H82 Development of a Statistical Model to Determine the Postmortem Interval (PMI) Using the Human Skin Necro-Microbiome

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The goal of this presentation is to educate attendees regarding the new predictive algorithm that was developed for determining the PMI using skin swabs of decomposing human cadavers.

This presentation will impact the forensic science community by reporting the development of a regression model which accurately predicts the PMI (to within ~2 days) of a decomposing human cadaver using bacterial skin swabs.

Efforts to establish new and more accurate methods to estimate the PMI of a human cadaver discovered in an uncontrolled environment have thus far met with limited success; however, breakthroughs in the ability to quickly, cheaply, and quantitatively analyze bacterial populations in the tiniest of samples have opened new avenues for these efforts. Thus far, much necrobiome research has focused on the gut microbiota; however, the bacteria of the skin might be a superior choice in this endeavor for a variety of reasons.

In this pilot study, bacterial swabs were collected from the ear and nasal canals of decomposing human cadavers at the Anthropological Research Facility at the University of Tennessee at Knoxville. Total DNA was extracted from the swabs and 16S rRNA metagenomic sequencing was performed, followed by complete phylogenetic analysis to identify all bacteria in the samples and their relative abundance. The data were then transformed to allow consideration of all taxonomic levels (species, genus, etc.): ear-only, nose-only, or jointly considered data; and curated versus non-curated lists of bacterial taxa. These variables were considered simultaneously using a variety of computational models, specifically regressors, each with their own advantages and disadvantages, which plotted the behavior of the various bacterial taxa as a function of time, that is, the progression of decomposition in an uncontrolled environment.

The goal of this computational analysis was to establish a predictive model such that the unknown PMI could be determined using skin bacterial swabs. To that end, these efforts have been successful. It was discovered that the k-nearest-neighbor regressor (at $k = 4$) can be used to predict the PMI of untested samples with an average accuracy of within 55 Accumulated Degree Days (ADD), which represents about two days in the summer months in most of the United States. It was also found that, quite surprisingly, higher taxonomic levels were more informative than lower taxonomic levels, increasing the likelihood that results of this pilot study will be generalizable. In addition, considering data from both ear and nose swabs is far more powerful than either alone, as is considering the entire dataset, rather than a manually curated list, another surprising result. In sum, this pilot study yielded a robust statistical model that performs well when challenged to predict the PMI using only bacterial swabs from the skin of a decomposing human cadaver.

Microbiome, Postmortem Interval, Computational Biology