Welcome to the IAFN’s SAFEta Project and the California Clinical Forensic Medical Training Center’s

Touch DNA Webinar

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Thank you in advance for your help and cooperation!

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Locard's Exchange Principle

"Every contact leaves a trace“
...but is there enough to collect, analyze and profile?

Touch DNA Headlines!!

- Investigators using 'touch DNA' to solve property crimes
- 'Touch DNA' helps crack 1992 Bethel murder
- Touch DNA" Cleared JonBenet's Kin
- Harris county law using 'touch DNA' to solve property crimes

Outline For Today

- Touch DNA in sexual assault cases
- What is touch DNA?
- What does the examiner need to consider during collection?
- Review of scientific studies
- Guidelines for collection
- Challenges
- Case Study
Sexual Assault
Three Basic Forensic Questions

- Did sexual contact occur?
- If sexual contact occurred, with whom?
- Was the sexual contact consensual or non-consensual?

Note: It may be useful to determine if any contact occurred with alleged assailant.

Fundamental Forensic Objective: Independent Reconstruction

- The independent reconstruction of the events in question must be:
  - Accurate
  - Scientifically sound
  - Evidence-based
  - Objective (stands alone and does not rely on witness testimony)

- DNA is the gold standard
  - Corroborates contact (potentially, sexual contact)
  - Establishes identity of the donor
  - The scientific foundation of forensic DNA is firmly established
  - Legal controversies focus on the process of handling and analyzing the evidence

What Is DNA?

- Deoxyribonucleic Acid
- Body’s Genetic Information
- Located in Chromosomes
- Unique to Each Individual
Sources of Biological Evidence

- Blood
- Semen
- Saliva
- Hair roots
- Teeth, bone marrow
- Tissue

Typical Biological Fluid Screening

- Examination of an item to locate and identify biological stains
- Accomplished with microscopy, alternate light sources, and presumptive and confirmatory tests
- Stains are identified for DNA testing
- Example

  Stains are documented with photography. Blood is identified using presumptive and confirmatory test. A portion of the stain is swabbed for DNA analysis.
But Wait....

Touch DNA???

Possible sources of Touch DNA:
- Gun
- Knife
- Ropes
- Gloves
- Hat

Touch DNA: DNA transferred to an item through contact with the skin
What is “Touch DNA”? 

- Touch DNA is DNA that is transferred via skin cells when an object is touched or handled.
- Touch DNA comes from:
  - DNA fragments from top layer skin cells (no nuclei)
  - DNA fragments in sweat
  - Deeper level skin cells that contain nuclei (whole DNA)
- Typically, only minute amounts of DNA are left behind after an object is touched or handled.
- Successful recovery is dependent on threshold amounts for detection and profile development.

Touch DNA and “Shedder Status”

- Humans shed an average of 400,000 skin cells per day.
- Variable individual propensity in the rate of skin cell sloughing (“good shedders” and “bad shedders”).
- Significant variation between individuals and in the same individual over time.
- Hand washing eliminates superficial cells.

What Influences the Amount of Touch DNA Left After a Contact?

- Donor Shedder Status at the time of contact.
- Donor habits (body touching “loads” fingers).
- Type of contact (pressure, friction, duration).
- Substrate touched (rough, smooth, porous, solid).
- Perspiration (sweat increases DNA transfer).
- Deposition to collection interval (mechanical removal, environmental conditions, etc.).
**Touch DNA**

- While touch DNA analysis can be a very powerful tool in helping to solve cases, not all samples are suitable for this kind of testing.
- The likelihood of developing a meaningful profile from a touch DNA sample is greatly dependent on the nature of the contact and the nature of the item.
- Touch DNA samples must be collected properly.
- There are no screening methods available to locate touch DNA.

**Potential Sources of Assailant DNA from the Sexual Assault Forensic Exam (SAFE)**

- **Saliva**
  - Body surface
  - Body cavities (lubricant or sexual activity)
- **Semen**
  - Body cavities
  - Body surface
- **Epithelial cells ("Touch DNA")**
  - Body surface
  - (Clothing)

**What Guides the Examiner’s Search for DNA?**

- Patient history (also, LE history)
  - General contact
  - Assaulitive or traumatic contact
  - Sexual contact
- Physical exam findings
  - Visible
  - Palpable (tenderness)
  - Alternate light source
- Blind sampling of high yield areas (protocol)
Recovering Foreign Epithelial DNA May Be Helpful If...

