

# Beyond Direct Contact: Secondary Transfer of Touch DNA and Its Implications for Forensic Interpretation

Deepika Sharma<sup>1\*</sup>; Amaan Amir<sup>2</sup>; Muskan Mishra<sup>3</sup>; Saumya Tripathi<sup>4</sup>

<sup>1,2,3</sup>M.Sc. Student, <sup>4</sup>Assistant professor

<sup>1,2,3,4</sup>Department of Forensic Science, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India

Corresponding Author: Deepika Sharma\*

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**Abstract:** The secondary transfer of touch DNA has become a significant issue in contemporary forensic science due to advances in DNA profiling methods. Touch DNA involves genetic material left behind through the shedding of epithelial cells during physical contact, allowing for the extraction of DNA profiles from very small biological samples. In the past, finding an individual's DNA on an object was seen as proof of direct interaction; however, recent studies have revealed that DNA can also be transferred indirectly via intermediary people or objects. This occurrence challenges the traditional understanding of DNA evidence and prompts crucial inquiries about the connection between DNA detection and actual participation in a criminal act. This review highlights the current knowledge regarding secondary transfer mechanisms, the various factors that affect its occurrence, and findings from experimental studies performed in both controlled and realistic settings. The variability linked to shedding ability, contact conditions, surface characteristics, and environmental influences underscores the unpredictable nature of indirect DNA transfer. Additionally, the review examines how secondary transfer impacts forensic interpretation, stressing the importance of shifting from a source-level to an activity-level assessment. Grasping the limitations and possible alternative transfer scenarios is crucial for precise evidence interpretation, effective courtroom communication, and the responsible use of touch DNA analysis in forensic practice.

**Keywords:** Touch DNA; Secondary Transfer, Forensic Interpretation, Activity-Level Evaluation, DNA Persistence, Low-Template DNA, Forensic Casework.

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## I. INTRODUCTION

Touch DNA is the genetic material that gets transferred when epithelial cells are shed and deposit on an object or another person due to physical contact. The analysis of touch DNA has become an important tool in forensic science, as it enables the recovery of DNA profiles from very small amounts of biological material deposited through simple contact. In the past, the presence of an individual's DNA on

an object was considered strong evidence of direct physical interaction. However, with the development of highly sensitive DNA typing technologies, it is now recognized that DNA can also be transferred indirectly through a process known as secondary transfer. This phenomenon has introduced significant challenges in the interpretation of touch DNA evidence and has raised concerns regarding the relationship between the detection of DNA and an individual's actual involvement in a criminal event.

