Guidelines
For The Management Of

Hyperosmolar Hyperglycemic State

By

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Hyperosmolar Hyperglycemic State

The condition is characterized by hyperglycemia, hyperosmolarity, and dehydration without significant ketoacidosis.

Older patients usually at seventh decade of age with type 2 diabetes mellitus or undiagnosed diabetes mellitus who have some concomitant illness (Infection is the most common cause) that leads to reduced fluid intake and carries a higher mortality rate than DKA, estimated at approximately 10-20 %.

Presentation is usually with severe dehydration and focal or global neurologic deficits.

One third of cases, the clinical features of HHS and DKA overlap and are observed simultaneously (overlap cases).

Diagnostic features

- Plasma glucose level of 600 mg/dL or greater
- Effective serum osmolality of 320 mOsm/kg or greater
- Profound dehydration up to an average of 9L
- Serum pH greater than 7.30
- Bicarbonate concentration greater than 15 mEq/L
- Small ketonuria and absent-to-low ketonemia
- Some alteration in consciousness

History

- Most patients with history of diabetes, which is usually type 2.
- In 30-40% of cases, HHS is the patient's initial presentation of diabetes
- HHS usually develops over a course of days to weeks unlike DKA, which develops more rapidly.
- Often, there is a preceding illness which results in several days of increasing dehydration.
- Patients may complain of polydipsia, polyuria, weight loss, weakness.
- Patients do not typically report abdominal pain, a complaint that is often noted in patients with DKA.
- A wide variety of focal and global neurologic changes may be present, including the following:
    - Drowsiness and lethargy
    - Delirium
    - Coma
    - Focal or generalized seizures
    - Visual changes or disturbances
    - Hemiparesis
    - Sensory deficits

Physical examination

Examine for evidence of hyperosmolar hyperglycemic state (HHS), focusing on hydration status, mental state, and signs of possible underlying causes, such as a source of infection.

- Vital signs.

- Tachycardia is an early indicator of dehydration; hypotension is a later sign.
- Tachypnea may occur due to respiratory compensation for metabolic acidosis in overlap cases.
- Assess core temperature rectally.
  - Abnormally high or low temperatures suggest sepsis as an underlying cause.
  - Lack of fever does not rule out infection.
  - Hypothermia is a poor prognostic factor.
- Hypoxemia can be a concurrent problem affecting mental state.

- Perform a thorough skin examination.
  Skin turgor is another clue to hydration status.
- Examine the head, eyes, ears, nose, and throat (HEENT).
  - Examination may reveal altered hydration status (e.g., sunken eyes, dry mouth).
  - Cranial neuropathies, visual field losses, and nystagmus may be present.
- The extremities may manifest evidence of peripheral oedema or of dehydration.

Causes

= In general, any illness that predisposes to dehydration may lead to hyperosmolar hyperglycemic state (HHS).A wide varieties of major illnesses may trigger HHS by limiting patient mobility and free access to water
= A preceding or intercurrent infection is common,pneumonia and urinary tract infections are the most common underlying causes of HHS
= Stress response to any acute illness tends to increase hormones that favor elevated glucose levels. Cortisol, catecholamines, glucagon, and many other hormones have effects that tend to counter those of insulin.
= Examples of such acute conditions are: CVA, silent myocardial infarction, pulmonary embolism.
= Patients with underlying renal dysfunction and/or congestive heart failure are at greater risk.
= Drugs

Diuretics
Beta-blockers
Atypical antipsychotics (clozapine, olanzapine)
Alcohol and *cocaine*
Total parenteral nutrition and fluids that contain dextrose

= Elder abuse and neglect also may contribute to underhydration.
= Noncompliance with oral hypoglycemic or insulin therapy can result in HHS.

