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 x 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 $NaHCO_3$ 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 PO_4 to maintenance when PO_4 < 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, $PaCO_2$ < 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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