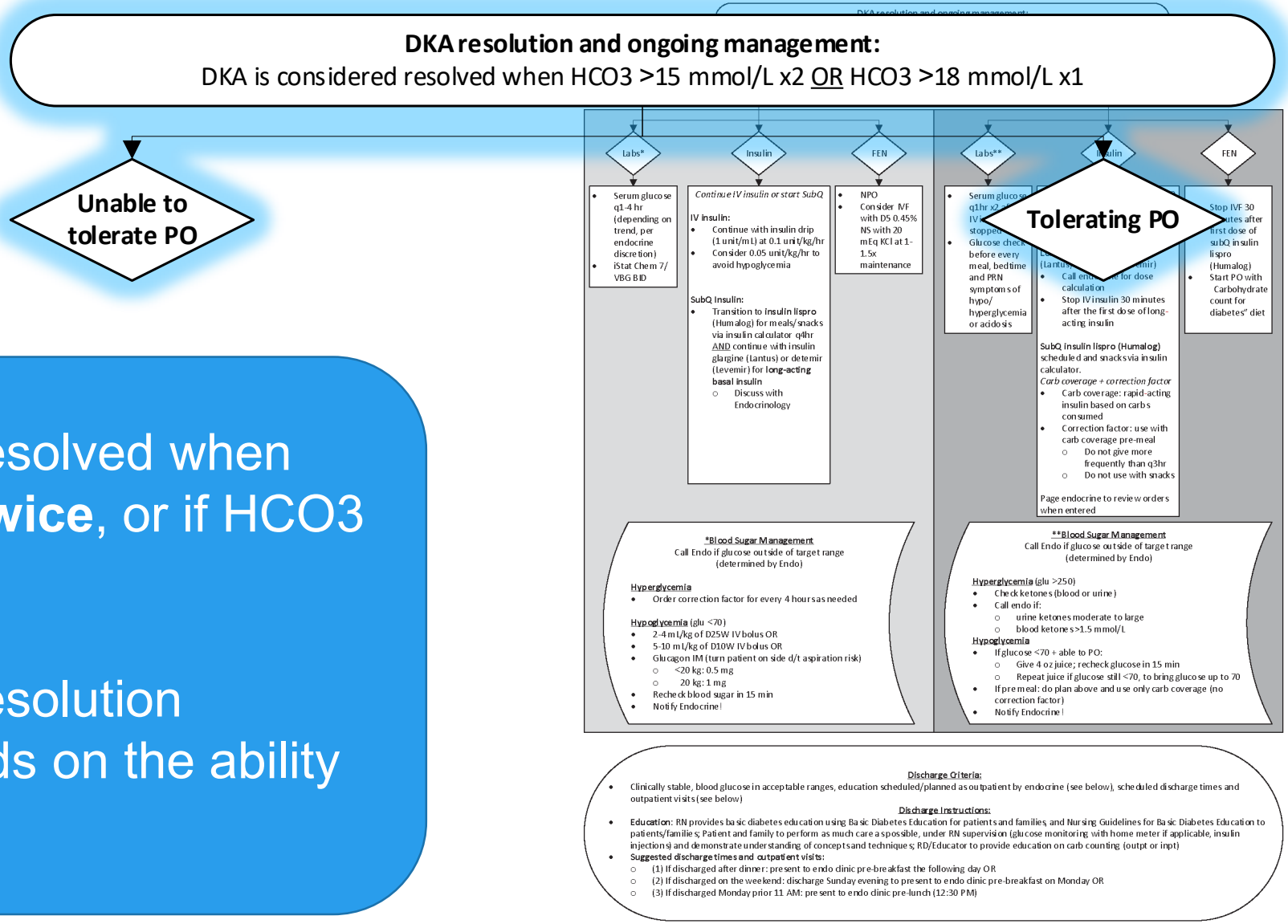
LAST UPDATED: 02.27.23

- DKA is considered resolved when HCO3 >15 mmol/L **twice**, or if HCO3 >18 mmol/L **once**
- If DKA is resolved, resolution management depends on the ability to tolerate PO or not.