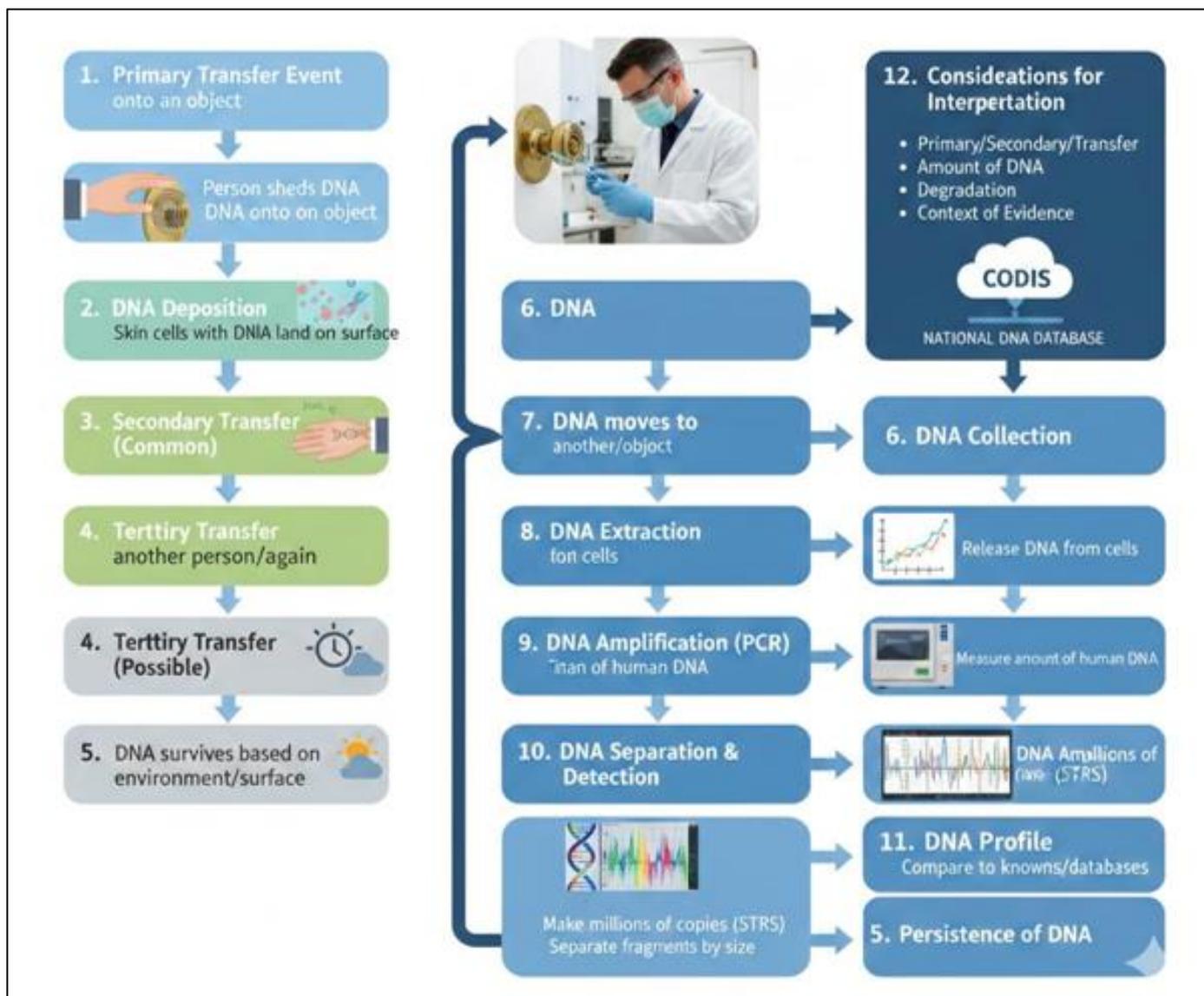


Fig 1 Introduction of Touch DNA

Secondary transfer of touch DNA takes place when skin cells or biological material are first moved from a donor to an intermediary object or person and then later transferred to another item or individual without the donor ever making direct contact with the final surface. Common actions like shaking hands, sharing personal belongings, or touching frequently used items can enable such transfers. The likelihood and degree of secondary transfer depend on several factors, including a person’s shedding status, the length and pressure of contact, the type of surface, environmental conditions, and the time elapsed between transfers. Consequently, simply finding DNA on an item does not necessarily confirm direct involvement, presence at a crime scene, or physical interaction with the item in question.

The increasing recognition of secondary DNA transfer has shifted forensic thinking from simply identifying whose DNA is present to a more intricate assessment of the circumstances surrounding how and when the DNA was introduced.

This change is especially important in cases involving minimal contact evidence, such as items like weapons, clothing, mobile phones, or household goods, where various transfer mechanisms may occur. Misunderstanding secondary transfer can result in incorrect conclusions, which may influence investigative paths, judicial outcomes, and the overall credibility of forensic testimony. As a result, courts are progressively expecting forensic specialists to explore alternative transfer scenarios and to communicate the limitations and uncertainties linked to touch DNA evidence.

This review aims to condense existing information about the secondary transfer of touch DNA and to emphasize its difficulties and consequences for forensic analysis.

➤ *Secondary Transfer of Touch DNA*

The secondary transfer of touch DNA involves the non-direct deposition of genetic material onto a surface via an intermediary person or object, without any direct contact between the original source and the final surface.



