Investigation of Fire Deaths in Maine
Colby Forensic Seminar 2018

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State of Maine
Objectives

- Review descriptions of burn injury
- Understand how the development of the fire affects injury, survival and presence of products of combustion
- Review of typical artifacts in charred bodies
- Review the autopsy approach to fire deaths
- Look at example cases to see how investigation, autopsy, etc combines to determine cause and manner of death
The bodies were discovered in the white 2001 Pontiac sedan with Rhode Island plates before dawn Monday. The car was burning in the parking lot of a business.
Disclosure

- I have no financial interest or other relationship with any manufacturer(s) of any commercial product(s) and/or provider(s) of commercial services discussed in this presentation or with any commercial supporters of the educational activity.
### Cases Reported to OCME Maine

<table>
<thead>
<tr>
<th>Years</th>
<th>Total Cases*</th>
<th>Structure Fires/Deaths</th>
<th>Car Crashes Blunt trauma</th>
<th>Plane Crashes/Deaths Blunt trauma</th>
<th>Suicides</th>
<th>Undetermined**</th>
<th>Other***</th>
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</thead>
<tbody>
<tr>
<td>2015</td>
<td>15</td>
<td>13/14</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>2016</td>
<td>22</td>
<td>15/17</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>2016</td>
<td>11</td>
<td>9/10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

*All cases (individual deaths) reported as associated with Fires

**Undetermined: Accident vs Suicide

***Other types of death include: Smoking while on O2, Clothing ignited from fire to burn brush, space heater in tent caught fire

NOTE: The numbers may be greater than total cases due to setup of table
Location/cause of fires

- Structure fires: house, place of business
  - Accidental from electrical, heating especially woodstoves, cooking, smoking
  - Homicide or Suicide may find accelerant
- Vehicle fires: car, plane
  - Accidental when crash with subsequent fire
  - Homicide or Suicide may find accelerant
- Others: Brush fires, fire pits or campfires, gas grill explosions are mostly accidents
Development of Fires in Structures

- Difference between room of origin and another location in the same structure
- What to expect in terms of Carbon monoxide (CO), smoke, thermal injury, other contaminants and irritants such as hydrogen cyanide (HCN)
Room of origin

- Typical fire at 30 seconds after ignition
  - Organic and inorganic chemicals in smoke are present leading to irritation of eyes and tearing, coughing, choking, gagging
  - Convective and radiative heat lead to heat stress
  - High smoke density results in limited visibility
- Victim disoriented but still usually attempts to extinguish fire, warn others and/or escape
Room of origin

- Typical fire 2 minutes after ignition
  - Spreading smoke forms hot layer at ceiling but rapidly descends to floor and contains decreased O2 (if less than 7% O2 primary factor in incapacitation and death)
  - Low O2 cannot exist unless smoke is very hot so systemic hyperthermia is also a factor in death
  - Although CO is present not lethal at this time because it takes time for CO to increase in the smoke to lethal levels
  - HCN may be present due to synthetic materials burning but also takes time to reach lethal levels
  - If burning materials contain chlorine, bromine, or fluorine these increase irritants in the smoke and may cause damage to respiratory tract with long term pulmonary injury
- Unless person is trapped, intoxicated or asleep they should still be able to escape and survive
- Heat shock (thermal injury) and O2 depletion are cause of death
Away from room of origin

- Heat and O2 depletion less
- Smoke effects with irritation and decreased visibility are most important
- Incapacitation due to generally due to CO and HCN
- Exposure time a critical factor
Inhalation of POC

- Primarily carbon monoxide (CO) produced by combustion of furniture, plastics, etc
- Hydrogen cyanide (HCN) produced by burning polymers
- Amount in blood dependent on age, other comorbidities such as emphysema, advanced ASHD
Types of Burn Injuries

• Flame- Actual contact of the body and the flame with scorching of the skin progressing to charring
• Radiant heat- No contact, just exposure to heat waves
• Flash- Sudden ignition or explosion of gases, petrochemical or particulate matter; Short duration, may be combined with flame and hot gases
• Contact burns (with hot object)
• Scalding (hot liquids, not usually fire)
What factors influence outcome?