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LAST UPDATED: 02.27.23

*CLINICAL PATHWAY:*

# Diabetic Ketoacidosis Resolution and Ongoing Management

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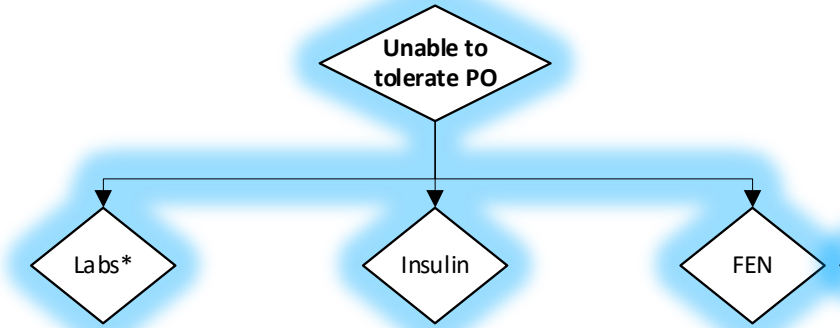
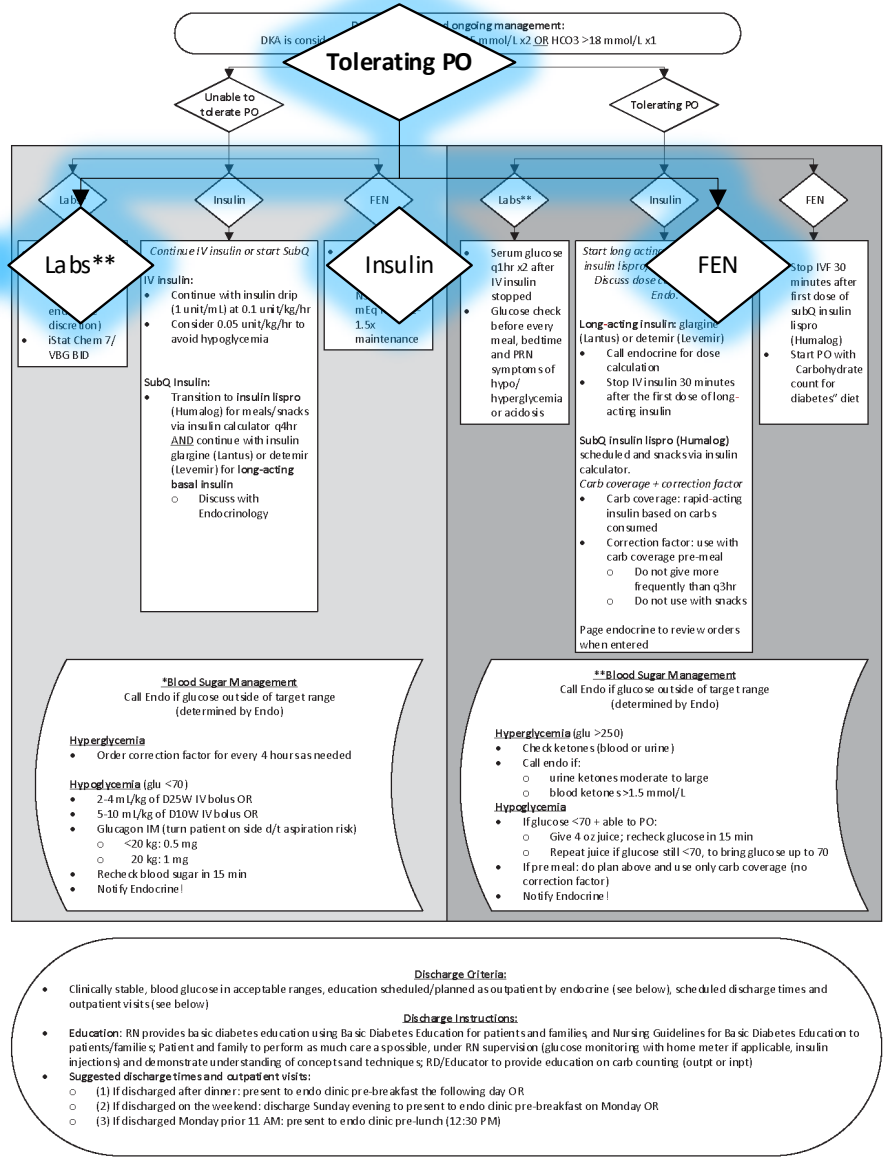



- Care is divided into labs, insulin and FEN considerations for both categories.




**Discharge Criteria:**

- Clinically stable, blood glucose in acceptable ranges, education scheduled/planned as outpatient by endocrine (see below), scheduled discharge times and outpatient visits (see below)