Fig 2 Secondary Transfer of DNA

In this scenario, epithelial cells or biological materials are initially transferred from the main donor to an intermediary individual or object and are later deposited onto another surface through subsequent contact. Secondary transfer can happen through normal everyday interactions such as handshaking followed by touching an object, sharing personal items, or coming into contact with commonly used surfaces. Depending on how the transfer occurs, various situations can arise, including transfers from one person to another to an object and from an object to a person to another object. In certain cases, tertiary transfer might also happen, although the likelihood diminishes with each additional transfer. In contrast to primary transfer, which occurs when DNA is left behind through direct contact, secondary transfer makes the forensic analysis more complex since finding someone's DNA does not automatically mean they interacted directly with the object or were present at the crime scene. Consequently, grasping the processes and conditions

surrounding secondary transfer is crucial for the proper assessment of touch DNA evidence.

➤ *Factors Affecting Secondary Transfer*

The extent and effectiveness of secondary transfer of touch DNA are influenced by several factors. One important factor is an individual's ability to shed skin cells, as some individuals naturally lose more cells than others. The nature of the contact, including its duration, the pressure applied, and the friction generated during handling, greatly affects the quantity of DNA that is transferred. The properties of the surface also significantly impact transfer efficiency, with non-porous surfaces typically allowing for easier transfer compared to porous ones. Environmental conditions, such as temperature, humidity, and the interval between contacts, can influence the longevity of DNA and its degradation. Considering the combined effects of these factors, secondary transfer tends to be quite variable and unpredictable.

