Intern Project

Case review

HYPEROSMOLAR HYPERGLYCEMIC STATE

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Hyperosmolar Hyperglyceamic State

"It is true that the mind can only see what it knows"...Anonymous.

This topic was of interest to me because twice I had admissions that both had similar case history and presentations to the case being discussed; I failed to pick them up!

What is HHS?

HHS was usually known as hyperosmolar hyperglycemic nonketotic coma (HHNC), but the terminology has now changed because coma is found in only fewer than 20% of patients with HHS.

Hyperosmolar hyperglycemic state (HHS) is one of two serious metabolic derangements that occurs in patients with diabetes mellitus and can be a life-threatening emergency.

The condition is characterized by: 1. hyperglycemia,
2. hyperosmolarity,
3. Dehydration without significant ketoacidosis.

Compared to Diabetic ketoacidosis, (DKA), the other acute complication of diabetes, HHS is: 1.less common,
2. Differs in the degree of dehydration, acidosis and ketosis.
3. It also usually presents in older patients with Type II diabetes mellitus,
4. Carries a higher mortality rate than DKA estimated approximately around 15%.

Most patients with HHS present with dehydration and focal or global neurological deficit However, almost a third of cases seen would have clinical features of HHS and DKA overlapping.

Based on the consensus statement published by American Diabetic Association, diagnostic features of HHS may include the following:

- 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

Pathophysiology.

What basically happens in HHS is that there is:

1. A reduction in the effective circulating insulin with a concomitant elevation of counter-regulatory hormones, such as glucagon, catecholamines, cortisol, and growth hormone which contribute to the increase of glucose and ketoacid production.

2. Decreased renal clearance and decreased peripheral utilization of glucose which leads to hyperglycemia.

3. Hyperglycemia and hyperosmolarity result in an osmotic diuresis and an osmotic shift of fluid to the intravascular space, resulting in further intracellular dehydration.

4. This diuresis also leads to loss of electrolytes, such as sodium and potassium.

Bearing these in mind, patients with HHS usually have an associated illness going on which leads to their reduced fluid intake. Infection would be the most common cause, but there are many other conditions that can cause altered mentation, dehydration, or both and most times whatever associated illness they may have may not be easily identifiable.

Therefore in type II diabetics there is a preexisting lack of insulin or resistance to it, so an added physiologic stress such as an acute illness can cause further net reduction in circulating insulin and tip them over towards hyperosmolar hyperglyceamic state.

Why don't they develop ketoacidisis?

Reason for this in unknown, but likely contributing factors may include;

1. The availability of insulin in amounts sufficient to inhibit ketogenesis but not sufficient enough to prevent hyperglycemia.

2. Hyperosmolarity itself may decrease lipolysis, limiting the amount of free fatty acids available for ketogenesis.

3. Lower levels of counter-regulatory hormones have been found in patients with HHS compared with those with DKA.

Epidemiology.

Hyperosmolar hyperglyceamic state is less common than diabetic ketoacidosis estimated to be less than 1 case per 1000 person-years in the United States of America.

It carries a high mortality rate of about 10 – 20 % and is usually due to an underlying illness. This rate of mortality in HHS increases with increasing age and with higher levels of serum osmolality.

HHS has also been found to be slightly more higher in females as compared to males.

Unlike DKA, hyperosmolar hyperglyceamic state has a mean age of onset early in the seventh decade of life most of whom are elderly and demented and are at the highest risk due to their lack of ability to care for themselves.

How do we actually pick them up clinically?

History

1. Most patients with hyperosmolar hyperglycemic state (HHS) have a known history of diabetes, which is usually type 2.
2. In **30-40% of cases, HHS is their initial** presentation of diabetes.
3. HHS usually develops over a course of **days to weeks unlike DKA, which develops more rapidly.**
4. Often, a **preceding illness** results in several days of increasing dehydration. This coexisting acute illness (e.g., vomiting) or chronic comorbidity (e.g., dementia, immobility) may **impair adequate oral rehydration.**
5. Patients may complain of **polydipsia, polyuria, weight loss, weakness**.
6. Patients **do not typically report abdominal pain**, a complaint that is often noted in patients with DKA.
7. 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

O/E:

As mentioned above, both DKA and HHS are medical emergencies that require prompt recognition and management. An initial history and rapid but careful physical examination should focus on:

- Airway, blood, and circulation (ABC) status
- Mental status
- Possible precipitating events (eg, source of infection, myocardial infarction)
- Volume status

VITALS :

- **Tachycardic** (early indicator of dehydration; hypotension is a later sign) which is suggestive of profound dehydration due to volume depletion.
- **High sugar levels-** (capillary or venous)
- **Tachypnea** may occur due to respiratory compensation for metabolic acidosis in overlap cases.
- **Temperature-** measured 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.**
- Oxygen saturation- **(hypoxemia can be a concurrent problem affecting mentation.)**

HEENT:

- altered hydration status (e.g., sunken eyes, dry mouth)
- Cranial neuropathies, visual field losses, and nystagmus may be appreciated, which are symptoms of HHS. They are usually reversible with therapy.