**Discharge Instructions:**

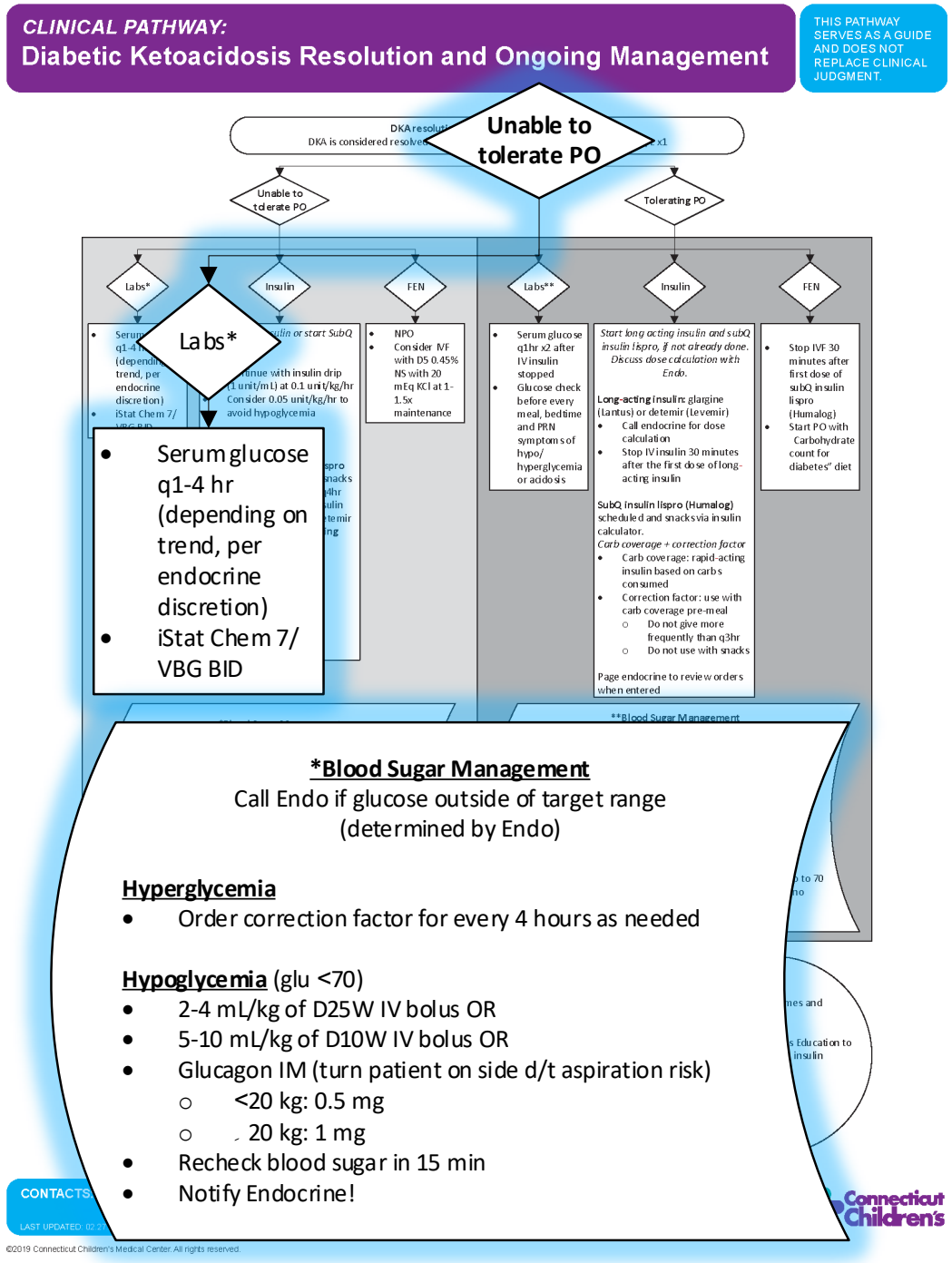
- **Education:** RN provides basic diabetes education using Basic Diabetes Education for patients and families, and Nursing Guidelines for Basic Diabetes Education to patients/families; Patient and family to perform as much care as possible, under RN supervision (glucose monitoring with home meter if applicable, insulin injections) and demonstrate understanding of concepts and techniques; RD/Educator to provide education on carb counting (outpt or inpt)
- **Suggested discharge times and outpatient visits:**
  - (1) If discharged after dinner: present to endo clinic pre-breakfast the following day OR
  - (2) If discharged on the weekend: discharge Sunday evening to present to endo clinic pre-breakfast on Monday OR
  - (3) If discharged Monday prior 11 AM: present to endo clinic pre-lunch (12:30 PM)

