

A Case of Hyperglycemia induced by Hypothermia

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Introduction

Hyperglycemia as a response to stress and injury has been well established.^{1,2} Hypothermia is defined by a core body temperature <35°C, is a physiological stress associated with significant morbidity and mortality.³ The physiological effects of hypothermia impact virtually every organ system in the human body.⁴ In particular, hypothermia can induce hyperglycemia via catecholamine-induced glycogenolysis, decreased insulin release and inhibition of insulin transport across cell membranes.⁴ In non-diabetic trauma patients as well as general medical patients, hyperglycemia on admission to the hospital in non-diabetic patients is associated with increased mortality.^{2,5}

Epidemiology

Each year, approximately 1500 patients in the United States have hypothermia noted on their death certificate; however, the incidence of primary and secondary hypothermia and the associated morbidity and mortality remain unknown.³

Objective

Hyperglycemia on presentation is associated with increased mortality when compared to normoglycemia in trauma patients.² Here we present a case of stress-induced hyperglycemia secondary to hypothermia.

Case Report

History:

A previously healthy 26-year-old male was brought to the emergency department after being found unresponsive, face-down in a creek. The patient was found to be hypothermic (32.1°C), with pinpoint pupils. EMS gave the patient Narcan however the patient did not improve. The patient was intubated on route to the hospital. Due to his hypothermia passive and active rewarming was begun while in the emergency department.

Examination:

Vitals: T-32.1°C, HR-59, BP-71/74, SaO₂-99% on mechanical ventilation
Physical exam was remarkable for weak peripheral pulses, several abrasions on his anterior chest, back, right thigh, right knee and both arms bilaterally.
ROS unable to be performed due to intubation.

Investigations

Laboratory testing:

- ❖ Leukocytosis (17.4)
- ❖ Elevated glucose (314)
- ❖ AKI (creatinine 1.66)
- ❖ Elevated CK (454)
- ❖ pH 7.04, wide anion gap metabolic acidosis, lactic acidosis (15)
- ❖ Hypokalemia (2.8)
- ❖ Elevated AST (347) and ALT (492)

Imaging studies were reviewed and no significant findings were reported.

Hospital Course

- ❖ Transferred to the ICU and given IV fluids, antibiotics and continued warming
- ❖ Condition improved within the next 24 hours and he was subsequently extubated
- ❖ Further investigation into his laboratory abnormalities revealed the following:
 - ❖ AKI and elevated CK were 2/2 to rhabdomyolysis
 - ❖ Lactic acidosis and acute liver failure were 2/2 to hypoperfusion
 - ❖ Leukocytosis likely 2/2 to stress response, antibiotics discontinued
- ❖ Hyperglycemia (Blood glucose 314) resolved as his temperature normalized, without the use of insulin or other oral hyperglycemic agents.
- ❖ Diabetic workup was negative (HbA_{1c} 5.4) and the patient had no known diabetes or other medical history, allowing us to conclude that his hyperglycemia was caused by hypothermia
- ❖ Workup for ingestion of any drugs, toxic substances or poisons came back negative.
- ❖ Further history revealed that the patient had attempted suicide via drowning
- ❖ Patient was treated at an inpatient psychiatry facility once medically stable

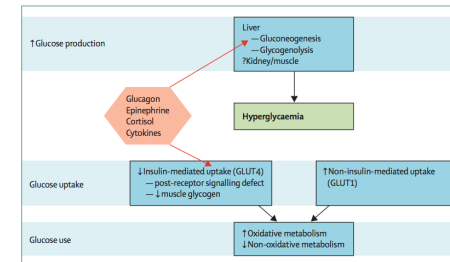


Figure 1. Diagram outlining metabolic mechanism by which stress hyperglycemia occurs. Diagram from Dungan, K. M., Braithwaite, S. S., & Preiser, J. C. (2009). Stress hyperglycaemia. *Lancet (London, England)*, 373(9677), 1798–1807. [https://doi.org/10.1016/S0140-6736\(09\)60553-5](https://doi.org/10.1016/S0140-6736(09)60553-5)

Discussion

Each year in the United States approximately 1500 patients in the United States have hypothermia on their death certificate.³ The physiological effects of hypothermia on the human body are numerous.⁴ Cardiac output, respiratory rate and reflexes decrease while diuresis increases.⁴ Electrolyte abnormalities are also common including hypokalemia and hyperglycemia.⁴ Interestingly, patients who are found in cold water as in this case are thought to have worse outcomes than the typical hypothermic patient.⁶ Furthermore, non-diabetic general medical patients as well as trauma patients with hyperglycemia on admission have increased mortality when compared to normoglycemic patients.² Given the significant morbidity and mortality of accidental hypothermia, along with the increased morbidity and mortality of hyperglycemia on admission it is imperative to stabilize and treat patients with this comorbidity quickly and effectively.

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