The Value of Osmolality Testing in Nephrology

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Abstract

A simple diagnosis of low serum sodium as hyponatremia is not sufficient to provide a treatment plan. Without testing for serum osmolality, urine osmolality, and urine sodium levels, we cannot know if the patient has true hyponatremia or “pseudo-hyponatremia”. Giving IV fluids to a patient without knowing the true diagnosis of hyponatremia through these lab results will not treat the low serum sodium and may extend the patient’s hospital stay by a day or more and compromise patient health.

Application Note

I use serum osmolality to evaluate the cause of hyponatremia. Serum osmolality, urine osmolality, and urine sodium are the initial lab tests that I order when I am first asked to consult on a patient with hyponatremia. Serum osmolality helps me differentiate hypotonic hyponatremia from iso-osmolar and/or hyperosmolar hyponatremia (from hyperglycemia, mannitol, hyperlipidemia or hyperproteinemia). In the later cases of “pseudo-hyponatremia,” you will find a normal or high serum osmolality with a falsely low measured serum sodium. Furthermore, urine osmolality is used to distinguish between impaired water excretion, or Syndrome of Inappropriate Antidiuretic hormone secretion) (SIADH), and hyponatremia with normal water excretion.

Once a diagnosis of “true hyponatremia” has been established by low serum osmolality, I then use the urine sodium to differentiate between cases of hypovolemia, euvolemic, and hypervolemia. Based on the results from the urine sodium and the history and physical of the patient, I then make my treatment decision to treat the patient with isotonic (0.9%) or hypertonic (0.3%) saline. If the patient has peripheral edema or fluid overload, he should be treated with diuretics and/or fluid restriction. Whereas, if the patient has a urine osmolality > 150 mosm/kg, they have SIADH and because the body is retaining water, the patient should be fluid restricted, and not given any saline fluids.

The risk of not ordering both serum osmolality and urine osmolality will lead to treating the electrolyte abnormality such as hyponatremia incorrectly, which can harm the patient. Most commonly, the patient will be getting IV fluids even in cases of “pseudohyponatremia” when there is a false reading of low sodium in hyper-proteinemia, hyperlipidemia, or after surgery using high osmotic agents. In addition, cases of SIADH can be missed if a urine osmolality is not ordered. In this condition, the body retains water instead of excreting it normally in urine, so the urine osmolality will be very high. Saline IV fluids given in a patient with SIADH will only lower the sodium level more or keep it unchanged and the patient’s condition will not improve or may get worse.

Both hyponatremia at admission and hospital-acquired hyponatremia result in increases in ICU admissions and hospital readmissions, as well as a greater utilization of healthcare resources. Ordering serum and/or urine osmolality upfront as the first tests a physician orders in hyponatremia will reduce the length of stay of a patient in the hospital. A reduced length of stay per patient with hyponatremia will reduce the cost of care as well as fewer ICU days. This is because the serum and urine osmolality give the physician the vital information on the diagnosis of the hyponatremia. If the physician knows the diagnosis on the initial day of admission, then the precise treatment begins the same day and the patient will be out of the ICU or discharged earlier when stable. Commonly, I am consulted on a hyponatremic patient in the ICU after the patient has been receiving saline IV fluids for hyponatremia for 2 days with no change in the serum sodium level, which happens because osmolality was not ordered. Once I get consulted as a Nephrologist, I order the serum and urine osmolality and may discover that the patient has SIADH and should be off IV saline, and rather be fluid restricted. Thus, not ordering serum and urine osmolality may lead to the wrong treatment plan and thus a longer length of patient stay, higher hospital cost, and risk to patient health. In my experience, osmolality testing on the first day would reduce the number of days in the hospital by a day or more.

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The Value of Osmolality Testing in Emergency Medicine

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Abstract: The purpose of this note is to detail my experience and opinions regarding the utility of osmolality testing in an emergency department setting. I hope to inform practitioners about the uses of this important laboratory test in the emergency management of patients with diabetes, as well as several other conditions.

Osmolality serves as a marker for multiple disease states, notably hyperglycemic, hyperosmolar state (HHS), ingestion of toxic alcohols, and hyponatremia. Typically, when an osmolality test is not ordered, it is because the physician failed to consider these life-threatening conditions, which can lead to errors in patient care.

