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CRIME SCENE PROTOCOLS FOR DNA EVIDENCE

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TECHNICAL MEMORANDUM

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The following provides information on the current protocols for the collection and packaging of DNA samples from crime scenes. It also contains information on the potential contamination of evidence and the possibility of recovery of suspects DNA from smeared unidentifiable fingerprints.

The Canadian Police Research Centre is grateful to the authors and to the Forensic Identification Research and Review Section (FIRRS) for permission to reprint this as a Technical Memorandum. For further information, please call FIRRS at (613) 998-6188.

Information sur les règles en vigueur concernant la collecte et la conservation des échantillons genetiques recueillis sur les lieux d'un crime. On y retrouve aussi des renseignements sur la contamination possible des preuves et la collecte de données genetiques à partir d'empreintes abîmées et non identifiables.

Le Centre canadien de recherches policières remercie les auteurs et la Section des recherches et des etudes en identite judiciaire pour lui avoir permis de reproduire cet article comme document technique. Pour plus d'information, veuillez appeler la Section des recherches et des etudes en identite judiciaire, au (613) 998-6188.

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Title/Titre: Crime Scene Protocols for DNA evidence

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OBJECTIVE

The objective of this bulletin is to provide Canadian Forensic Identification (FI) Specialists with current information on topics such as the potential contamination of evidence due to secondary transfer of DNA between exhibits and the possible recovery of a suspect's DNA from smeared unidentifiable fingerprints.In addition, the current protocols for the recovery and packaging of DNA samples from the crime scene are discussed in detail.

INTRODUCTION

Deoxyribonucleic acid (DNA) is a biological molecule that contains the genetic code of an individual and is thus unique to that person. DNA is present in every living cell with only a few exceptions (i.e. mature red blood cells) but degrades with time when the cell dies; the rate of degradation is dependent on temperature, humidity, UV exposure etc. Since the late 1980's [I] forensic scientists have been utilising the DNA present in biological samples such as saliva, semen, blood, vaginal fluid and hair, as a method of identifying either the perpetrators or victims of crime. Typically, a sample is collected from the crime scene or from an exhibit removed from the scene and a DNA profile is generated. The DNA profile is then compared to the profile generated from a known sample obtained from the individual. Only a small portion of the DNA molecule is compared so when the profiles are identical the forensic scientist must give a statistical weight to the evidence which outlines the chance of some other individual having left the sample. When the profiles do not have an identical pattern the DNA from the sample does not belong to the individual.

The analysis of a DNA profile involves several stages; extraction, amplification, separation and comparison. First the DNA is extracted from the specimen and then amplified by a process known as the Polymerase Chain Reaction (PCR). The amplified fragments are then separated according to size using a technique called polyacrylamide gel electrophoresis which generates a bar code-like profile. It is these bar code-like profiles that are compared.

In a letter to the editor of Nature, it was suggested that DNA from cells sloughed off from the outer epidermis of the skin, could be transferred from the individual to an object or to a second individual [2]. In a more recent publication scientists stated "that primary transfer of DNA by handling is possible" but interpreting the results is difficult if not impossible [3]. In addition, they found no evidence of secondary transfer. It was suggested that some individuals slough off many cells and are therefore more likely to transfer their DNA to another surface. Other individuals slough off relatively few skin cells and are unlikely to transfer their DNA.

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This bulletin describes the experiments that were conducted by members of FIRRS in collaboration with scientists in the Central Forensic Laboratory (CFL) to investigate these claims. We wanted to investigate the possibilities of swabbing unidentifiable fingerprints found at major crime scenes for the suspect's DNA. In addition, we wished to confirm that our crime scene protocols were not resulting in the contamination of evidence due to sequential handling of exhibits i.e. accidental transfer of DNA from another exhibit or surface to the murder weapon.

This bulletin has been arranged in order of subject. Included in each section are the experimental details, results and discussion relating to that particular subject. The general recommendations are presented at the end of these sections. The final section describes the correct packaging protocols for DNA evidence that the Identification Specialist needs for processing of the crime scene.

EXPERIMENTS

All samples were processed for DNA according to the laboratory protocols routinely used by the Biology Sections of the RCMP Forensic Laboratory [4].

Assessment of Epithelial Cell Sloughers:

1) The inner surfaces of the hands and fingers of several individuals were swabbed to determine which individuals showed a tendency to slough off epithelial cells from their skin.
2) A small sample of blood was also collected from each individual and processed to determine the DNA profile for comparison purposes.