**CONTACTS:** CEM DEMIRCI, MD | REBECCA RIBA-WOLMAN, MD | EMILY GERMAIN-LEE, MD

LAST UPDATED: 02.27.23

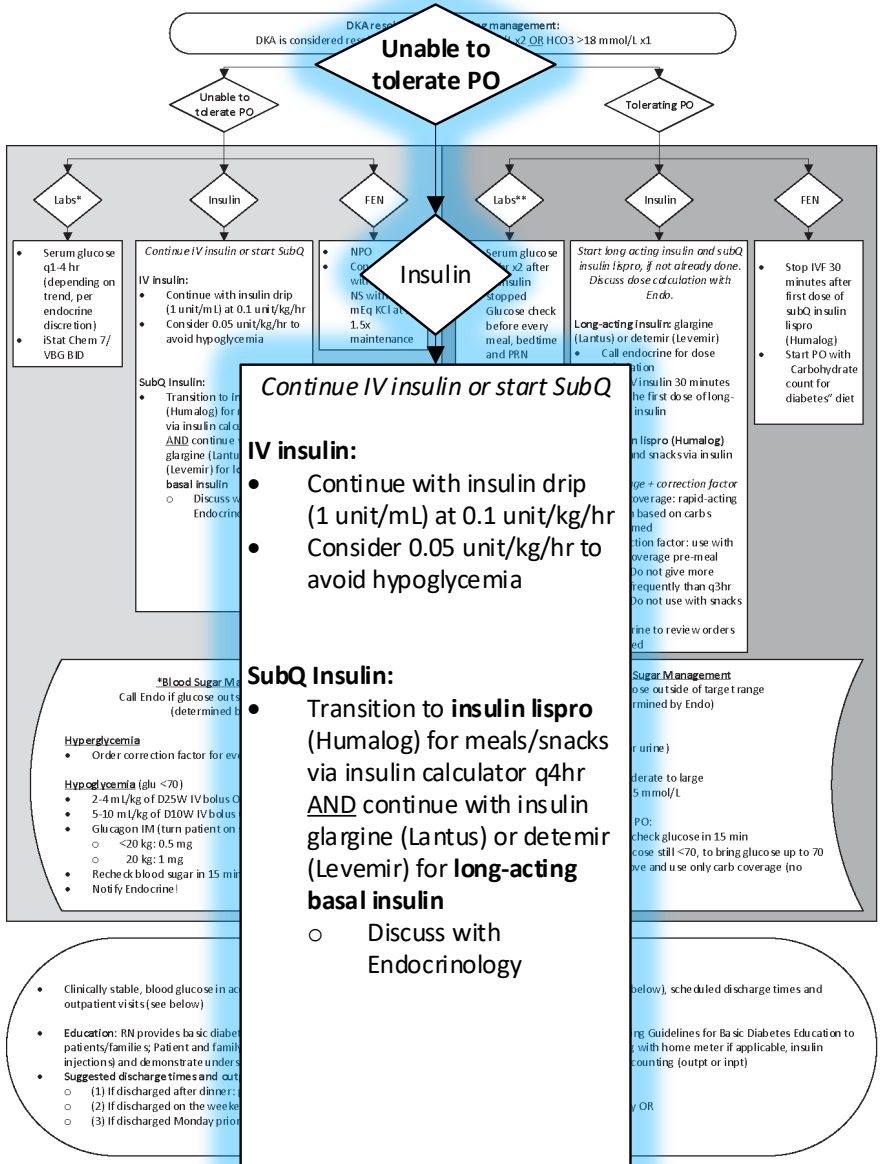
## Unable to tolerate PO

- Labs are spaced depending on the patient's trends.
- Glucose target ranges will be provided by endocrine. If the glucose falls outside of the range, endocrinology should be notified.
- If hyperglycemia is present, correction factor should be ordered.
- If hypoglycemia is present, options for glucose replacement are given here.



## Unable to tolerate PO

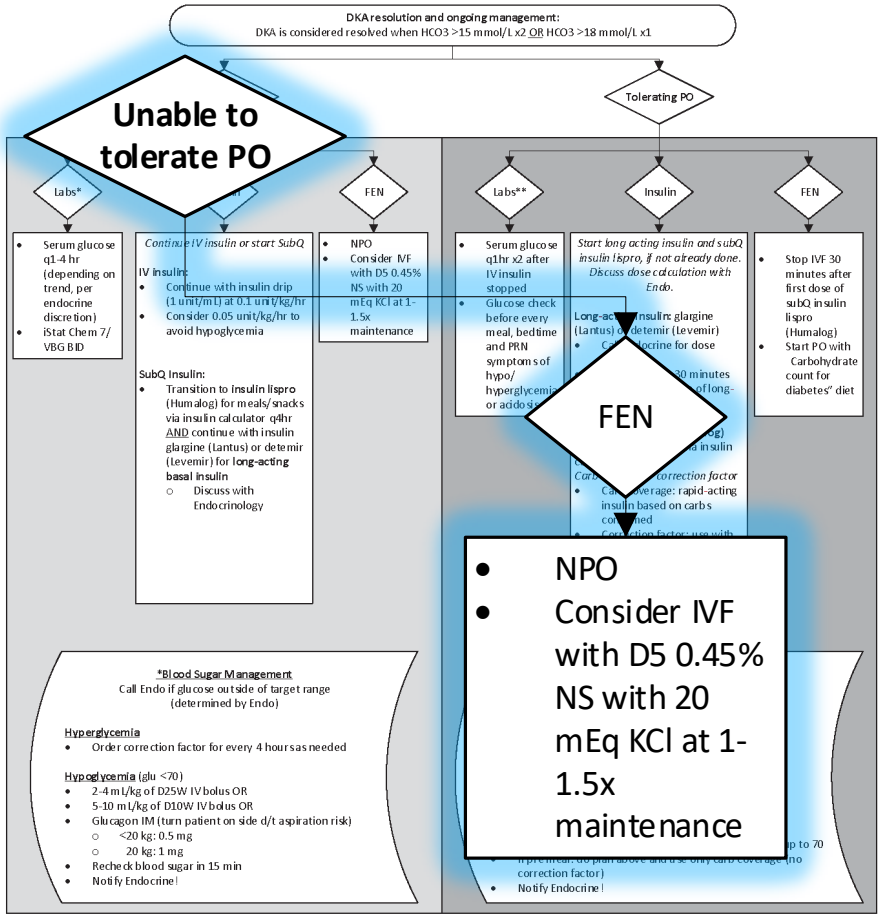
- Insulin IV should be continued if the patient is unable to tolerate PO, although subQ may be started in discussion with endocrinology.



## Unable to tolerate PO

- If the patient is unable to tolerate PO, keep them NPO and consider IVF at 1-1.5x maintenance.
- Fluid composition should be D5 0.45% NS with 20 mEq KCl.
  - Note that this is different from DKA specific fluids.



