Diabetes Ketoacidosis Emergency Department Evaluation Pathway

Evidence Based Outcome Center

EXCLUSION CRITERIA

- Age < 12 months

! ALERT
Patient exhibiting signs of shock:
FOLLOW PALS GUIDELINE

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

Signs Suggestive of DKA	
Clinical Signs	**Historical Features**
Dehydration	Polyuria/Polydipsia
Vomiting	Fatigue
Kussmaul breathing	New onset enuresis
Abdominal tenderness	Nausea/vomiting
Lethargy	Nocturia
Mental status changes	Headache
Smell of ketones (fruity smell)	Weight loss
	Confusion
	Abdominal pain
	New Candida infection

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 Assessment for patients at high risk for cerebral edema complications
- Glasgow Coma Scale (GCS)

High risk cerebral edema❶ — YES → Notify PICU **AND** plan for ADMIT

High risk cerebral edema❶ — NO →

Signs of herniation
- Bradycardia/hypertension/respiratory insufficiency
- Anisocoria (Unequal pupil size)
- Unresponsiveness

YES → **Cerebral Edema Treatment Pathway**

NO →

Initial Fluid Resuscitation
- 20 mL/kg NS Bolus over 30 minutes | 1 L Max
- Followed by 1.5X maintenance IV Fluids (Refer to PICU DKA orderset) ❷ Max 150 mL/hour

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

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	CBC w/diff
BMP	Urinalysis with micro*
Magnesium	Serum Osmolality (Osm)

Quantitative Beta hydroxybutyrate – STAT (ß-HB)

*Consider urinalysis with culture if febrile

Recheck glucose after initial fluid resuscitation

Meets DKA Definition

1) pH < 7.3 **AND/OR** HCO_3 < 18
2) **AND** Hyperglycemia with blood glucose > 200 Mg/dl
3) **AND** Ketones in Urine or ß-HB >1

*CONSULT ENDOCRINOLOGY
* If BG >600 mg/dL, OSM >320 mOsm/kg or few to no ketones, consider HHS

YES → **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
- Insert 2nd PIV once DKA diagnosis has been established
- Consult Endocrinology

Utilize PICU DKA orderset
- Order insulin drip to start if 1hr from initial fluid resuscitation
- If K+ is >5.5 or not yet resulted order NS fluids @1.5X maintenance rate (max 150ml/h)
- If serum (K+) potassium is <5.5 order 2 bag fluids
- Reach out to PICU team if need aid with orders/setup

*if ordering 2 bags, call pharmacy to send bags to correct unit
*If time in ED expected to be >60 mins, utilize recommended lab and monitoring frequencies as in PICU order set

If insulin drip is not being started and Transport to PICU is expected to be > 60 mins, then consider a single dose of long-acting insulin (insulin glargine or insulin detemir), after consult w/ Endocrinology.

Notify PICU attending for any of the following:
- Glucose < 80 mg/dL
- Glucose falling > 100 mg/dL/Hour – (Goal decline of BG is < 50-100 / hour)
- Urine output < 1mL/kg/hour over 2 hours **OR** negative fluid balance
- Intractable vomiting
- Change in mental status (including severe or increasing headache)
- BG >600, Osm >320 – concern for HHS

ADMIT to PICU

NO → **Meets Ketosis Non-Acidosis Definition**

1) pH ≥ 7.3 **OR** HCO_3 ≥ 18
2) **AND** Urine Ketones ≥ Small (15 mg/dL) **OR** ß-HB ≥ 1

CONSULT ENDOCRINOLOGY

Ketosis Non-acidosis Pathway

Assess for Hyperglycemia hyperosmolar state
Consult Endocrinology Manage Off Pathway

1 High risk of cerebral edema
- Severe headache
- Recurrent vomiting
- History of Cerebral Edema
- Depressed mental status

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

(Recommend always using NS fluids – if want to vary from this, need to be discussed with PICU)

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

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Diabetes Ketoacidosis Intensive Care Unit Management Pathway

Evidence Based Outcome Center

EXCLUSION CRITERIA

- Age < 12 months

Inclusion Criteria

1) pH < 7.3 **AND/OR** HCO_3 < 18
2) AND Hyperglycemia with blood glucose > 200 Mg/dl
3)AND Ketones in Urine or ß-HB >1

Signs of Cerebral Edema — YES → **Cerebral Edema Treatment Pathway**

NO

Potassium (K+) < 5.5 mEq/dL **AND** Patient is voiding well

NO

INSULIN

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 if unknown

FLUIDS

1.5 x maintenance | Max: 4L/m2 in 24hr
Discuss rate with attending if >150 mL/h

Start NS

YES

INSULIN

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 if unknown

FLUIDS (Two-Bag System) ❷

1.5 x maintenance | Max: 4L/m2 in 24hr

Bag 1:Start NS **with**
30 mEq/L Potassium Acetate
- AND -
30 mEq/L Potassium Phosphate