• Adequate DNA to identify the donor
• History indicates no prior contact
  - No recent contact (? time frame)
• Significant location of recovery
  - Intimate body part
  - Specific clothing location
• (Quantity of DNA recovered is sufficient to substantiate traumatic contact...e.g. strangulation)

Recovering Foreign Epithelial DNA is Unlikely to Help If...

• Inadequate DNA to identify the donor
• History indicates prior contact
  - Recent contact ? (time frame?)
• Timing of the contact is important
• The issue is consent vs non-consent

UC Davis Forensic Science Graduate Program

• Research projects related to Touch DNA
  - Sexual Assault Suspect Exam
  - Male Touch DNA from fabrics
  - Touch DNA from skin after mock struggle (2)
  - Wet Vacuum collection system (MVac)
    ➢ Clothing recovery: cuttings vs Mvac
    ➢ Presence of DNA donor sweat and recovery
    ➢ Touch DNA recovery after mock strangulation
Sexual Assault Suspect Exam

• Victim epithelial cells recovered from the suspect's
  - Hands
  - Fingers
  - Penis
  - Scrotum

• Positive recovery confirms contact...potentially, sexual contact

Victim DNA Recovered from the Suspect
Analysis of 102 Suspect Kits-Chani Sentiwany

• Genital Swabs
  - Penile glans / shaft combined
  - Glans only
  - Shaft only
  - Scrotal

• Finger Swabs (54 kits, 2006-2009)
  - Right index, middle, thumb
  - Left index, middle, thumb

Definition of Probative

• **Probative Value** in this study is achieved when the victim could not be eliminated as a source of biological material found on the suspect.
• This includes mixtures and single source results
Yield of Male Touch DNA from Fabrics

Vishi Sethi

- Question: After a simulated “grab and struggle” (assailant hand to clothed victim), can enough cellular material be obtained from the evidentiary fabric(s) for STR profiling?

- 3 male “assailants” + 1 female “victim”
- Fabrics: cotton, polyester, 60/40 blend
- Fabrics wrapped around victim’s arm
- 15 second “grab and struggle”
- Samples extracted: 12 hours, 7 days
- Extracts quantified: Quantifiler Duo
- Shedder status: 1 male (+) ; others (-)
**Yield of Male Touch DNA from Fabrics**

*Vishi Sethi*

- Maximum DNA recovery:
  - 7.0 pg/µl total human DNA
  - 5.0 pg/µl male-specific DNA
  - Cotton fabric; wrist; 12 hours post deposition
- No significant differences
  - Fabric types
  - Time intervals
- All recoveries *below* Quantifiler Duo threshold (standard curve)...no STR done

**Yield of Male Contact DNA Evidence in an Assault Simulation Model**

*Michael Sandoval*

- Question: Can amplifiable amounts of male assailant contact (epithelial) DNA be recovered from the skin of female victims after acts of simulated grabbing and struggling?
- 2 male “assailants” + 2 female “victims” = 3 couples
- All surfaces washed prior to contact
- Contact: victim wrists + upper arms
  - 5 second “grab” – no resistance
  - 10 second “grab” + struggle to release grip
- Double swab collection with sterile water
- Extracts quantified: Quantifiler Duo
- Amplification: *Identifiler* + *Yfiler*
Yield of Male Contact DNA Evidence in an Assault Simulation Model
Michael Sandoval

- Maximum concentrations of total DNA extracted:
  - “Grab” only – 40 pg/µl
  - “Grab + struggle” – 90 pg/µl
- Maximum concentrations of male DNA:
  - “Grab” only – 20 pg/µl
  - “Grab + struggle” – 40 pg/µl
- Struggling consistently yielded more DNA than grabbing alone

Contact DNA from female “victims” analyzed with Identifiler and Yfiler:
- Very few peaks present
- No full profiles (13 CODIS or 17 Y-STR loci) - from either male or female DNA

Conclusions:
- DNA transmission correlates with amount of time and pressure exerted
- Stochastic variation was significant
- Consider using other DNA technologies