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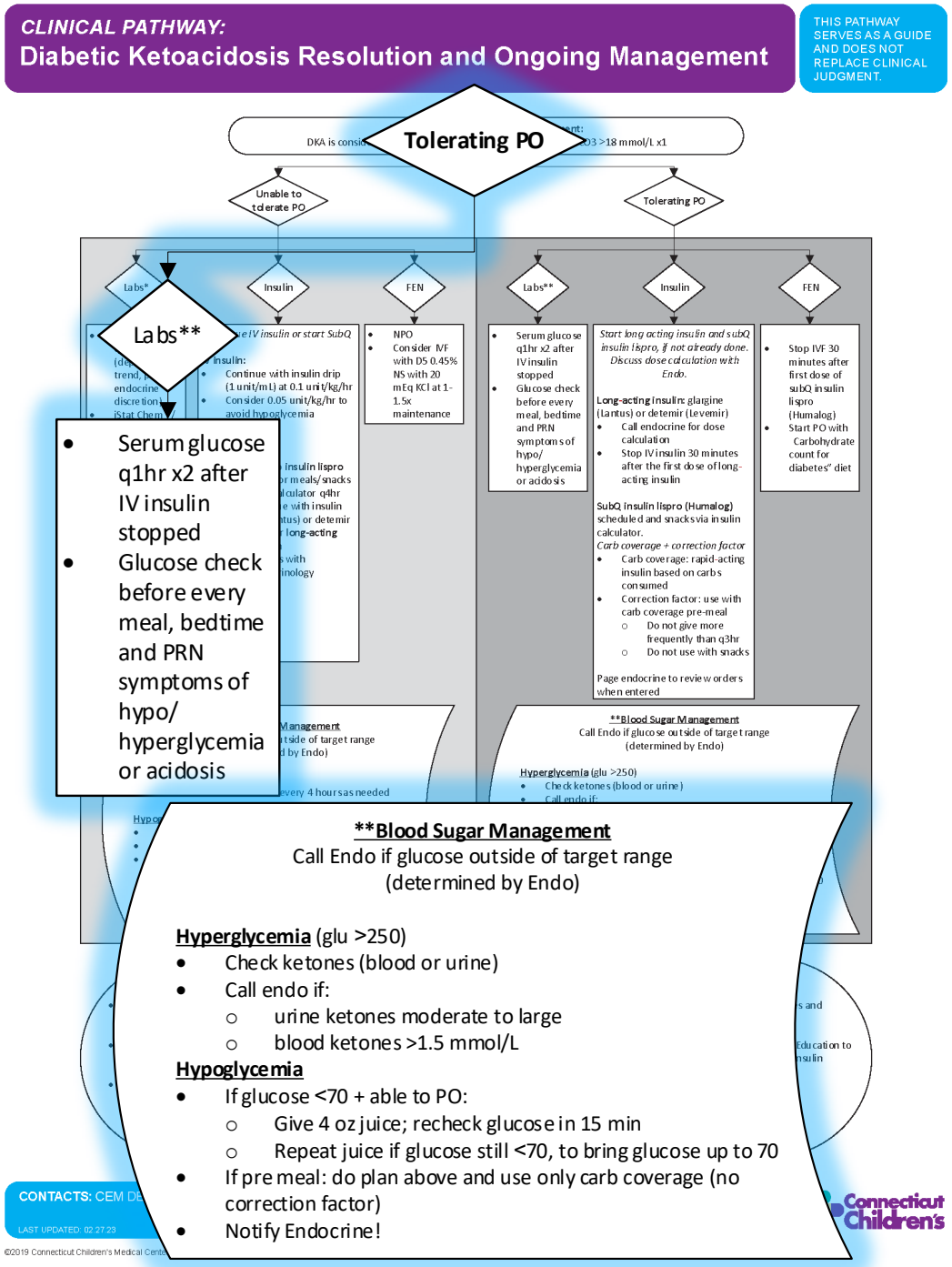
LAST UPDATED: 02.27.23

