The DNA Field Experiment:
Cost-Effectiveness Analysis of the Use of DNA in the Investigation of High-Volume Crimes

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RESEARCH REPORT

April 2008

research for safer communities

URBAN INSTITUTE
Justice Policy Center

This document was prepared under a grant from the National Institute of Justice.

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ACKNOWLEDGMENTS

The authors would like to thank the many individuals who assisted our efforts in collecting, preparing, and analyzing the data used in this study.

At the National Institute of Justice, former director Sarah Hart was the architect of the DNA Field Experiment and we thank her for her foresight in developing this project. Edwin Zedlewski and Katharine Browning provided exceptional leadership throughout the evaluation, and John Paul Jones II and Mark Nelson offered important technical comments. John Morgan, Thomas Feucht, and Susan Narveson provided valuable direction.

At the Urban Institute, Terence Dunworth provided thoughtful guidance throughout the project. We benefited greatly from exceptional research assistance both at the Urban Institute and at the experimental sites. At Urban, Bogdan Tereshchenko, Aaron Sundquist, and Carly Knight helped craft data collection instruments and analyzed data. Kevin Ward, Julie Wilkinson, Lacey Ballantyne, Abby Brown, Erin Balogh, and Alanna Rosenberg provided able research assistance working directly with the experimental sites—the project could not have been completed without their diligent efforts. Denise Herz, Scott Decker, and Tim Bynum served as partners in this experiment and each made a substantial contribution to both the research and the project by troubleshooting early problems in implementation. Eric Grodsky and Adele Harrell served as external experts and provided critical insights into the evaluation's design and methods.

In Denver, Chief Gerald Whitman, District Attorney Mitch Morrissey, Crime Laboratory Director Gregg Laberge, Detective Phillip Stanford, and Judge Carlos Samour all contributed substantial time and expertise to facilitate the study's implementation and evaluation. We would also like to thank Simon Ashikhmin for his efforts in collecting data, serving as a liaison, and answering our questions.

In Topeka, Sindey Schueler provided guidance and unending patience in explaining the complex procedures of DNA analysis. Amy Roles and James Anderson assisted data collection. We would also like to thank Assistant District Attorney Cynthia Long for her assistance collecting data and explaining the prosecutor's perspective. We would also like to thank Chief Ronald Miller, Detective Thomas Sipp, Lieutenant Kip Lowe and KBI forensic scientists Alan Mattox and Karen Oyerly for their assistance in this project.

In Orange County, the authors would like to thank all of the partners in the Sheriff's Department and the District Attorney's for their insights and advice in helping us better understand the use of DNA evidence. In particular, we would like to thank Elizabeth Thompson for her expertise and guidance throughout the experiment. We would also like to thank Tom Nasser, Dean Gialamis, Ilene Krokaugger, Michelle Stevens, Heidi Hunsicker, Robert Binz, Jillian Zoccoli, Stacy Vallercamp, Ruth Ikeda, Aimee Yap and Matthew Nixt from the Sheriff's Crime Lab, Assistant

Sheriff and Acting Sheriff-Coroner Jack Anderson, Captain Bob Blackburn, Sergeant Mike Gavin and Sgt. Paul Fuzzard from the Orange County Sheriff's Department, and Scott Scoville from the Orange County District Attorney's Office for their help at each stage of the experiment and for everything they have taught us.

In Phoenix, the authors would like to thank the Phoenix Police Department's Laboratory Services Bureau, in particular Kelcey Means and Heather Fairchild, for spearheading the DNA experiment in Phoenix. The time and energy the lab put into this experiment was invaluable. The authors would also like to thank Police Chief Jack harris, Sergeant Ben Sywarungsymun, Sergeant Greg Moats, Sergeant Michael Dwyer, Sergeant Tim Woods, and Sergeant Robert Carrillo from the Phoenix Police Department for their dedication to the experiment and for answering our numerous questions. A special thanks to the Maricopa County District Attorney's Office, including Shawn Steinberg and April Sponsel, for its role in this experiment.

In Los Angeles, we received substantial support from members of the Los Angeles Police Department (LAPD)—Chief William Bratton, Commander Harlan Ward, Detective Jim Dawson, Detective Diane Weston, Assistant District Attorney Lisa Kahn, and Brenda Brubaker all invested their time and energy into this experiment from the beginning. We would also like to thank Jeffery Thompson and Lawrence Blanton from the LAPD's Scientific Investigations Division and Greg Matheson, director of the Crime Lab for assistance throughout this project.

We would also like to thank Ronald Arndt, agent-in-charge of the Denver Laboratory for the state of Colorado; Eva Steinberger, assistant chief of DNA programs for the California Department of Justice's Bureau of Forensic Services; and Randy Johnson of the Arizona Department of Public Safety for providing insight into the case verification process at the various state labs in our study.

EXECUTIVE SUMMARY

In the United States, DNA analysis is almost exclusively used to investigate violent criminal incidents. Great Britain, by contrast, has employed DNA forensics in nonviolent criminal investigations on a national scale since 2001. The success of this strategy is one reason the National Institute of Justice launched the DNA Field Experiment in five communities (Orange County and Los Angeles, California; Topeka, Kansas; Denver, Colorado; and Phoenix, Arizona). The DNA Field Experiment evaluates the expansion of DNA evidence collection and testing to the investigation of property crimes.

We report the results of a prospective, randomized study of the cost-effectiveness of DNA in investigating high-volume crimes, including residential burglary, commercial burglary, and theft from automobiles. Biological evidence[1] was collected at up to 500 crime scenes in each site between November 2005 and July 2007, and cases were randomly assigned to the treatment and control groups, producing a roughly equal split of cases within each site. In the treatment group, DNA processing as well as traditional practices were used to investigate the case.[2] In the control group, biological evidence was not initially tested, and case outcomes were due only to traditional investigation.

The study's main findings are that:

- Property crime cases where DNA evidence is processed have more than twice as many suspects identified,[3] twice as many suspects arrested, and more than twice as many cases accepted for prosecution compared with traditional investigation;
- DNA is at least five times as likely to result in a suspect identification compared with fingerprints;
- Suspects identified by DNA had at least twice as many prior felony arrests and convictions as those identified by traditional investigation;
- Blood evidence results in better case outcomes than other biological evidence, particularly evidence from items that were handled or touched;
- Biological material collected by forensic technicians is no more likely to result in a suspect being identified than biological material collected by patrol officers.

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[1] We define biological evidence as evidence recovered from crime scenes that is thought to contain human cells in the form of hair, tissue, bones, teeth, blood, or other bodily fluids.

[2] In the first months of the investigation, while the biological material was being tested, detectives and investigators did not know if the case was assigned to the treatment or control groups, and thus investigations proceeded identically for both samples.

[3] Technically, a CODIS match does not identify a suspect. Individuals who are identified because they match a known profile in the convicted offender or forensic indices do not immediately become suspects, but rather individuals that need to be evaluated by the case investigators to determine if they could be the offender. In this study, we only report matches where the investigators identified the matched person as a suspect. Thus, for simplicity, we refer to the CODIS match as identifying a suspect.

SUSPECT IDENTIFICATION, ARREST AND PROSECUTION

Overall, a suspect was identified in 31 percent of cases where biological evidence was present and analyzed. In the control cases where the biological evidence was collected but not tested, a suspect was identified in 12 percent of cases. The rate of suspect identification in control-group cases using traditional investigative practices is comparable to the FBI's estimate that 12.7 percent of burglary cases were closed in 2005. In the treatment group, there was an arrest in 16 percent of cases. In the control group, 8 percent of cases yielded an arrest. Across the five sites, there were 173 arrests among the treatment cases, 87 more arrests than in the control group.

FINGERPRINT VS DNA EVIDENCE

DNA evidence led to a considerably higher number of suspect identifications and arrests than fingerprint evidence. In cases where both fingerprint and biological evidence were collected, suspects were identified through the Combined DNA Index System (CODIS) database at twice the rate they were identified by AFIS (Automated Fingerprint Identification System)—16 percent in CODIS and 8 percent in AFIS. Suspects were arrested following a CODIS hit at three times the rate (9 percent) they were arrested following an AFIS hit (3 percent). However, this overstates the effectiveness of fingerprint evidence, which was collected at only a third of crime scenes.

Overall, a suspect was identified by biological evidence in 16 percent of cases, but identified by fingerprints in only 3 percent of cases. Likewise, an arrest was made via CODIS identification in 9 percent of cases and an arrest was made following fingerprint identification in just 1 percent of cases. Across all crime scenes where biological evidence was collected and tested, DNA evidence was five times more likely to lead to a suspect identification and nine times more likely to lead to an arrest than fingerprints.

CRIMINAL HISTORY OF IDENTIFIED SUSPECTS

Suspects identified using DNA evidence had substantially more serious criminal histories than those identified through traditional investigation. Suspects identified by DNA averaged 2.9 prior felony convictions and 5.6 prior felony arrests, compared with 0.9 prior felony convictions and 1.7 prior felony arrests for suspects identified using traditional investigation in the control group.

