G76 Estimating Time-of-Death by Body Temperature Analyses - A New Mathematical Strategy

Anthony T. Paganini, PhD, Michigan State University, A519 East Fee Hall, Division of Anatomy, Department of Radiology, East Lansing, MI 48824; and Thomas Adams, PhD, Michigan State University, Department of Physiology, 2240B Biophysical Sciences Building, East Lansing, MI 48824*

After attending this presentation, attendees will learn of a revised curve-fitting method of postmortem estimation of time-of-death by body temperature.

This presentation will impact the forensic community and/or humanity by presenting a new way of analyzing temperature data without making a priori assumptions regarding postmortem cooling rates or involving measurement of complex heat transfer parameters

Accurate determination of a patient's time-of-death is routine in a hospital, nursing home, hospice, or other well-monitored setting. It is more difficult when death occurs alone at home, at an isolated hunting site, in a vehicle in a remote area, at a crime scene or at some other unsupervised site. Time-of-death (TOD) nonetheless provides crucial information required in many clinical and forensic investigations.

Numerous techniques have been used for the past fifty years to estimate TOD, including quantitative analysis of body tissue and fluids or qualitative staging of rigor mortis, postmortem lividity, putrefaction, or mummification of the decedent's remains (6). Sequential and precise measurements of the change in deep body temperature during the postmortem period have been also been employed by numerous investigators (3). The amount of postmortem temperature data collected is practically limited by the amount of time the medical examiner is allowed access to the body by police and the stability of the environment in which the body was found.

Previous investigators have developed equations (2, 4) or intricate finite-element computer simulations (5) to predict postmortem body cooling from analyses of empirical data collected from the recently deceased and from tests on manikins. In most cases these analyses use three or fewer postmortem data points and impose, a priori, a multi-exponential curve fit. Data presented here are a first-order attempt using a thermodynamic model and non-linear regression with at least ten postmortem data points.

We are developing mathematical and curve-fitting techniques to construct an analytical model for which body cooling rate is deduced and from which time-of-death is estimated. Data for this model require measurements of internal body temperature during postmortem cooling at matched clock times, although not necessarily at regular intervals. Inexpensive, portable temperature monitoring and logging devices facilitate making these measures are currently available. An estimate of the person's body temperature at death and ambient temperature are also required, as are data about body weight and the quality of clothing or other body covering. Data about the person's physical activity immediately prior to death, medication history, environmental conditions, and exposure circumstances provide useful ancillary, but not essential information. The analyses are equally valid for people whose bodies are found in water or in air. Data analyses are made either with programmable calculators or with standard spread sheet programs. Time-of-death is reported as a range depending on the strength of the correlation coefficient revealed by curvefitting data for the fall in multiple postmortem body temperatures. Interpretations of preliminary analyses for people whose postmortem cooling rate is recorded in a monitored environment as well as bodies found at crime scenes are providing important information to amend the mathematical model, increase its validity and improve the precision for estimating time-of-death by temperature.

References:

1. Adams, T., Heat Stress, Chp. 98 in Patty's Toxicology 5th Ed. E. Bingham et al. editors, John Wiley, 2001.
2. Henssge, C., Death time estimation in casework, I. The rectal temperature time of death nomogram, Forensic Science International, Vol. 38, pp. 209-236, 1988.
3. Knight, B., The evolution of methods for estimating the time of death from body temperature, Forensic Science International, Vol. 36, pp. 47-55, 1988.
4. Lynnerup, N., A computer program for the estimation of time of death, Journal of Forensic Sciences, Vol. 38 (4), 816-820, 1993.
5. Mall, G. and Eisenmenger W., Estimation of time sine death by heat-flow Finite-Element model. Part I: method, model, calibration and validation, Legal Medicine (Tokyo), Vol. 7, pp. 1-14, 2005.
6. Spitz, W., Medicolegal Investigation of DeathGuidelines for the Application of Pathology to Crime Investigation, Charles C. Thomas, Springfield, 1993.

Postmortem, Time-of-Death, Temperature

 ** Presenting Author*