Bag 2: Start D10 NS **with**
30 mEq/L Potassium Acetate
- AND -
30 mEq/L Potassium Phosphate

Fluid titration ❶ | Total fluid rate 1.5 x maintenance

- While patient is acidotic maintain NPO status
- If Potassium (K+) < 5.5 mEq/dL AND patient is voiding well discontinue normal saline and initiate two bag system ❷

If concern for HHS, discuss with attending

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: q1hr
- VBG w/lytes, CBG w/lytes OR ABG w/lytes: q2hr
- Serum ß-HB: q4hr
- BMP: q4-q12hr
- Magnesium & Phosphorus: q8hr-q12hr

Additional Labs

- Serum Osmolality (OSM): q4hr – If patient is high risk for Cerebral Edema, glucose is increasing, or high initial OSM, concern for HHS
- Urinalysis with micro, Urine Culture, or Throat Culture – If patient history supports
- Urinalysis dipstick for ketones when bicarb >14 - Qvoid

Monitoring:

- Vital signs q1hr
- Cardio-respiratory monitor, pulse oximeter, strict I & Os including po intake
- Neuro checks Q1hr

Other medications:

- 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)

Signs of herniation

- Bradycardia/hypertension/respiratory insufficiency
- Anisocoria (Unequal pupil size)
- Unresponsiveness

YES → **Cerebral Edema Treatment Pathway**

NO

Transition Criteria
pH ≥ 7.3 **OR** HCO_3 ≥ 18

YES

Transfer to Floor
- AND -
Transition to Ketosis Non-acidosis Pathway
(New onset diabetes patients transition to Diabetes Care Phase)

❶ Fluid titration based on serum glucose:

Serum glucose (mg/dL)	D10 NS + 30 mEq Potassium Acetate/Liter + 30 mEq Potassium Phosphate/Liter	NS + 30 mEq Potassium Acetate/Liter + 30 mEq Potassium Phosphate/Liter
Less than 120	100 % = _____ ml/hr	Off
120 – 200	66 % = _____ ml/hr	33 % = _____ ml/hr
201 – 300	33 % = _____ ml/hr	66 % = _____ ml/hr
Greater than 300	Off	100% = _____ ml/hr
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	50% = _____ ml/hr	50% = _____ ml/hr

Cerebral Edema Treatment Pathway
Evidence Based Outcome Center

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:
  Posm = 2 [NA+] + [Glucose]/18 +[BUN]/2.8.
- Recommend following serum Osm Q4h with clinical exam

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

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

- Consider Neurosurgery consult 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.

Ketosis Non-Acidosis Emergency Department Pathway

Evidence Based Outcome Center

EXCLUSION CRITERIA
- Age < 12 months
- Diabetic Ketoacidosis
- Cerebral Edema
- Hyperglycemia hyperosmolar state
- Cystic Fibrosis
- New onset diabetic

Inclusion Criteria
1) pH ≥ 7.3 **OR** HCO_3 ≥ 18
2) Hyperglycemia > 200 Mg/dl
3) **AND** Urine Ketones > Small **OR** ß-HB > 1

Moderate to Large Ketones
(≥ 40 on Urine Ketones or ß-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 ❸

Small to Trace Ketones
(<40 on Urine Ketones or ß-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 ❸

TIME: 0
Initial Insulin Dose

1 Frequency of Labs
- Venous blood glucose: **q1hrs**
- Urine dipstick for ketones: **qvoid**
- Serum B-hydroxybutyrate and VBG: **90 minutes after initial insulin dose**

2 Monitoring
- Vital signs: **q1hrs**
- Cardiac monitor
- Pulse Oximetry
- Neuro check: **q1hrs**
- Strick I & Os, including po intake

3 IV Fluids
- Corrected Sodium level ≥ 140 mEq/L: **½ NS**
- Corrected Sodium level < 140 mEq/L: **NS**

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

Tolerating PO?

YES

IV fluids
Reduce to maintenance ❸

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: 90 Minutes
After Initial Insulin Dose

Order Quantitative ß-hydroxybutyrate – STAT and VBG Labs

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)

NO

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

Tolerating PO?