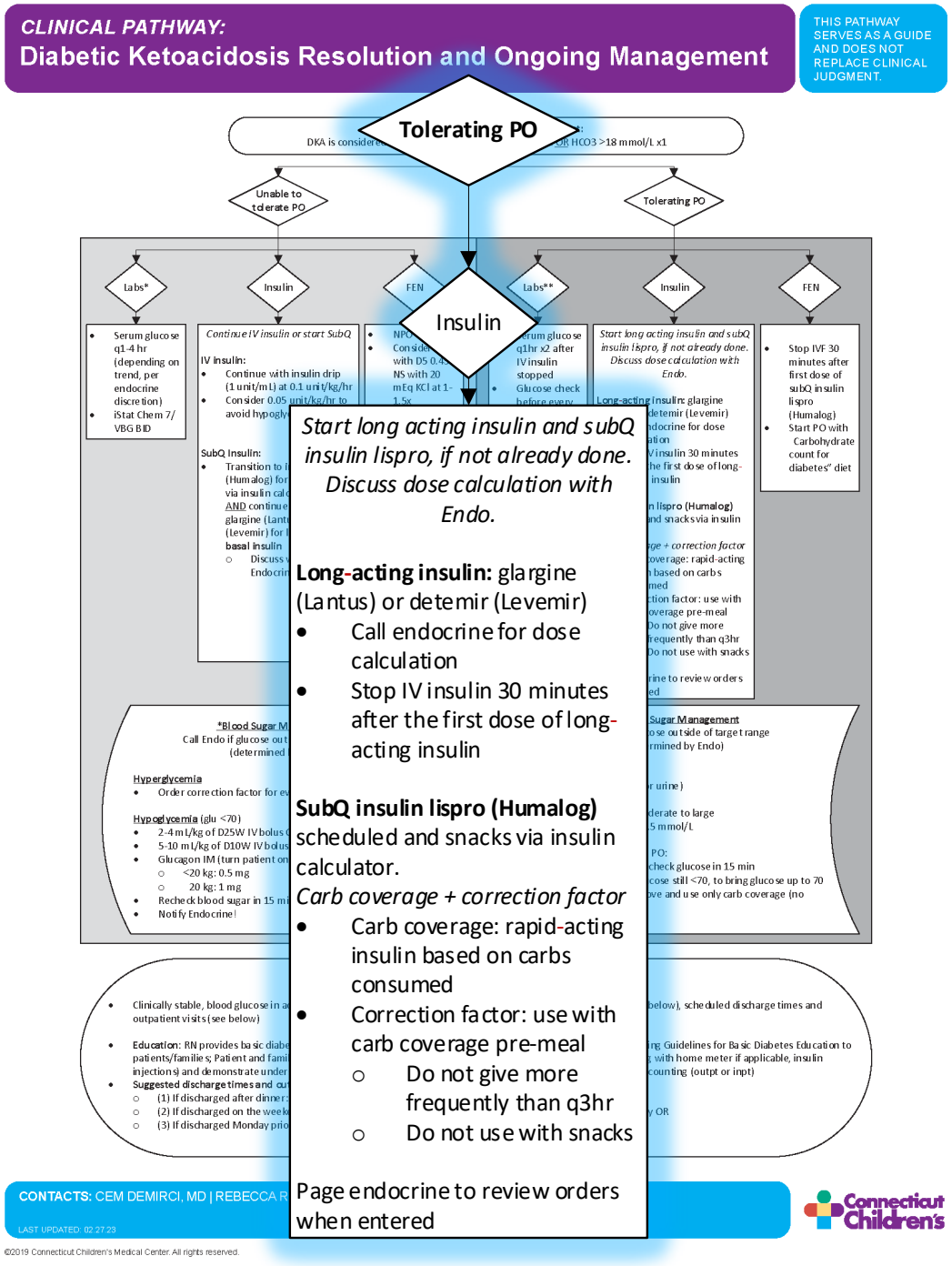
## Tolerating PO

- If the patient is tolerating PO, the labs will be scheduled q1hr x2 after the IV insulin is stopped with glucose checks surrounding meals and PRN.
- Target glucose ranges will be provided by endocrinology.
- If hyperglycemia is present, ketones should be checked. Endo should be notified if ketones are mod-large or blood ketones are >1.5 mmol/L.
- If hypoglycemia is present, options to replace glucose are listed.



## Tolerating PO

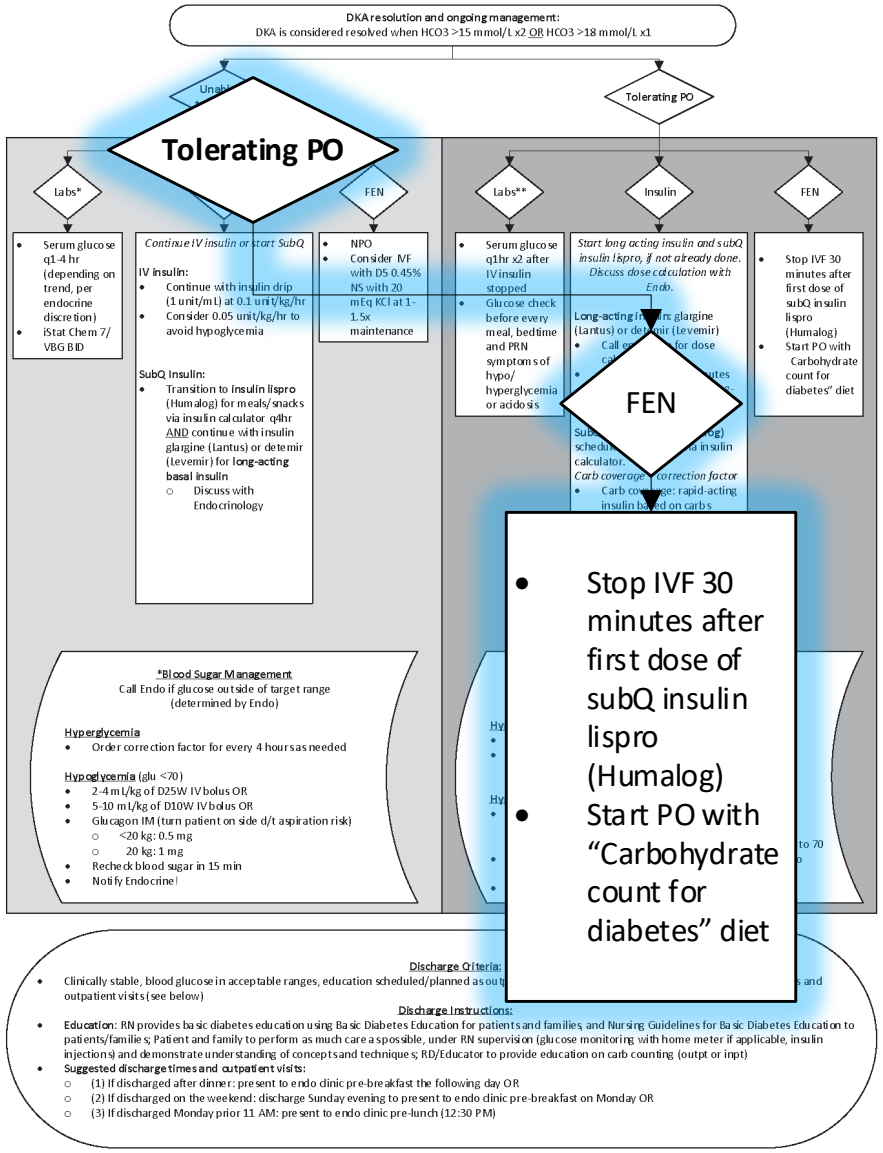
- Once the patient is reliably tolerating PO, long acting insulin and subQ insulin Lispro should be started.
- Doses and orders should be discussed and reviewed with Endocrinology.