BEST PRACTICES IN DNA EVIDENCE COLLECTION

This analysis yields four main findings regarding crime scenes and evidence-collection processes:

- Blood and saliva samples are significantly more likely to yield usable profiles than samples of cells from items that were touched or handled.

- Unlocked crime scenes in which the stolen property was unlocked have lower odds of yielding a sample that leads to a suspect identification. Similarly, crime scenes investigated during the 2–10 p.m. shift—when calls for service peak and officer time is most constrained—are least likely to yield a DNA profile.

- Evidence collected by crime scene technicians is no more likely to yield a DNA profile and a subsequent CODIS match than evidence collected by patrol officers.
- Whenever possible, evidence collectors should acquire whole items (rather than swab the evidence item for evidence) to maximize the probability of obtaining a DNA profile.

COST-EFFECTIVENESS OF DNA

The study generates two estimates of the additional cost of testing DNA evidence. First, we estimate how much is added to the cost of crime investigations and find that processing a single case with DNA evidence added about $1,400. Second, we estimate how much it costs to identify and arrest suspects who would not have been identified via traditional investigations. We estimate a cost per additional suspect identified of $4,502, and a cost per additional arrest of $14,169. These costs represent the investment required to solve cases that would otherwise go unsolved—that is, we find it costs $4,502 to identify a suspect that would otherwise not be identified.

DISCUSSION AND IMPLICATIONS FOR POLICY AND PRACTICE

The DNA Field Experiment tested different approaches to using DNA as an investigative tool in property crimes. It was not a test of established best practices. Four sites implemented new protocols for this demonstration and experimented with new strategies for identifying and collecting DNA evidence. For example, Orange County tested whether collecting and processing samples from touched or handled items was cost-effective.

All five sites experienced problems in implementation. Even so, DNA processing produced results that were superior to traditional investigation. Still greater improvements would likely result as more experience with DNA is gained. For instance, the site (Denver) with the best results experimented the least and most closely followed procedures that we identify as producing the best outcomes. This suggests that the other sites' outcomes would be improved by following similar strategies. Thus, our findings are almost certainly lower-bound estimates of the potential effectiveness of DNA in solving property crimes.

These results are a snapshot of the changes from expanded use of DNA. As jurisdictions gain experience processing cases with DNA, results should improve from the baseline reported in this study. Importantly, throughout the study, the number of offenders included in the CODIS databases increased, and will continue to do so, which will further improve the effectiveness—and cost-effectiveness—of using DNA in property crime investigations.

Jurisdictions considering expanding their use of DNA as an investigatory tool should recognize that DNA investigations involve many actors in a complicated process. Key actors—crime laboratories, police, and prosecutors—must share data and collaborate in ways that are not routine in traditional investigations.

In all five sites, limited resources for these agencies were an important barrier to expanding the use of DNA. Highest-cost sites relied in large part on outsourcing due to limited in-house lab capacity. Without a substantial increase in lab capacity, expanding biological evidence collection will create an additional backlog. Collecting DNA in property crimes will increase the number of suspects that detectives need to track and arrest and the number of defendants district attorneys need to prosecute and public defenders need to represent. These agencies must be prepared to absorb this increased volume of cases. If not, backlogs, will strain the criminal justice system's ability to process other cases.

Expanding the use of DNA as an investigative tool has profound implications. In 2006, the principal crimes investigated using DNA evidence—murder and rape—accounted for about 110,000 crimes in the United States. That same year, there were more than 2 million burglaries. Other crimes potentially amenable to DNA-led investigations—theft from auto and motor vehicle theft—account for millions of additional crimes. If identifying, collecting, and processing DNA evidence becomes the national norm for criminal investigations of property crimes without substantial new processing capacity, the criminal justice system will be overwhelmed.

In summary, our research suggests that large numbers of offenders not currently identified by traditional investigations could be identified via DNA. A gap arises because the capacity of police and labs to identify and collect DNA is limited, crime laboratories are severely constrained in their ability to process biological evidence in volume, and prosecutors have not prepared for the impact of large numbers of cases where DNA evidence is the primary source of offender identification. Since DNA-led investigations are more costly than business as usual, substantial additional investments will be required to expand the capacity of crime laboratories, police, and prosecutors to use this investigative tool efficiently.

CHAPTER 1—THE USE OF DNA IN BURGLARY INVESTIGATIONS

The use of deoxyribonucleic acid—DNA—to identify, confirm, or exonerate suspects, has become a staple of many police departments in their investigation of violent crimes. Traditionally, DNA has been applied only to the most serious violent crimes, due to limitations in the resources available to collect and process the biological material. Anecdotal reports suggest that DNA has been effective in improving clearance rates for these types of crime, particularly for sex offenders who most often leave biological evidence behind (Weedn and Hicks 1998). The effectiveness of DNA in those cases has led to efforts, such as this demonstration project, to expand DNA evidence collection and processing to other types of crime, such as burglary (Federal Bureau of Investigation [FBI] 2005).

While the use of DNA to solve property crimes in the United States is a relatively new idea, with very limited prior research, there is substantial international experience with this approach. In particular, the British Home Office began their DNA Expansion Programme in 2000. The goal of the project was two-fold. First, it provided funding to police in England and Wales to collect DNA samples from all known offenders to increase the scope of the National DNA Database. Second, it funded increased collection of DNA material left by offenders at crime scenes, particularly volume crimes (burglary and vehicle crimes) that had low closure rates (Home Office, 2005).

Since the implementation of the DNA Expansion Programme, the Home Office found a 74% increase in DNA material collected, a 76% increase in DNA submitted for processing and a 32% increase in crime scene samples uploaded into the National Database over the course of the Programme (2000-2005) (ibid). The Programme increased in the number of crime scenes where DNA material was collected from 7.3% in 2000/2001 to 12% in 2004/2005 High volume crimes accounted for 61% of crimes where DNA was found on scene. Where DNA biological evidence was collected, 45% of crime scenes yielded a DNA profile uploaded into the National Database.

The program led to a substantial improvement in suspect identifications. The overall detection rate in burglaries was 16%, compared to a 41% rate in cases where biological evidence was collected. (ibid). The Programme also estimates that approximately 50% of the DNA database made detection led to a conviction and 25% of the convictions led to custodial sentences (Asplen, 2004). In another project, Pathfinder, the Home Office's Forensic Science Service, in conjunction with the Lancashire Constabulary and the Greater Manchester Police, found that while DNA is only found at about one sixth of the total number of crime scenes than fingerprints, DNA generates a higher proportion of maters per scene attended (FSS, 2005). The Pathfinder Project also found that police officers placed the highest value on DNA identification, ahead of fingerprints, in considering the most important forensic evidence in suspect identification (Burrows et al., 2005).

Results such as these suggest that the demand for additional DNA collection and testing increases will likely increase over time. However, limited resources of police departments, laboratories, and prosecutor's offices across the country limit the ability of these agencies to expand their DNA testing capabilities. The National Institute of Justice's DNA Field Test was designed to provide funds to five communities (Orange County, California; Los Angeles, California; Topeka, Kansas; Denver, Colorado; and Phoenix, Arizona) to expand their DNA collection and analysis to include the investigation of property crimes, specifically burglaries.

In May 2005, law enforcement agencies from these five communities submitted proposals in response to the National Institute of Justice's DNA Expansion Program solicitation and became demonstration sites for the DNA Field Experiment. As part of the demonstration, each site agreed to participate in the evaluation and follow an experimental protocol in cases where DNA evidence was collected at burglary scenes. Each site agreed to collect biological evidence in 500 cases—these cases were the first 500 cases to produce biological evidence from the point at which the project began. The sites agreed to have 250 cases randomly assigned to a treatment group and 250 to a control group. Treatment and control cases were both investigated via traditional means, and the biological evidence was tested in cases assigned to the treatment condition. Each case therefore underwent identical processing, except that biological material in the treatment cases was tested. Thus, any difference in outcomes is attributable to the DNA testing.

In October 2005, the Urban Institute began its evaluation of the impact and cost-effectiveness of the demonstration. While each demonstration site has a different protocol for training evidence collectors and identifying and collecting biological material at the crime scene, the assignment process is identical—cases were assigned to a treatment or control condition by the Urban Institute prior to undergoing forensic analysis. Once a case was assigned, administrative data were collected on the attributes of the crime scene and the evidence collector, and other contextual variables theoretically related to the quantity and quality of samples collected. Administrative data were also collected that described the results of DNA analysis and the legal disposition of the case.

Cost data were also collected to measure the additional costs from processing DNA evidence. To estimate the cost of processing a case involving DNA evidence from beginning to end, cost data were collected for each stage of case processing. The processing costs estimated in this study include only processes that were different between groups, so business-as-usual investigation practices are the same between groups and not included in these cost estimates. In addition, costs associated with the additional investigation— including arrest—that result from additional suspect identifications from DNA were measured. These additional processing costs and case outcomes were compared with outcomes for control cases in the cost-effectiveness analysis.