- Extent of burns
- Severity of the burns
- Victim’s age and co-morbidities
- Presence of Inhalation injury
- Clothing
Extent of injury

Diagram showing the extent of injuries with percentages indicated.
Clothing

- Tends to get accidentally ignited in very young and the old
- Cooking &/or Cigarette smoking is particularly hazardous, esp long-sleeved nightgown, robe or dress
- Clothing may protect by reflecting and absorbing some heat, esp in radiant heat or flash type fires
  - properties of clothing-fabric
  - Tightness of fit-
    - Decreased severity if light or loose fitting; dry and multilayers allows airflow
    - Increased severity by dark, wet clothing or clothing stretched tightly over skin
Classification of Severity of Thermal burns

- **1st° BURN**: Superficial
- **2nd° BURN**: Dermal
- **3rd° BURN**: Full thickness
1\textsuperscript{st} Degree Burns

- 1\textsuperscript{st} degree: superficial erythema, no blistering
- Typical sunburn
2\textsuperscript{nd} Degree Burns

- 2\textsuperscript{nd} degree: Partial thickness moist, red, blistered lesion;
  - Superficial:
    - Basal layer not totally destroyed
    - Heals without scarring
  - Deep
    - Complete destruction of epidermis
    - Destruction most of basal
    - Dermal appendages spared
3rd Degree Burns

3rd Degree-Full Thickness

- Coagulative necrosis epidermis and dermis with destruction of dermal appendages
- Dry white leathery, no blisters
- May be brown or black if charring or eschar
4th Degree Burns

- 4th Degree
  Incinerating injuries extend beyond skin
### DIFFERENCES B/W ANTEMORTEM AND POSTMORTEM BURNS *

<table>
<thead>
<tr>
<th>Antemortem burns</th>
<th>Postmortem burns</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Line of redness</td>
<td>▪ no line of redness</td>
</tr>
<tr>
<td>▪ Vesicles / blisters contain serous fluid with albumin &amp; chlorides</td>
<td>▪ vesicles contains air only</td>
</tr>
<tr>
<td>▪ Infection—pus &amp; sloughing</td>
<td>▪ base is dry, hard &amp; yellow</td>
</tr>
<tr>
<td>▪ Base of blister inflamed</td>
<td>▪ vital reaction absent</td>
</tr>
<tr>
<td>▪ Healing with------ granulation</td>
<td>▪ no increase in enzyme reaction</td>
</tr>
<tr>
<td>▪ Soot in upper respiratory tract</td>
<td>▪ no carboxyhemoglobin in blood, usually &lt;5% COHb</td>
</tr>
<tr>
<td>▪ Vital reaction present</td>
<td></td>
</tr>
<tr>
<td>▪ Increase in enzyme reaction &amp; -SH group in periphery of burns</td>
<td></td>
</tr>
<tr>
<td>▪ &gt;5% COHb in blood</td>
<td></td>
</tr>
</tbody>
</table>

Are there really gross indicators of antemortem thermal injury?

- Blistering vs Skin slip?
- Erythema vs lividity in fire?
- Circumstances, clothing and other objects in environment affect what is seen on the body
Smoking, O2 & Fires

- Smoking is a leading cause of fires and fire related deaths, use of O2 is a small subset of cases
- ME, NH, MA and OK participated in a retrospective review of deaths from 2000-2007 published MMWR
  - 38 cases fire fatalities associated with long term O2 therapy (LTOT)
  - Single fatality with all except one fire with 2 deaths
  - House fires in 24 while the rest confined to the area around the smoker
  - Fatality rates: OK--6.7 per 10 million; ME--4.8; NH—2.9; MA—2.1
  - 34 (89%) were on LTOT and smoking, 1 nonsmoker on LTOT ignited O2 by a family member smoker, 3 deceased were family members of the smoker on LTOT