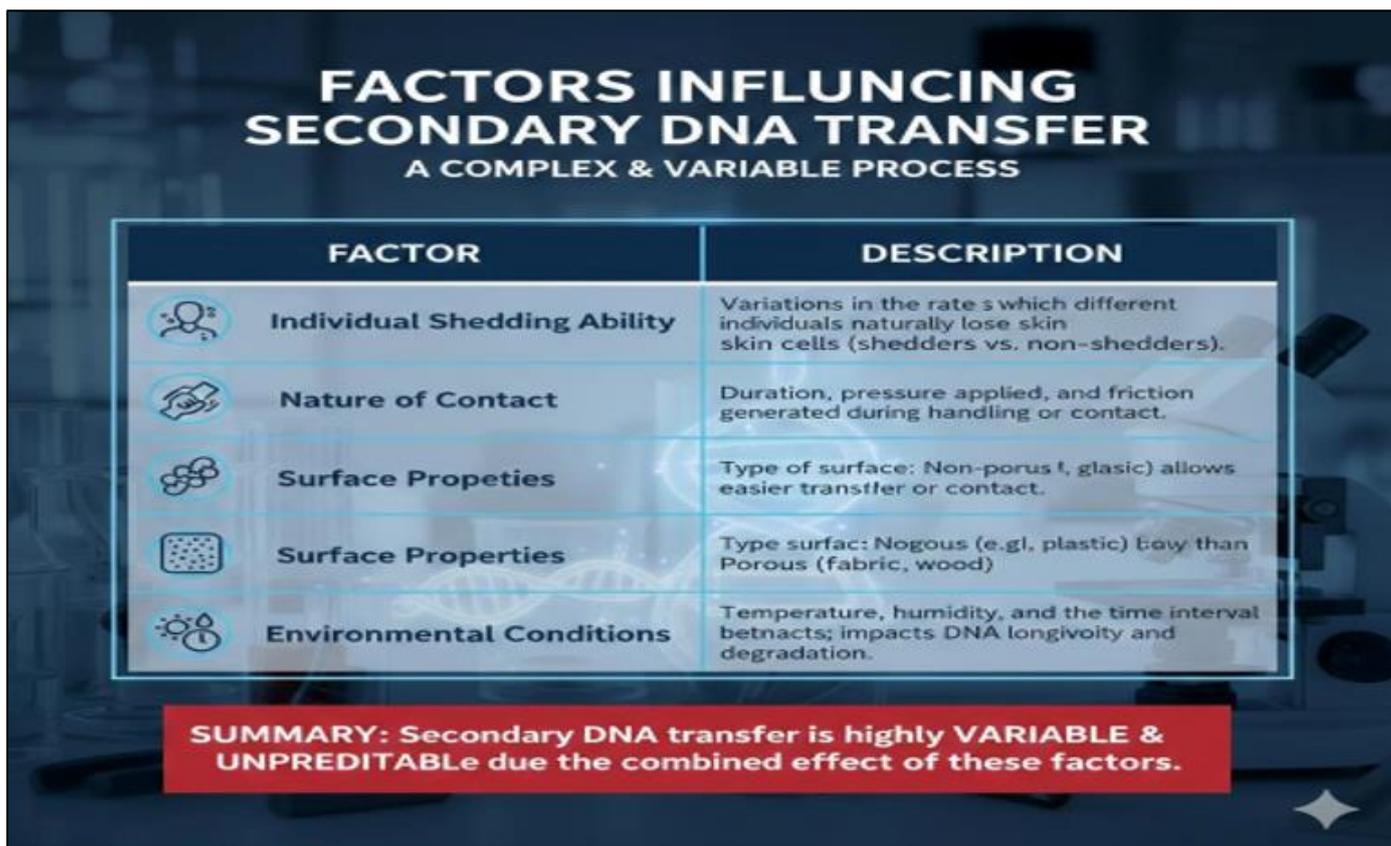


Fig 3 Factors Affecting Secondary Transfer of DNA

➤ *Experimental Studies and Research Findings*

A variety of experimental studies have been carried out to explore the presence, frequency, and conditions of secondary transfer of touch DNA in both controlled lab environments and real-world situations. Research has repeatedly indicated that secondary transfer can lead to detectable amounts of DNA and, in some instances, complete or interpretable DNA profiles. Experiments simulating typical activities, such as handshaking followed by interacting with objects, sequentially handling items by several people, or indirect transfer via shared surfaces, have demonstrated that DNA can be transferred without direct contact between the original donor and the final substrate.

The quantity and quality of DNA obtained through secondary transfer are typically lower and more inconsistent than those from primary transfer. Numerous studies have indicated that only partial or mixed DNA profiles are often retrieved, illustrating the intricate nature of indirect transfer occurrences. The effectiveness of secondary transfer is influenced by various factors, including an individual’s ability to shed DNA, the nature and length of contact, characteristics of the surfaces involved, and the elapsed time between transfers. Research shows that while secondary transfer is not always consistently reproducible, it is possible under realistic circumstances and can result in forensic DNA profiles. These findings highlight the necessity of viewing secondary transfer as a viable explanation when analyzing and interpreting touch DNA evidence.

➤ *Forensic Interpretation and Casework Implications*

The acknowledgment of secondary transfer has greatly affected how touch DNA evidence is understood in forensic investigations. In the past, finding an individual’s DNA on an object was regarded as compelling proof of direct contact or involvement. However, the potential for indirect transfer has raised doubts about this premise and underscored the importance of careful interpretation. The mere presence of DNA does not always guarantee direct handling, physical interaction, or presence at the scene of a crime.

This concern has prompted a transition in forensic evaluations from source-level interpretation, which concentrates on whose DNA is found, to activity-level interpretation, which examines how and when the DNA may have been deposited. Secondary transfer is especially pertinent in cases involving items that are frequently handled, such as weapons, clothing, mobile phones, or everyday household objects.

In situations where various transfer events could take place, overlooking different transfer mechanisms might lead to incorrect conclusions and could influence investigative choices and judicial results. Consequently, forensic specialists need to assess DNA evidence by considering the specific case details, the history of the evidence handling, and potential transfer scenarios. Additionally, in court settings, it is crucial to effectively convey the limitations, uncertainties, and possibility of secondary transfer in order to ensure a correct interpretation of the evidential significance of touch DNA.

## II. DISCUSSION

### ➤ *Changing View of Touch DNA Evidence*

The increasing comprehension of secondary transfer has significantly altered the perception of touch DNA evidence in modern forensic science. Previously, the discovery of a person's DNA on an object was often seen as compelling evidence of direct contact. However, studies conducted over the past decade have demonstrated that DNA can be transferred indirectly through typical daily interactions. This has prompted a reevaluation of the conventional perspective and underscored the importance of careful contextual analysis.

