A123 A New Approach to Estimating Accumulated Degree Days (ADD): Using Binary Observations From Various Regions of the Body With Random Forest Modeling (RFM) and Geographic Information Systems (GIS)

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After attending this presentation, attendees will understand a new approach to estimating ADD to more accurately estimate the Postmortem Interval (PMI) by using binary observations from several regions of the body in conjunction with RFM and GIS.

This presentation will impact the forensic science community by offering an alternative approach to estimating ADD that will result in less-biased estimates by examining discrete features as opposed to components or arbitrarily weighted suites of characteristics, which leads to more accurate estimates of ADD.

Estimating PMI has long been a focus within the medicolegal community, particularly once rigor and algor mortis have passed as potential indicators of PMI. Currently, the most prominent method for estimating ADD is Megyesi and colleagues' Total Body Score (TBS).[1] Megyesi et al. have provided qualitative observations for three anatomical regions (head and neck; trunk; and limbs) that are assigned weighted scores and summed together to provide a quasi-continuous score that can be used to estimate ADD.[1] The model provided by Megyesi et al. resulted in an r^2 value of 0.84 for log 10 transformed ADD and squared total body score.[1] The current study seeks to improve ADD estimates by incorporating information from more anatomical regions and by using discrete binary (presence or absence) traits and advanced statistical models.

Ten donors received at the Forensic Anthropology Center were selected for the current study. For inclusion in the study, a donor must have had a known time of death, had not been subjected to an autopsy, and did not possess any overt trauma that might disrupt normal decomposition. Each donor was placed in a freezer for at least 24 hours before placement to ensure each donor was at the same temperature before placement. The ten donors were placed in a transect at the Anthropology Research Facility in a section designated for research. Donors were kept in body bags until they had reached ambient temperature.

A binary scoring list was developed for 16 regions of the body to be scored independently of one another. The 16 regions of the body scored include: (1) head and neck; (2) left upper arm; (3) right upper arm; (4) left lower arm; (5) right lower arm; (6) left hand; (7) right hand; (8) left upper leg; (9) right upper leg; (10) left lower leg; (11) right lower leg; (12) left foot; (13) right foot; (14) chest; (15) abdomen; and, (16) genitals. Each region was scored with the same list of 39 binary observations that examined bloating (6 observations), skin coloration (2 observations), purge (4 observations), skin appearance (14 observations), and insect activity (13 observations). Additionally, the head and neck region included two additional observations relating to retention of the scalp. In sum, each body was evaluated for the presence or absence of 626 traits each day from placement (at ambient temperature) through 2,000-averaged ADD.

Data were subjected to RFM regression using 1,000 trees and a maximum of five random variables tested at

each node. The data were partitioned into a 70% training set, 15% validation set, and 15% test set. Each region was tested individually in addition to the entire body.

Known ADD was plotted against estimated ADD from the RFM regression, resulting in r^2values ranging from 0.74 (right foot) to 0.96 (all regions). Additionally, estimated ADD scores, from the regression, for each region were used in GIS to display heat maps showing the decomposition of each region for each donor and also to conduct hot spot analysis. Further, the individual heat maps were summed to create a general model displaying overarching trends in decomposition progression, which was also subjected to hot spot analysis. The heat maps reveal that the abdomen, genitalia, and upper leg decompose more rapidly than the rest of the body. Additionally, the right upper limb, chest, and feet exhibit significantly different hot or cold spots as compared to contiguous body regions.

Results indicate that using discrete observations from anatomical regions in conjunction with RFM provide excellent estimates of ADD that can be used to confidently estimate PMI.

Reference(s):

1. Megyesi M.S., Nawrocki S.P., Haskell N.H. Using accumulated degree-days to estimate the postmortem interval from decomposed human remains. *J Forensic Sci.* 2005; 50(3):618-626.

Forensic Science, Forensic Anthropology, Time-Since-Death Estimation