



A preliminary investigation of textile fibers in smothering scenarios and alternative legitimate activities



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ABSTRACT

Was this group of target fibers transferred during a criminal action? Is it possible that it was transferred during another legitimate activity? Acquiring knowledge about the activity, whether legitimate or criminal, leading to the transfer of a group of fibers is a recurring challenge encountered throughout the evidence interpretation process. Trace evidence such as fibers may assist with generating a reasoning of the activity which produced the trace, but this assumes that one already has a thorough understanding of the transfer phenomenon. How to generate and then use such relevant knowledge? What are the influencing parameters and which ones should (or can) be controlled?

The present work focuses on homicides by smothering using a pillow and the transfer of fibers on the face of the victim in such events. A legitimate activity – represented by a night's sleep on a pillow – was also investigated since such legitimate, alternative explanations concerning the presence of fibers could likely be formulated by the suspect.

The number and distribution of fibers transferred onto the victim's face in either scenario were investigated and interpreted using a Bayesian approach. Results showed that the shedding capacity of the pillowcase strongly impact the number of fibers recovered. The nature of the action, *modus operandi* and amount of friction could not be excluded in their influence on the transfer of fibers. Finally, likelihood ratios indicating the number of fibers recovered from the victim's face can provide relevant information by supporting either criminal or legitimate proposition (i.e., smothering or night's sleep scenario).

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1. Introduction

Textile fibers can be recovered in criminal cases involving intense contact between individuals engaged in physical or sexual assaults, brawls and particularly homicides. For years now, studies highlight that fibers from the perpetrator are transferred onto the victim during the criminal action and conversely [1–4]. The number of textile fibers recovered depends notably on the characteristics of the different substrates (shedding capacity of the donor and structure of the recipient), the type of contact and the phenomenon of persistence [3–7]. These are parameters that should be discussed when reasoning at the activity level [8–10].

When a group of target fibers recovered on the victim's clothes shares common physical and chemical characteristics with a questioned fabric, it is possible to link the fabric to the criminal

action with a certain degree of uncertainty. These fiber concordances represent potentially important evidence if the suspect denies any contact with the victim, especially in cases where no DNA trace is available. However, the value of such evidence for the investigation could become very low when the suspect claims having justified and legitimate contact with the victim shortly before the alleged crime. This is a common situation, typically encountered in domestic violence where those involved know each other or even live together. Proposing an alternative activity to explain the presence of fibers also requires consideration of the transfer phenomenon and persistence of fibers. Therefore, reasoning needs to take place at the activity level. Many have already studied transfer and persistence of fibers in various scenarios [1,4,11–17] and, with the exception of transfer on car seats [18–20], most studies have systematically considered simplified activities rather than realistic scenarios [1,4,17,21–24]. Moreover, to the knowledge of the authors, no transfer study has yet been carried out based on legitimate alternative activities involving contact close to criminal actions.

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Let us consider a case where a healthy middle age female was found dead on her bed. During the investigation, a group of 170 target orange cotton fibers was collected from her face that were not differentiated from the victim's pillowcase. Although the victim's husband claims he found his wife dead when he woke up in the morning, the prosecutor suspects the husband to have smothered the victim with her pillow during the night.

Legal medicine is frequently requested first in determining the cause of death. However, in smothering cases involving a pillow, it's difficult to detect characteristic signs of asphyxia. Usually, there is absence of any characteristic marks (e.g. congestion, abrasion or petechiae) unless the victim is able to defend him/herself from the assailant [25–30]. It is problematic as typical smothering victims tend to be very young, very old, disabled, or incapacitated by restraints such as illness or drugs [28–30]. In such complex situations, it may be interesting to consider trace evidence such as textile fibers. However, is it more relevant to observe 170 orange cotton fibers on victim's face in the prosecution's scenario (*claiming death by smothering*) or rather in the account provided by the defendant (*natural death*)? Without any data, it might be difficult to offer relevant and significant contributions supporting either scenario. Although the evidence in the present case focused only on fibers found on the victim face, it is important to note that fibers can also be recovered from the respiratory tract such as the nose and mouth cavity [31]. To this date, no study which investigates the transfer of fibers in smothering/night's sleep scenarios has been found.

