Diabetic Ketoacidosis (DKA) Care Guidelines – Critical Care

CHOC Children's

Inclusion Criteria (Definition of DKA):

- Blood glucose (BG) > 200 mg/dl
- Acidosis (bicarbonate < 15 or blood gas pH < 7.3)
- Associated glycosuria, ketonuria &/or ketonemia

Requires Critical Care level of care

Initial Evaluation

Assessment: VS, weight, severity of dehydration, level of consciousness, acute trigger for DKA e.g. infection, trauma, failure to take insulin, pump failure

Laboratory: stat bedside BG, Panel 9, phosphorous, magnesium venous pH, pCO2, pO2, CBC, HbA1c, UA, appropriate cultures if infection suspected

Correction of Dehydration

- Estimate fluid deficit
- Subtract initial bolus received
- Divide remaining deficit over 48 hours
- Add deficit replacement/hour to normal maintenance/hr = Total fluid rate per hour
- Revaluate I/O for excessive ongoing urine loss
- **Do not bolus > 40 mL/kg in 4 hours unless hypotensive or significantly compromised perfusion**

Ongoing Monitoring

- BP, HR, RR
- Neuro checks every hour
- I/O measurements every hour
- Bedside glucose every hour
- Panel 9 every 2 hours X3 then every 4 hours if improving

Neuro checks for S/S of cerebral edema every hour

Principals of 2 Bag System

- Total fluid rate is dependent on amount needed for treatment of dehydration as above (usually around 1.5 X maintenance)
- Using 2 bags allows for change in glucose infusion rate without ordering multiple IV bags
- Insulin drip rate is adjusted to ensure resolution of acidosis – 0.05-0.1 unit/kg/hr
- Do not decrease insulin rate below 0.05 unit/kg/hr without discussion with Endocrinologist on-call

Progress to 2 Bag System Starting with Phase 1
On page 2 of DKA Critical Care Guidelines

Cerebral Edema Signs and Symptoms

Headache
Altered or fluctuating level of consciousness
Sustained heart rate deceleration
Abnormal and deteriorating neurological exam
Abnormal respiratory pattern
Recurrent vomiting
Rising blood pressure
Decreased oxygen saturation
Change in neuro status: Restlessness,

Cerebral Edema Treatment

- **Give mannitol 0.25-0.5 gm/kg** may be repeated X 1 for a total max of 50 gm
- Ensure adequate circulation but if possible reduce fluid rate by one third
- Avoid maneuvers and drugs likely to increase intracranial pressure
- If intubation is necessary consider neurosurgery consult for intracranial pressure monitoring
- Treat suspected cerebral edema based on clinical criteria immediately. Do not delay treatment to obtain confirmatory CT scan.

Recommendations/Considerations

- **The severity of DKA** is defined by the degree of acidosis: **mild** – pH 7.2 – 7.3: **moderate** – pH 7.1 – 7.2; **severe** pH < 7.1
- Goal is to decrease the glucose no more than 100 mg/dl per hour
- If glucose decreases rapidly this may increase the risk of cerebral edema
- Monitor Na level correction to ensure NA rises as glucose decreases using calculation of corrected Na level

Calculations:

- Anion gap = Na – (Cl+HCO3); normal is 12 ± 2 mmol/l
- Corrected sodium = measured Na + 1.6 X [(glucose mg/dl – 100) / 100]
- DKA at diagnosis is more common in children < 5 yrs of age
- Omission of insulin is the leading cause of recurrent DKA in adolescents

Causes of Morbidity and Mortality:

- **Cerebral edema,** which occurs in 0.5 – 1 % of all episodes of DKA, is the most common cause of mortality in children with DKA, Cerebral edema usually develops 4 – 12 hours into treatment, but it can occur at any time
- **Hypokalemia**
- **Na Bicarb should not be given without discussion with two attending physicians as this increases the risk for cerebral edema.**
- **For insulin drip, tubing must be manually primed.**

Reassess the appropriateness of Care Guidelines as condition changes. This guideline is a tool to aid clinical decision making. It is not a standard of care. The provider should deviate from the guideline when clinical judgment so indicates

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Individual rates of Bag 1 and Bag 2 are dependent on glucose level with goal of maintaining glucose of 150-300.
Total rate depends on fluid needs.