Early in my career as an emergency physician, I saw an elderly nursing home resident with altered mental status and infected urine; a “bread and butter” case. I admitted her to the in patient service for IV antibiotics and rehydration, with presumed UTI and encephalopathy. Additionally, she had a serum glucose greater than 800, so I put her on sliding scale insulin. She was not seen again until the following day, when the admitting physician found her in profound septic shock with refractory hypotension. I learned my lesson from this case: she was in HHS secondary to UTI. She should have received aggressive fluid resuscitation (1 liter an hour of NS for 2-4 hours, followed by 500 cc’s an hour). Had I thought of the diagnosis, I would have ordered a serum osmolality, and I would have learned the patient was hyperosmolar, critically ill, and in need of aggressive resuscitation.

The most common reason I order a serum osmolality is for patients with significant hyperglycemia (glucose > 600) and signed of dehydration, to rule out HHS. Another emergent indication to check serum osmolality is in cases of suspected toxic alcohol ingestion (ethanol, methanol, ethylene glycol or polyethylene glycol) in patients with altered mental status and/or lactic acidosis. Hospitals do not have the capability to test emergently for toxic alcohols (using gas chromatography), so it is investigated by measuring the osmolal gap (measured osmolality – calculated osmolality). Elevation means the patient has ingested an osmotically-active toxin. Finally, osmolality can be important in differentiating causes of hyponatremia. Both serum and urine osmolality is used to define hypovolemic hyponatremia (i.e., from dehydration) vs. euvolemic hyponatremia (i.e., SIADH).

The results of osmolality testing are crucial to the management of patients with the above disease entities. In patients with hyperglycemia, HHS is treated with rapid and substantial fluid resuscitation, while DKA (diabetic ketoacidosis) is typically treated with an insulin drip. Left untreated, HHS has a mortality of 20%, 100 times that of DKA. Toxic alcohol ingestion can cause life-threatening multi-organ failure. Serum osmolality is the test of choice, and once evidence of ingestion (by increased osmolal gap) is detected, there is an antidote (Fomepizole) which is 100% effective if given in time. Hypovolemic hyponatremia is typically caused by dehydration, and is treated with IV fluids. Euvolemic and hypervolemic hyponatremia has multiple causes, most commonly SIADH (Serum of Inappropriate ADH secretion) and CHF (Congestive heart failure) and fluid restriction is the mainstay of treatment. The serum and urine osmolality are used to differentiate the various causes of hyponatremia as well.

Typically, if a patient is diagnosed with HHS, it leads to an infectious workup. Approximately 60% of cases are caused by infection. Pneumonia is most common, and UTI’s are also quite frequent. Thus, chest x-ray and urinalysis are important adjunct tests. Serum electrolytes and renal function play a pivotal role in managing these patients. The fluids given and rate often needs to be adjusted to account for any complex fluid or electrolyte problems. Myocardial schema can also lead to HHS, so an ECG and troponin is useful.

The one thing most of the above patients have in common is altered mental status. In my opinion, most patients with altered mental status of unknown etiology should have a serum osmolality ordered. It serves as a “poor man’s screen” and essentially rules out toxic alcohol ingestion. These ingestions need to be treated urgently, as organ failure is often imminent. It provides a rapid diagnosis of the hyperosmolar hyperglycemic state in diabetic patients. And it provides clues to the underlying diagnosis in patients with severe hyponatremia, who may present with seizures and AMS.

As an emergency practitioner, osmolality is not a lab test I order on every patient, but it is a “can’t miss” test in cases of hyperglycemia, altered mental status, and hyponatremia.

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The Value of Osmolality Testing

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Abstract
Measured osmolality is a great initial screening tool when evaluating patients with metabolic acidosis, ingestions with various alcohols and alcohol-derivatives, common intoxications, and disorders of plasma sodium. It helps narrow down the differential diagnoses for these conditions in a cost- and time-effective manner. Hospitals and health systems can include measured osmolality in clinical pathways for these conditions to help reduce cost of care and improve quality of care.

Description
Some common conditions patients present with in emergency rooms, hospital wards, and ICU's are ingestions with various alcohols and alcohol-derivatives, common intoxicants, metabolic acidosis, and electrolyte disorders like hypo- and hypernatremia. The differential diagnosis for each of these conditions – namely the list of possible causative agents – can be long, and involve several dozen possibilities.

Consider metabolic acidosis, for instance; the list of possible causes (called "differential diagnosis ") can be over one hundred. It is highly expensive to test the lab analyte for each possible cause. Additionally, such a process of elimination would be time-consuming, cost-ineffective, and probably clinically unhelpful. What is needed in such situations are one or two tests that can help narrow the differential diagnosis to a manageable list – which can then be tested in a more cost-effective and time-efficient manner.