Changes in Yield of Contact DNA over time after a Physical Assault
Walter Perez

- Question: Can amplifiable amounts of male assailant contact (epithelial) DNA be recovered from the skin of female victims after acts of simulated grabbing and struggling?
Changes in Yield of Contact DNA over time after a Physical Assault

Walter Perez

• 5 male “assailants” + 5 female “victims” = 5 couples
• Male shedder status assessed
• Male hand wash + female shower prior
• “Assault” = male grabs female’s left wrist, female struggles to release grip (30 sec)
• Double swab collection with sterile water
• Plan: repeat “grab” daily; sample q15 min (to 120 minutes)

DNA extracted: QIAmp DNA invest. Kit
DNA quantified: Quantifiler Duo
Shedder status: NO human or male DNA
“Grab” samples at time zero: NO male DNA above the Quantifiler Dou detection threshold was recovered
No further sequential “grab” scenarios done
No “assailant” profiles could be developed

Conclusions:
- All 5 “assailants” were “bad shedders”
- 30 second “wrist grab” model failed to transfer sufficient male DNA for profiling
- Stochastic variation was significant
- Consider using other DNA technologies
- If male perspiration was present, DNA yield may have been higher
Promising New DNA Collection Technique: The MVac

• Initially designed and used for pathogen collection in food safety analysis
• “Wet vacuum” system which sprays a special buffer onto the substrate and immediately collects suspended particles into a sterile container
• Pilot studies suggest potential in forensic DNA collection

M-vac Wet Vacuum System

• Microbial-Vacuum (M-vac) Background/Purpose
  • Food Safety
  • Bacterial pathogens
• M-vac Forensic Application
  • Biological Evidence Collection
• Research Projects

• Wet-vacuum system that can be used on several surfaces.
• The M-vac sprays a buffer (DNA and nuclease free) onto a surface while a vacuum is applied to collect buffer and suspended particles.
• Able to cover a large surface area (unlike swabs or sponges).
M-vac Wet Vacuum System

M-vac can be used to collect evidence from many surfaces

Touch DNA Collection From Clothing: Traditional Cuttings vs Wet Vacuum System

Marc Wander

• Conclusions
  - MVac was much more effective in recovering touch DNA than traditional cuttings
  - MVac can sample much larger areas more efficiently than cuttings (especially important if the history is uncertain or absent)
  - Presence of sweat significantly increased the deposition and recovery of Touch DNA (for some males more than others)
  - DNA profile generation was about equal

Comparison of MVac and Surface Swabs for Collecting Touch DNA from Skin

Katie Leigh Caswell

• One male “assailant” + one female “victim”
• Strangulation simulation:
  - Male forcefully grabs female’s upper calf
  - Female “struggles” to resist male’s grip
  - “Struggle” times: 30, 60, and 90 seconds
  - Each interval repeated 4 times = 12 samples
• Strangled contact area sampled with MVac
• DNA quantification: Quantifiler Duo
• DNA verification: Identifiler
Comparison of MVac and Surface Swabs for Collecting Touch DNA from Skin

Katie Leigh Castwell

• Results
  - Male “shedder status” not assessed
  - Limited study = “Proof of Concept”
  - All 12 samples yielded verified autosomal DNA
    ➢ 30 sec: autosomal = 2.4ng  male = 1.5ng
    ➢ 60sec: 5.2ng  4.7ng
    ➢ 90sec: 26.9ng  5.2ng
  - Each interval had at least one sample that yielded a full male profile (30 sec had 2!)
  - Most samples yielded at least a partial profile

• Conclusions
  - MVac effectively recovers touch DNA from skin
  - MVac efficiently samples larger areas than swabbing (especially important with ? history)
  - In general, the longer (and more vigorous) the contact, the more touch DNA will be transferred
    ➢ Significant variability was present
    ➢ The 30 second interval yielded the most full profiles (2)

Seven Guidelines to Consider Regarding Touch DNA Evidence

Crime Lab Perspective
1. **SUFFICIENT CONTACT**

The nature of the item suggests prolonged and/or rigorous contact has been made with the item.

- Steering wheel: **YES!**
- T-shirt (because the suspect may have touched it): **NO!**

2. **LIMITED HANDLING**

The type of item and the location of the item suggest it has NOT been handled by numerous unknown people.