THE BURGLARY INVESTIGATION PROCESS

Although not widely used, forensic DNA analysis can play a role in the typical process of investigating burglaries. The Home Office (2004) Reducing Burglary Initiative identified three principles for effective investigations:

1. Building in investigative techniques that can be applied routinely and in a systematic fashion,
2. Following a set of procedures that correspond to the basic steps burglars follow in the commission of the offense, and
3. Maintaining flexibility in the collection and recording of all evidence.

By following the steps burglars take in effecting their crimes, it is possible to determine the likely locations of DNA evidence at a crime scene. Residential burglars proceed through several steps, including generating a motive, target identification, entering the dwelling, searching the house, gathering items, leaving the house, and disposing of items (Wright and Decker 1994; Eck 1992; Greenwood and Petersilia 1975; Klockars 1974; Miethe and Meier 1994; Swanson, Chamelin, and Territo 2002). Each step identifies possible crime scene attributes where DNA evidence may be found that include the point of entry to the crime scene, tools and other items left behind at the scene, property and other items handled but not taken from the scene, the point of exit from the scene, and, finally, goods subsequently sold at pawn shops or recovered from offenders (fences or drug dealers).

With respect to DNA evidence collection, time matters. In order to identify and collect evidence, first responders and follow-up investigators must be aware of the possibility of collecting DNA evidence before it deteriorates or is too contaminated to yield a profile. However, though the collection of physical evidence is among the most critical steps in the investigation process, identifying and collecting DNA evidence has not traditionally been a priority for burglary detectives. To address these issues within the context of each jurisdiction's training and culture, each experimental site modified investigative protocol to maximize the likelihood that DNA evidence would be collected if it was indeed at the property crime scene.

PREVALENCE AND INCIDENCE OF OFFENDING BY BURGLARS

A key goal for the demonstration sites was to identify serial property offenders and interrupt their criminal careers. Since many offenders identified by DNA will be identified through databases of convicted offenders, the burglars captured via DNA are expected to be among the most serious and prolific property offenders. Though little is known about the persistence of criminal offending exhibited by burglars, substantial research has examined the career offending trajectories of habitual offenders in general.

The goal of the DNA Field Experiment was to increase the number of suspects identified, arrested, and convicted in high-volume crimes. In 2005, 2,154,126 burglaries were reported to police, according to the FBI. However, there were only 298,835 arrests nationwide in burglary cases, yielding a nationwide arrest rate of just 13.7 percent. Moreover, this overestimates the true likelihood that there will be an arrest in any one burglary since, in some cases, multiple offenders may be arrested. The official clearance rate—the percentage of burglaries in which a suspect was identified—was 12.6 percent in 2005 (BJS 2006). However, the clearance rate includes burglary cases cleared for reasons other than arrest. And, the National Crime Victimization Survey (NCVS) reports that in 2005, there were 3.5 million burglaries, 67% more than were officially reported to police. When combined with the number of arrests, this yields an 8.5 percent arrest rate in burglaries. Again this is also likely an overestimate since there may be multiple suspects per arrest. In addition, since some burglaries are solved when a suspect is caught on scene, the expected arrest rate for this study should be much lower in our study. All cases enrolled in this study had biological evidence was recovered at the scene. In general, biological evidence is rarely recovered when a suspect is caught on scene. Thus, the appropriate counterfactual—the expected rate of clearing cases without using DNA in a burglary investigation--- would be the clearance rate observed in the control group.

Career Criminals

The career criminal literature examines the patterns of offending over an individual's life course. Systematically studying the criminal career, Wolfgang, Figlio, and Sellin (1972) found that more than half of all crimes and two-thirds of violent crimes were committed by only 6 percent of a given birth cohort. By age 30, this group of offenders had been charged with 74 percent of all crimes committed by members of the birth cohort, including 84 percent of personal injury offenses and 82 percent of serious property offenses (Collins 1977, 16). Shannon (1980, 4)[[AU: not in reference list]], studying the Racine birth cohort, found that in the 1942 birth cohort, 1 percent of males accounted for 29 percent of felony contacts; in the 1949 birth cohort, 3 percent of males accounted for 50 percent of felony police contacts; and in the 1955 birth cohort, 6 percent of males accounted for 70 percent of felony police contacts. In a later study, using the RAND inmate survey, Peterson, Braiker, and Polich (1980) classified 25 percent of the cohort as career criminals and found that they committed about 60 percent of the armed robberies, burglaries, and auto thefts reported by the whole sample.

Capture of Career Criminals

One of the most dramatic changes in criminal justice policy over the past thirty years has been the creation and implementation of habitual offender laws. These laws are aimed at the selective incapacitation of offenders who are repeat offenders of serious crimes. These habitual offender laws, including "three strikes" laws, use an offender's criminal history to selectively incapacitate those at greatest risk of serious, chronic, and persistent offending. Colorado's habitual offender laws enacted in 1979 and subsequently modified over time are representative of these policies. The statutes create a four-level system with escalating sentences beginning with the third felony conviction. Habitual offender laws force judges to sentence the habitual offenders to a determinate sentence that is considerably higher than the maximum in the felony-class presumptive ranges for nonhabitual offenders.

Similar habitual-offender (three strikes) laws exist in 26 states as well as in the federal system. California's three strikes law is fairly typical of habitual offender laws both in structure and in terms of the events that motivated its passage—the headline-grabbing murders of Kimber Reynolds and Polly Klaas by offenders on parole or with lengthy criminal histories. In California, the law mandates that for an offender with one previous serious or violent felony conviction, the sentence for any new felony conviction (not just a serious or violent felony) is twice the term otherwise required under law for the new conviction. For a third strike, a person who has two or more previous serious or violent felony convictions, the sentence for any new felony conviction is life imprisonment with a minimum term of 25 years. Since being enacted in 1994, the three strikes law in California has been used to sentence almost 80,000 second strikers and 7,500 third strikers to (Legislative Analyst's Office [LAO] 2005).

Career Burglars

While felony burglary is not usually associated with the serious and violent offending that habitual criminal laws target, there is substantial evidence that many burglars engage in persistent offending. In a study that examined a cohort of incoming California prison inmates, Peterson et al. (1980) found that 13 percent of incoming inmates reported burglary as their most serious committed offense, 58 percent reported having committed a burglary in the previous three years, and those who committed burglary reported committing an average of more then 15 burglaries annually. Likewise, Petersilia, Greenwood, and Lavin (1978) found that almost 50 percent of the sample reported auto theft as their first serious crime and 30 percent stated that burglary was their first serious crime. Using arrest histories to examine rates of burglary offending, Blumstein and Cohen (1987) found an average of 5.7 burglaries committed per year, and Cohen (1981, 1983) found an average of 5.3 burglaries per year by an individual. When self-report data—rather than arrest or conviction data—are observed, burglary incidence is dramatically higher. Chaiken and Chaiken (1982) found a range of 116 to 204 burglaries per year committed by incoming prisoners, Visher (1986) found that both prison and jail inmates reported an average of 98.8 burglaries a year, and Chaiken and Rolph (1985) found an average of 114.6 burglaries per year. Thus, apprehension of a single burglar is likely to have a disproportionately higher payoff in reducing the number of burglaries in a community.

DNA EVIDENCE

DNA stores the genetic code of the human body and is present in every nucleated cell. Each person's DNA sequence is unique and when analyzed provides precise information about the identity of an individual. The likelihood that any two non-identical siblings have the same 13-loci DNA profile can be as little as one in one billion or more (NIJ 2002).

Biological specimens must be properly collected, stored, and submitted to the crime lab to get a sample that can be analyzed. Evidence is generally collected from victims, from suspects, and from victims' and suspects' belongings in person crimes, and from crime scenes through forensic examinations conducted by trained forensic scientists. In burglaries, the perpetrator may leave behind a variety of biological material, including blood, saliva, and skin or epithelial cells. Biological samples may undergo DNA analysis after they are collected or stored for later analysis. With advances in technology, it is possible to use DNA analysis to help solve very old cases that are considered “cold” or unsolvable (NIJ 2002). Evidence must be handled properly to avoid decomposition or contamination. As with all crime scene evidence, documentation of the chain of custody is also critical to guard against mistakes or allegations of tampering that may challenge the evidence’s validity in the courtroom (OVC 2001).

DNA evidence collected from victims and crime scenes can be searched against samples from a specific (reference) suspect when other evidence points toward that individual. DNA profiles from crimes can also be searched against DNA from convicted offenders, in hopes of getting an offender hit that can lead to an arrest. Further, DNA profiles from different crimes can be compared against each other to link serial crimes and aid in the investigation of all linked cases. In cases where no suspect is identified, a “John Doe” warrant may be filed, depending on the jurisdiction, in which a DNA profile is the subject of a warrant rather than a named individual (NIJ 2002). The John Doe warrant effectively stops the clock on the statute of limitations, allowing the investigation to continue.