One such test is <u>*measured osmolality*</u>. This can help narrow the differential diagnoses for the following conditions:

1. Ingestions with various alcohols and alcohol-derivatives (e.g., methanol, ethanol, ethylene glycol, propylene glycol, isopropyl alcohol)
2. Common intoxicants like toluene, salicylates, ethylene glycol, propofol, isopropyl alcohol; as also iatrogenic overdosing with mannitol, sorbitol, and glycine (commonly used during surgical procedures like neurosurgery and TURP)
3. Metabolic acidosis – especially of the high anion gap variety (HAGMA for short)
4. Electrolyte disorders like hypo- and hypernatremia

The measurement of plasma osmolality helps to calculate the "Osmolal Gap". Combining the use of the Anion Gap and the Osmolal Gap helps narrow the list of differential diagnosis for HAGMA from a hundred plus, to less than a dozen (see Figure 1). This leads to significant cost savings and a quicker and proper diagnosis, and eliminates the patient spending days in an ICU bed waiting for results of several dozen tests. From a cost-analysis point of view, just one or two patient stays in ICU can cost as much as the cost of the instrument that measures osmolality (osmometer) – approximately USD 40-50K.

Measurement of the plasma osmolality is also crucial to making the correct diagnosis in patients with Hyponatremia (see Figure 2). The possibilities are completely different -

and so is the proper treatment – depending on whether osmolality is low, normal, or high. It would be very easy to make the wrong diagnosis if the osmolality were not measured or not available, and thereby end up giving the wrong treatment to the patient. Not only would that be potentially harmful to the patient; but also very expensive, given that some of the medications now available to treat SIADH (one of the causes of hyponatremia) cost literally USD 500-1000 per day! Just one or two misdiagnosed patients can cost the hospital system as much as the price of the osmometer! *This is not counting the possible costs arising from litigation for malpractice* by misdiagnosis and improper treatment. Similar logic applies for patients with Hypernatremia.

The use of osmolality and Osmolal Gap as a screening test for certain defined conditions – like the ones enumerated above – can lead to the construction of clinical pathways. These pathways would be akin to the workup of patients suspected of having pulmonary embolism, for instance, whereby the D-dimer and the V/Q scan help both in making the proper diagnosis, as well as guide the proper therapy. Another example would be the clinical pathway for DVT, using the D-dimer and Duplex ultrasound. The osmolality could be used similarly, incorporated into a clinical pathway or algorithm, in patients suspected to have the four broad conditions enumerated above. Quick and proper diagnosis helps decide whether the patient needs to be admitted to the hospital; if so, to which type of bed (ICU versus ward); and thereafter help decide what appropriate therapy to provide; etc. The actual construct of the pathway would likely depend on the specific site at which the testing is being done (ER, ICU, ward, clinic, etc).

It is obvious that such pathways will yield benefits in terms of bed utilization; and thereby can help reduce the cost of care and improve the quality of care. The cost savings would accrue at the level of the patient, the hospital, the hospital system, the insurer, and eventually the health care system.

