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Transfer of fibres on the hands of living subjects and their persistence during hand washing

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ABSTRACT

Textile fibres were transferred to the hands of ten living subjects and their persistence was determined after hand washing. Average number of fibres transferred was 300 ± 133 (female 288 ± 92, male 311 ± 163) per 100 cm^2 hand area in the 100 experiments. However the number of fibres transferred was not gender dependent but individual dependent. The hand texture of subjects was compared with the number of fibres transferred but the relationship was not observed. The number of fibres transferred varied significantly for the 10 repeated experiments performed under the same conditions for the same subject.

The subjects were then asked to wash their hands with water. One test group washed their hands with standing water, and the other with running tap water. Afterwards, the number of fibres remaining on the test subjects' hands were investigated. Migration of the fibres on the surface of the observed hands did occur but total loss of transferred fibre after hand washing did not occur. The average number of fibres remaining per 100 cm^2 hand area was 14 ± 10 (range = 3–72) for hand washing with standing water, and 10 ± 12 (range = 0–79) for washing with running tap water. The results of this study show the possibility of finding fibres on the hands of a person involved in a criminal case even after hand washing before fibre collection.

1. Introduction

Fibres are commonly found trace evidence in many criminal cases involving physical contact between an offender and victim because fibres are transferred readily according to Locard's exchange principle. An offender often leaves fibres behind at the scene, on an object or on the victim. Also, the fibres of a victim's garment will transfer to the body or garment of the offender. Any fibres transferred during such contacts can provide valuable evidence of contact because they establish associations between people. However, transferred fibres do not persist for very long after contact. As a result, the transfer and persistence characteristics of fibres have been the subject of many studies.

Previous studies have provided significant experimental data to help interpret evidence of fibre transfer and persistence. Transfer and persistence data have presented on various factors including the pressure [1], time [2–8], secondary transfer [9], fibre size [1,2,7,10], recipient surface [5,6,9,11], weather [8,6], activity [5,12], washing [7,12], and generic class of fibre [7,10]. Regardless of the nature of the transfer involving garments, it has been established that there is a rapid initial loss of fibres [13].

The population, transfer and persistence of fibres on living subjects is another important topic of fibre persistence studies because the actions of a living offender/victim can be major factors in fibre loss [7]. Ashcroft, Evans and Tebbett [14] have shown that fibres transferred from ski masks onto the head hair of a living subject can persist for up to 6 days where hair was not washed, and for up to 3 days even when hair was washed. Salter and Cook [12] studied the persistence of fibres that were transferred onto head hair of a living subject. They showed that running followed by hair washing removed all of the fibres. Palmer and Burch [7] studied the transfer and persistence characteristics of fibres on the skin of living subjects. They transferred target fibres to the bare arms of living subjects and their persistence was determined at intervals up to 24 h, during which normal daily activities including bathing or showering were undertaken. They showed that the fibre loss followed an exponential decay. They also showed that no fibre matching the target garments was recovered beyond 24 h after the initial transfer. Regardless of the nature of the recipient, it has been established that there is a rapid loss of fibres after washing. However, to the best of the authors' knowledge, there is no reported study on the persistence of fibres after hand washing. In many criminal cases, it is not uncommon that the victim or offender washes his/her hands after contact for many reasons: for hygiene, clearing unpleasantness, or to intentionally remove evidence. In such cases, fibre recovery from the hands of the people involved can provide crucial evidence in both

Abbreviations: F[t], number of fibres transferred; F[b], number of fibres remaining after hand washing with standing water in a basin; F[r], number of fibres remaining after hand washing with running tap water; F[ta], number of fibres transferred per 100 cm^2 hand area; F[ba], number of fibres remaining per 100 cm^2 hand area after hand washing with standing water in a basin; F[ra], number of fibres remaining per 100 cm^2 hand area after hand washing with running tap water.