RESEARCH LINKING DNA EVIDENCE TO CASE OUTCOMES

DNA evidence is a widely accepted investigative tool and is routinely collected and analyzed in homicide and sexual assault cases (Lovrich 2003; Weedn and Hicks 1998). As early as 1996, in cases where it was available, DNA was used as evidence in 41 percent of plea agreements and 34 percent of trials. At the same time, DNA evidence was rarely used in burglary investigations and was introduced in only 2.7 percent of burglary trials in 1996 (DeFrances and Steadman 1998).

In the past five years, there has been growing interest in expanding the capacity of police agencies and crime laboratories to collect and analyze DNA evidence in high-volume crimes, such as commercial and residential burglary and theft from automobiles. Interest in the use of DNA in these investigations is driven by high recidivism rates among burglars and the observation that the severity of offenses burglars commit may increase over time (Langan and Levin 2002).

As collection of DNA at high-volume property crime scenes is relatively recent and fairly unusual, very little empirical literature documents the efficacy of DNA evidence in solving and clearing these types of crimes. Three pilot projects to reduce DNA backlog have been undertaken in Miami-Dade (Florida), New York City, and Palm Beach County (Florida). Analysis of data collected in those projects suggests that DNA backlog reduction from property crimes can have major public safety benefits (Zedlewski and Murphy 2006). As more offenders are included in the Combined DNA Index System (CODIS), identification of suspects using DNA is expected to increase as well (Florida Department of Law Enforcement State DNA Database Statistics). An earlier pilot study in New York City found that biological evidence from 201 burglaries yielded 86 CODIS-uploadable profiles, yielding 31 CODIS matches, a hit rate of 15 percent (NIJ 2004). In addition, 37 forensic matches linked profiles to other unsolved crimes, including sexual assault and robbery. A similar pilot study of 755 profiles collected at burglary scenes in Miami-Dade and Palm Beach counties yielded 362 CODIS-acceptable profiles (NIJ 2004).

Some evidence from the United Kingdom shows that the use of DNA in burglary cases also increases the likelihood of identifying a suspect. The Home Office estimates that when DNA is recovered from domestic burglary crime scenes, the identification rate increases from 15 to 46 percent. About half of subjects identified are ultimately convicted, and about one in four convicted offenders received custodial sentences. The Home Office further estimates that each of these detections prevented an additional 7.4 crimes being committed.

The United Kingdom Home Office's DNA Expansion study tested the efficacy of DNA collection at burglary scenes and found that

- only 11 percent of all examined crime scenes yielded DNA samples;
- most (77 percent) of the samples were robust enough to yield DNA profile(s); and
- of those profiles, 59 percent passed the screening criteria necessary for entry into the national database. In total, 0.8 to 2.2 percent of burglary crime scenes attended yielded DNA samples that were eventually loaded onto the national database (MEG34, Crime Scene Examinations).

The Home Office's DNA Expansion study also compared the effectiveness of fingerprint analysis with DNA analysis in suspect identification. In a study conducted in 2002 and 2003, fingerprints were collected in 33 percent of cases, while DNA was collected 10 percent of cases. Fingerprints were found to yield a higher number of forensic matches per crime scene (9.2 versus 4.6 per 100 crime scenes). However, DNA analysis yielded a higher percentage of database matches per submitted sample than fingerprint analysis (49 versus 28 percent). The literature suggests that a DNA sample was nearly twice as likely to yield a match as a fingerprint (MEG39, Fingerprints and DNA). While there is growing evidence that biological material collected at crime scenes can yield suspect identifications and arrests, the prevalence of biological material at crime scenes in the United States has not been studied.

Databases Supporting DNA Analysis

Throughout the late 1980s and early 1990s, as the use of DNA gained acceptance in legal and scientific arenas, the use of DNA analysis in sexual assault cases became more common. To support the use of this technology, localities, states, and the federal government began creating DNA databases to store, search and share DNA profiles from convicted offenders, missing persons, and crime scenes. By the early 1990s, most states began creating DNA databases and many states began collecting DNA from convicted murderers and sex offenders (NIJ 2002). Successful use of DNA in solving crimes led to the creation of CODIS, computer software for operating a centralized, national DNA database. This system began as an FBI pilot project in 14 states and local laboratories in 1990 and led to the DNA Identification Act of 1994 which created a national DNA database index coordinated by the FBI (FBI 2000).

THE COMBINED DNA INDEX SYSTEM (CODIS)

CODIS (Combined DNA Index System) is an umbrella term describing all DNA index systems (federal, state, and local), which search profiles from crime scenes against DNA profiles from known and unknown persons. There are three hierarchical components of CODIS: a local-level DNA Index System (LDIS), a state-level DNA Index System (SDIS), and a national-level DNA Index System (NDIS). NDIS is managed by the Federal Bureau of Investigation under the authority of the DNA Identification Act of 1994, while management of SDIS and LDIS varies by state. Each level has its own protocols and eligibility criteria for submission of DNA profiles. Generally the criteria are stricter when moving from the local (i.e., LDIS) to the national (i.e., NDIS) DNA index systems. LDIS and SDIS protocols and eligibility criteria vary by state, but all states must conform to the submission requirements of NDIS.

The first tier of the system, the Local DNA Index System (LDIS), is housed in the forensic DNA laboratory typically operated by local police and sheriff departments. The second tier, the State DNA Index System (SDIS), is a state laboratory conducting forensic DNA analysis that collects data from local laboratories, performs searches across these sources, and transmits data to the national database. Finally, the national tier or NDIS (National DNA Index System) collects DNA profiles from participating states and helps support communication and sharing of DNA information between states (NIJ 2002). There is only one designated SDIS laboratory per state.

THE NATIONAL DNA INDEX SYSTEM (NDIS)

A national data bank of DNA profiles was established in 1994 with passage of the DNA Identification Act. This database contains DNA profiles that can be searched by crime laboratories in each state to augment their efforts to identify the perpetrator of a crime and to link DNA from one crime scene to another. The databases are divided into several indices:

- a forensic index containing profiles from crime scenes;
- an offender index containing profiles from convicted offenders or arrestees (depending on the state);
- an unidentified human remains index containing profiles taken from personal items from unidentified bodies;
- a missing persons index containing profiles from missing persons; and,
- a relatives of missing persons index containing profiles generated from close relatives of missing persons.

The first two indices, the forensic index and the offender index contain the largest number of profiles and are the most used by law enforcement. The profiles submitted to the state offender or arrestee index are governed by each state's law. The state DNA laboratory can only collect samples from offenders convicted of offenses or arrested for offenses as outlined in their state law. Inclusion of profiles from their various indexes into NDIS is dependent on NDIS rules. The NDIS offender index permits profiles from those samples that are collected under that state's offender law's.

The FBI mandates that state laboratories follow standards designed to ensure the quality of results (FBI 2000). The standards require laboratories use specific control samples that are incorporated into stages of the analytic procedure to ensure results obtained are correct. These controls include positive (an internationally known sample profile) and negative amplification controls that test the validity of the procedure and are indicators of the success of the procedure and any potential contamination that may exist. In addition, blank reagent controls are required to monitor all reagents in the analytical procedures and to detect potential contamination from reagent sources. Internal lane standards and allelic ladders monitor the detection stages of the procedure and are used to reliably type the various genetic areas examined. Several laboratories use additional controls such as an extraction control that monitors the procedures success from beginning to end. Each of these controls has a specific purpose with a goal to ultimately verify that the processing returns an accurate profile as verified by the results of these controls.

In order that all laboratories can compare results, the FBI specifies the core genetic areas called loci that are used in CODIS and places certain requirements for a profile to be uploaded to the various indexes in NDIS. There are thirteen core FBI loci. For upload of a genetic profiles into the NDIS offender index, the FBI requires that the offender profile contain all thirteen loci. For upload of a profile to NDIS forensic index, the FBI requires ten of the thirteen core loci be present. Additional rules exist for the upload of forensic mixture profiles to NDIS. Uploading consists of electronically sending the chain of alphanumeric characters that make up the DNA profile to the NDIS. When a profile is uploaded into NDIS it becomes part of the national database and is continually searched in both indices until a match occurs (Georgia Bureau of Investigation [GBI] 2008).

At the conclusion of this study (October 2007), 5,070,473 profiles were in the offender index and 194,785 profiles were in the forensic index (FBI 2007).

THE STATE DNA INDEX SYSTEM (SDIS)

Arizona

Arizona's SDIS is made up of an offender and forensic index and is managed by the Arizona Department of Public Safety. The offender index has recently expanded its parameters to include all offenders convicted of felonies, and as of January 2008 collection from major felony arrestees. In Arizona, seven local crime laboratories (including Phoenix) submit eligible forensic profiles to SDIS. The submission standards for SDIS mirror those of NDIS in that offender DNA profiles must have a minimum of 13 loci to be entered into the offender index and a minimum of six loci to be entered into the forensic index.