		Bag 1	Bag 2		
	Plasma Glucose	NS	D10 ½ NS	Final Dextrose Concentration %	Final NaCL Concentration
Start Phase 1	>300	100%	0%	0	NS
Once BG <300 Phase 2	225-300	50%	50%	5	¾ NS
Phase 3	150 – 224	25%	75%	7.5	2/3 NS
Phase 4	100 – 149	0%	100%	10	½ NS
	<100	Change to D12.5% with ½ NS + K and hold insulin drip for 30 minutes until BG > 150			

Recheck BG every 1-2 hrs.

Phase 1 (No added Dextrose)
For glucose > 300
Bag 1: NS + 40 K+ at FULL fluid rate
Recommend Kphos +/- K Acetate instead of KCL
Order Bag 2 but do not use until Phase 2
Change to Phase 2 once glucose level is < 300

BG < 300

Phase 2 (D5 ¾ NS)
For glucose ≥225
Bag 1: NS + 40 K+ at 50% of total fluid rate
Bag 2: D10½ NS + 40 K+ at 50% of total fluid rate
After starting Phase 2 if the BG is above 300, then increase insulin drip by 0.01 unit/kg/hr to max of 0.1 unit/kg/hr (e.g. 0.05->0.06->0.07 units/kg/hr)
DO NOT RETURN TO PHASE 1
Also if CO2 not resolving by 1 meq/L over 2 hours, increase insulin by 0.01 unit/kg/hr to max of 0.1 unit/kg/hr

Recheck BG every 1-2 hrs.

BG 150-224

BG ≥ 225

Phase 3 (D7.5 2/3 NS)
For glucose 150-224
Bag 1: NS + 40K at 25% of total fluid rate
Bag 2: D10½NS + 40K at 75% of total fluid rate

BG < 150

Phase 4 (D10 ½ NS)
Once glucose < 150
Bag 1: NS + 40K OFF
Bag 2: D10½NS + 40 K+ at FULL rate of total fluid
DO NOT RETURN TO PHASE 3
To resolve acidosis, remain on D10 with goal BG 150-300 with titration of insulin.

If glucose level remains < 150 and persistent acidosis, order new IVF of D12.5 ½ NS + 40 K+.

If glucose level remains < 150 and bicarb above 15, then decrease insulin rate by 0.01 unit/kg/hr to minimum of 0.05 units/kg/hr.

If BG under 100, change to D12.5 with ½ NS + K. Temporarily stop insulin drip to prevent severe hypoglycemia, and retest in 30 minutes. Restart insulin drip once BG > 150; start at minimum 0.05 units/kg/hr.

Recheck BG every 1-2 hrs.

Recheck BMPand Phos every 2-4 hours

NA

If NA decreasing by 2 mEq/L in 2 hrs. Assess for Cerebral edema

K+

If K+ > 5.5 Decrease K+ in IV fluids

If K+ = 3.6-5.5 Same K+ in IV fluids

If K+ < 3.5 Increase K+ by 20-40 mEq/L in IV fluids up to max of 60 mEq/L

If K+ < 3.0 Give K-rider 0.5 mEq/kg, max 20 mEq

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Diabetic Ketoacidosis (DKA) Critical Care Guidelines continued Transition to SQ Insulin

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Guidelines for Transition

1) PH > 7.3
2) Serum Bicarbonate ≥ 17
3) Child demonstrates the desire and ability to eat
   a. Patient is alert and demonstrates interest in eating
   b. Time is appropriate for meal or snack
   c. Demonstrates positive bowel sounds

Orders

1) Endo Diabetes Transition order set (includes Diabetes transfer orders)
2) Endo Diabetic Admit order set

Meal Time Insulin Guidelines

1) For all ages, if the patient is not in DKA, the insulin dose should be guided by the endocrinologist with consideration of age, weight, and hyperglycemia
2) Insulin dose is calculated by total daily dose which ranges from 0.3-1 unit/kg/day depending on age and severity of hyperglycemia

Insulin Regimens

For children on insulin pump, consult Endocrinology

Multiple Dose Injections (Basal/Bolus)

Short acting insulin (Humalog/Novolog) will be given with meals, bedtime (and possibly 2 AM) based on:

- Insulin for carbohydrates eaten with meals and snacks (ratio to be decided based on patient's age)
- Correction scale insulin based on glucose checks with meals, at bedtime (and possibly 2 AM).

