G73 Applying Statistical Principles to the Entomological Estimation of Postmortem Interval

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After attending this presentation, attendees will understand how four statistical principles apply to the estimation of ambient temperature necessary to enable the entomological estimation of postmortem interval. Specifically, attendees will understand how estimate precision, random variation, sufficient sample size and sampling breadth, and the choice of estimation model (e.g., linear, non-linear) should be considered and taken into account when postmortem interval ambient temperatures are estimated.

This presentation will impact the forensic community and/or humanity by highlighting how the consideration of four statistical principles can inform the estimation, accuracy, and precision of the postmortem interval, as made through entomological techniques.

After attending this presentation, attendees will understand how four statistical principles apply to the estimation of ambient temperature, which is required for estimation of postmortem interval using entomological evidence. Specifically, attendees will understand how estimate precision, random variation, sufficient sample size and sampling breadth, and the choice of estimation model (e.g., linear, non-linear) should be considered when postmortem interval ambient temperatures are estimated.

This presentation will impact the forensic sciences community by highlighting how the consideration of four statistical principles can inform the estimation, accuracy, and precision of the postmortem interval, as made through entomological techniques.

By examining the type and developmental stage of insects found on remains, entomological techniques can provide an estimation of the time since death or the postmortem interval. Insect development is highly dependent on ambient temperature, therefore, estimate using insect evidence require determination of the temperatures that the remains were exposed to following death. While these exposure temperatures can be readily determined in many cases, in others, when no temperature recordings are available, they must be indirectly estimated, often by examining the relationship between the temperatures at the site where the remains were found and those recorded at a nearby weather station. This relationship can be determined by taking temperature recordings at the site where the remains were found for an extended period of time following their recovery and comparing these with the temperatures recorded over the same period of time at the nearby weather station. Using the statistical techniques of regression, the relationship between these two measures can then be defined by a suitable mathematical equation that, for a given weather station temperature, can provide an estimate of the corresponding temperature at the site where the remains were found.

However, because these temperature estimations are obtained by the mathematical regression modeling of the relationship between two sets of measured values, the application of four statistical principles can enhance the accuracy and precision of the estimated temperatures. First, because both sets of temperature measures are affected by random variation, the resulting regression model will be inherently imprecise—that is, single unique temperature values cannot be precisely predicted but, more realistically, a range of compatible temperature values can be determined. This range of compatible values is identified through the calculation of the "confidence interval for an observation" [1: 275-278] for each temperature estimated.

Second, because the precision of any given model will improve (i.e., the range of compatible values will narrow) according to the number of pairs of measurements available for model development, a sufficient number of temperature pairs should be included in the data collection used to develop the model. Third, it is also important to ensure that a sufficient number of comparative temperature pairs are collected over the full range of expected values (i.e., the range of temperatures that the remains were estimated to be exposed to prior to being found). If this is not done then 'outlier' temperatures will need to be estimated by extrapolating the model beyond the range of values that were used for its development. Because such extrapolated estimates assume that the relationship between the two sets of temperatures is the same beyond the measured values as it is within the measured range, erroneous temperature estimates will result when this assumption is not met. Of course, ensuring that the assumption applies in a given circumstance requires that actual temperature measures be collected across a sufficiently broad range of values.

Fourth, while a straight line (i.e., linear) relationship is often expected to best model the relationship between two measures, this is not always the case. As such, to enhance the accuracy of the temperature estimates, the type of relationship between the two sets of temperature measures should be appropriately

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studied so that the applicable mathematical model (i.e., linear or one of the many non-linear possibilities) for each set of temperature data can be accurately determined. In fact, it is possible that different models may be required for different parts of the same set of data (e.g., day versus night). For example, because of the characteristics of a setting where remains were found, temperatures at that site might be found to be generally higher during the day, but lower at night (in comparison to the corresponding weather station temperatures), thus necessitating the development of two distinct models to be used to estimate the applicable temperatures, according to the time of day.

During the presentation, examples illustrating each of these statistical principles, and their applicability and impact upon the entomological estimation of postmortem interval will be demonstrated and discussed.

Reference:

1 Glantz SA. Primer of Biostatistics (Sixth Edition). New York, NY: McGraw-Hill, 2005.

Postmortem Interval, Statistics, Entomology