H86 The Design and Validation of a Finite-Element Body Cooling Model for Calculating the Postmortem Interval

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After attending this presentation, attendees will be informed regarding: (1) the latest developments in this research area; and, (2) the theory behind the mathematical cooling model and the performance of that model.

This presentation will impact the forensic science community by presenting a new model that has been validated using a body donation program and that describes the cooling of bodies much more accurately than current models.

Estimation of the time of death is an important issue in forensic medicine and may be one of the decisive factors in the investigations of homicidal deaths. For determining the time since death in the early postmortem period, body temperature is a commonly used parameter, a technique introduced in the 19th century. Since that time, many models have been developed to determine the time since death by measuring the body temperature, ranging from very simple one-parameter to complex models. The model that is routinely used in forensic practice is the empirical model by Henssche. The model is based on the assumption that every body follows a "typical," empirically derived cooling curve. This "typical" cooling curve is modeled by an exponential cooling rate, with the power of the exponent determined by the environmental temperature and the weight of the victim. Because the currently used empirical models are based on "typical" cooling curves, they will apply, in principle, only to those cases in which the victim has "typical" body dimensions, has a "typical" posture, is still intact, and is lying on a "typical" surface. To correct deviation from this standard correction, factors are applied. Resulting errors in the time-since-death estimation vary from 3 hours up to almost 12 hours on 20-hour timescales, making the results very unreliable.

This study developed a numerical model to determine the time since death based on body cooling kinetics. This model is based on the heat exchange in a final element grid. The advantage of the finite volume approach is that the posture and body dimensions are inputs to the model as well as the surroundings of the body, such as contact surface, (partial) submersion in water, partial coverage by clothes, etc. Furthermore, not only the core temperature will be sampled, but also the temperature on other different locations, such as the extremities, chest, and head. All these positions on the body have specific cooling rates, which will give, for each moment in time, a unique set of temperatures, which allow for an accurate optimization of the model. A literature search shows that exploratory work is performed using this approach but, when reviewing this literature, it becomes clear that a balance had to be found between technical accuracy and usability in forensic practice.

The model that will be presented requires input parameters, such as the dimensions of the victim's body. A better estimation of these parameters leads to a more accurate calculation of the time since death. The feasibility to use medical imaging techniques (Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) scans) to assess the body composition was investigated in collaboration with the department of radiology.

The thermodynamic theory behind the model will be presented as well as the performance of the model in controlled conditions. For this internal validation, this study measured the cooling dynamics of bodies at the morgue of the hospital using the body donation program. The results of this internal validation will be used to develop a statistical model, which will report the time of death and the confidence intervals. The results will be compared with the current gold standard, the Henssche model.

Body Cooling, Mathematical Model, Time of Death