Ketoacidosis with Unexpected Serum Isopropyl Alcohol

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CASE

A 34-year-old woman presented to the emergency department with a chief complaint of acutely worsening abdominal pain. The patient reported the abdominal pain to be in the left lower quadrant and of several months' duration but noted that it had worsened substantially over the previous 10 days. She also reported diffuse muscle pain and nausea without emesis, no food intake over the previous 72 h, and only limited recent fluid intake consisting of ginger ale, water, Gatorade, and homemade liquor. Her last menstrual period was 2 weeks before admission. Her medical history was remarkable for posttraumatic stress disorder, bipolar disorder, gestational diabetes, a previous gastric bypass surgery, and an ambiguous history of "injury to the liver and pancreas." She denied taking any medications or other illicit drugs, specifically denied "binge" drinking, and had recently received a tattoo from an unlicensed tattoo artist. She was homeless and resided in a tent city with her husband.

The only remarkable findings of the physical examination were tachycardia and a mildly enlarged, nontender liver. She appeared ill and smelled of a campfire but was otherwise awake, alert, and cooperative. Selected laboratory results are shown in Table 1. Low urea nitrogen and albumin concentrations suggested probable malnutrition. The observed hypocalcemia of 7.4 mg/dL could be attributed only partly to the low albumin concentration, because the albumincorrected total Ca concentration—which is equal to the measured total [Ca] + 0.8 mg/dL × (4.0 – [Albumin]), where [Ca] is the calcium concentration in milligrams per deciliter and [Albumin] is the albumin concentration in grams per deciliter (*1*)—was 8.8 mg/dL, less than the institutional lower reference limit.

Opiates and tricyclic antidepressants were identified in the patient's urine. The presence of opiates was not commented on in the medical record, so whether the clinical team was aware of this finding was unknown. The records of the hospital system did not have any prescriptions for tricyclic antidepressants for the patient, so the positive result for this analyte could be due to the use of a tricyclic antidepressant obtained illicitly or with an outside prescription; alternatively, it could be due to a cross-reacting substance.

The attending physician in the emergency department requested assistance in interpreting the highly increased concentration of β-hydroxybutyrate. Furthermore, the clinical team wanted to know if detecting isopropyl alcohol in the alcohol screen implied that the homemade liquor ingested by the patient contained isopropyl alcohol.

DOI: 10.1373/clinchem.2010.157248

Table 1. Laboratory data.[a]

	Result	Reference interval
Arterial blood		
pH	7.28	7.35–7.45
$P\text{CO}_2$,[b] mmHg	14	33–48
$P\text{O}_2$, mmHg	124	80–104
Calculated bicarbonate, mEq/L	6	24–31
Base deficit, mEq/L	19.2	0.0–2.0
Lactate, mg/dL	32	3.6–9.0
Venous plasma		
Sodium, mEq/L	133	136–145
Potassium, mEq/L	3.9	3.7–5.2
Chloride, mEq/L	98	98–108
Carbon dioxide (total), mEq/L	8	22–32
Glucose, mg/dL	69	75–105
Anion gap, mEq/L	27	3–11
Urea nitrogen, mg/dL	6	8–21
Creatinine, mg/dL	1.1	0.2–1.1
Calcium, mg/dL	7.4	8.9–10.2
Albumin, g/dL	2.3	3.5–5.2
β-Hydroxybutyrate, mg/dL	130.2	0.00–2.08
Serum		
Osmolality, mOsm/kg	322	280–300
Osmolal gap (calculated[c]), mOsm/kg	56	−10 to 10
Serum alcohol screen (gas chromatography)		
Ethanol, mg/dL	128	Negative
Acetone, mg/dL	37	Negative
Isopropyl alcohol, mg/dL	140	Negative
Methanol, mg/L	Negative	Negative
Ethylene glycol, mg/dL	Negative	Negative
Urine drug screen (enzymatic immunoassay, Olympus AU400 EMIT)		
Opiates	Positive	Negative
Tricyclic antidepressants	Positive	Negative
Ethanol	Positive	Negative

[a] Factors for converting conventional units of measure to SI units: bicarbonate, mEq/L × 1 = mmol/L; lactate, mg/dL × 0.1110 = mmol/L; sodium, mEq/L × 1 = mmol/L; potassium, mEq/L × 1 = mmol/L; chloride, mEq/L × 1 = mmol/L; carbon dioxide, mEq/L × 1 = mmol/L; glucose, mg/dL × 0.05551 = mmol/L; anion gap, mEq/L × 1 = mmol/L; urea nitrogen, mg/dL × 0.357 = mmol/L; creatinine, mg/dL × 88.4 = μmol/L; calcium, mg/dL × 0.25 = mmol/L; albumin, g/dL × 10 = g/L; β-hydroxybutyrate, mg/dL × 96.05 = μmol/L; osmolality, mOsm/kg × 1 = mmol/kg; osmolal gap, mOsm/kg × 1 = mmol/kg; ethanol, mg/dL × 0.2171 = mmol/L; acetone, mg/dL × 0.172 = mmol/L; isopropyl alcohol, mg/L × 0.0166 = mmol/L; methanol, mg/L × 0.0312 = mmol/L; ethylene glycol, mg/dL × 0.1611 = mmol/L.

[b] $P\text{CO}_2$, partial pressure of CO_2; $P\text{O}_2$, partial pressure of O_2.

[c] Osmolal Gap = Measured Osmolality − Calculated Osmolality. Calculated Osmolality = (1.86 × [Sodium]) + ([Glucose]/18) + ([Urea Nitrogen]/2.8) + 9, where the sodium concentration is expressed in milliequivalents per liter and the glucose and urea nitrogen concentrations are expressed in milligrams per deciliter [Glasser *(11)*].

Questions to Consider
• What are common causes of a combined high anion gap and increased osmolality?
• What can cause ketoacidosis?
• What is the appropriate approach to this patient with an increased serum isopropyl alcohol result?

References

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Final Publication and Comments

The final published version with discussion and comments from the experts will appear in the October 2011 issue of *Clinical Chemistry*. To view the case and comments online, go to http://www.clinchem.org/content/vol57/issue10 and follow the link to the Clinical Case Study and Commentaries.

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