Differential diagnoses

Cerbrovascular accident
Central nervous system infection
Hypoglycemia
Hyponatremia
Severe dehydration
Uremia
Hyperammonemia
Drug overdose
Sepsis

Investigations

= Serum glucose level usually is elevated, often to greater than 800 mg/dL
= Serum electrolytes & renal function, (urea and creatinine concentrations)
= CBC & blood film
= The calculated anion gap is usually less than 12 mmol/L:
Anion gap = $([Na+] + [K+]) - ([Cl-] + [HCO3-])$ normal value: 8 to 12 mEq/L
= Arterial blood gas analysis (ABG) usually the blood pH is greater than 7.30.
= Serum osmolarity and/or osmolality are usually greater than 320 mOsm/L.
Predicted osmolarity is calculated using the following formula :
$2(Na^+)$mEq/L +$2(K^+)$mEq/L + glucose (mg/dL)/18 + BUN (mg/dL)/2.8
If BUN not available, use B.Urea in (mgldL)& divide by 6 ,i.e., Urea/6 to convert to mEq/L
= Urinalysis can reveal elevated specific gravity (evidence of dehydration), glycosuria, small ketonuria, and evidence of urinary tract infection (UTI).
= Urine &blood cultures are useful.
= Cerebrospinal fluid (CSF) cell count, glucose, protein, and culture are indicated in patients with an acute alteration of consciousness and clinical features suggestive of possible CNS infection
= Creatine phosphokinase (CPK) with isoenzymes should be measured routinely because both MI and rhabdomyolysis can trigger HHS, and both can be secondary complications of HHS.

Imaging Studies

- A chest radiograph is useful to screen for pneumonia.
  Abdominal radiographs are indicated if the patient has abdominal pain or is vomiting.
- CT scan of the head
  - CT scan is indicated in many patients with focal or global neurologic changes.
  - It may be useful for patients who show no clinical improvement after several hours of treatment, even in the absence of clinical signs of intracranial pathology.

Management

- All patients diagnosed with HHS require hospitalization, usually to an intensive care unit for close monitoring.
- Airway management & in comatosed patient endotracheal intubation may be indicated.
- Intravenous access. CV line for better assessment of fluid replacement.
- Fluid deficits in hyperosmolar hyperglycemic state (HHS) are large; the fluid deficit of an adult may be 10 L or more

= Administer 1-2 L of isotonic saline in the first 2 hours.
= A higher initial volume may be necessary in patients with severe volume depletion, slower initial rates may be appropriate in patients with significant cardiac or renal disease.
= Caution should be taken to not correct hypernatremia too quickly, as this could lead to cerebral edema.
= After the initial bolus, we can continue on normal saline or use half strength normal saline once blood pressure and urine output are adequate.

= Once serum glucose drops to 250 mg/dL, the patient must receive dextrose in the intravenous fluid. This may decrease the risk of developing cerebral edema

- Initiate insulin therapy
    - Although many patients with HHS respond to fluids alone, intravenous insulin in dosages usually less to those used in DKA can facilitate correction of hyperglycemia.
    - Insulin used without concomitant vigorous fluid replacement increases risk of shock.
    - Adult 0.1 U/kg IV once, followed by 0.1 U/kg/h
      alternatively: 0.14 U/kg/h without a bolus dose can be used.

- Replete potassium and magnesium as needed. Use of insulin may exacerbate hypokalemia. In virtually all cases of HHS, supplemental potassium is necessary, as serum level drops secondary to insulin therapy and correction of metabolic acidosis.
  Do not start potassium until initial serum level is ascertained.
  10 -20 mEq IV over 1 h & as needed based on frequently obtained laboratory values, adjust dose to obtain serum levels of 4.5 mEq
  If patient can tolerate oral medications or has gastric tube in place, KCl can be given orally up to 60 mEq per dose, with dosing based upon frequently obtained laboratory values.

- Sodium bicarbonate may be considered if a patient has significant acidosis (pH <7.0) particularly if inotropic agents are required to maintain blood pressure.
  1-2 ampoules containing (44-88 mEq)in normal saline IV q1-2h as needed;
  if administered for very severe acidosis, almost always administer as IV infusion, not as IV bolus or push IV.
  The concentration of sodium bicarbonate : 8.4% w/v (1 mmol/mL)

- Detection and treatment of an underlying illness is critical. Antibiotics need to be administered early.
- Frequent reevaluation of the patient's clinical and laboratory parameters are necessary. Recheck glucose concentrations every hour. Electrolytes and arterial blood gas analysis should be monitored every 2-4 hours or as clinically indicated.

Complications

- Ischemia or infarction to any organ, including the heart and brain
- Hypoglycemia
- Hypokalemia
- Cerebral edema (rare)
- Thromboembolism
- Rhabdomyolysis

Prognosis

The overall mortality rate is between 10% and 20% and is dependent on coexisting conditions and complications

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