A126 Differential Temperatures of the Human Body and Fire

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After attending this presentation, attendees will better understand how temperatures external to the body in a fire can be more than 1,000°F-1,600°F, but the internal core temperature of the body does not rise by a single degree until a later interval of the fire (20-30 minutes).

This presentation will impact the forensic science community by providing documented time and temperature ranges in relation to heat-related changes of the body.

In taphonomic research, ambient temperatures are considered a key variable that affects the body's rate of decompositional changes over time. Temperature is also highly important in fire research since heat produces the burn patterns that are observed on the body at the crime scene or morgue. Aside from industry standard crematorium temperatures, there is scant data on temperatures at which the human body burns externally and internally.

Experimental fire research captured the temperatures around and inside the body using data loggers, Type K thermocouples, and digital photography. Three adult cadavers were placed inside of two structures and one outdoor fire with wood and ignitable liquids. Small incisions were made in the abdomen and a thermocouple wire was inserted a couple of inches into the liver. External temperatures of the interior structure along with internal liver temperatures were recorded. Fires burned for 8 to 50 minutes. For the structures, fire went through the stages of: incipient growth, development, fully developed, flash over, post flashover, and decay. Each of the stages has the capacity to inflict burn injury to the skin, fat, muscle, and later, bone. During the first five minutes of growth and development of the fire, temperatures increased to 1,500°F inside the structures with full involvement of the fire. The internal body temperature did not raise a single degree in less than ten minutes of burning.

The first structure fire (S1) burned for eight minutes with flashover occurring at four to five minutes and maintaining temperature for an additional three minutes prior to water extinguishment by the San Luis Obispo Fire Department in California. Temperatures climbed after three minutes up to 1,500°F at the floor and ceiling. Ignitable liquids were used to start the fire on the body as a suicide-by-gasoline in a room with a corner origin. After an eight-minute structure fire, the body was transformed into a charred mass of shrunken muscles with bone exposure of the extremities. The wrist fractured and the ankles broke away at the distal tibia and fibula. Exposed bones were charred and calcined for the feet, ankles, lower legs, distal arms, hands, face, and head. The internal body temperature did not change.

The second structure (S2) burned for 25 minutes with flashover occurring by three to four minutes with floor temperatures that peaked at 750°F and remained below 600°F for ten minutes until water suppression. Ignitable liquids were used to start the fire with a body inside of a shed full of combustible materials. At 22 minutes, the body had visible calcination of the face, head, and ribs during the fire. The suppression crew hit the body directly with a straight stream of water, which caused displacement and fragmentation of the fragile burned bones and superficial soft tissues. Sections of the calcined face, skull, and ribs were blasted off of the body, thus altering the final condition. There were no significant temperature changes in the internal body.

The outdoor fire (O1) burned for 50 minutes with temperatures peaking at 1,700°F after the first ten minutes,

then hovered around 800°F for the duration of the fire. The body was on top of wood pallets, with more pallets placed on top along with other brush and started with ignitable liquids. The lower arms and legs were calcined, with charred and calcined bones of the head. The internal body temperature rose above 200°F after 18 minutes of burning and increased to 380°F by the end of the 50 minutes. By this point, the liver and other internal organs were exposed and charred. Bones of the head and extremities were exposed with patterned charring and calcination.

The results demonstrate that the external temperatures can reach 1,200°F-1,600°F or higher in the fire environment, but that the internal temperatures of the organs and soft tissues remain unaffected until after the first 20-30 minutes of burning. It also illustrates the variation in temperature for structure (ventilation-controlled) and outdoor (ventilation-driven) fire environments responsible for creating the burn patterns to bone that are examined by medical examiners and forensic anthropologists.

Burned, Temperature, Taphonomy