Disclosure

- NMS labs provided the BHB testing free of charge for research purposes

Background

- Deaths related to cold exposure challenging to certify
- No specific autopsy findings that make the diagnosis
  - Cherry red lividity/erythema of joints
  - Wischnewsky lesions
  - Hemorrhagic pancreas

Scene findings most specific
Scene findings
- Environment found in
- Inappropriate clothing for weather
- Documented temperature
  - At or below freezing
  - Can be above freezing ex 52 F and raining
- Compromised thermoregulation
  - Elderly, alcohol

Unusual findings
- Paradoxical undressing
  - Reportedly 50-70% 
- Terminal burrowing
  - Less than 25% of cases
**Betahydroxybutyrate (BHB)**
- Marker of ketogenesis and ketoacidosis
- Seen in uncontrolled diabetes, chronic alcoholics, poor nutrition states
- Proposed to be elevated in cold exposure due to breakdown of fat
  - Attempt at thermoregulation
- Normal <50mcg/ML
- Ketoacidosis >250 mcg/mL

**Study**
- Used Lablynx to search for cases where cold exposure was COD or contributing
- Searched reports for scene indicators and autopsy findings of cold exposure
- Noted if hx DM or chronic ETOH
- Ordered BHB on blood
- Searched cases in which BHB ordered but no cold exposure noted as controls

**Demographics-Cold exposure**
- 25 M, 11 F
- 25 W, 11 B
- Age 27-90, mean 56
BHB not elevated-Cold Exposure

- 22/36 (61%) either below detection or considered normal (<50mcg/mL), 1 interfering substance
  - Temp range (low of day before discovered)
    - 1-40 F (mean 15 F)
  - Hx diabetes 1/22
  - Hx EtOH or liver pathology 9/22
  - Signs of cold exposure at autopsy
    - Wischnewsky 11/22
    - Cherry red livor/erythema 9/22
    - Pancreas hemorrhage 1/22
    - None 5/22

BHB elevated-Cold exposure

- 14/36 (39%) above 50mcg/mL (80-900 mcg/mL)
  - Temp range (low of day before discovered)
    - 0-52 F (mean 19 F)
  - Hx diabetes 2/14
  - Hx EtOH or liver damage 5/14
  - Signs of cold exposure at autopsy
    - Wischnewsky 10/14
    - Cherry red livor/erythema 9/14
    - Pancreas hemorrhage 1/14
    - 3/14 no signs
    - 2/3 chronic ETIOH or liver pathology

BHB level breakdown

- 9/14 below ketoacidotic level (range 80-220 mcg/mL)
- 5/14 at ketoacidotic level (range 270-900 mcg/mL)
  - Older age (72-82)
  - Temp 0-33 F
  - 2/5 hx diabetes,
    - 1/5 vitreous glucose not elevated
    - 1/5 decomposed
  - 3/5 no documented DM or EtOH hx/liver pathology
BHB-Control cases

- 12 cases in which BHB ordered but Cold exposure not implicated in the death
- BHB 23-2200 mcg/mL
- 6/12 related to Diabetes mellitus
  - 4/6 DKA caused or contributed, all BHBs 1200 or above
  - 2/6 Normal BHB- DM caused or contributed
- 5/12-Combined drug toxicity
  - Cold environment but appropriately dressed, no signs of hypothermia
- 1/12 CO toxicity

Secondary findings

- Body received in state of undress or unclothed
  - 14/36 (48%) cases
- Evidence of terminal burrowing
  - 2/36 (5.5%) cases

State of undress
BHB above normal in 39% of cold exposure cases
- Ketoacidotic range in 25% of cases, all had no hx of DM or normal vitreous glucose with hx DM
- BHB normal or below detection 61% cases
- No signs of hypothermia at autopsy in 22% of cases
- 3 BHB above normal, 5 normal or below detection
- Scene findings still most specific in diagnosis of hypothermia