H105 DNA Preservation of Skeletal Elements From the World Trade Center Disaster: Some Recommendations for Mass Disaster Management

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After attending this presentation, attendees will learn which degraded skeletal elements recovered from a mass fatality incident are more likely to yield DNA for identification. Additionally, the authors will discuss management implications inherent in deciding which elements to sample for DNA identification.

This presentation will impact the forensic community and/or humanity by providing sampling protocol recommendations for forensic scientists/anthropologists who work in mass disaster identification.

When antemortem information is available, fingerprints and dental radiographs are more efficient than DNA for identifying intact victims. However, when antemortem information is not available or in cases of extreme body fragmentation, remains often can only be identified through DNA. Temperature, humidity, UV light, decomposition, soil microbes, fire, water, mold and other factors all contribute to the degradation of DNA in human tissue. Many studies have measured DNA degradation rates for bone and tissue subjected to heat, fire, water, burial in soil and time. Previous studies have also concluded that DNA degrades in different human organs at different rates, with liver and kidney tissue showing rapid degradation and brain tissue showing slow degradation. Additionally, research has demonstrated that bone preserves DNA better than soft tissue, since the structure of bone acts as a physical barrier to the external influences that can readily degrade soft tissue. Because the World Trade Center victim identification effort highlighted many of the confounding taphonomic factors that influence DNA preservation, the differential recovery rates of DNA between skeletal elements were examined.

DNA has been employed in disaster victim identification (DVI) for over 15 years. Initially, DNA was used as a last resort, usually when fingerprints, radiographs and dental records were not available. More recently, DNA has been used to reassociate larger, anatomically identifiable body parts, while smaller pieces were grouped as untestable common tissue. In 2000, DNA was first used as the sole method of identification for the 155 victims of the Kaprun cable car fire in Austria. Since then, the use of DNA has increasingly become the primary method of identification for victims of mass disasters and has become the most reliable method of reassociating even the smallest fragments. In any mass disaster, DNA sampling protocols have a ripple effect throughout the identification process, as small changes in these protocols may result in substantial savings in time and expense, and may greatly influence DNA identification rates.

Despite the prevalence of using DNA in DVI, the literature contains relatively little information regarding the variability in DNA identification success rates between different skeletal elements. Hence, little research has been conducted into which elements are most suitable for DNA testing. Yet, choosing the most effective bone for sampling is crucial in the identification process. Anecdotal statements have suggested that long bone fragments, such as femur and tibia, are better for DNA sampling than cranial or rib fragments. However, these findings remain unconfirmed by DNA studies and are not supported by the present study. Using a subset of remains from the World Trade Center dataset, the variability in DNA identification rates between different skeletal elements were examined. The subset consists only of recovered bone fragments that were smaller than 4” and that were submitted in their entirety for nuclear DNA testing. Due to their size as well as the unique combination of taphonomic insults they had been subjected to, these remains are among the most challenging to identify from mass disaster sites.

Due to the unique nature of the World Trade Center disaster, it is proposed that the results of this examination represent a ‘worst case scenario’, which could be used to help establish sampling standards and protocols aimed at maximizing DNA identification rates from fragmented human remains. These recommendations are used to highlight potential challenges that undoubtedly arise during mass fatality incidents that involve severe fragmentation of remains.

Taphonomy, Skeletal Element, Mass Fatality Incident

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