- Door knob to a bedroom: **Maybe (with references)**
- Doorknob to McDonalds restroom: **NO!**

3. **PROBATIVE**

There is reason to believe that the suspect/victim could not easily explain away touch DNA on an item.
4. SPECIFIED LOCATION

There is reason to believe that prolonged and/or high-friction contact was made with an item in a very specific location.

YES! NO!

5. NOT CONTAMINATED

Touch DNA should not be pursued when the item is covered in blood, another biological material, mud, or other thick debris which would make it impossible to collect potential touch DNA.

FIREARMS RELATED EVIDENCE
6. LIMITED SKIN-TO-SKIN SAMPLES

Brief skin-to-skin contact is generally not suitable for touch DNA due to the brief nature of the contact and because the individuals' own DNA will likely be present. Samples which are collected from skin-to-skin contact that is longer and more vigorous may be suitable for DNA analysis.

Obtaining reference samples from the owner and anyone else who may have recently driven the vehicle is very important!

7. LIMITED VEHICLE SAMPLES

Certain samples from areas of the vehicle that are necessary to touch in order to drive the vehicle may be suitable for touch DNA analysis. Most vehicle samples will generally not be handled long enough or rigorously enough to deposit enough DNA to obtain a profile.

Currently, DNA testing types at 15 different STR loci or locations, and the gender identification location, Amelogenin.
Interpretation of DNA Data

- An analyst looks at the electropherogram data and makes sure controls (extraction and amplification) and blanks are giving the expected results.
- The DNA profile for the evidence samples are compared with any reference samples (e.g. suspect and victim DNA samples) in the case.
- The DNA data for an evidence sample may contain DNA typing results from a single individual (single source) or multiple individuals (DNA mixture).

Interpretation can take a couple of hours to multiple days

Single Source Male Profile

Mixture Evidence Sample
**Mixture of at Least Four People**
(Example: mixture of suspect, victim, boyfriend, and child)

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**Touch DNA in Sexual Assault**

**Challenges**

- When to look for it?
- Where to look for it?
- Maximize recovery
  - To facilitate developing full donor profile
  - (Quantity to substantiate traumatic transfer)
- Utilizes all available DNA technologies
  - To ultimately generate a full donor profile from small amounts of recovered DNA

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**Touch DNA in Sexual Assault**

**Addressing the Challenges**

- When to look for it?
  - Examiner takes *detailed history* regarding:
    - Time since contact
    - Nature of the struggle
    - Degree of force involved
    - Duration of the struggle/contact
    - Was assailant sweaty?
  - Blind swabbing protocol employed when history is limited
Touch DNA in Sexual Assault

Addressing the Challenges

- Where to look for it?
  - Examiner takes detailed history and determines the location(s) of significant contact(s)
  - Routine neck swabs in strangulation (TBD)
  - Area(s) of expected high yield (TBD) swabbed routinely?
  - Swab visible blunt force injuries (TBD)
  - Swab area of significant tenderness (TBD)
  - Alert crime lab regarding significant clothing contact

- Maximize recovery
  - Perishable evidence…swab ASAP
  - Double swab technique
  - Swab type?
    - Moistening solution (detergent vs water?)
    - Methods for more sensitive collection (M-Vac?)

- Maximize existing and/or develop new DNA technologies to facilitate full donor profiles from small amounts of recovered contact (epithelial) DNA

- Interpret positive recovery in context
  - Retrospective case work analysis (historical details vs actual recovery)
  - Experimental (e.g. calf “strangulation” model)
  - Larger and expanded studies based on initial small studies
Forensic Nursing Practice
Implications of Touch
DNA

Case Study

Background

• Utah Bureau of Forensic Sciences (UBFS), Utah state crime lab, began using Yfiler in March 2009.
• Presentation to SANE group on Y-STR in March 2011.
• What are the practice implications of this new form of DNA testing? Does this indicate any changes in practice regarding evidence collection?