YES

NO

Glucose < 200 mg/dL OR rapidly decreasing
Change IV Fluids
D10 ½NS at maintenance
AND
½ NS or NS at maintenance ❸

Continue to offer PO

Quantitative ß-hydroxybutyrate – STAT and VBG Labs

Disposition

Discharge Criteria: Consult Endocrinology
- Urinary ketones are trace to negative
  OR
  ß-HB decreasing or < 0.6 mmol/L
  (Consult Endo: ß-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

PICU Admission Criteria:
- pH < 7.3 **AND** HCO_3 < 18
- Hyperglycemia > 200 Mg/dl
- Corrected Na > 150
- **AND** Ketones in Urine

Inpatient Admission Criteria:
- Ketones Large to Moderate **OR** ß-HB > 2 mmol/L
- Not Tolerating PO
- Pscyho social issues that necessitate inpatient treatment

Ketosis Non-Acidosis Inpatient Treatment Pathway

Evidence Based Outcome Center

EXCLUSION CRITERIA

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

Ketosis Non-Acidosis Criteria

1) pH >/=7.3 or HC03 >/=18
2) AND urine ketones >/=small or BHB >/=1
3) Known diabetic
4) Determine type of ketosis correction to be used (urine vs serum) and frequency of ketosis per Endo

New admits and PICU transfers
Assess inclusion, exclusion, and PICU criteria
Consult Endocrinology

! ALERT
If blood sugar < target blood Sugar from hyperglycemia correction formula twice, then switch to D10 fluids to allow for ketosis correction

Tolerating PO?

NO

- Start D5 IVF + sodium chloride + potassium @ 1.5x maintenance 4
- Continue labs and monitoring 1 2
- Administer insulin as directed, dose determined by most recent ketone level
- Offer small sips of water
- Offer Zofran for N/V
- Consider lipase level

YES

- Start 1.5x IVF + NaCl + K+ 4
- Offer water or 0 carb beverage
- Continue labs and monitoring 1 2
- Administer insulin as directed, dose determined by most recent ketone level
- If glucose < target glucose threshold (=target blood sugar from hyperglycemia correction formula), hold ketosis correction. If repeat BG check < threshold, switch to D5 IVF and give ketosis correction

See Addendum 1 for snack options.

! ALERT
Once ketones are negative, may resume BG checks and insulin dosing qAC, HS, 2am

Urine ketones negative or ß-HB < 0.6

STOP Pathway

1 Frequency of Labs

- POC BG TBD based on Endo rec (q2h, q3h, q4h, or meals/hs/2a
- Align frequency of BG check to match frequency of ketosis and hyperglycemia correction
- Urine ketones: qvoid (have pt attempt to void every 2hr. If unable to void, use last void available to dose ketosis correction
- BHB checks only if using serum ketosis correction protocol, frequency TBD

2 Monitoring

- Monitoring VS and neuro checks: **q4hrs**
- Strict I & Os

3 Insulin

1) **Small ketones** = 15mg/dL urine ketones or BHB 1-1.4mmol/L
2) **Moderate ketones** = 40mg/dL urine ketones or BHB 1.5-2.4mmol/L
3) Large ketones = 80mg/dL urine ketones or BHB ≥ 2.5mmol/L

- Note: HOLD ketosis correction if blood glucose < target blood sugar from hyperglycemia correction formula (i.e. ≤7yr BG <180mg/dL, ≥8yr, BG <150mg/dL)
- For **small ketones**, give ketosis correction with Novolog ____ (10% Long acting insulin dose)
- For **moderate ketones**, give ketosis correction with Novolog ____(15% long acting insulin dose)
- For **large** ketones, give ketosis correction with Novolog ____(20% long acting insulin dose)
- Give in addition to hyperglycemia correction
- If time for meal/snack also add insulin for carb coverage

4 IV Fluids

Sodium content:

- Corrected Sodium level ≥ 140 mEq/L: **½ 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 4 – 5.5: **ADD** 20 meq/L KCl and 20 meq/L Kphos
- K > 5.5: **NO** potassium

Disposition

PICU Admission Criteria:
- Altered mental status
- pH < 7.3 **AND** HCO_3 < 18
- Corrected Na >150
- Hemodynamic instability

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

Discharge Criteria: Discuss Endocrinology
- ß-HB < 0.6 mmol/L or urine ketone negative
- Consider ß-HB 0.6 -1.9 mmol/L
- Patient is tolerating PO

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Assessment for patients at high risk for cerebral edema complications

- Age < 24 months
- GCS < 13 after volume resuscitation
- Presenting pH < 7.15
- Presenting HCO_3 < 5 mEq/L
- Presenting PCO_2 < 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 withT2DM, 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

Snack	Volume	CHO	Snack	Volume	CHO
Saltine Crackers	1 Pkg (2 crackers)	4 grams	Graham Crackers	1 Pkg (3 crackers)	15 grams
Jello Snacks	1 Pkg (8oz)	17 grams	Pudding Snacks	1 Pkg (8oz)	23 grams
Peanut Butter Crackers	1 Pkg (6 crackers)	23 grams	Gatorade	8oz	14 grams