If there is an offender match (e.g., the crime scene evidence to an offender sample), an additional step is undertaken. Each of the local laboratories is notified immediately of an SDIS match. The state lab does not provide identifying information until the match is confirmed. To confirm the match, the state lab reanalyzes the original offender sample that generated the match in SDIS to verify that it produces the same DNA profile as the submitted crime scene profile. If this quality assurance step yields a match between the original and reprocessed sample, the state crime lab provides the local crime lab with the offender's name.

If there is an SDIS forensic match, e.g. crime scene evidence from one laboratory matches to crime scene evidence from another, the local crime laboratory will verify that a match has been made. If a match is confirmed, the local laboratories will exchange paperwork with details about their respective cases and the assigned investigators' contact information.

California

California's SDIS is made up of three main indices: forensic, convicted offender, and arrestees. The databank is the third-largest SDIS in the nation, due to the passage of Proposition 69 in 2004 (California Secretary of State 2004). This law broadened the scope of individuals from whom DNA samples can be collected to include

- adults and juveniles *convicted* of any felony offense,
- All registered sex offenders (felonies and misdemeanors);
- Adults *arrested* for any Penal Code Section 290 felony sex offenses, murder, or voluntary manslaughter.;
- Any person required to provide DNA as a condition of a misdemeanor plea; and,
- Starting in 2009, any adult arrested for any felony.

This expanded criteria was also retroactive - meaning that any person newly convicted, or presently confined, or on probation or parole following conviction or adjudication for any crime must provide DNA samples if he or she has a prior qualifying offense.

The eligibility requirements for uploading a forensic sample into California's SDIS are less strict than Colorado and Arizona in that California permits submission to its forensic indices of profiles with a minimum of seven loci. While the eligibility rules are relaxed compared to the FBI and other states in the demonstration, California requires proper testing of control samples and verification of the DNA profile in the event of a hit in one of the offender indices. There were 941,772 forensic and offender DNA profiles in California's SDIS as of October 2007.

Colorado

Colorado's SDIS is operated by the Colorado Bureau of Investigation. This database is made up of two main indices: a forensic index and an index for offenders convicted of felonies. The submission standards to SDIS mirror those of NDIS in that DNA profiles must have a minimum of 13 loci to be uploaded into the offender index and a minimum of 10 loci to be uploaded into the forensic index. Colorado requires a confirmation process for offender and forensic matches that is similar to the process described for Arizona's SDIS.

The offender index had an average number of 57,261 samples during the study period. Juveniles are included in the Colorado SDIS but their samples cannot be uploaded to the NDIS.

Kansas

The state crime laboratory in Kansas is operated by the Kansas Bureau of Investigation (KBI). Unlike other jurisdictions in the demonstration, the Topeka Police Department (TPD) did not have a local crime laboratory, and KBI processed all biological evidence that TPD submitted. Kansas's SDIS is made up of three main indices: offenders convicted of felonies or burglaries, forensic samples from crime scenes, and arrested felony offenders. The offender index was created in 2002 and the arrestee index was created in early 2006. As a result, the Kansas SDIS contains relatively few profiles compared with the other states in the demonstration. The latest data describing the composition of the Kansas SDIS database in August 2007 recorded 42,953 profiles.

For a DNA profile to be uploaded into the forensic index in SDIS, it must have a minimum of eight (or six in some limited instances) loci (which is less strict than Colorado and Arizona). If a forensic match occurs, KBI notifies TPD of the match and the profile remains in SDIS for subsequent searches. As in the other demonstration sites, if the profile matches a profile in one of the offender indices, KBI reanalyzes the original offender sample. If this quality assurance step yields a match between the original and reprocessed profile, KBI provides TPD with the suspect's name.

THE LOCAL DNA INDEX SYSTEM (LDIS)

Phoenix, Arizona

Phoenix's LDIS maintains indices for known investigative DNA profiles and forensic DNA profiles. The investigative index includes any DNA profile that has been legally obtained from a suspect, apprehended person or investigative lead in a crime. This means that the individual has given oral consent for a DNA sample to be collected or a search warrant or court order was obtained to collect the DNA sample. The forensic index includes crime scene evidence profiles that are developed from evidence that are believed to have been left by the perpetrator.

Orange County, California

Orange County's LDIS has a single forensic index. The criteria for submission to this index system are a minimum of seven loci along with proper control sample testing. At the time of the last forensic hit in this study—May 2007—there were 3,084 DNA profiles in this LDIS.

Denver, Colorado

Denver's LDIS is managed by the Denver Police Department's Crime Laboratory Bureau and has main indices for suspects and forensic DNA profiles. The suspect index consists of any DNA profile that has been legally obtained from a suspect of a crime. In most cases, this means that the suspect has given oral consent for a DNA sample to be collected. The criteria for submission to the forensic index is relatively low—a minimum of seven loci are required and proper control sample testing. As of October 2007, there were 1,832 samples in this database.

Los Angeles, California

LAPD has a local server (LDIS) where all forensic unknown DNA profiles are loaded pending transmission to the state database (SDIS). Once transmitted, they are searched against all profiles in SDIS, including those previously uploaded by the LAPD.

Topeka, Kansas

The Topeka Police Department has no crime lab, but the DNA testing is handled by the KBI which is an SDIS site.

THE USE OF DNA MATCHES IN THE INVESTIGATION

Once a hit occurs and the suspect identification has been confirmed, the state crime lab sends identifying information to the local crime lab (where applicable), which, in turn, forwards that information to the relevant police agency. In California, Colorado, and Arizona, a confirmed offender CODIS match is sufficient grounds for an arrest warrant for the suspect. In these three states, the investigator must collect another DNA sample (usually a buccal swab) once the suspect is in custody. This swab is then analyzed by the local crime lab and compared to the original crime scene DNA profile. Generally, this confirmation sample must be analyzed and a match confirmed before the preliminary hearing. This additional confirmation step is generally undertaken to allow analysts at the local crime lab to deliver all forensic testimony (should it be required).

In Topeka, identifying a suspect via an SDIS match is not considered sufficient grounds for an arrest warrant. Before an arrest warrant is issued, an investigator must obtain a confirmation sample, either through a voluntary contribution from the suspect, or by court order via a search warrant. Only after a sample is obtained, analyzed, and found to confirm the match will an arrest warrant be issued.

CHAPTER 2—RESEARCH DATA AND METHODS

The goal of the DNA Field Experiment was to assess how much more an investigation costs when DNA evidence is collected and processed during the criminal investigation of property crimes, and whether processing DNA evidence leads to better case outcomes (e.g., to measure the cost-effectiveness of DNA in the investigation of high-volume crimes). To do so, a prospective, randomized design was implemented in five experimental sites. The National Institute of Justice funded five communities (Orange County, California; Los Angeles, California; Topeka, Kansas; Denver, Colorado; and Phoenix, Arizona) to expand their DNA collection and analytic capacity to facilitate the investigation of high-volume property crimes, specifically residential and commercial burglaries and thefts from automobiles.

Each experimental site collected biological material from up to 500 property crimes. The 500 cases were not selected—these were the first 500 cases in the jurisdiction where biological material was found at the crime scene after the project started. The Urban Institute randomly assigned 250 cases where biological material had been collected in each experimental condition (treatment and control). Cases in the treatment group underwent DNA testing as soon as possible, while cases in the control group did not begin DNA processing for at least 60 days. Costs of each stage of case processing were calculated and an individual cost of processing was assigned to each case based upon how many processing steps were undertaken. The effectiveness of the experiment was evaluated in four ways.

First, a cost analysis was performed to estimate the average marginal cost per treatment case. The cost analysis estimates the cost of each stage of case processing, to determine the average additional cost of processing a case with biological evidence. The cost analysis estimates a cost for each of six stages of a case with DNA evidence: preliminary testing, generation of profile, CODIS entry, case verification, investigation, and post-arrest. In addition, a cost is estimated for the average case where biological evidence is collected.

Second, an impact analysis estimated the differential outcomes between the treatment and control conditions. The impact analysis estimates the differential likelihood that a case leads to each of three end outcomes:

- Was a suspect identified? (by CODIS, fingerprint, eyewitness, or other means)
- Was an arrest made?
- Was the case referred for prosecution?

Third, differential outcomes were linked to the costs of processing treatment cases. The result was an estimate of the cost-effectiveness of incorporating DNA evidence into the investigative process for high-volume property crimes. The cost-effectiveness analysis estimated the cost per suspect identification, arrest, and case accepted for prosecution.

Finally, a separate analysis was conducted to identify "best practices" in DNA evidence collection by isolating the attributes of test group samples associated with better case outcomes. This analysis examined whether different sample attributes predict each of three intermediate outcomes for a sample:

- Was a profile obtained?
- Was the profile uploaded into CODIS?
- Was a match obtained?