# Tolerating PO

- Once the patient is reliably tolerating PO, IVF should be stopped 30 minutes after the first dose of subQ insulin is given.
- Carbohydrate counts should be started.



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LAST UPDATED: 02.27.23

*CLINICAL PATHWAY:*
# Diabetic Ketoacidosis Resolution and Ongoing Management

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

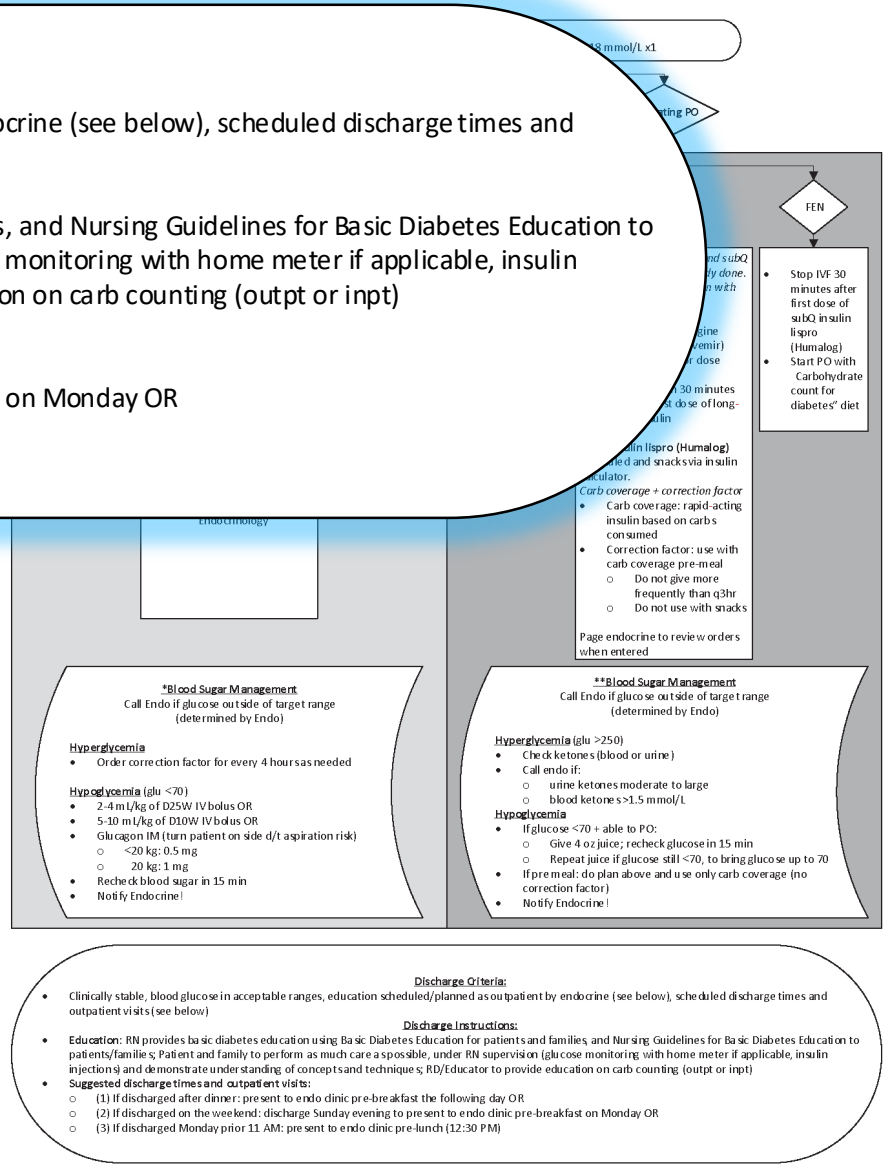
**Discharge Criteria:**

- Clinically stable, blood glucose in acceptable ranges, education scheduled/planned as outpatient by endocrine (see below), scheduled discharge times and outpatient visits (see below)