*From: MMWR; August 8, 2008/57(31); 852-854
Fires

- Temperatures in fires vary considerably
  - Chemical fires up to several thousand degrees
  - House Fires 900°-1200°F, unlikely adult body will burn to ash
  - Cremation requires 1½ to 2 hours at 1600-1800°F
Autopsy on the Fire Victim

- Consult with Fire Investigators if you did not go to the scene (what is known about cause of fire)
- Xray body in bag and then additional as needed
  - May aid in identification
  - Presence of bullets, fragments or pellets is ‘a clue’ 😊
  - Documents and shows all metallic objects around the body (important if possible explosive device)
Autopsy on Fire Victims

- Evidence: If concern for deliberately set fire collect clothing in air tight containers for accelerant testing
- Photograph external body as received, airway and any other significant internal findings
- Internal exam
  - Collect blood for toxicology
  - Antemortem injury
  - Natural causes of death not related to fire
  - Presence of soot in airway
Toxicology

- Collect blood, vitreous, muscle and/or other tissue for testing
- Carbon monoxide intoxication measured as carboxyhemoglobin, needs to be tested in blood or muscle
- Alcohol or illicit drugs may be present and increase risk fatality due to decreased consciousness impairing ability to escape
- Testing HCN in postmortem blood as an indicator of toxicity is often not reliable due to many factors (postmortem instability or production, false positives, and some methodologies nonspecific) but it is available in specialty labs
Carbon Monoxide Intoxication

<table>
<thead>
<tr>
<th>*CO Hgb Level</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>Normal value</td>
</tr>
<tr>
<td>15-20</td>
<td>Headache, Confusion</td>
</tr>
<tr>
<td>20-40</td>
<td>Disorientation, fatigue, nausea, visual changes</td>
</tr>
<tr>
<td>40-60</td>
<td>Hallucination, combativeness, coma, shock, shock state</td>
</tr>
<tr>
<td>60 or above</td>
<td>Cardio-pulmonary arrest, Death</td>
</tr>
</tbody>
</table>

*CO HgB = Carboxyhemoglobin

In a fire, fatal CO levels are usually >=50% (may vary as low as 20% depending on underlying pulmonary or cardiac disease)
Autopsy: Artifacts seen in charred bodies

- Splitting of skin or complete destruction of skin
- Changes due to contraction (coagulation of muscles) and shrinkage of skin
  - Pugilistic pose
  - Frog leg position
  - Protrusion of tongue (Lips)
- Exposure of muscle or internal viscera
- Spared areas of skin may show leathery appearance without typical burns
- Bones may be gray white, crumbly, heat fractures
- Postmortem epidural hematomas
Timing of charring artifacts in bodies (at 670-810 degF)*

- Pugilistic attitude 10 minutes
- Rib Cage and Facial Skeleton exposed-20 minutes
- Body cavities visible and organs exposed 30 minutes
- Arms severely charred early
- Burning of all flesh from thighs and shins takes about 35 minutes

Skin Splitting/ Destruction
Skin Splitting/ Destruction
Pugilistic Pose
Arms and hands flexed, ‘Frog-legs’
Shrinkage of soft tissues may lead to either protrusion of tongue or sealing of lips protecting teeth.
Exposure of Muscle & Internal Viscera
Leathery Skin where not charred
Bones blackened, grey white, heat fractures
Heat Fractures in Skull

- Cracks in skull usually above temples on vertex, may radiate from central area in star burst pattern
- Outward bursting of bone flaps and extrusion of brain due to steam pressure building up in skull
- Direct contact with flames may cause defect in skull
Postmortem Epidural ‘Hematoma’
Xray of Epidural in fire victim
Issues/Questions in Fire Deaths

- Cause of death:
  - Fire, natural, other injury

- Manner of death:
  - Accident, Natural, Homicide, Suicide, Undetermined

- Why did individual not escape?

