A NOVEL APPROACH TO IDENTIFYING OPTIMAL COLLECTION LOCATIONS OF TRACE LEVEL DNA EVIDENCE

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In 2005, the Government Accountability Office (GAO) published a report criticizing the various agencies involved in the response to the 2001 Amerithrax attack, citing their failure to use probability sampling in initial strategies, thus reducing the level of confidence in a negative result. The same principle could be applied to the analysis of a crime scene involving human DNA evidence. Although guidelines for the collection and preservation of DNA evidence at a crime scene are well-documented, there has not been an empirical study of the probability of finding trace levels of DNA at various sites within a crime scene.

A goal of this project is the development of a general, empirical model that can be used to apply probability sampling techniques to the collection strategy to aid in the recovery of DNA at the scene of a crime. We theorize that the locations of low-level DNA samples in a particular space will depend on the donor, and the extensive space air diffusion that occurs in a ventilated room. We have employed a powerful mechanical engineering tool, computational fluid dynamics (CFD) to model the transport and deposition of human cells and DNA material in an enclosed air space with the goal of predicting optimum sample locations throughout that space. CFD is a modeling technique in which computer algorithms are applied to the analysis of fluid flows. The particulars of a space (e.g. volume, flow rates, vents) are variable included in the millions of calculations used to simulate the interaction of fluids and gases with complex surfaces.

Building upon previous studies, CFD modeling was applied to: 1) a controlled collection chamber and, 2) a typical office, to identify the locations at which there was a high probability of finding trace levels of DNA. Using this technique, low levels of DNA were collected from areas that would not normally be sampled, thus representing evidence that would have been lost in the absence of CFD modeling. The samples were analyzed using standard genetic profiling techniques and the application of low copy number profiling protocols including miniSTR analysis allowed for the recovery of additional genetic information.

These data suggest that CFD modeling may be used to aid in the successful sampling of crime scene DNA.