B7 Improving the "Front End" of DNA Analysis and Trace Evidence Collection Through a Versatile Vacuum-Based Device

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Learning Overview: After attending this presentation, attendees will understand: (1) the current status of sample collection at crime scenes and in the lab; (2) the challenges that exist; (3) the potential improvements in sample collection; and (4) the development of a novel device created for this purpose.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by highlighting the improvement of the "front end" of evidence/sample collection and by providing an alternative tool that could significantly improve our ability to obtain the most information from often cryptic evidence commonly encountered at crime scenes.

Much of the evidence found at crime scenes exist in trace amounts. Low template (LT) DNA, chemical residue, small particulates and fibers are all commonly encountered trace evidence that can be critical to forensic investigations. With respect to DNA analysis the vast majority of research has focused on improving the downstream analysis steps, whether through increasing the sensitivity of PCR or by developing interpretation guidelines for LT DNA profiles. While advances have been made in these areas of the analysis workflow, much of the stochastic errors and amplification artifacts still remain a problem. In contrast, little work has been done on enhancing the "front end" of the DNA analysis workflow such as sample collection. Currently sample collection of touch DNA, particulates, liquids and fibers, involves either swabbing or tape lifts. Studies have demonstrated the short comings of these methods especially with respect to DNA collection with swabs. Much of the DNA collected remains trapped within the fibers of the swab during extraction which makes downstream analysis of already low amounts of sample more difficult.

The goal of this study was to develop a novel collection method that would improve the amount of sample recovered and released during extraction which would in turn eliminate many of the problems encountered downstream. To this end a Venturiq based vacuum device (VVD) (Patent Pending US20170212015A1) was designed and implemented. The VVD is field portable, and through the use of various attachments can handle a variety of sample collection tasks in both wet and dry modes. The current study completed three trials for Initial evaluation of the VVD.

Trial 1: 100 individuals touch samples were obtained through the manipulation of sterilized stainless-steel bars and the resulting samples collected with the VVD were subjected to DNA extraction and quantification using real-time PCR. *Trial 2:* A known number of microscopic pollen grains were applied in solution to cotton fabric and allowed to dry followed by collection using the VVD and repeated two more times. The collected pollen grains were then counted to determine the collection efficiency. *Trial 3:* To demonstrate the ability to collect sample from within a large object in the field the device was applied to collect a fungal pathogen growing within the interior of a living tree, the resulting sample was then plated onto agar plates to confirm growth of the fungi. The results from trial 1 demonstrated an average of 2.16 ng (± 4.94 ng) of genomic DNA and 1.82×10^5 total copy number ($\pm 4.02 \times 10^5$) of mtDNA were recovered for potential profiling and analyses. Trial 2 resulted in 70% (± 9.4 %) of the pollen being recovered. Lastly trial 3 resulted in the successful growth of fungal spores collected from the interior of the tree on malt extract agar plates.

The results of the three trials demonstrate the ability of the VVD to collect a variety of sample types successfully. Further evaluations are underway to optimize the device and evaluate its ability to collect additional forensically relevant samples from various substrate and surface types including rough surfaces.

Sample Collection, Vacuum, DNA