EXT: The extremities may manifest evidence of peripheral volume sequestration or of dehydration.

CVS/ RESP/ ABD features differ depending on underlying co morbidities.

Differentials would include:

1. Any cause of altered mental status
2. Central nervous system infection
3. Hypoglycemia
4. Hyponatremia
5. Severe dehydration
6. Uremia
7. Hyperammonemia
8. Drug overdose
9. Sepsis

Lab investigations

1. FBC- may show leukocytosis. Majority of patients with hyperglycemic emergencies present with leukocytosis, which is proportional to the degree of ketonemia.

Leukocytosis unrelated to infection may occur as a result of hypercortisolemia and increased catecholamine secretion.

However, a white blood cell count greater than 25,000/microL or a band count greater than 10 percent may designate infection and indicates a need for further work up

2. Urea, creatinine, electrolytes- may show

Hypokalemia or hyperkalemia- elevated potassium levels, may be due to extracellulatr shift caused by insulin deficiency, so if there is **low serum potassium, it should be a red alert as this suggests profound total body loss- these patients need cardiac monitoring!**

Hyponatremia or hypernatremia may be present. Low serum sodium may be due to the osmotic effect of glucose drawing water into the vascular space but this is usually pseudo-hyponatremia in the setting of hyperglycemia.

High serum glucose- > 800g/dL

High osmolality- >320mOsm/L = ((2 x Na) + Urea + Glucose)

3. Cardiac enzymes should be measured routinely as myocardial infarction and rhabdomyolysis can both trigger HHS and both are also complications of HHS.

4. Blood cultures.

5. ABG- pH in HHS in most cases is >7.3

6. Urinalysis- check for ketones, glucosuria, send culture & sensitivity.

7. Do Cerebrospinal fluid (CSF) only when indicated i.e. in patients with an acute alteration of consciousness and clinical features suggestive of possible CNS infection.

When these cases do present, where do we start?

Management

If you are in the field…

1. Like any other emergency, secure ABC first and move on!

GET A&B RIGHT before proceeding to anything else! Airway is top priority especially in comatosed patients, where intubation may be necessary. Secure C- spine if there is possibility of head or neck trauma involved.

2. Get IV access- large bore needles, get baseline bloods; give boluses- 500ml NaCl.

3. IDC for urinalysis and urine output monitoring!

4. If **capillary blood sugar is not available, empiric 50 mls of D50 should be administered to comatose patients without delay.** Undiagnosed and untreated hypoglycemia, which may present with signs and symptoms very similar to those of HHS, is readily reversible but can be rapidly lethal if not treated promptly.

5. When transferring patient, make sure the receiving facility is prepared for a comatose, dehydrated, and/or hyperglycemic patient and whether there is a possibility of a cerebrovascular accident (CVA). Inform them before leaving your station or while enroute to hospital.

6. Talk to patient. Update patient and relatives on current plan of management.

At Accident & Emergency Department..

1. Secure airway and breathing as needed,
2. Establish intravenous access, initiate vigorous fluid resuscitation, and obtain appropriate laboratory and radiographic studies.

Remember fluid deficits in hyperosmolar hyperglycemic states (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.
- **Note that 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.**
- Different centers have protocols and guidelines in fluid resuscitation of these cases and should be adhered to

3. Start insulin therapy in the ED.

  - **Although many patients with HHS respond to fluids alone, intravenous insulin in dosages similar to those used in DKA can facilitate correction of hyperglycemia.**

* Important to note **that Insulin used without concomitant vigorous fluid replacement increases risk of shock.**

4. Replace potassium and magnesium as needed.

5. Early detection and treatment of an underlying illness is crucial. Antibiotics need to be administered early.

6. Frequent reevaluation of the patient's clinical and laboratory parameters are necessary. (E.g. U&E, C's, glucose)

***All patients diagnosed with HHS require hospitalization, usually to an intensive care unit for close monitoring.**

Cornerstones of management...

