DIABETIC KETOACIDOSIS

Pathogenesis
1. Insulin insufficiency causes the breakdown of glycogen, fats and proteins to meet energy needs; these catabolic reactions produce gluconeogenesis that in the absence of insulin still cannot be used by the tissue cells thus aggravating the hyperglycemic state
2. This hyperosmolar, hyperglycemic, ketotic state causes cell dehydration and polyuria with great electrolyte and fluid loss
3. The brain is the only organ independent from insulin

Etiology
1. New onset
2. Failing to take insulin
3. Psychological stress
4. Physical stress (e.g., infection)

Definition
1. Serum glucose > 300
2. pH < 7.3
3. Bicarbonate < 15

Signs and Symptoms
1. Hyperglycemia, acidosis, polyuria, polydipsia, polyphagia, vomiting, weight loss, headache, dehydration, abdominal pain, lethargy to coma, tachypnea with kussmaul breathing, acetone breath, glycosuria, ketoneuria

Management
1. ABCs
2. Two Intravenous Lines
   a. One to infuse fluids
   b. One to draw labs
3. Volume Replacement
   a. Obtain fluid type and intake given by referring facility
   b. Bolus with Normal Saline (NS) 20cc/kg and repeat until perfusion, heart rate and blood pressure are restored
   c. Replacement Fluids: Percent dehydration (10 – 20% or 0.1 – 0.2) x (kg x 1000) + maintenance fluids in 24 hours (reduce boluses from the total)
   d. Do not give more than (4L x m2) in 24 hours
      i. \( m2 = (4 \times kg) + 7 \) divided by (90 + kg)
   e. Can give two times maintenance for the time of the transport instead of Replacement Fluids
   f. Control glucose drops by adding dextrose
      i. Change NS to D5NS when blood glucose level decreases to ≤ 300 mg/dl
      ii. Change D5NS to D10NS when blood glucose level decreases to ≤ 200 mg/dl and pH ≤ 7.3
iii. Control the drop in blood glucose to 80 – 100 mg/hr to prevent cerebral edema

4. Blood Glucose
a. Get blood glucose level at least every 30 minutes. Also get a blood gas to check pH and bicarbonate level
b. Regular insulin drip at 0.1 u/kg/hr in NS (concentration: 1 unit/ml)
c. Continue insulin drip until metabolic acidosis is resolved
d. Only stop insulin if blood glucose level is < 100. Check blood glucose level in 30 minutes after stopping. Restart insulin if blood glucose level ≥ 200. Make sure D10NS is running

5. Electrolyte Imbalances
a. When K+ ≤ 4 add 20 mEq/L KCL to maintenance fluids
b. When K+ drops to 2 give KCL (carefully monitor administration of 1 mEq/kg over 2 hours)
c. When K+ ≥ 6
   i. Give 15 mg/kg CaCl
   ii. And 1 mEq/kg/dose NaHCO3 IV (or 0.3 mEq/kg x base deficit)
d. K+ imbalances may cause arrhythmias with changes in T, ST, and U waves in ECG
e. Add PO4 to maintenance when PO4 < 2 with half the amount KCL
f. Treat Na+ if there are signs and symptoms of CNS abnormalities with 5 – 10 cc/kg 3% hypertonic saline
   i. Na+ often increases as blood glucose decreases

6. Osmolarity: normal serum 290 – 300 mOsm/l
a. Serum osmolarity = 2(Na+ + K+) + (Glucose/18) + (Bun/2.8)
b. > 320 mOsm/l correct over 36 hours
c. > 340 mOsm/l correct over 48 hours

7. Cerebral Edema
a. Signs and symptoms: headache, decreased GCS, hypertension with bradycardia, pupil changes
b. Typical onset of cerebral edema is 4 – 24 hours after initiation of therapy
c. Highest risk: Age < 5 years, pH < 7.1, PaCO2 < 20 mmHg, if blood glucose drops > 100 mg/hr, fluids > 50 ml/kg in the first four hours, blood glucose > 1000 mg/dl
d. Treatment options:
   i. 3% Hypertonic Saline at 5 – 10 cc/kg
   ii. Mannitol 0.25 – 1 gm/kg
   iii. Slow maintenance fluids and add glucose

8. Continuous Assessment of Patient’s Status Especially Neurologically

9. Intubate if GCS < 8
a. Use Vecuronium 0.3mg/kg
i. Avoid Succinylcholine it may release K+
b. Use Sodium Pentothal 2.5 – 5 mg/kg (BP must be stable)
i. Avoid Ketamine it may increase Intracranial pressure
c. Keep PaCO2 close to patient’s level before intubation

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