Case Study

• SANE paged to collect evidence on a groping victim, per LE “collect evidence from her mouth as she bit suspect’s finger.”
• Additional Background on Assault – Same perpetrator suspected of 4 assaults on or near campus within an 8 hour time frame.
• No evidence collection on any other victims.
• All groping victims, but increasing aggression throughout the day in the assaults.
Case Study

Details of assault:
- Suspect attacked victim as she was getting in her car, pushing her down across the front seat.
- Where did the suspect touch the patient?
  - Oral cavity – finger went in mouth
  - Shoulders – shook victim and pushed down
  - Around mouth, chin – tried to muffle her screams
  - Jacket button – tried to undo smooth metal button
  - Lower abdomen – hand under tights
  - Upper portion of tights – tried to pull down tights
  - Front, outer portion of underwear – lacy fabric, not smooth

Evidence obtained by SANE:
- Moistened Swabs:
  - Oral
  - Lips, around mouth and chin
  - Lower abdomen
  - Jacket button*
    - Outside of front portion of underwear*
- Clothing:
  - Jacket, tights, underwear, skirt

*Not recommending SANEs or LE collect swabs from clothing, but collect the clothing.

Law Enforcement:
- Identified 5 suspects matching description of assailant.
- One of the suspects was found to have a healing bite mark on one finger. Buccal swab from this suspect was obtained.
Case Study

DNA Yield of Y-STR Testing

<table>
<thead>
<tr>
<th>SWABS</th>
<th>DNA Profile</th>
<th>Y-STRs</th>
<th>Suspect part of mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skirt</td>
<td>No male DNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jacket Shoulders</td>
<td>YES</td>
<td>&gt;3 males</td>
<td>YES-matches major portion</td>
</tr>
<tr>
<td>Tights</td>
<td>YES</td>
<td>&gt;1 male</td>
<td>YES-matches major portion</td>
</tr>
<tr>
<td>Underwear</td>
<td>No male DNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower abdomen</td>
<td>YES</td>
<td>YES</td>
<td>YES-matches major portion</td>
</tr>
<tr>
<td>Underwear</td>
<td>YES</td>
<td>YES</td>
<td>YES-matches major portion</td>
</tr>
<tr>
<td>Jacket Button</td>
<td>No male DNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Around mouth, chin</td>
<td>YES</td>
<td>Yes</td>
<td>YES-matches major portion</td>
</tr>
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Swabs collected by forensic scientists in crime lab

Swabs collected by SANE

Case Study

DNA Yield of Traditional STR Testing

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<tr>
<th>SWABS</th>
<th>DNA Profile</th>
<th>Traditional STR</th>
<th>Suspect Part of Mixture</th>
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</thead>
<tbody>
<tr>
<td>Skirt</td>
<td>Not attempted</td>
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<td></td>
</tr>
<tr>
<td>Jacket</td>
<td>YES</td>
<td>More than 2</td>
<td>No</td>
</tr>
<tr>
<td>Tights</td>
<td>YES</td>
<td>More than 1</td>
<td>No</td>
</tr>
<tr>
<td>Underwear</td>
<td>No male DNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Abdomen</td>
<td>Not attempted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underwear</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Jacket Button</td>
<td>No male DNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Around mouth, chin</td>
<td>Not attempted</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Swabs collected by forensic scientists in crime lab

Swabs collected by SANE

Prosecution Outcome:
- Victim was unable to identify the suspect in a photo line-up.
- Prosecutor, “The DNA findings made all the difference.”
- Plea bargain was reached. Suspect currently serving time and receiving therapy at the Utah State Prison.
Case Study

- Changes in practice from this case:
  - Creation of a Touch DNA form for collecting evidence in groping or stranger assault cases and in other cases in which touch from the suspect would not be an expected finding, i.e. violation of a protective order. Guidelines are written for collecting clothing and clearly identifying what areas are touched by the assailant. Swabbing of clothing to be done by crime lab.
  - Educating law enforcement on collecting DNA evidence in groping cases.

Contamination and DNA

- Packaging Two Items Together
- Evidence Collection
  - Dandruff
  - Talking
  - Sneezing
  - Coughing
  - Dirty Implements
  - Gloves
  - Swab drying box
- Last thing you want is to become part of the case.

Resources and Contact

- Forensic forms, instructions and protocols available at: www.ccfmtc.org
- William M. Green, MD
  916-930-3080
  william.green@ccfmtc.org
Thank you for attending!

A evaluation of today's webinar will be done via a survey monkey link, sent to the email you have on file for a certificate of attendance will be awarded at the completion of the survey. This event will be archived on line at the IAFN on line learning center. Go to: www.forensicnurses.org.

Remember if you have any questions to contact SAFEta at info@safeta.org or by calling 1-877-819-SART.

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