E42 Validation of a Dry Vacuum Swabbing Method for the Recovery of Epithelial Cells From Handled Porous Substrates

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Learning Overview: After attending this presentation, attendees will understand the value of employing an efficient collection technique for the analysis of touch-based samples and be able to evaluate the application of dry vacuum swabbing on commonly handled porous evidentiary materials.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing validation data supporting the use of an alternative collection technique, a dry vacuum swabbing method, for handled porous items of evidence for genetic analysis. Evaluation of the efficiency, reliability, and potential limitations of this collection methodology will help analysts decide under what conditions it could successfully be applied to forensic casework.

Analysis of low template touch DNA samples has always been a challenge for forensic analysts. Over the years, the field of forensic science has seen numerous improvements in technology in terms of analytical approaches and reaction chemistries that have been made commercially available to improve the quantitative and qualitative recovery of such samples. However, in order to increase the initial yield of recovered DNA, optimization of the collection technique applied is just as crucial to the DNA workflow.

Several collection techniques have traditionally been employed in the collection of touch-based samples in crime laboratories. More recently, a commercially available wet vacuum collection application has also been applied to casework samples. Each of these techniques have their own benefits and challenges, some working better on more non-porous substrates, others working better over larger surface areas, and some showing poor recovery of epithelial cells.

Several mock items of evidence were handled, then samples were collected using several collection techniques: double swabbing, scraping, tape lifting, and the in-house dry vacuum swabbing technique. Substrates evaluated in this study included an array of commonly encountered porous substrates submitted for touch DNA analysis, such as articles of clothing and rope. In one scenario, individuals wearing long-sleeved cotton shirts were dragged across the floor by their arms. Each of the collection techniques were applied in an attempt to target the “suspect” versus the “victim” DNA. Statistically significant increases in the amount of recovered quantifiable DNA were observed when using the dry vacuum swabbing technique (F_s=8.270; df=3,28; p=0.0004) when compared to the other collection techniques evaluated. This subsequently resulted in the generation of robust, high-quality Short Tandem Repeat (STR) profiles in which 100% of the “suspect’s” alleles were detected. In contrast, traditional collection techniques produced lower quality STR profiles with a high degree of allelic dropout. In another scenario, “victim’s” hands were tied together by the “suspect’s” using natural fiber rope. Once again, all collection techniques were utilized and evaluated. Samples from the middle of the rope (the portion in contact with the “victims”) were collected separately from the ends of the rope (those in greater contact with the “suspects”). Once again, downstream genetic analysis showed that the dry vacuum swabbing collection technique recovered the highest quantity of DNA from the rope ends when compared to all other collection techniques assessed, recovering 80+% of victim and perpetrator profiles from both the center and ends of the rope, respectively. Recovery of low-level touch DNA from simulated sexual assault scenarios in which “suspects” forcibly removed “victim’s” denim jeans and bra also showed drastic differences between the performance of the assessed techniques, with the dry vacuum swabbing collection technique recovering an average of 3.81% more male DNA attributable to the “suspect” than the other collection techniques.

As the number of touch type DNA samples being submitted for casework analysis continues to rise, it is imperative that front-end optimization is achieved to bolster the success of downstream analyses. While recovery of touch DNA has historically been challenging for forensic analysts, this research has proved that the dry vacuum swabbing collection technique may be an ideal workflow solution for the efficient recovery of epithelial cells from porous substrates, especially in instances in which targeted collection is needed to avoid wearer or “victim” DNA. Additionally, this technique is easy and cheap to assemble in a forensic laboratory and does not require the purchase of dedicated and expensive commercial products.

Touch DNA, Dry Vacuum Swabbing, DNA Collection