1. Fluids

2. Insulin

3. Repletion of electrolytes

4. Antibiotics

In the ward…the focus is on..

- Continued management of the fluid, electrolyte, and glucose disturbances is necessary until these have resolved.
- Diabetic teaching is necessary to prevent recurrence.

At discharge & further Outpatient Care

- Follow up clinics is essential.
- Diabetic teaching, both in the hospital and after discharge, by the primary care physician and/or a visiting home nurse, is essential to modify behavior and enhance compliance.
- A home evaluation by a visiting nurse may be useful to identify factors limiting adequate access to water.

Inpatient & Outpatient Medications

- Adjust insulin or oral hypoglycemic therapy on the basis of the patient's insulin requirement once serum glucose level has been relatively stabilized.

Medicolegal Pitfalls

- Failure to manage the airway with endotracheal intubation when necessary
- Failure to provide adequate fluid resuscitation (leading to shock)
- Cerebral edema (more common in children) secondary to overly rapid hydration (especially with hypotonic fluids) or failure to add glucose to fluids when the level falls to less than 250 mg/dL
- Hypoglycemia due to excessive insulin use without the initiation of glucose-containing fluids
- Failure to replete potassium in patients who have a total body potassium deficit but an initially normal serum potassium level (On the other hand, administration of intravenous potassium has been associated with significant morbidity and death, especially with iatrogenic errors.)
- Failure to treat empirically and early with broad-spectrum antibiotics when sepsis appears to be a possible precipitant

Case History

54 year old Fijian female, a known type II diabetic on oral hypoglycemic

PC: buttock abscess for one week prior to presentation

Reduced appetite and generalized weakness for 2 days.

Fever, chills and rigors

Confused

HxPC:

Patient has had abscess for over a week now and was treating it with herbal medicines. Relatives noted that the abscess was not improving, and more foul smelling.

They also noted that she was not her normal self at times, and was too weak to mobilize in and out of bed.

ROS: reduced appetite no bowel or urinary symptoms no vomiting

Chills & rigors no fits no SOB no chest pain/orthopnea/PND

Past Med Hx:

DM II for 7 years

3rd admission- 2007: uncontrolled DM II, Hyprelipidemia

-2009 (Feb): right hand sepsis

-Current

Allergies: nil

Drug Hx:

Glipizide 10 mg BD Artorlip 20mg nocte

Social Hx;

Retired civil servant lives at Rifle Range with husband and two grandchildren.

Denies smoking, alcohol, kava. Community ambulatory.

O/E: obese Fijian female, looks drowsy, dehydrated, septic looking. GCS- 15/15

Vitals: BP: 167/ 87 P: 113 Temp: 38 RR: 25 CBG: HI O2 sats: 94% in RA

Heent: pale conjunctiva

Dry oral mucosa, JVP normal.

Chest: dual HS no murmur, clear lung fields bilaterally

Abd: soft, flabby, no masses felt.

Ext: cap refill- 3- 4 secs, rapid pulse, neurovasscular intact

Perineal exam: large, sacral carbuncle, 8cm x 6 cm x 3cm, discharging pus ++, foul smelling. Evidence of herbal medicine over ulcer and in rectum.

PR: no fistula, soft fecal mater, normal anal tone, no mass felt.

Assessment: Diabetic Carbuncle

Uncontrolled Diabetes II

R/o Septicaemia.

Investigations

FBC: Hb- 9 PCV/MCV 38/82 WCC- 25,000 PLTS- 183,000

U&ECr U- 30 Cr- 247 Na – 127 K – 4.8 RBS – 38

Blood Culture: Contaminated

Coag Profile- Normal

Plan:

1. Admit to WSW
2. For soluble insulin infusion, IV N/S 1L 8hrly
3. Commence IV cloxa, flaggyl and gentamycin
4. Withhold breakfast, for debridement in OT in mane.
5. X-match 2O PRBC and transfuse when ready.

DISCUSSION

1. UECR results were not reviewed until after 24hrs of admission.

   - OSMOLALITY was not calculated

   - Electrolytes imbalances not corrected.

2. Patient was admitted in general ward, found semi-comatosed early next morning.

3. Failed to consider diabetic emergencies (HHS & DKA) as initial assessment.

4. Inadequate fluid resuscitation.

5. Use of insulin infusion to control sugars rather than fluid resuscitation.

6. Management too focused on surgical intervention rather than stabilizing medical abnormalities

Reference

- ***www.uptodate.com***
- ***www.emedicine.com***
- **Kumar & Clarke Internal Medicine**
- **Lautoka Hospital HHS/DKA protocol**