Pooling vs. Site-Specific Analysis

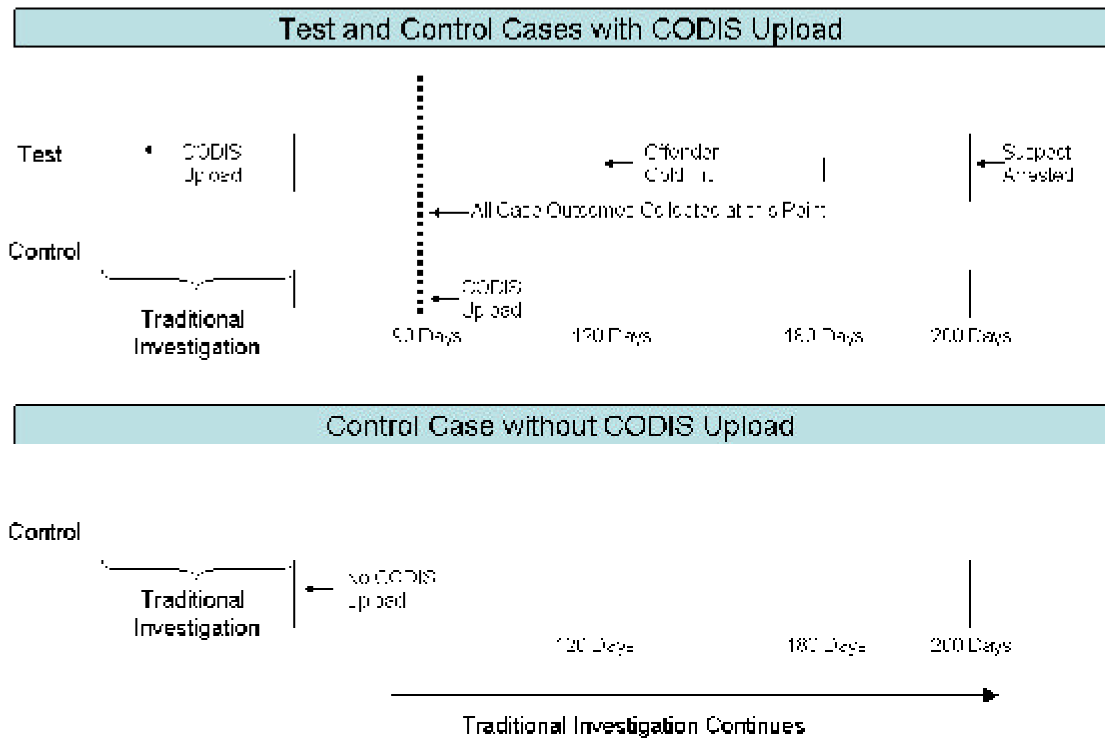
One critical design issue was whether to pool the data across experimental sites or to consider the sites independently. In this analysis, we chose to pool sample-level data to estimate multivariate models that isolate best practices, using site dummies to capture site-specific effects on key sample outcomes. However, since post-investigatory practices vary substantially across sites, we could not pool data to examine whether those attributes affect case outcomes (such as an arrest). Thus, we studied each site's case outcomes independently.

ISSUES IN IMPLEMENTATION

One critical element of case processing was outside the evaluation's control. In designing the experiment, it was necessary to allow the test cases to be analyzed before the control cases were tested. The goal of the random assignment is to allow the test cases to be fully processed before the control cases undergo any testing which allows the control group outcomes to be interpreted as the expected outcome without DNA testing. The inference from this design is that any differences in final dispositions are the result of the availability of DNA analysis. Prior to the evaluation, a 60 day delay in processing control cases was estimated to allow sufficient time for DNA processing and investigation for the test cases. Sixty days after a case was assigned to an experimental group, differences in outcomes would be observed, and these results would be uncontaminated by testing of control-group samples. However, early in the evaluation, it became apparent that test cases were not routinely processed within 60 days. When this occurred, control cases were undergoing DNA processing before test cases were completed. Thus, the final dispositions of cases could not be directly compared. Since cases in both groups had undergone DNA testing, there was no longer a true counterfactual—cases with no DNA testing—to observe.

Figure 2.1

Study Design—Paired and Unpaired Analysis



Source: Urban Institute.

Figure 2.1 describes these issues graphically for a generic case. In every site, it should be noted, some control cases were uploaded to CODIS and some were not. The graphic under the heading "Test and Control Cases with CODIS Upload" describes the situation in which control cases are uploaded into CODIS before test case processing is complete." In this example, samples from a control case are uploaded at 90 days. From that point forward, the control case is processed identically with test cases, and the effects of treatment are no longer observable. In the second example, "Control Case without CODIS Upload" the control case is never tested, and there are no interpretation problems. There are two ways to resolve this issue.

First, the evaluation could assume that the outcomes for a control case could be observed early in that case's processing. That is, we could assume that the outcomes observed 60 days after the date of the crime was a fair representation of the final disposition for that case. There is substantial support for this approach. Detectives in all five experimental sites reported to evaluators that in these high-volume crimes, suspect identification by traditional means routinely occurs very early in the cases investigation—likely within the first 15 days. Thus, after day 15—and especially after day 60—it was very unlikely that any new information would be developed. As a result, outcomes observed at day 60 represent a true estimate of the cases' ultimate disposition. These reports are validated by departmental policies that dictate that cases not solved shortly after the crime occurs be assigned a low priority.

However, this approach may lead to an overestimation of the effectiveness of DNA. That is, if new information is developed in some cases after 60 days, then the approach described above will assign cases a value of no suspect identified, when, in fact, a suspect may later be identified. To address this, we ran a second analysis where outcomes of treatment and control cases were paired.[4] In the pairing process, we identified treatment and control cases that were assigned as close to the same date as possible. We then observed how long the control case was processed before CODIS upload. If the control case was uploaded, we counted the days from case assignment until CODIS upload. This count was then used to define the period of observation of the paired test case. We report these values in separate paired analyses throughout the paper.

In summary, the analysis that follows uses two approaches to inferring the effects of DNA testing on outcomes. In the first approach, we observe all outcomes for a test case and compare these to the outcome for control cases observed at the time the control case DNA are tested. In the second approach, we censor test case outcomes on the date that the control case DNA are tested, and we refer to this as the 'paired' comparison. We censor control case outcome for all cases at the time the DNA is tested, as outcomes for control cases from DNA testing are outside the study framework.

Other Limitations

Two other important caveats to the DNA Field Experiment should be noted at the outset. Cases were randomly assigned once the crime lab had been notified that biological evidence had been identified, collected, and transported. Thus, all costs of processing those cases prior to the point of randomization (including the cost of training and evidence collection) are outside of the study framework. In addition, this analysis does not address the question of the prevalence of collectable DNA evidence at crime scenes, since all crime scenes in this study yielded at least one potential DNA sample. Moreover, the short time frame of the evaluation allowed cases to be followed for only a limited period of time. Thus, the final disposition of many cases—including conviction and sentencing of arrested suspects—is not observed in this evaluation.

THE EXPERIMENTAL SITES

Each of the five sites received demonstration funding in FY 2005. The experiment began in September 2005 and the demonstration sites began to enroll samples into the project in October 2005. Orange County began collecting samples at commercial and residential burglary scenes in December 2005 and finished collecting DNA from its 500th case in February 2007. Los Angeles began collecting DNA at residential and commercial burglaries in April 2006 and finished with 392

[4] It is important to note that we are not matching cases. That is, we are not using information about test cases to identify control cases with similar attributes, and adjusting values based on that match. Rather, we are simply using information about the length of control case processing to determine the appropriate period to observe Test cases in experimental sites where Control Cases were tested.

cases in July 2007. Phoenix started collecting biological samples in January 2006 for their residential and commercial burglaries and thefts from auto and completed their 500th case in June 2007. Denver began collecting evidence from residential and commercial burglaries in March 2006 and their 500th case was reported in July 2007. Topeka started collecting biological evidence from residential and commercial burglaries as well as thefts from auto in December 2005 and finished with 260 cases in July 2007.

Overview of Evidence Collection and Processing

The five demonstration sites used different protocols for the collection and processing of biological evidence from a burglary crime scene.

In Topeka, the Kansas Bureau of Investigation (KBI) led the demonstration project. The goal of the project was to increase the use of biological evidence in property crimes and to incorporate the collection of biological materials into standard protocol for patrol officers. Having police officers collect biological evidence from the crime scene represented a significant change in policy in Topeka as only crime scene investigators (CSIs) were responsible for that task before the demonstration. Between December 2005 and July 2007, Topeka patrol officers collected biological evidence from 260 property crime scenes, including theft from automobiles. The KBI processed and analyzed each submitted sample in the treatment group and a portion of the cases in the control group. Results of DNA analysis were reported back to the police department. Detectives assigned to the case would then attempt to locate and apprehend the suspect. If the charging attorney in the District Attorney's office judged the case suitable for prosecution, it proceeded to court.

In Denver, the police department, crime laboratory, and District Attorney's office collaborated throughout the demonstration project. CSIs, trained in the technique of surface swabbing items for bodily fluids, were primarily responsible for collecting bodily fluids from property crime scenes (mainly residential burglaries) while patrol officers and detectives were permitted to transfer the entire item of evidence to the laboratory for forensic analysis. The police department's in-house crime laboratory processed and analyzed the submitted evidence (including submission of DNA profiles to the Colorado Bureau of Investigation who submits the profiles to SDIS) and reported the match results to the detective assigned to the case. The detective would then attempt to locate, and, if necessary, apprehend the suspect. Finally, a deputy District Attorney would employ Colorado's strict sentencing guidelines for property crime offenses committed by people with a history of felonies and seek to prosecute the case.