- Confirm Identification (name is often suspected or tentative)
Causes of death based on relationship to fire

- Death prior to fire: Manner of death varies
- Death due to fire: Manner of death often accidental but depends on cause of fire
  - Immediate
  - Delayed
Death prior to fire

- **Natural deaths**
  - Cardiac (often while smoking or cooking)
- **Suicides**
  - Gunshot wounds, hanging, etc
- **Homicides:**
  - Gunshot wounds, stab wounds, other traumatic injury
- **Accidental**
  - Traumatic injuries typically in vehicular crashes with subsequent fire
Immediate Deaths in fire

• Inhalation of Products of Combustion (Smoke Inhalation)
  • Most commonly carbon monoxide
  • Also hydrogen cyanide and other irritants
• Overwhelming thermal burns
• Flame effect: Inhalation of hot or superheated gases (rare, often with steam)
• Contributing factors which affect levels of POC
  • Cardiac and Respiratory Disease
  • Drugs
Inhalation Products of Combustion (Smoke Inhalation)
Inhalation of Hot Gases (Flame effect)
Thermal Burns (heat shock)
Delayed Deaths

- Usually hospitalized
- Usually have lower levels of CO in blood
- Have less severe thermal injury or burns involve less surface area
- Death is usually caused by shock, fluid loss, acute respiratory failure (injury to tracheobronchial tree) or even later by sepsis,
Identification of Burn Victims

- DNA: comparison with parents (mother), known toothbrushes, hair brushes, tissues or any item known to belong to decedent
- Dental: Antemortem and postmortem Dental X-rays, dental charts or dentures
- Fingerprints if hands not charred (rare)
- Tattoos if they can be cleaned and compared
- Antemortem Xray or medical charts confirming Prior surgical procedures
Dental Identification

- Lips and surrounding soft tissue shrunken and firm make viewing teeth difficult
- X-ray comparisons usually require disarticulation of mandible and removal of upper jaw
- May be complicated by charring and fragmentation of tooth enamel
- Use of superglue before jaws removed help to preserve teeth
Tattoo
CASE #1
Orrington reeling from death of father, three children in weekend fire (Media reports)

- The sole survivor of the fire was wife and mother Christine Johnson, 31. On Sunday, Johnson remained at Eastern Maine Medical Center, where she was being treated for smoke inhalation.
- Fire is reported just after 2:30 AM when neighbors hear the wife calling for help.
- The people who were the first to arrive on the scene of the fire said it appeared that Ben Johnson died after putting his wife out of harms way on a breezeway roof and then going back inside the burning house to save his children.
CASE #2
House Fire, 1 dead

- Fire Marshals responded to fire at 7:34 AM
- Body found at 12:30 PM
- It was expected that the body belonged to the wife of a couple residing in that house
- Husband left for work at 5:30 AM & said that she seemed fine, talking about mowing the lawn
CASE #3
3 dead after airplane crash in Owls Head; plane struck truck during takeoff

- The accident happened Friday around 5 p.m. when the plane was taking off and it struck a pickup truck driving across the runway.
- The plane crashed into the truck on the runway, caught fire and continued on about 300 yards into the woods beyond the runway.
CASE #5
October 27, 2012

**Grandson arrested in fire death**

Police charge Derek Poulin, 23, with murder and arson in connection with an Old Orchard Beach house fire in which Patricia Noel was found dead.
Fire Deaths Summary

- Often cannot tell cause of death from external examination
  - If not doing full autopsy, should at least look at trachea and correlate with scene, history and circumstances
- Charring may obscure external injuries
- Without autopsy will not have information on natural disease or some internal injuries
- Antemortem and postmortem skull fractures may initially look very similar
- X-rays very helpful in fire deaths
Fire Deaths

• CO may be present
  • Even with other overwhelming COD (ie GSW, blunt trauma) though usually in lower levels
  • May be present in high levels even when no or minimal soot is found in trachea
  • Significance of CO level must be evaluated in context with age, medical history
Remember...

Working
SMOKE ALARMS
SAVE LIVES
Change Your Clock, Change Your Battery

“Dedicated To Life Safety”