Surviving the impossible, a pH incompatible with life

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LEARNING OBJECTIVES

1. Present literature search findings on the lowest pH values compatible with life.
2. To discuss a life-threatening complication of diabetes with specific focus on pathogenesis and treatment.

CASE PRESENTATION

- A 66 y/o male with a PMH of type 1 diabetes mellitus presented to the ER with shortness of breath, vomiting for 1 day, and urinary frequency.
- The patient did not use his insulin pump over the last day when his symptoms started; however, when he uses his pump, blood glucose levels are usually less than 120 mg/dl.
- Additionally, he has an alcohol addiction and has been drinking more recently.

PHYSICAL EXAMINATION

- Vitals: HR 102 bpm, RR 30 breaths per minute
- Restless and confused. The patient was alert and oriented to person and place but not to time; however, he was able to answer questions and follow commands.
- Tachycardia and tachypnea with use of accessory muscles of respiration to breathe.

LABORATORY DATA

Glucose (70-99 mg/dl)	991
Acetone (negative)	Small
Sodium (136-135 mmol/L)	127
Potassium (3.5-5.2 mmol/L)	7.2
Creatinine (0.61-1.24 mg/dl)	3.83
Anion gap (5-13 mmol/L)	> 40
Carbon Dioxide (24-31 mmol/L)	Undetectable
Lactate (0.5-2.0 mmol/L)	12.3

Urinalysis	Glucose > 500 (negative mg/dl) Ketones 20 (negative mg/dl)

Venous Blood Gas (VBG)	pH 6.505 (7.35-7.45) pCO2 27 (25-45 mmHg) HCO3 2.1 (22-28 mmol/L)

INTERVAL HISTORY

- The patient became bradycardic and ultimately went into pulseless electrical activity (PEA) and asystole.
- Cardiopulmonary resuscitation was started
- The patient was given the following:
  - Two 1L boluses of normal saline
  - IV insulin drip at 0.1 unit/kg/hr
  - 1 mg of atropine IVP
  - 3 mg of epinephrine IVP
  - 150 mEq of sodium bicarbonate IVP
  - 300 mg of amiodarone IVP
  - 4 mg of calcium chloride IVP
  - Sodium bicarbonate infusion at 150 ml/hr
- The patient was intubated for airway protection, started on norepinephrine for hypotension, and the hypothermia protocol to improve neurological outcomes.
- Return of spontaneous circulation was achieved after 14 minutes and the patient was admitted to the ICU.
- His subsequent ABG was improved: pH of 6.808, pCO2 20.5, HCO3 6.3. The patient improved over the course of his hospitalization and was extubated with no neurological sequelae.

DIABETIC KETOACIDOSIS (DKA)

- DKA is a fatal complication of both type 1 and type 2 diabetes mellitus with a case fatality rate of 1-5%.
- 23-37% of patients with DKA are diagnosed with diabetes mellitus on presentation.

PATHOGENESIS

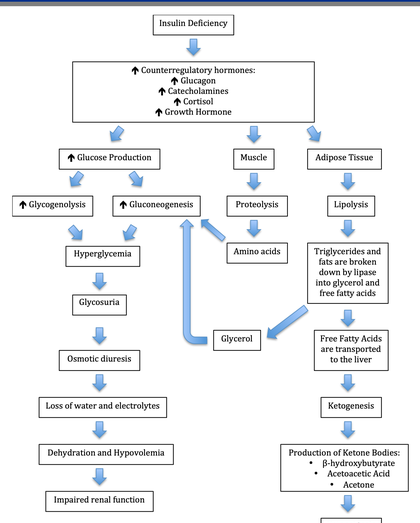

Figure 1. Pathogenesis of DKA.

TREATMENT RECOMMENDATIONS

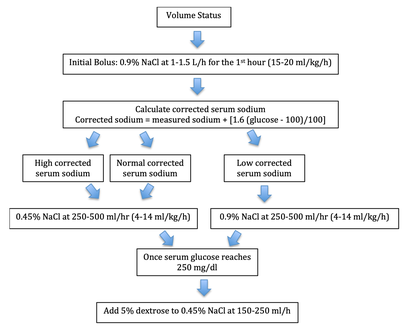

Figure 2. Correction of volume status in DKA.

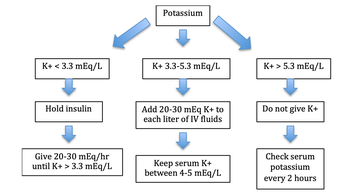

Figure 3. Correction of potassium in DKA.

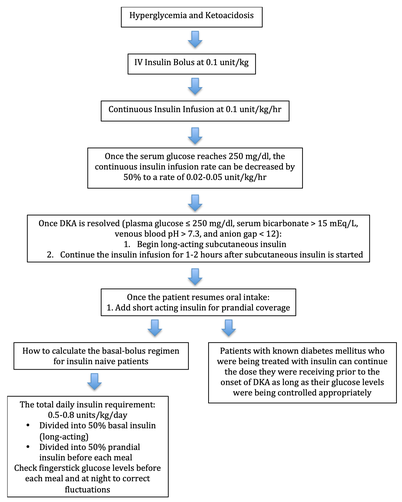

Figure 4. Addressing hyperglycemia and ketoacidosis to treat DKA.

LITERATURE SEARCH

Reference	pH
Guneysel 2009	6.82
Kamarzaman 2009	6.27
Van de Vyver 2017	6.74
Liska 2018	6.55
Gupta 2019	6.66

Table 1. Lowest pH values found in our literature search of case reports from 2009 to 2020.

- Our patient's pH on VBG was 6.505, making it one of the lowest pH values seen in DKA.
- A pH less than 6.8 is usually incompatible with life.
- The mean difference between arterial and venous pH is 0.03.
- Sodium bicarbonate use is controversial in DKA; however, it is recommended that patients with a pH < 6.9 should receive sodium bicarbonate due to the numerous adverse effects associated with acidosis.

CONCLUSIONS

- Diabetic ketoacidosis is a fatal complication of diabetes mellitus with high rates of morbidity and mortality.
- Treatment involves addressing volume status, hyperglycemia and ketoacidosis, electrolyte imbalances and precipitating factors.
- Early, aggressive treatment of DKA is important to improve patient outcomes, especially in those with severe acidemia.

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