The City of Phoenix and the Maricopa County Attorney's Office worked together to expand their use of DNA evidence in burglary crimes. The Phoenix Police Department's Laboratory Services Bureau Forensic Biology Section trained responding officers and detectives in the collection of DNA. These trained DNA collectors would respond to a burglary scene to collect DNA and then transport the evidence back to the precinct so that the lab could process it. Once the lab received notification that a case had DNA evidence, the lab would, if necessary, sort through the evidence and then send the most probative samples to an outsource lab for testing. After the lab had received the results from the outsource lab, these results were reviewed and appropriate profiles were uploaded into CODIS. If there was a hit in CODIS, the lab notified the investigator as the DNA match information became available. If the hit was an offender hit, the investigator assigned to the case was then tasked with obtaining an arrest warrant, finding the suspect (either in custody or on the streets), and making the arrest. If the hit was a forensic hit the investigator was tasked with contacting the other cases' investigators and following up on any leads developed from this forensic hit. The County Attorney's office moved forward with prosecution once an arrest had been made.

In Orange County, California, the DNA Expansion Project allowed the Sheriff's Department to continue to build its DNA lab capacity and test the probative nature of touch samples. DNA in Orange County was collected at burglary crime scenes by trained forensic specialists. Once a responding deputy had done an initial walkthrough of the crime scene, they called the lab to discuss any potential DNA evidence. If evidence was present, the forensic specialist would respond to the scene to do the collection. The evidence was collected, booked into evidence, and the lab was notified of the potential DNA evidence. The DNA was then processed at the OCSD laboratory to try to obtain a CODIS-eligible profile. After a profile was uploaded into CODIS and a hit was obtained, the lab would notify the investigator of all available information. The investigator would then move forward with the case and attempt to locate any suspect listed to make an arrest. If an arrest was made, the prosecution would work with the investigator to prepare the case for court.

In Los Angeles, California, the Los Angeles Police Department and the Los Angeles County District Attorney's Office worked together to expand the collection of DNA to include high-volume burglary crimes. The LAPD Criminalistics Laboratory of the Scientific Investigation Division (SID) trained their latent print and forensic photographers from the Technical Laboratory to collect DNA evidence. These newly trained CSI technicians responded to burglary scenes to collect DNA evidence, booked it into evidence, and then submitted a report of what they collected. The investigators also received a copy of this report and could request that the lab test the DNA evidence. Once a lab request came in, the lab packaged the evidence to send to the outsource lab (paid for with grant funds in order to avoid diverting limited resources from the existing DNA backlog of violent crime). This evidence was then returned to LAPD SID with the analysis completed. The data were then reviewed and, when possible, the profiles were uploaded into CODIS. If a hit occurred in CODIS, the lab notified the investigator as the suspect or case information became available. The investigator assigned to the case was then tasked with completing the investigative follow-up and working with the prosecution to obtain an arrest warrant, find the suspect, and make the arrest. The Los Angeles District Attorney's office moved forward with prosecution once an arrest had been made.

THE RESEARCH DESIGN

The evaluation tested the hypothesis that processing DNA evidence from high-volume crime scenes using DNA analysis was more cost effective than the business-as-usual approach to a burglary investigation, which involves no DNA analysis. In addition, the evaluation identified and estimated the added marginal costs associated with expanded use of DNA in the investigative process. To test these hypotheses, a prospective, random assignment design was used. After biological evidence was collected, cases (and samples) were randomly assigned to a treatment or comparison condition. Treatment cases were treated by undergoing DNA processing to identify a viable profile and a subsequent comparison to known offender/forensic profiles. Control cases did not undergo DNA testing for at least 60 days. To ensure similarity in case processing, outcomes for both groups were measured 60 days from group assignment. Because the cases/samples in the control condition were not subject to DNA analysis, the control modeled the business-as-usual practice of not using DNA analysis to identify suspects in burglaries.

The Randomized Design

In every prospective random assignment study, the main threat to validity is the threat of crossovers—that is, situations in which treatment samples are not treated and control samples are treated. The general analytic model is:

$$[(M_T - M_C)/(T_T - T_C)] = \text{Impact of treatment} \qquad (2.1)$$

where M is the mean effect observed in the treatment group (T) and the comparison group (C). In this model, the difference in observed effects ($M_T - M_C$) is unbiased if and only if there are no crossovers—that is, if the number of treatment cases that were treated (T_T) approaches unity and the number of control cases that were treated (T_C) approaches zero.

Procedures to Maintain the Integrity of the Randomized Design

To ensure consistent adherence to the random assignment protocols, several quality controls were embedded in the project design. Since statistical adjustments are a less efficient means of controlling for crossovers than active control of the selection process, the Urban Institute maintained control of the random assignment and worked collaboratively with the experimental sites to maintain the integrity of case assignment. Three processes were used to accomplish these goals: the Urban Institute hired and trained a part-time, on-site study liaison in each of the five experimental sites; a brief introductory and training site visit was conducted with the Urban Institute (UI) on-site liaison and staff from the experimental sites; and the selection process was continually monitored.

The part-time site liaison, hired and trained in each experimental site, had three areas of responsibility: working with sites to review and monitor compliance with random assignment; assisting sites in developing data-collection instruments and to review and input data into a standardized research database developed at UI; and serving as an on-site liaison to assist in site visits and collection of primary cost data.

Each experimental site identified a demonstration program manager to assist the evaluation in conducting the study. The UI site liaison worked closely with that individual to monitor the compliance of case assignment. This included holding weekly or bimonthly meetings with the demonstration program manager to review case flow and discuss any issues with project implementation, case assignment, and data entry and management. A monthly phone conference was held with the National Institute of Justice project manager, the demonstration program manager, and UI staff to discuss assignment issues, implementation, and data management. Biannual cluster meetings were attended by at least three key staff from each experimental site, and staff from the Urban Institute and the National Institute of Justice.

In demonstration projects such as this one, some sites experience more difficulty than others in implementation. Key implementation issues included case processing, maintaining the integrity of the random assignment, and generating, maintaining, and sharing project data. In general, the UI site liaison worked directly with staff at the experimental sites to address obstacles. However, in several instances, it was necessary for UI staff to travel to the sites to address implementation obstacles. Between these problem-solving site visits and routine data-collection site visits, UI staff traveled to each site at least twice and conducted more than a dozen site visits in all.

The Data Collection Instrument

Each experimental site had in place a data system designed for internal data management and reporting. However, a review of the five demonstration site proposals found that not all sites had a system that integrated data collection across the key stakeholders in the project—the police, the crime lab, and the prosecutor's office. To create consistent reporting, a user-friendly Microsoft Access database was developed and populated with data from each experimental site. Table 1 lists the variables for which data were collected. The database was designed in a normalized form because some data elements could occur more than once per case. For example, a single case could be associated with three DNA samples for which data were needed. The normalization of the database allowed accurate tracking of each sample while preserving the data that did not change within a single case (table 1).

Data entry varied by site. Since the data necessary to populate the Urban Institute MIS needed to be gathered from a variety of sources (e.g., CEDaRS in Topeka or DCTS in Los Angeles) that have varying formats, it was generally necessary for data to be reentered into the UI database rather than transferred electronically. In Phoenix, the UI site coordinator, in conjunction with staff from the lab, was responsible for entering data from the police department, the District Attorney's office, and the lab. In Topeka, two crime analysts were responsible for entering the majority of data into the Access database while some data were transferred electronically from the KBI. The UI site coordinator performed weekly audits on the entered data. In Denver, the part-time study coordinator entered all of the data manually, and the UI site coordinator performed weekly audits. In Orange County, the site coordinator collected data from the police department, the lab, and the District Attorney's office by making trips to each office. In Los Angeles, the data were collected by a police department employee who entered data directly into the UI database. These data were then audited by our site coordinator before being sent to UI.

