H66 World Trade Center Revisited: A Bayesian Approach to Disaster Victim Identification

Benjamin J. Figura, MA, New York City Office of the Chief Medical Examiner, 520 First Avenue, New York, NY 10016*

The goal of this presentation is to demonstrate to attendees the potential of a multivariable identification process using Bayesian statistics in a mass fatality context. The specific variables presented include anthropological estimates of age and sex, dental information, and recovery location and uses the World Trade Center disaster as an example.

This presentation will impact the forensic science community by providing an alternative approach to victim identification for disasters featuring highly fragmented and/or degraded remains and where traditional identification methods have reached their limits. The approach presented utilizes fragments of data deemed insufficient for identification based on a single modality.

Disaster victim identification (DVI) for mass fatality incidents involving highly fragmented and/or degraded remains is a difficult process because the individuating information that is required by the various identification disciplines is often limited. For example, the roughly 9,000 unidentified remains from the World Trade Center (WTC) disaster possess varying amounts of anthropological, odontological, and/or DNA data that go unused because none is sufficient for identification on their own. Further, information such as recovery location is often available but never directly utilized in the identification process. Steadman et al. (2006)[1] recently demonstrated how age, sex, stature, pathology, and dental data may be combined in a Bayesian framework to generate a statistical statement regarding the relative strength of a single circumstantial identification. The goal of this research is to apply the Steadman et al. approach to combine age, sex, dental, and recovery location data in a mass fatality context, where a defined victim population presents practical and statistical advantages. This approach incorporates the concept of a *statistical threshold for identification* as currently used for direct DNA-based identifications of WTC remains (Posterior Odds > $4x10^9$).

Ante- and postmortem data from the WTC disaster were utilized in this research. Likelihood ratios were calculated for each theoretical combination for the following variables:

Age: Likelihood ratios were calculated for age based on estimates using the Suchey-Brooks (1990)[2] method for the pubic symphysis for each theoretical combination of Age and Phase. The WTC victim age distribution was used as the prior odds and data collected by Hartnett (2010)[3] was used as a reference sample.

Sex: Likelihood ratios were calculated for sex based on estimates using the Phenice (1969)[4] characteristics with the WTC victim sex distribution as the prior odds. Data collected by Konigsberg et al (2002)[5] was used as a reference sample.

Dental: Likelihood ratios were calculated for the available dental patterns of the unidentified WTC remains based on the expected pattern frequencies in the "population-at-large" according to the Odontosearch application (Adams 2003).[6]

Recovery Location: The WTC victim population was divided into subgroups based on known location at the time of the incident (Tower 1, Tower 2, AA 11, UA 175, etc). Likelihood ratios were calculated for membership within a particular WTC subgroup based on the recovery location of the remains (grid system established by the New York City Fire Department). Likelihood ratios were determined for each combination of group and location using the location of identified remains as a known sample and the total number of remains recovered at each location as the prior odds.

The average likelihood ratios calculated for age, sex, and recovery location are comparable to the contribution of individual CODIS STR alleles. The available dental patterns were more informative, with likelihood ratios ranging from just above 1 up to 37,956. Combining these variables using the Product Rule under a theoretical "best-case" scenario produces a likelihood ratio of $8.3x10^6$, which does not meet the established threshold for identification ($4x10^9$). However, it does result in a smaller required contribution from any potential DNA evidence. These results suggest that partial DNA profiles may be sufficient for identification if other available information is considered within a Bayesian framework.

The consideration of additional variables beyond DNA in a quantitative manner allows for a truly multidisciplinary DVI process and has the potential to allow for identification of highly fragmented and/or degraded remains that might not otherwise be identified. The quantification of these variables also has the potential benefit of providing a mechanism for ranking of database search results similar to dental identification applications.

References:

 ** Presenting Author*

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 ** Presenting Author*