ParaDNA Presumptive Screening: DNA on the Investigative Timeline

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Forensic DNA

- DNA is a “gold standard” in forensic science
  - Extremely Durable
  - Suspects do not need to be present
  - Only need a trace amount to be present
  - Can be found from almost any tissue, including hair (mitochondrial vs. nuclear), fingernails, bone, teeth and body fluids
  - Can be left on a wide range of evidence
  - Uniquely identifies every individual (except for twins)
    - STR statistics routinely exceed 1 in 6 billion with trillions, quadrillions and quintillions common (World Population ~7.13 Billion, Kauai Population ~72,000)
Effects of DNA on Crime

- British Home Office
  - Suspect Identification: from 16% without DNA to 41%
  - 2x suspect identification over fingerprint evidence
  - Prevented an average of 7.4 additional crimes per criminal
- National Institute of Justice, DNA Field Test
  - 5x suspect identification over fingerprint evidence
  - 9x times more likely to result in an arrest
  - 2x as many cases accepted by prosecution
- The Denver District Attorney’s Office
  - 26% drop in property crime
  - 5.5x successful prosecution rate
  - Longer prison sentences achieved
  - $29 million in savings through identifying criminals faster, shortening investigation and prosecution timelines, and achieving longer sentences
Standard Method of DNA Analysis

Collect sample from arrestee → Log sample into police evidence system → Transport sample to forensic lab

Log sample into lab's evidence system → place sample in evidence vault → remove sample from evidence vault

Test sample →

Review sample data → Report sample result to police → Arrest suspect second time
The Current Issue: Backlog

Single sample processing time: 54hrs and 15min

Honolulu Police Department Backlog

- Case backload of approximately 600 cases
- Each analyst can only process around 42 cases per year.

HPD Approximate Timeline

- Murder: 2-3 Months
- Sexual Assault: 3-6 Months
- Property Crimes: 2+ Years

Legislature changes:

Act 207 passed, Sexual Assault Kit Backlog
Arrestee sample collection on certain types of cases

Exhibit 4. Turnaround time for violent crimes vs. property crimes

<table>
<thead>
<tr>
<th></th>
<th>Number of days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average turnaround time for violent crimes</td>
<td>106</td>
</tr>
<tr>
<td>Average turnaround time for property crimes</td>
<td>154</td>
</tr>
</tbody>
</table>
Ramifications of the DNA Backlog
Current Private Options

- Sorenson Forensics and Bode Cellmark Forensics
  - Standard turn around time approximately 8 weeks
  - Cost per sample: $525-750
  - $75 comparison to control profile, $150 for evidence profile
  - One suspect/one control minimum of $1050
  - HPD has to review for CODIS upload
  - Expedited processing available
  - Both have expert witness fee of around $2,200 per day plus expenses
THE SOLUTION

ParaDNA® Product Family
ParaDNA® Screening Test

- Generates a relative percent DNA score and gender call
  - Utilizes 2 STRs plus Amelogenin (gender marker)
- Sample types: saliva, blood, semen, touch/cellular
- Develops more reliable, targeted and cost-effective submissions policies
  - Triage samples effectively; exclusion of low level DNA samples
  - Inclusion of key items for full DNA analysis
  - Focus resources more appropriately and more cost effectively
  - Reduce evidence backlogs
  - Increase effective submissions of touch DNA samples (e.g. triage property crime)
ParaDNA® Intelligence Test

- 5 STR profile plus Amelogenin (gender marker) and relative percent DNA score
  - Mixture detection
- Sample types: saliva, blood, semen, touch/cellular, buccal
- Provides early tactical intelligence
  - Quickly include or eliminate suspect(s) from investigation
  - Rapid linking of individual’s DNA at the scene
  - Link scenes easily by comparing profiles held on-instrument database (import/export functionality)
  - Allocate staff resource earlier and more cost effectively
  - On scene analysis using Field-portable option
    - Immediate sampling and identification
    - Triage and prioritise samples
The Current Picture

**paradna**

**Collect evidence at the scene**

**Goal:** Recover probative evidence items and assess what may have happened at the scene

**ParaDNA screening**

**Goal:** Triage and prioritize samples that are best suitable for DNA analysis, improve submission success rates and gain rapid investigative leads as quickly as possible

**Forensic DNA processing (traditional STR or Rapid)**

**Goal:** Generate useable DNA profiles for comparisons and database searches and produce reports
Limitations

• Presumptive Test
• Mixture analysis
  • Can identify that a mixture exists and give some allele calls in Data Analysis software
• Low level touch samples
  • Currently we do not use this system on low level items in major cases
• Cannot interact with CODIS
  • Does house an on board database
Validation: Neat Samples
Validation: Sensitivity

- Data (grey/light blue bars) follows expected decreases in number of alleles called
- Introduction of weigh boat (non-absorbent, green bars) examination method coupled with experience gained much improved results later in study
- Estimated 100-200pg from 1:20 and 1:10 dilution was able to generate useable profile information

<table>
<thead>
<tr>
<th>Dilution</th>
<th>% Samples returning &gt;7 (ParaDNA Data Anal.)</th>
<th>Equiv. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>neat</td>
<td>90%</td>
<td>1.6μg</td>
</tr>
<tr>
<td>1:2</td>
<td>100%</td>
<td>800pg</td>
</tr>
<tr>
<td>1:5</td>
<td>50%</td>
<td>400pg</td>
</tr>
<tr>
<td>1:10</td>
<td>25%</td>
<td>200pg</td>
</tr>
<tr>
<td>1:20</td>
<td>100%</td>
<td>100pg</td>
</tr>
<tr>
<td>1:100</td>
<td>0%</td>
<td>16pg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Saliva dilution series (Intel. Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saliva Neat</td>
</tr>
<tr>
<td>Saliva 1:2 Dilution</td>
</tr>
<tr>
<td>Saliva 1:5 Dilution</td>
</tr>
</tbody>
</table>
Validation: Mixture Detection