### ➤ *Unpredictable Nature of Secondary Transfer*

A major challenge associated with secondary transfer is its unpredictable and variable characteristics. The amount of DNA transferred depends on multiple interacting factors, such as individual shedding tendencies, the nature and length of contact, surface types, and environmental conditions. Certain individuals tend to leave larger amounts of DNA, whereas others may only leave slight traces. This inconsistency complicates the establishment of reliable expectations concerning transfer events.

### ➤ *Challenges Due to High-Sensitivity DNA Analysis*

Advancements in DNA profiling methods have made the interpretation process more complex. Highly sensitive analytical techniques now enable the extraction of DNA profiles from minimal biological samples. Although this has enhanced the sensitivity and evidential significance of touch DNA, it has also introduced the chance of identifying background DNA, indirectly transferred DNA, or DNA that is not connected to the supposed incident.

### ➤ *Interpretation Issues and Risk of Misleading Results*

These results could lead to confusing or unanticipated DNA profiles, raising the likelihood of misinterpretation if the context of the case is not thoroughly examined. Just having DNA present may not truly represent the real sequence of events without a careful assessment of the relevant circumstances.

### ➤ *Shift Toward Activity-Level Evaluation*

These difficulties have prompted a transition in forensic analysis from focusing on source-level details to an activity-level perspective. Forensic scientists must now account for the conditions and circumstances surrounding the deposition of DNA, rather than merely identifying whose DNA is present. This approach necessitates the combination of scientific evidence, relevant case details, patterns of object use, and potential alternative methods of transfer.

### ➤ *Need for Further Research and Standardization*

In spite of heightened research initiatives, obstacles persist because of the absence of uniform protocols and extensive datasets concerning secondary transfer in practical situations. Additional experimental investigations that mimic real-life conditions are essential to bolster the scientific foundation for interpretation.

### ➤ *Importance of Communicating Limitations*

Additionally, it is crucial to effectively convey the uncertainties and limitations associated with touch DNA evidence in forensic reports and during courtroom testimony. Clear communication guarantees that the evidential significance of touch DNA is properly comprehended and helps to avoid over interpretation.

## III. CONCLUSION AND FUTURE PERSPECTIVE

The increasing recognition of secondary transfer has notably transformed how touch DNA evidence is understood in modern forensic science. With the development of advanced DNA profiling technologies, it has become clear that genetic material can be transferred indirectly through intermediary people or items, which can still lead to detectable or analyzable profiles. These discoveries underscore a significant limitation in conventional beliefs, as finding DNA on an item cannot be taken as conclusive evidence of direct involvement or contact in a crime.

The analysis of touch DNA is further complicated due to the intricate and variable nature of secondary transfer.

Factors such as individual shedding tendencies, the type and length of contact, the properties of surfaces, and environmental conditions all play a role in influencing transfer, longevity, and retrieval of DNA. Thus, forensic analysis must go beyond mere identification and take into account the unique details of the case, the evidence's handling history, and the potential for alternative transfer methods.

The heightened analytical sensitivity of contemporary DNA techniques, although improving detection abilities, has also increased the chances of uncovering trace or background DNA that may not be pertinent to the event in question. This highlights the necessity for careful, context-driven interpretation backed by an assessment of activities and, when suitable, scientific and probabilistic reasoning.

Future initiatives should concentrate on producing solid experimental data under realistic conditions to enhance the comprehension of secondary transfer dynamics and bolster evidence-based analysis. The creation of standardized protocols, adequate training for forensic professionals, rigorous evidence management practices, and effective communication of uncertainties within forensic reports and courtroom statements are crucial to reducing the likelihood of misinterpretation.

In summary, secondary transfer ought to be viewed as a natural and scientifically validated component of trace DNA evidence, rather than a limitation of forensic DNA technology. A well-rounded, transparent, and context-sensitive method of interpretation will enhance the dependability, credibility, and judicial significance of touch DNA evidence, ensuring its appropriate use in forensic investigations and legal processes.

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