Most of the individuals sampled had sufficient DNA present on at least one of their hands to generate a complete DNA profile. In several of these experiments the DNA typing showed the presence of DNA profiles from more than one individual. It was possible to interpret such mixtures since the DNA profiles of the donors were known.

Transfer of DNA from an Individual to a Surface:

1) Three sample surfaces were selected, based on the likelihood that they would be encountered in a crime scene; a wooden handled knife, a rubber handled hammer and a plastic telephone receiver. Prior to each experiment the surfaces of these objects were cleaned thoroughly and swabbed to ensure that no DNA was present (control swabs).
2) An individual held the object for five minutes.
3) The surface of the object was swabbed a second time to determine if any DNA had been transferred from the individual.

Two of the control swabs showed a slight presence of DNA but no profile was observed when these samples were analysed. The majority of the processed swabs yielded a full DNA profile of the individual who had been holding the object although a couple contained extra peaks. The remaining swabs had either partial profiles of the subjects or no profiles. One swab yielded a full profile that did not correspond to the individual who had been holding the object. This could be due to a sample being mislabeled or it could suggest that foreign DNA was present in sufficient amounts to overwhelm the DNA of the hand.

Transfer of DNA from a Surface to an Individual:

1) Telephone receivers are handled frequently so it was speculated that a significant amount of DNA would be present on the receiver. Prior to the experiment, the receiver was swabbed to ensure that only the user's DNA was present (control swab).
2) A latex glove was swabbed to determine that no DNA was present (control swab).
3) An individual wearing the glove held the receiver for five minutes.
4) A swab was taken of the glove to determine if DNA had been transferred from the receiver to the glove.

The control swabs of the telephone receivers all yielded full profiles of the users of the telephones and the control swabs of the clean gloves all yielded no DNA. Only a few of the individuals sampled acquired sufficient DNA from a telephone receiver for a full profile of the primary telephone user to be obtained from swabs of their gloved hands.

Transfer of DNA from a Surface to an Individual and then to Another Surface:

1) The wooden handled knife was cleaned thoroughly with a 70% ethanol, and 1:10 bleach solution.
2) The surface of the handle was swabbed to ensure that no DNA was present (control swab).
3) A telephone receiver was swabbed to ensure that only the user's DNA was present.
4) A latex glove was swabbed to determine that no DNA was present (control swab).
5) An individual wearing the glove held the receiver for five minutes and then held the cleaned knife for five minutes.
6) The knife was swabbed to determine if secondary DNA transfer had occurred from the receiver to the knife.

All of the control swabs from the cleaned knife contained no DNA. One control swab from the clean gloves yielded DNA but failed to produce a profile when analysed. Half of the samples had sufficient DNA present for analysis but only a couple yielded full DNA profiles that matched the original telephone user. The majority of the remaining swabs either gave no profile or generated mixed profiles, none of which matched the original telephone user. This illustrates the difficulties associated with swabbing commonly touched surfaces. Even when a full profile is generated it can not be assumed that this matches the primary user of that telephone.

Exchange of DNA Between a Surface and an Individual:

1) The telephone receiver was swabbed to determine it's 'natural state of DNA' i.e. whose DNA was present during normal usage (control swab).
2) The telephone receiver was then cleaned using a 70% ethanol, and 1:10 bleach solution and swabbed again (control swab).
3) After twenty-four hours of regular use an individual held the receiver for five minutes without gloves.
4) Both the receiver and the hand were then swabbed to observe whether any exchange of DNA from the surface to the individual and vice versa had occurred.

The control swabs of the 'cleaned' telephone receiver showed that in the majority of cases not all of the DNA was removed. It is possible that the cleaning of the telephone receiver resulted in other sources of DNA from the mouth piece (saliva) being redistributed over the entire receiver surface. A large amount of original DNA might mean that traces were left after cleaning.

Swabs taken after the telephone had been held gave very confusing results. Sometimes full profiles of both the phone user and the phone holder were observed, but it was equally likely for only the full profile of the phone users to be observed. To further complicate matters, we also observed a profile that matched neither the phone holder nor user.

Only a few of the individuals sampled acquired sufficient amounts of DNA from casual handling of the telephone receiver to yield a full profile of the telephone user.

RECOMMENDATIONS

It would appear that certain individuals have sufficient quantities of epithelial cells present on the surface of their skin to transfer their DNA to foreign surfaces.