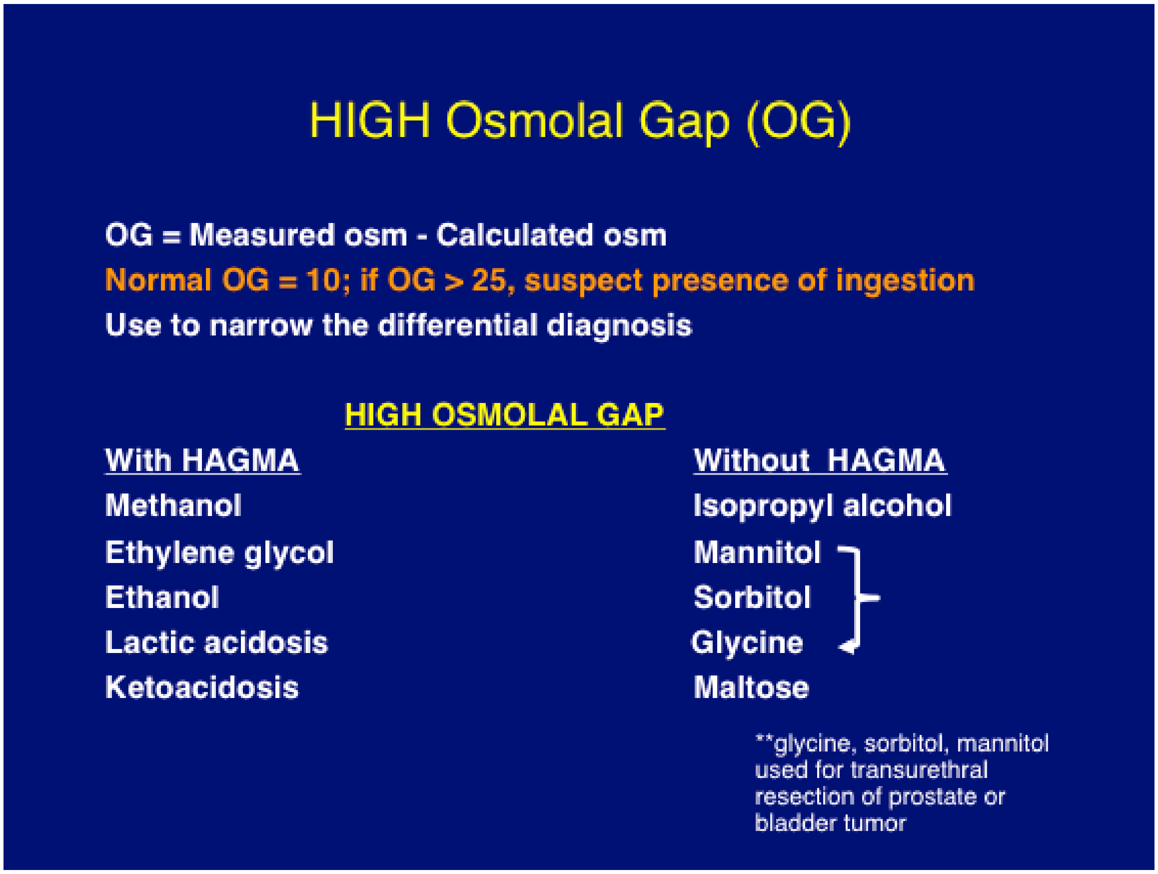

Figure 1: Osmolal Gap can help narrow the Differential Diagnosis of HAGMA

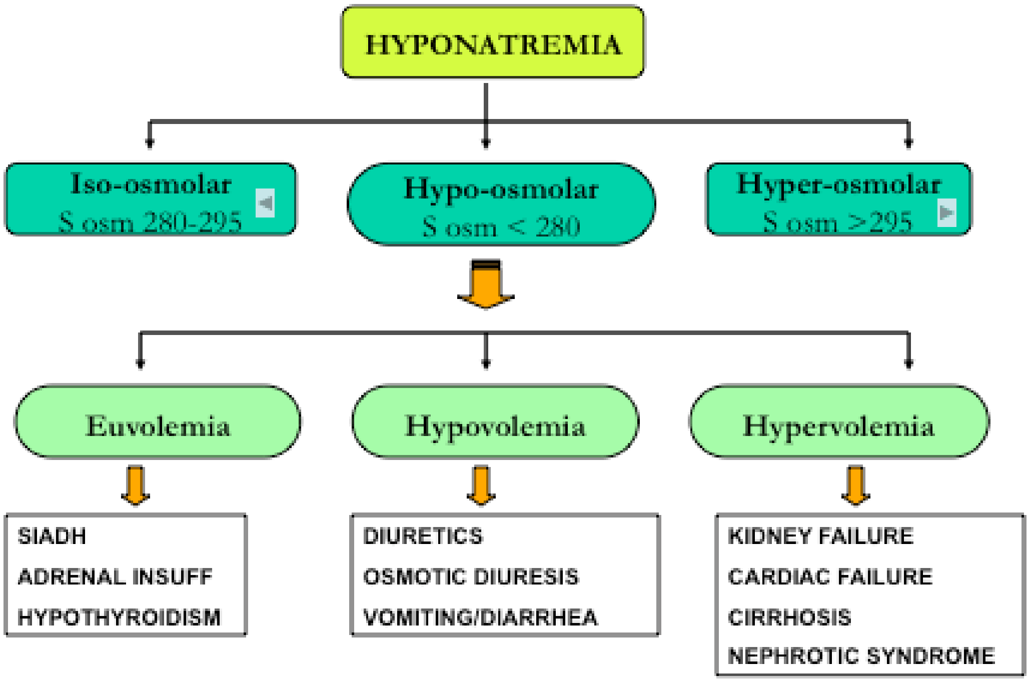

Figure 2: Differential Diagnosis of HYPONATREMIA