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the investigative and corroborating phases of the ensuing police investigation. However, once an investigator notices that the people involved have already washed their hands before evidence collection, most investigators abandon any attempt to collect fibre evidence from the hands of people involved because they believe that all fibres transferred to the hands would be lost after hand washing. These kinds of beliefs have been supported by the results of several previous studies [7,15] and a review [16] that highlighted the loss of trace evidence (fibres and GSR) may be due to actions of living persons, including washing. Moreover many people believe that fibres hardly persist on a living person's hands after washing because the human hands have smooth surfaces.

However, it is quite clear that not all the people involved have enough time, water, soap, or sanitizer to thoroughly wash their hands. If this is true, then some fibres may remain on the hands of people involved. Our hypothesis was that transferred fibres may persist on the hands after washing, and we designed this study to assess this.

2. Materials

2.1. Target fibres

A red summer-season T-shirt composed of 100% red cotton was chosen as the donor garment for ease of subsequent identification and counting target fibres. During the experiments, one red T-shirt was used as purchased. Bulk samples of fibres from the T-shirt were mounted and examined by stereomicroscope to confirm the fibre types listed on the T-shirt label, as well as to provide control fibres for comparisons with target fibres.

2.2. Fibre recovery

Fibre recovery was achieved using fingerprint lifting tape (Instant lifter (10×10 cm^2), B-24200, BVDA) on the hands of subjects. These tapings were then placed on white backing cards. Tapings were examined using a low-power Leica DFC 295 stereomicroscope and target fibres were counted.

2.3. Subjects

Five male and five female Korean volunteers who were graduate students participated in the experiments. The area of the hands of each subject was measured using commercial graph paper.

2.4. Transfer and persistence

A commercial hand gripper (3 kg pressure to close) was used for fibre transfer from the donor garment to the hand of subject. Before transfer and persistence experiments, the subjects were asked to thoroughly wash their hands using soap and to dry them in air. No use of any towel or tissue was allowed at this stage. Subjects were then asked to wrap the hand gripper with the donor garment with their own hands, and to close the hand gripper using one hand ten times, consecutively. After that, subjects were asked to close the same hand gripper with their other hand in the same manner (Fig. 1). The contact area of the T-shirt with the hand gripper, manner of gripping, and intervals of gripping were not controlled. After the transfer experiments, the subjects were asked to wash their hands in two different manners; with standing water and with running water.

2.4.1. Washing with standing water (experiment set 1)

The subjects were asked to wash their hands with 800 mL of cold water in a basin. The intensity and vigor of hand rubbing was not controlled but the washing time was limited to 10 s. No use of soap was allowed at this stage. The water in the basin was then filtered through a filter paper. The number of fibres on the filter paper was counted. The subjects were then asked to dry their hands with a laboratory paper hand towel and wait for 10 min without touching anything. After these processes the hands of the subjects were examined with a stereo microscope to get a fix on the fibre adhering locations. The subjects' hands were then taped and the number of target fibres was counted to establish the number of fibres remaining. All fibres observable under the stereomicroscope were counted. Ten transfer and persistence experiments were performed by the ten subjects, and this experiment was repeated ten times for each subject. The total number of experiments was thus 100. The number of fibres that had transferred to the hands was calculated with the sum of the numbers that were found in the hand wash basin and the numbers that were lifted with tape from the subjects' hands.

Fig. 1. Method of fibre transfer using a hand gripper and a red-T-shirt.

2.4.2. Washing with running water (experiment set 2)

The same subjects were asked to wash their hands with running tap water for 10 s. The flow rate of tap water was adjusted to 700 ml/min. The intensity and speed of hand rubbing was not controlled but the washing time was limited to 10 s. Ten transfer and persistence experiments were performed by the same ten subjects, and this experiment was repeated ten times for each subject. No use of soap was allowed at this stage. The subjects were then asked to dry their hands with a laboratory paper hand towel and wait for 10 min without touching anything. After these processes the hands of the subjects were examined with a stereo microscope to get a fix on the fibre adhering locations. The subjects' hands were then taped and the number of target fibres was counted to establish the number of fibres remaining. All fibres observable under the stereomicroscope were counted. Ten transfer and persistence experiments were performed by the ten subjects, and this experiment was repeated ten times for each subject. The total number of experiments was thus 100. The number of fibres transferred was not counted in this experiment.