The possibility of finding DNA from a surface that has been only handled by one individual does exist. However, it must be emphasized that these were controlled experiments using clean surfaces and individuals whose DNA profiles were known. This made interpretation of the results relatively easy. In a real crime scene any swabs taken from a surface are likely to contain a mixture of unknown profiles that may be impossible to interpret. In light of this, we are not recommending swabbing surfaces in general.

On the other hand, there have been cases reported in Canada where the suspect's DNA was recovered from a "clean" knife and a victim's DNA was found on a belt used in a strangulation. In some jurisdictions in Australia, police officers are now routinely swabbing items found at a crime scene [5]. In Germany, the murderer's DNA was reportedly recovered from the neck of a strangulation victim [6]. We would suggest that at serious crime scenes, the Identification Specialist should consider swabbing smeared prints that are of no value for identification, found near the point of entry. Other surfaces, like some weapons, are notoriously bad for the development of fingerprints, but could yield results for DNA analysis.

Although the controlled experiments described here have illustrated that primary transfer is a possibility, it is not clear that further experiments would yield conclusive results that could be used to predict the likelihood of success in casework. Instead, it is requested that results from casework swabs, positive or negative, be reported to this office, so that some idea as to the likelihood of DNA recovery could be determined. Further work in this laboratory will focus on recovery techniques that could be used for situations in which body fluids are, and are not, visible.

Secondary transfer of DNA occurs when an individual acquires another person's DNA from handling an object and then transfers this foreign DNA to a second surface. Although secondary transfer of DNA was shown to be extremely unlikely to occur, it was possible under these ideal conditions. In light of this, we recommend that Identification Specialists always wear clean gloves when collecting what is presumed to be the murder weapon. Then, should DNA be found on the weapon, which does not match that of the victim, it can be safely assumed that it was not transferred onto the surface during the examination of the scene.

COLLECTION & PACKAGING

General Procedures:

When collecting and packaging DNA evidence there are two important points to remember: avoid contamination of the sample and always dry the sample as quickly as possible.

To avoid contamination of the sample, use common sense. Wear face masks to avoid contaminating a sample with your DNA (sneezing or coughing sprays saliva over a wide area). When handling exhibits that have biological fluids on the surface, change gloves even if the gloves look clean. This prevents the transfer of DNA between exhibits. Prior to handling what appears to be the murder weapon, always change gloves, again even if they look clean. This ensures that any DNA found on the exhibit was present on the surface before the exhibit was handled by the Identification Specialist. Always handle exhibits separately and package exhibits individually in sealed containers. Do not seal sample envelopes with saliva; use a glue stick instead.

Stains containing DNA were originally moist regardless of the type of surface that the stain was deposited upon or the type of biological fluid that was the source of the DNA. For samples that are still moist at the time of collection, the priority is to package the exhibit in such a way that allows an air flow around the surface. At a location where the risk of contamination can be avoided, such as a commercially available evidence drying cabinet [7],the sample should be completely air-dried before being sent to the appropriate Biology Section of the Forensic Laboratory for DNA processing. If wet exhibits are sealed in a waterproof package, bacteria will grow which can degrade the DNA.

Unless hand delivering the exhibits, always package them with protective materials in such a way that they can be opened safely at the Laboratory.

Non-porous,

For biological fluids (blood, saliva, semen etc.) and smeared fingerprints that are observed on a non-porous surface such as linoleum, glass, wood or cement, which can not be removed from the scene, it is necessary to prepare a swab. Using a clean swab moistened with distilled water, rub the surface of the stain or fingerprint several times in order to absorb as much of the residue as possible. Air dry the swab before sealing in a suitable container.

For biological fluids that are observed on non-porous surfaces that can be removed from the scene the exhibit should be air dried and submitted to the laboratory.

Porous:

For biological fluids observed on porous surfaces such as wallpaper which can not be removed from the scene, it is necessary to prepare a swab (described earlier).

For stains that appear on fabric, paper or carpeting, the stain and surrounding area should be cut out of the material and allowed to air dry before packaging in an exhibit bag.

If allowing stains to air dry at the scene is not possible without risk of contamination then wrap the material in clean brown paper and place in a suitable container but do not seal. Dry the sample as soon as possible to prevent bacterial damage.

CONCLUSION

DNA is a powerful piece of evidence that can be used to establish the association of a suspect or victim to a crime scene. Be aware that at a serious crime scene smeared fingerprints or palmprints can be swabbed for possible DNA evidence and remember the Identification Specialist's important role in maintaining the integrity of DNA evidence by avoiding contamination both during the collecting and packaging of this type of exhibit.

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[7] Contact Brian Yamashita, (613) 998-6190.