B117 Using Bayesian Networks for the Interpretation of Low-Template DNA Profiles at the Activity Level

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After attending this presentation, attendees will understand how to interpret low-template DNA profiles at the activity level using a graphical model and understand more about phenomena like transfer, background, persistence, and contamination.

This presentation will impact the forensic science community by changing the interpretative approach about DNA evidence generally based on source level propositions.

Today, a very limited quantity of epithelial cells deposited on an object can yield to a DNA profile. Such profiles are known under the term low-template DNA. Such sensitivity has opened new interpretative issues, principally because of the uncertainties regarding the nature of the biological material involved, the relevancy of the evidentiary material, and the representativeness of the DNA profile obtained. Interpreting DNA evidence arising from low-template DNA is a challenge yet to be solved. Significant contributions have been made when the case is assessed at the "source" level. Some researchers have started to investigate some of the factors that impact the trace level deposition and the profile quality. It is fair to say that very little is known about combining these variables into a coherent interpretative model and moving the interpretation of these cases from the "source" level to the "activity" level; however, "activity" level propositions should be presented in order to help the court understand the significance of the forensic findings within the context of a criminal case.

When considered in this context, the likelihood ratio reflects more than the mere discriminatory power of the DNA. The likelihood ratio also depends on different phenomena: transfer, persistence, contamination, and background. Each of these is influenced by the others. For example, the transfer phenomenon can be affected by the shedder's quality, the substrate's quality, and the nature of the contact; on the other hand, the persistence is dictated by the substrate quality, exogenous factors (i.e., temperature, humidity rate, light exposure, etc.), and the time between the evidence deposition and collection.

The purpose of this doctoral research is to design a graphical model (in the form of Bayesian networks) for solving the probabilistic relationships between parameters that are of relevance to the interpretation of a low-template DNA recovered during a police investigation. The model allows identifying the datasets that are the most relevant to the task at hand. By doing this, it is possible to focus the experimental data-gathering process only on the factors that play a major role. Then the model (appropriately informed with acquired data) allows an assignment of likelihood ratios at an activity level in a range of scenarios. In the end, a sensitivity analysis shows the robustness of the proposed model even in the presence of uncertainty in this forensic field.

Vehicle thefts have been selected from among the various forensic scenarios. This scenario presents several advantages compared with the others. First, different types of substrate are present in a car; second, the presence of the victim (the car owner) can be assumed/integrated into the graphical model.

According to the results, the factors having the strongest impact on the likelihood ratio are transfer and the background. These phenomena can also significantly affect the evaluation according to case-specific propositions.

Interpretation, DNA Evidence, Bayesian Networks

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