**Discharge Instructions:**

- **Education**: RN provides basic diabetes education using Basic Diabetes Education for patients and families, and Nursing Guidelines for Basic Diabetes Education to patients/families; Patient and family to perform as much care as possible, under RN supervision (glucose monitoring with home meter if applicable, insulin injections) and demonstrate understanding of concepts and techniques; RD/Educator to provide education on carb counting (outpt or inpt)
- **Suggested discharge times and outpatient visits:**
  - (1) If discharged after dinner: present to endo clinic pre-breakfast the following day OR
  - (2) If discharged on the weekend: discharge Sunday evening to present to endo clinic pre-breakfast on Monday OR
  - (3) If discharged Monday prior 11 AM: present to endo clinic pre-lunch (12:30 PM)

- Discharge criteria and instructions are listed here.
- RN will provide basic diabetes education to the patients and families.
- It is the goal that patients/families should perform much of the care during their stay as possible, with RN supervision.
- RN or the educator will provide education on carbohydrate counting, either inpatient or outpatient.
- Specific times for endocrinology follow up are given depending on discharge time.




**CONTACTS:** CEM DEMIRCI, MD | REBECCA RIBA-WOLMAN, MD | EMILY GERMAIN-LEE, MD

LAST UPDATED: 02.27.23

# Review of Key Points

- Severity of DKA will define the level of care needed.
- Initial fluid management is 0.9% (normal) saline given in 10-20 mL/kg boluses until the patient has adequate peripheral perfusion.
- Fluid management is then aimed at replacing intra- and extracellular water and electrolytes, while flushing out glucose and ketones in the urine.
- PICU attending and/or Endocrinology should be notified immediately with ANY evidence of cerebral edema.
- Once a patients blood glucose and bicarbonate have corrected, they will be transitioned to subQ insulin on an individualized plan from Endocrine team

# Quality Metrics

- Percentage of patients with pathway order set usage
- Percentage of patients on pathway for ≤ 24 hours (excluding patients with pH≤6.9)
- Percentage of patients without hypoglycemic episodes while on pathway (defined as blood glucose <70 mg/dl)
- Percentage of patients with 1-2 episodes of hypoglycemia after pathway completed
- Percentage of patients with 3 or more episodes of hypoglycemia after pathway completed
- Percentage of patients with documented (by endocrine team) reason(s) for DKA
- Percentage of patients follow-up appointment scheduled at the time of discharge
- Length of stay

# Pathway Contacts

- Cem Demirci, MD
  - Department of Endocrinology
- Rebecca Riba-Wolman, MD
  - Department of Endocrinology
- Emily Germain-Lee, MD
  - Department of Endocrinology
- John Peng, MD
  - Pediatric Emergency Medicine
- Adam Silverman, MD
  - Pediatric Emergency Medicine and Pediatric Intensive Care Unit
- Leonard Comeau, MD
  - Pediatric Intensive Care Unit
- Daniel Fisher, MD
  - Pediatric Intensive Care Unit

# References


- Wolfsdorf J, Craig ME, Daneman D, Dunger D, Edge J, Lee WR, Rosenbloom A, Sperling MA, Hanas R; International Society for Pediatric and Adolescent Diabetes. Diabetic ketoacidosis. *Pediatr Diabetes*. 2007 Feb:8(1):28–43.
- Cooke DW, Plotnick L. Management of diabetic ketoacidosis in children and adolescents. *Pediatr Rev*. 2008 Dec;29(12):431-5.
- Wolfsdorf J, Glaser N, Agus M, Fritsch M, Hanas R, Rewers A, Sperling MA, Codner E. Diabetic Ketoacidosis and Hyperglycemic Hyperosmolar State: A Consensus Statement from the International Society for Pediatric and Adolescent Diabetes. Pediatr Diabetes. 2018 Oct; Suppl 27:155-177.
- Nyenwe EA, Kitabchi AE. The evolution of diabetic ketoacidosis: An update of its etiology, pathogenesis and management. Metabolism. 2016 Apr;65(4):507-21.

# Thank You!

## About Connecticut Children's Clinical Pathways Program

The Clinical Pathways Program at Connecticut Children's aims to improve the quality of care our patients receive, across both ambulatory and acute care settings. We have implemented a standardized process for clinical pathway development and maintenance to ensure meaningful improvements to patient care as well as systematic continual improvement. Development of a clinical pathway includes a multidisciplinary team, which may include doctors, advanced practitioners, nurses, pharmacists, other specialists, and even patients/families. Each clinical pathway has a flow algorithm, an educational module for end-user education, associated order set(s) in the electronic medical record, and quality metrics that are evaluated regularly to measure the pathway's effectiveness. Additionally, clinical pathways are reviewed annually and updated to ensure alignment with the most up to date evidence. These pathways serve as a guide for providers and do not replace clinical judgment.