H23 Beyond the Fire: Taphonomic Variables of Burned Human Remains

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After attending this presentation, attendees will learn how different taphonomic variables can change or impact the condition of burned human remains.

This presentation will impact the forensic science community by intro- ducing several important taphonomic variables that directly affects how the human body burns in a fire and what is left for forensic analysis. These variables are inherent to most fire-related deaths, be it in cases of accidental death or homicide.

Fire has the amazing ability to alter things in its path, with the human body being no exception. The victim's body is an important variable to consider during fire reconstruction since it is a fuel load and contributes to the burning process. The material properties of tissues and how they burn differs for skin, fat, muscle, and bone. Each tissue has differential thicknesses, compositions, and layered anatomical arrangements. In addition to the body, some of the most significant variables include those introduced by charac- teristics of the individual, heat sources, combustible materials, conditions of the environment, spatial relationship of the body in the fire, extinguishment, and in some cases, criminal modification of the body before and/or after the fire.

Individual: Variables of each victim play an important role in how the body burns and what is left for the forensic investigation, in terms of their age, sex, health, and weight.

Age: can be broken down into developmental and degenerative stages, or more specifically, juvenile, adolescence, adulthood, and elderly.

Juvenile and Adolescence: The body size of a young child differs considerably from an adult. Children typically have higher body-fat ratios than adults, and more importantly, their bones are growing and developing from birth through late adolescence and early adulthood. Young bone lacks the dense mineralization typical of the healthy adult skeleton, and has devel- oping structures of epiphyses, diaphyses, and metaphyses, which survive the burning process.

Adult: Bodies of adults are larger and have bulkier tissue mass and denser bones than children. Health and weight also vary more in adults than in children. The burned remains of healthy adults with average body weight, good muscle tone, and strong bones will leave significant evidence for analysis. Bulkier muscles can be expected to protect bone for a longer duration than the smaller tissue mass in children but, more importantly, adult bone is fully mineralized, dense, and more durable through most taphonomic changes, including fire.

Elderly: Emaciated or poor muscle tone of elderly individuals provides less tissue protection around bone during burning in comparison to younger adults. The skeletal structure of elderly individuals, particularly those with degenerative bone loss such as osteoporosis, gradually become more fragile during life, particularly for those with osteoporosis, and burning only increases the fragility and brittleness of the skeletal remains.

Sex: Males and females differ in their body size, composition, shape, and distributions of fat and muscle, and therefore respond differently to burning. Gender differences change as individuals pass through adolescence, early adulthood, middle age, and late adulthood. The relative amounts of body fat and distributions may differ for the sexes, but remain primarily concentrated around areas of the torso, abdomen, thighs, and central body. The important variable to consider here is how body size and relative distri- butions of body fat for the individual contribute as a fuel load during the burning process.

Weight and Health: A person's weight is variable throughout his or her lifetime with growth and development, changes in dietary habits, and changes in their metabolic rates as one ages. Individuals who are overweight or obese have more body fat than to those who are average weight or thin. The combination of open flame, liquefied body fat, and a wicking substance such as clothing or upholstery can sustain a localized fire.

Heat Sources: A fire produces several sources of heat that affect human tissues, ranging from confected heat from superheated fire gasses, radiant heat, open flame, to direct burning of the body. A body can expe- rience a range of injury from superficial damage of radiant heat coming from a distant room to direct flame impingement and thermal reduction of bodily tissues. Intensity of the radiant heat striking the body is a key factor, in addition to the temperature of the fire.

Combustible Materials: Modern home furnishings contain both synthetic and natural materials. The more common synthetic materials are carpet, linoleum, vinyl, foam, and plastics. Common household items made with natural products include wooden furniture and flooring, cloth and textiles, books and paper products, and other items. Each material reacts differently to heat, and influences the fire dynamics and what is left for forensic analysis.

Environment: A strong interrelationship exists among the envi- ronment, different fuels present, heat, size of the compartment/space, and how these factors directly affect a body as it burns.

House Fires: Structural fires are challenging scenes because a three- dimensional space is reduced to layers of charred debris. Structures can be houses, trailers, or buildings. House fires include a host of variables that influence how a fire travels, grows, and spreads. Spatially there is more area for a fire to travel along horizontal and vertical surfaces (walls, ceilings, furniture, and hallways).

Vehicle Fires*:* Within cars, most of the interior is made of synthetic fabrics, carpet, plastics, and sometimes leather. The different properties of these materials, along with the small compartment size, can make for a fast, hot

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fire if ample ventilation and circulation exist, thus affecting what is left of the body.

Spatial Relationships: Within a room or compartment space, the dimensions of height, length, and width influence the dynamics of a fire's growth and development. The size of a room or rooms, levels of a house or building, presence of a basement, height of a crawlspace, or presence of a solid foundation likewise are contributing factors, particularly when a structure is mostly or completely destroyed by fire.

During burning, structures of the walls, ceilings, roof, and floors begin to collapse along with contents of the house. A body may be directly affected by the disintegration of supporting structures of flooring and levels above and below. The combined effects of gravity, weight of a body, and struc- turally weakened flooring are optimal conditions for a body falling down to a lower level shortly after a structural fire is fully engulfed in flames.

Extinguishment: Fire suppression tactics influences survival of burned body evidence. The pressure of a direct fire hose stream is on the order of 100 psi or more. If the body is hit with a direct stream it will displace evidence of the body, particularly fragile burned bone, projecting it several inches or feet from the *in situ* position of the victim. Damage can be done to the body if supportive structures of furniture or flooring around the body are hit with a straight powerful stream, causing the body to shift its position or fall, producing fragmentation.

Criminal Activity: The use of arson to cover up criminal evidence or a victim's identity presents some of the more interesting and challenging variables in fire-death investigation. Any number of materials, fuels, and environments mentioned above can be utilized to burn a body. In some cases, the fire is set to appear as an accidental structural or car fire to throw off investigators, or to destroy evidence of the victim's identity, traumatic injury, or the victim's remains, altogether. Intentional fragmentation and relocation or scattering of burned human remains is especially challenging.

The taphonomic variables discussed in this presentation are but a handful of examples that must be considered for reconstructing and analyzing burned human remains. Each fire scene is unique because of the infinite combinations of materials and circumstances that are involved during a fire. The general principles discussed include standards utilized in the field of fire investigation. The human body adds a unique component that combines the investigative techniques and the expertise of arson, forensic pathology, and anthropology.

Taphonomy, Burned Bone, Fire Death

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