• Mixtures tested included Bood:Semen, Saliva, and Semen:Saliva
• Mixtures ranged from 1:1 to 1:9
• This includes initial samples with heavily overlapping profiles
• 81% of mixtures were detected with Data Analysis Software

<table>
<thead>
<tr>
<th>Samples run</th>
<th>21</th>
<th>% detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Mixture detected</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>(ii) Possible mixture detected + (i)</td>
<td>9</td>
<td>43%</td>
</tr>
<tr>
<td>(iii) Evidence of mixture in Data Analysis</td>
<td>17</td>
<td>81%</td>
</tr>
<tr>
<td>Evidence of minor contributor (if ref. known)</td>
<td>18</td>
<td>86%</td>
</tr>
</tbody>
</table>
Validation: Rust Inhibition

- ParaDNA employs direct PCR with no purification process.
- Therefore, PCR inhibitors are not removed.
- Increased amounts of rust (a known PCR inhibitor) did show a reduction in the efficacy of the system as expected.
- Of note, even on heavy rust, the system was able to determine allele calls and all calls were accurate.
Implementation Impact

• Each test costs under a hundred dollars a sample as opposed to up to one thousand for full analysis
  • Screening Test: $42
  • Intelligence Test: $54

• A wider array of cases have benefitted from analysis of DNA evidence, not just major crimes
  • Major crime samples run: 30 (42%)
  • Property crime samples run: 41 (58%)

• Results are returned within approximately 1 hour and 15 minutes after sampling
  • Allows actionable intelligence within hours or days of a crime being committed
  • Reduces the time focusing on false suspects or uninformative evidence

• Increases the strength of cases
  • Screening results have been utilized to obtain search and arrest warrants, therefore increasing the potential to find further evidence and locate stolen property
Early Success: ParaDNA

Benefits in property cases

• Utilize profiles determined by the ParaDNA Intelligence Test to obtain search warrants for the suspect’s buccal sample
• Able to connect a suspect to a burglary of firearms case by a drinking can left behind and then turn around and see allele consistencies with multiple other area burglaries
• Blood left behind at a county building burglary was consistent with the suspect in multiple high cost burglaries in the area
Early Success: ParaDNA

Sexual Assault

• A cigarette found at the scene appeared similar to a cigarette which a witness noticed the suspect smoking earlier that night
• The two cigarettes were tested against each other using the ParaDNA Intelligence Test
• Results showed consistency between the cigarettes
• Search warrant was obtained for the suspects buccal samples
• Suspect arrested
• Buccal sample, cigarettes and the sexual assault evidence were sent out for private testing
• Still awaiting laboratory results
Early Success: ParaDNA

Missing Person / Unidentified Remains

• Victim was swept out to sea during bad rip currents (undertow) on Kauai’s North Shore

• Unidentified remains were recovered a few days later on a near by beach

• A composite Intelligence Test profile was used to establish a presumptive link between the unidentified human remains and the recent missing person case

• Still awaiting laboratory confirmation
Early Success: ParaDNA

Fatal Hit and Run

• Fatal hit and run accident occurred with a stolen vehicle
• The vehicle involved was left at the scene, however, the suspect fled
• There was blood located in the drivers seat area of the abandoned vehicle
• Suspect was taken into custody with injuries consistent with vehicle damage
• ParaDNA Intelligence Test showed that the blood in the vehicle was consistent with the known profile obtained from the suspect
• Still awaiting laboratory results
Cost Analysis: ParaDNA

Example: Attempted Murder Blood Sample

• 3 samples were screened that would have otherwise been targeted for straight send out. The screening was able to determine further analysis was not necessary.

• Screening cost: $240

• Direct submission for full analysis would have cost approximately $1,600.

• Total Cost Savings: $1,360
Cost Analysis: ParaDNA

Example: Homicide Scene Cigarettes

• 12 cigarettes were found at the scene, where there were 3 persons of interest (suspects/victim).

• A screening cost of $630 was able to identify two cigarettes to triage for full STR profiling.

• Screening plus full STR confirmation of the screening results cost approximately $3,000.

• If we had to send out all of the cigarettes found and persons of interest control samples the cost would have been approximately $8,000.

• Total Cost Savings: $5,000
Cost Analysis: ParaDNA

Overview:
• Cost per sample: $42 screening test or $54 intelligence test
• We have screened a total of 71 items on the ParaDNA system.
• **Total cost:** Approximately $5,850
• To send the same 71 samples straight to a private lab for full STR testing, it would have cost approximately $44,000 - $70,000.
• **Total savings:** Approximately $38,000-$64,000
• **ParaDNA Screening Unit Cost:** Approximately $42,000
Special Thanks

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• Supervising Deputy Hawai’i Attorney General Kevin K. Takata
• Kaua’i Mayor Bernard P. Carvalho Jr.
• Kaua’i Police Commission
• Kaua’i Police Department Investigative Services Bureau, Fiscal Section, Evidence Sections and Patrol Services Bureau
Questions?

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