To overcome the lack of information in this field, the present work focuses on two main aspects: first, five volunteers were asked to perform various night's sleep and smothering simulations with different pillowcases which were selected mainly based on their shedding capacity. This allowed for investigating whether the transfer of fibers was variable – based on the number and the localization of fibers on the face – depending on the activity. The consideration of fiber localization is innovative as little research has investigated this particular parameter except in case reports [32–36]. It should be noted that, in the present article, the persistence of fibers was not investigated since it assumes that fibers were already collected at the crime scene and that the victim was not moved or manipulated after discovery. In such circumstances, losses can be considered negligible. Secondly, a Bayesian interpretation of the data is proposed as it is crucial to assess the evidential value of a fiber distribution in the light of the activities formulated by the prosecution and defense [37,38]. The knowledge provided in this work will assist the practitioners for the investigation of smothering caseworks and help in assessing the evidence at the activity level.

2. Materials and methods

2.1. Volunteers

Five individuals – two men and three women – volunteered to participate in the simulations of this study (Table 1). Each volunteer presented various morphological characteristics,

Table 1
Volunteer characteristics.

Volunteers (N = 5)				
Number	Gender	Age	Facial hair	Facial care
01	Male	23	Clean-shaven	None
02	Female	30	None	None
03	Female	27	None	Night cream
04	Male	25	Stubble	None
05	Female	21	None	None

haircuts, facial hair (from “clean-shaven” to “stubble”) and lifestyles (make-up, facial cream and care, etc.). To record the physical characteristics of the volunteers at the moment of the experiment, a questionnaire was filled out prior to each simulation. Details about legitimate simulations were also sought in the questionnaire (see Section 2.3).

2.2. Pillowcases

Simulations were performed using two different brands and models of pillowcases:

1. An orange pillowcase produced by Maddison; model Perka; size 60 cm × 60 cm. The fabric is woven and composed of 100% cotton fibers. Its shedding capacity was determined as *low*.¹
2. A burgundy pillowcase from the brand Jean-Jacques Benson (JJB); model Satin Deluxe; size 60 cm × 60 cm. This pillowcase is also woven and composed of 100% cotton fibers. Its shedding capacity is *moderate*.

These fabrics were chosen in order to present fibers with strong colors easily recognizable in order to simplify the recovery process. It was also necessary to consider colors that would minimize the risk of confusion with fibers unrelated to the simulations (i.e. contamination fibers). Based on a literature search, orange and burgundy fibers appeared to be rarely recovered from the bare skin and hair of living subjects [14,40]. Hence, six orange and six burgundy pillowcases (one per individual and one for preliminary testing, *see following section*) were bought at Manor supermarkets in Vevey and Geneva (Switzerland) respectively. As new fabrics may have loose surface fibers, pillowcases were machine-washed using a regular cycle (40 °C, 60 min) with 100 ml of laundry detergent. Pillowcases of the same color were washed together without any other fabrics. Finally, pillowcases were air dried and stored separately in paper bags.

2.3. Simulations

The transfer of fibers was investigated in the context of two different types of scenarios aimed to represent the prosecution and defense propositions in casework involving potential smothering homicide with a pillow.

2.3.1. Criminal action – smothering

The goal of this simulation set was to represent smothering homicides with pillows. As each criminal case is unique in its circumstances and execution, the decision was made to allow a certain level of freedom in the realization of the criminal smothering simulations. Since there are always unknown and non-reproducible parameters (strength, pressure, contact points, struggling intensity, etc.), it may be difficult to execute the action with the precision of real caseworks. Furthermore, without a total standardization of the activity it is possible to investigate the transfer of fibers in a broad way, which is the aim of this study. Thus, only the duration of the action was imposed and controlled. Considering legal medicine literature, it was decided that smothering simulations for one minute and thirty seconds would be performed, representing a coherent smothering duration that could result in death [28,41].

The greatest challenge when creating the simulations was to find a way to ensure the safety of the volunteers – particularly because we wished to perform intense smothering simulations

¹ Shedding capacities were assigned using a cotton scale according to Ref. [39] methodology.

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