Back to Basics:
The Limits of pH

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Introduction

- Extreme metabolic alkalosis (EMA) is rarely encountered acid-base disturbance with a high mortality rate.[1]
- Optimal management is challenging and the upper limit of human pH tolerance remains controversial.

Case Presentation

HPI:

- A 47-year-old female with metastatic ovarian cancer complicated by a small bowel obstruction received a palliative venting gastrostomy tube.
- She presented to the Emergency Room one week later with intractable nausea and vomiting and reported severe anxiety and diffuse muscle spasms.

Past Medical History:

- BRCA1+ metastatic ovarian cancer s/p hyperthermic intraperitoneal chemotherapy
- Malignant small bowel obstruction
- Pelvic deep vein thrombosis

Past Surgical History:

- Total abdominal hysterectomy/ bilateral salpingo-oophorectomy
- Omentectomy

Vitals/Exam:

- Afebrile, HR 89, BP 78/47, RR 22, SpO2 100% on room air.
- Anxious-appearing cachectic Caucasian female, hyperventilating, diffusely tremulous. Cardiopulmonary exam WNL. LUQ vented G-tube site non-tender and non-erythematous.

Labs:

146	81	29	139
1.9	**>45**	1.2	

Initial ABG:

- **pH=7.89,** pCO_2=35 mmHg, **HCO_3=67 mmol/L**

Hospital Course

- Severe hypokalemia, hypochloremia, and metabolic alkalosis were noted on initial chemistries and ABG.
- Intravenous potassium and fluid resuscitation were initiated. Three liters of normal saline were given to attempt induction of a hyperchloremic metabolic acidosis and correct the profound hypochloremia.
- Shortly thereafter, the patient became unresponsive and was found to have pulseless electrical activity.
- Return of spontaneous circulation was achieved after one round of CPR without defibrillation and she was neurologically intact.
- Nephrology was consulted and the decision to initiate corrective intravenous acid therapy was made. Hydrochloric acid was unavailable on hospital formulary; thus, arginine hydrochloride infusion, 150 mEq over 30 minutes, was initiated.

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- Multiple doses of lorazepam and fentanyl were simultaneously administered to address the respiratory alkalosis caused by the patient's anxiety and atypical hyperventilation.
- After six hours of acid infusion, repeat venous blood gas analysis noted pH=7.48, pCO2=63 mmHg, and bicarbonate=47 mmol/L. A repeat chemistry demonstrated normalization of her potassium to 4.6 mmol/L.

Clinical Follow Up

- After our patient's metabolic derangements were stabilized, additional history revealed she had misunderstood her previous discharge instructions and vented her gastrostomy tube up to five times daily before readmission.
- Subsequently, palliative care was consulted and our patient was discharged from the hospital two days later on home hospice.

Discussion

- Metabolic alkalosis occurs due to decreased bicarbonate excretion, an increase in bicarbonate production, or H^+ ion loss.[1] **Diuretic use and loss of chloride-rich gastric acid are common etiologies.**[1,2]
- EMA is typically characterized by **neuromuscular irritability**, **hypoventilation**, **seizures**, and **fatal cardiac arrhythmias** associated with a markedly elevated serum bicarbonate.[2]
- **Assessment of volume status** and hypochloremia guide the decision to trial intravenous fluid replacement.[1,2]
- Rare cases of survival have been documented in patients presenting with an arterial pH approximating 7.9.[2,3]
- **Alkalosis severity correlates strongly with prognosis;** mortality is nearly 45% when arterial pH exceeds 7.55 and 80% when the pH exceeds 7.65.[1]

Teaching Points

- Assessment for and **correction of underlying hypovolemia is essential to EMA treatment.**
- Intravenous acid therapy is a **safe and effective adjunctive method** to correct EMA. Its use is warranted **if end-organ manifestations are observed and rapid reversal is desired.**
- **Effective patient-physician communication** remains one of the most **crucial but underutilized** means of prevention.

References

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3. Betten DP, Bridger DJ, Felton BM. Profound alkalemia secondary to gastric outlet obstruction and acute renal insufficiency. The American Journal of Emergency Medicine. February 2013; 31(2):444e1-3