

EVALUATION OF AUTOPSY FINDINGS,
INVESTIGATIVE INFORMATION, AND THE
DETERMINATION OF BHB CONCENTRATIONS IN
CERTIFYING DEATHS FROM COLD EXPOSURE

Dr. Eckhardt
Dr. Arunkumar
Dr. Isenschmid
Dr. Logan

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

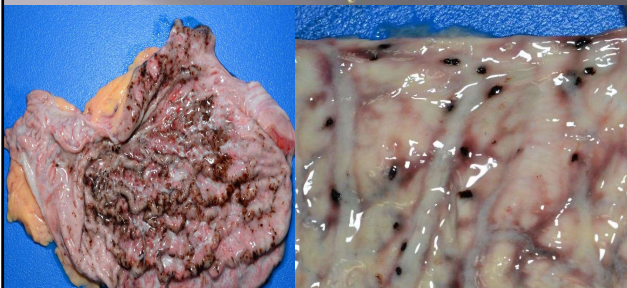
Cherry red lividity



Erythema of joints



Wischnewsky lesions



Hemorrhagic pancreas



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 ETOH 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







Conclusions

- ▣ 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
