

GUIDELINES FOR THE TREATMENT OF PEDIATRIC DIABETIC KETOACIDOSIS

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These standards were developed by members of the Metropolitan Community Pediatric Endocrinology Registry, including David M. Brown MD, Erica Eugster MD, Antoinette Moran MD, Kumud Sane MD, Kevin Sheridan MD, Joseph Sockalosky MD, Martha Spencer MD, and Christine Ternand MD. They are meant to provide a protocol for the usual treatment of DKA---clinical judgement may dictate deviation from these guidelines in individual circumstances.

Definition of DKA:

- 1) venous pH < 7.25 or arterial pH < 7.3; and/or bicarbonate < 15 mEq/L
- 2) and urine or serum ketones positive
- 3) glucose is usually but not always > 200 mg/dl

Goals of therapy:

- 1) hydration
- 3) correction of acid/base abnormality
- 2) clearance of ketones
- 4) normalization of blood glucose level
- 5) correction of electrolyte abnormalities, particularly potassium depletion
- 6) prevention of future episodes

In ER or office:

- 1) H and P (occult infection?), rapid glucose determination, check urine of blood for ketones
- 2) Place 2 IV's---at least one should be large enough to draw blood samples from.
- 3) Start 20 cc/kg NS flush to run over 1 hour.
- 4) Get STAT Glucose, Na, K, Cl, bicarb, BUN, creat, phos, VBG.
- 5) Cardiac rhythm strip if K>6.0 or <3.0 or if any clinical signs of arrhythmia are present.
- 6) Admit to the hospital (or an equivalent intensity of care facility) after the NS flush if the patient meets the above criteria for DKA.
 - a. Admit to the ICU or an alternative 1:1 nursing situation if the patient has any one of the following:
 1. alteration of mental status
 2. venous pH < 7.0 or arterial pH <7.1 after fluid flush

3. age less than 3 years
 4. if 1:2 nursing care is not available on general wards while patient is on insulin drip
 5. shock, cardiac arrhythmias, EKG changes associated with hyper- or hypokalemia
 6. recommendation of pediatric endocrinologist
- b. Otherwise, admit to hospital wards or equivalent facility where patient is under direct observation and receiving 1:1 or 1:2 nursing care.
 - c. Pediatric endocrinology should be involved from the beginning in all pediatric DKA admissions, either as the primary service or as consultants.

After initial hydration with 20 cc/kg saline flush:

Fluids (assume at least 10% dehydration):

- 1). If patient has good urine output and is not hyperkalemic, start D5W1/2 NS + KCl (or an equivalent solution). Otherwise, give a second 20cc/kg NS flush and then switch to D5W1/2NS.
 - a. Guidelines for the initial potassium rate (which will need to be modified during treatment based on ongoing K measurement):
 1. If K <3.5, add 60 meq/L to iv
 2. If K=3.5-5.5, add 40 meq/L to iv
 3. If K >5.5, no K in iv
 4. Some protocols give half of the potassium concentration as KPhos.
- *The inclusion of D5W from the start of treatment is not typical of most DKA protocols but we feel that this allows for a more gradual fall in blood glucose levels and circumvents some of the problems which occur when glucose is not added to the iv soon enough.
- 2) Calculate the maintenance+deficit and plan to replace this amount evenly over 36 hrs, recognizing that most patients will not receive the full amount.
 - a. Alternatively, give 2x maintenance, generally not more than 3000cc/m² per 24h.
- 3) When the serum glucose approaches 300 mg/dl or if the glucose is falling at a rate greater than 100 mg/dl/hour after the initial drop from the fluid flush, change the dextrose content of the iv fluids to D10W.
- 4) Monitor strict I/Os---re-evaluate fluid status frequently.
- 5) Have the nurses keep a diabetic flowsheet.
- 6) NPO until alert and not vomiting, then small amounts non-carbohydrate containing clear fluids; advance diet as tolerated. No oral carbohydrates until subcutaneous insulin is started.

Insulin:

- 1) After the fluid flush, start an insulin drip of 0.1 U/kg/hr (no bolus necessary).
 - a. If <3 years of age, then start at 0.05-U/kg/hr.
- 2) Start all new diabetics on human insulin.
- 3) Aim for a glucose drop of 50-100 mg/dl/hr. (Note that the glucose may initially drop considerably more than this following the fluid flush.) Small changes may need to be made in the insulin drip every couple hours to achieve this goal (usually about 20%). However, never completely discontinue the insulin drip until you are ready to start sub-q insulin (increase glucose instead).
- 4) Glucagon (1 mg IM) and D50W should be available in case of severe hypoglycemia.

Bicarbonate (only to be given in the ICU):

- 1) If the venous pH is <6.95 or arterial pH <7.05 after the initial fluid flush, begin replacing 1/2 of the calculated bicarbonate replacement dose over 6 hours. Monitor the pH every hour and discontinue the bicarbonate drip when the pH is >7.15.
 - a. $\text{calculated bicarbonate replacement dose} = \text{base deficit (desired serum bicarbonate mEq/L - actual serum bicarbonate mEq/L)} \times \text{weight (kg)} \times 0.3.$

Laboratory monitoring:

- 1) Glucose should be measured every hour by a bedside glucose monitoring device as well as by the lab. Once the serum glucose is <500 and paired samples are within 10% of each other, meter readings alone are acceptable.
- 2) Monitor STAT Na, K and pH every 2 hours until the insulin drip is discontinued.
- 3) Ca and Phos should be measured q 4 hours if the patient is getting KPhos.
- 4) Blood ketone monitoring should be done by meter at bedside every two hours until <0.6.

Neuro monitoring:

- 1) Nurses to do neurologic checks (mental status, pupil response) q 1-2 hr for first 12 hrs.
- 2) Mannitol available on station. Do not hesitate to give this (1 gram/kg iv push) if you believe the patient is experiencing neurologic changes secondary to increased intracranial pressure (decreasing level of consciousness, increased BP, decreased pulse, posturing). At that point, intubate and hyperventilate. When in doubt, treat the patient first until stable rather than immediately getting a CT scan.

Switching to subcutaneous insulin:

Please discuss with a pediatric endocrinologist the plan for starting subcutaneous insulin. The iv insulin should never be discontinued until subcutaneous insulin has been given.

Education

In newly diagnosed patients, education of the patient and family with diabetes survival skills is essential following correction of the DKA. This can be done in the hospital or as an outpatient if the patient is seen as an outpatient that day.

Discharge

- 1) Prior to discharge address the underlying cause of DKA. If it appears to be psychosocial, involve the appropriate mental health care professionals.
- 2). Before going home, the patient and family must know:
 - a. who they are to be in close contact with during the initial period of insulin adjustment and outpatient diabetes education, and when they are to return to clinic---they must be seen within 72 hours if they have received the education listed below in the hospital, or that day in clinic if that is where the initial education is to be given. They must be in daily phone contact with their diabetes provider the first week after discharge.**
 - b. how to use a glucose monitoring device to check blood glucose levels
 - c. how to draw up insulin and give injections
 - d. how to recognize and treat hypoglycemia, including administration of glucagon
 - e. the basic principles of diet in terms of both content and timing of meals and snacks