Long acting insulin (Lantus/Levemir) is given as with daily dose ranging from 30-50% of the total daily dose

Two Shot Regimen (Fixed Insulin Regimen)

Short acting insulin (Humalog/Novolog) will be given with breakfast and dinner

- Insulin for carbohydrates eaten with breakfast and dinner (ratio to be decided based on patient's age)
- Correction scale insulin based on glucose checks with breakfast and dinner. Correction at other times based on a case by case evaluation

Intermediate acting insulin (Humulin/Novolin – NPH)

- Given at breakfast with a daily dose ranging from 30-40% of the total daily dose in an attempt to provide coverage on a fixed meal plan regimen at lunch
- When an intermediate acting insulin is used lunch carbohydrate coverage is not to be used

Long acting insulin (Lantus/Levemir) is given at dinner with a daily dose ranging from 30-40% of the total daily dose

When using the two shot regimen we have found it safe to mix Humalog and Lantus at dinner if given immediately

Process

1) Order initial insulin doses STAT so that insulin will arrive within the hour
   a. Confirm all insulin doses with endocrinologist on call
2) D/C NPO status and trial clear sugar free drink or fluid to assess tolerance prior to first meal
   a. Order "carbohydrate specific diet" after consultation with endo team
3) When food and insulin at bedside start insulin based on insulin regimen above as appropriate
4) Stop insulin drip 15-30 minutes after 1st short acting insulin injection
5) Stop IV fluids after 1st meal unless continued dehydration.
   a. If dehydration, remove dextrose from IV fluid, run NS at 1X maintenance

General Guidelines for Meals

Under 3 yrs of age – up to 30 gms
3-5 yrs of age – up to 30-45 gms
6-10 yrs of age – up to 60 gms
11-14 yrs of age – up to 75 gms
Older than 15 yrs of age – up to 90 gms

Monitoring

Labs and Point of Care

- Blood sugar monitoring order should be changed to QID, AC, HS and 2 AM
- If needed to follow potassium or resolution of acidosis, BMP every 12 hours or based on discussion with endocrinologist on call
- If patient is hypokalemic, < 3.0, then consider oral potassium versus continued IV fluids based on discussion with endocrinologist on call

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Diabetic Ketoacidosis (DKA)
Critical Care Guidelines continued
Discharge Criteria

Discharge Criteria

Clinical criteria

- DKA has resolved
- Able to tolerate oral fluids and food
- Patient education for new onset or re-education for recurrent DKA completed
- Able to demonstrate safety skills, including insulin injection, treatment for hypoglycemia, and basic carbohydrate counting, as documented by Diabetes Educator and Endocrinologist.

Social Criteria

- Reasons for DKA addressed
- Identification of appropriate coping skills and support network for outpatient services, including psychology, as needed

Discharge Miscellaneous Information

- Appointment will be scheduled by the endocrine team including
    a. Skills class – SMARTIES (within 4 weeks)
    b. New onset with endocrine provider (within 4 weeks)
- Prescriptions will be sent to the appropriate pharmacy by the endocrine team
- Insulin vials or pens should be relabeled for home use and discharge with family
    a. This will need to be ordered in the electronic system
- If patient is at least 2 years of age and has never received the PPSV23 vaccine, please administer prior to discharge
    a. Patients should only receive 1 dose of this vaccine during childhood
- Flu vaccine should be given as well if appropriate season

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References
Diabetic Ketoacidosis Care Guidelines

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