Table 1. Required Data Elements

1. Study ID
2. System-wide unique identifiers
3. Precinct and District number
4. Date/time of offense
5. Offense type (1-5)
6. Address of crime
7. Date case assigned to detective
8. Date biological evidence collected
9. Number of biological samples collected
10. Sample type (blood, saliva, hair, mucous, fecal material)
11. Evidence items (cigarette butts, mask or glove, towel, beverage container, etc.)
12. Collection method
13. Group assignment (treatment or control group)
14. Date of group assignment
15. Date laboratory analysis requested
16. DNA profile obtained (y/n)
17. Date profile obtained
18. Date of DNA profile CODIS entry (by sample and case)
19. Date of DNA match to a known suspect determined by investigative leads (by sample and case)
20. DNA hit (by sample and case) (y/n)
21. Date of DNA hit
22. Type of CODIS hit (forensic match/ offender match)
23. Evidence item where DNA hit obtained
24. Suspect identified (y/n)
25. Suspect DOB
26. Suspect identified by traditional investigation
27. Suspect identified by CODIS match
28. Criminal case filed (y/n)
29. Date criminal case filed
30. Type of criminal charges filed
31. Warrant issued (date)
32. Suspect-in-custody date
33. Arrest made (y/n)
34. Arrest date
35. DNA basis for ID of suspect (y/n)
36. Other evidence
37. Acceptance or refusal by District Attorney
38. Reasons for refusal (if refused)
39. Preliminary hearing date
40. Trial date
41. Case disposition (acquittal or conviction)
42. Disposition date
43. Conviction obtained by plea or trial
44. Was DNA evidence essential component of disposition/conviction (y/n)

EMPIRICAL ANALYSIS

Although a randomized design was used to assign cases within each site, there was substantial variation across the sites on important case attributes. For example, responsibility for evidence collection was different in each site, the size of the CODIS database against which DNA samples were tested varied across the four states, and two sites primarily conducted forensic analysis at an in-house lab, two outsourced analysis, and one did some of both. *Within* in each site, however, there tended to be very little variation in processing. For example, in four of the five sites, there was no variation within the site whether cases were tested in-house or outsourced. These differences across sites, and similarities within sites, have important implications for case processing.

First, the outcomes for cases in each site will be nested in site-level outcomes. That is, important factors such as sentencing guidelines, police culture, prosecutorial attitudes toward property crimes, and other factors will vary across sites but not within a site. Therefore, any pooled analysis where data from all five sites are evaluated in a single model would have to account for this clustering. Because the experiment was limited to five sites, statistical corrections for clustering would have been generally ineffective. Thus, we chose to study the impact of DNA evidence collection and analysis one site at a time.

Within sites, there is no evidence that the randomization process was compromised. We observed only a single case that was a crossover. As a result, the impact analysis is very straightforward—the only difference in case processing will be whether the DNA was processed or not. And thus, all differences in outcomes are therefore due to DNA processing. In four of the five sites, there are no differences in the attributes of cases, and no multivariate analyses were necessary, as any differences in outcomes are due to DNA processing. In Denver, some differences in case attributes were observed, and multivariate models were used to isolate the effects of DNA case processing.

To isolate empirically the effect of the natural variation in case processing across sites, we specified outcome models to estimate the effect of case attributes on outcomes. We employed a similar strategy for cost analysis, where we assumed that all costs associated with DNA analysis are costs that would not occur if DNA analysis was not performed. A more thorough description of these three processes follows.

Cost Analysis

Cost data were collected on inputs (e.g., labor, supplies) in the processing of treatment cases. The price and quantity of each input was observed and estimates of the differential costs of processing were developed. These costs were then compared to outcomes in a cost-effectiveness analysis. Together, these results were then used to evaluate the hypothesis that DNA evidence collection and processing is more efficient than business-as-usual investigations in burglaries.

Cost-effective analysis (CEA) is a powerful tool for investigating the economic impact of crime control policies and programs. CEA converts all program inputs into a standardized metric (dollars) that allows comparisons within and across justice agencies. By contrast, other evaluative approaches—performance measurement, process evaluation, outcome analysis, impact evaluation—have limited comparative utility since the same result observed in different settings may have different meanings. In the CEA model, program inputs are labeled as "costs" and program outcomes are not monetized. This allows program cost per outcome to be compared in two ways. Each dollar of cost can be compared with each outcome to estimate the relative effectiveness of a policy change—for example, the change in arrest rates per each $1,000 of investment in DNA analysis. Alternatively, outcomes can be held constant—for example, how much more or less would it cost to use DNA analysis to achieve a 10 percent increase in the arrest rate compared with business as usual.

The general model for a CEA is to develop monetized estimates for all program inputs. To estimate costs, detailed data must be collected about each program input used in processing each case in the demonstration, for both the treatment and control cohorts. Data must also be collected about the price of each unit of input, since these prices will vary within and across sites. Together, these estimates of price and quantity are used to estimate the cost of the program for treatment and comparison groups.

For each of the five sites, the cost analysis of the use of DNA evidence in property crime investigations estimated the costs for each case enrolled in the sample. For each case, a cost was attached to each of six stages of processing. The costs describe the average expenditures associated with the completion of each stage in a case. Next, the progress of each case was observed in administrative data, and a cost was assigned to a case only if each stage was completed. The cost estimates for each stage include only the costs of processing an individual case—the fixed costs of operating a police agency or a crime laboratory and the costs of capital purchases (such as robotics in the crime lab) are not included. Thus, the costs described here reflect the costs to a police department with a mature crime lab that expands processing of biological material to high-volume property crimes, such as residential burglary. The costs to a municipality to set up a crime lab or to begin collecting DNA for the first time will be substantially higher. The six stages of case processing used in the cost analysis are defined in table 2.2.

Table 2.2. Stages of Case Processing

Stage	Title	Description
1	Preliminary testing	This stage includes labor and nonlabor resources expended during initial examination and processing of the sample. These steps include initial examination of the item(s), preparation of the test sample, and screening for the presence of human blood and a subsequent review (if necessary).
2	Generation of profile	This stage includes labor and nonlabor resources expended once a sample has been identified as containing human DNA and prior to recording a genetic profile. These steps include: DNA extraction, quantitation, dilution, concentration, sample cleanup, amplification, 310/3130 setup, gene mapper ID, and, where applicable, the technical review.
3	CODIS entry	This stage includes labor and nonlabor resources expended after obtaining a profile and prior to uploading the profile into CODIS. These steps include recording the DNA profile, determining if the profile meets the criteria for CODIS upload, uploading each DNA profile into CODIS, and a technical review, where applicable.
4	Case verification (state lab)	This stage includes labor and nonlabor resources expended by the state crime lab used to ascertain that an offender match in SDIS is verified in the state's own database. This includes the cost of reanalyzing the sample and reporting the match to the local crime lab. *Note*: This stage of processing occurs only if the CODIS hit matches to an offender in SDIS, the state's DNA database, and does not apply to forensic matches.
5	Investigation	This stage includes labor and nonlabor resources expended by police departments to locate, arrest, interview, and book a suspect, as well as resources expended on the generation of reports and technical reviews undertaken by forensic staff prior to arrest.
6	Post-arrest	This stage includes additional forensic lab resources involved in processing a confirmation sample from the suspect after arrest. *Note*: This stage of processing is assumed to occur only if the DNA matched to an offender at the state-level.

In table 2.2, the analysis of DNA evidence and the investigation process are divided into stages. For each of these stages, a cost was estimated, and the progress of each sample in each case was observed from administrative data. The accrual of costs in each stage is conditional upon a sample passing each prior stage. That is, costs associated with the generation of a profile accrue if and only if a sample passes preliminary testing. Likewise, costs associated with CODIS upload accrue if and only if a profile has been generated.

Cost data were collected via semistructured interviews with key stakeholders—forensic scientists in state and local crime labs and police officers and detectives who investigate burglary cases. For each of the three stakeholders, the unit costs of processing a case were estimated from the time the evidence was delivered from the property locker to the local lab until the case concluded, including suspect identification, apprehension, and arrest if the case progressed that far. For each stakeholder and each stage of case processing, labor and nonlabor (capital) costs were estimated separately. The cost-collection process began in December 2006 with follow-up meetings occurring throughout the study period. All prices and quantities were gathered in FY 2006, and costs and benefits are expressed in 2006 dollars.

The cost estimates presented in this report are average marginal costs, e.g. the additional costs of processing a case over and above the costs of processing a case using traditional investigative procedures for an average case. We conducted semi-structured interviews with police, prosecutors and crime lab staff to develop estimates of the additional cost of processing steps that are either not performed in traditional investigations, or that occur more often in cases where biological evidence is processed.

Some costs associated with DNA case processing in each site are not included in this evaluation. For example, the costs of training personnel to identify and collect biological material are not included. In addition, the costs of additional time at a crime scene are also not included. In this evaluation, cases were randomly assigned after each activity had occurred. Thus, the costs for cases in both groups are the same (a descriptive analysis of these costs is included later in this chapter). In addition, if the use of DNA in burglary investigations changes the likelihood that offenders will be arrested and convicted, other important costs and benefits will not be included. For instance, if more offenders are arrested and incarcerated, then the state will have to pay substantial additional costs to incarcerate those individuals. Likewise, because these offenders were incarcerated, there may be substantial benefits to the community and its residents from reductions in offending.

Labor Costs

Data were collected using a "bottom up" approach where the processing of each case was observed separately, and a cost was estimated for each case. The labor cost of DNA analysis and investigation were estimated by multiplying the price of each input (such as the fully loaded hourly wage of an employee) by the quantity of the input (the number of hours of labor for a particular case). Loaded wages, including the value of fringe benefits—paid-time off, employer health care contribution, social security contribution and other benefits—were gathered from employee rosters and administrative budgets. Where the wages of specific employees were not available, the midpoint of the position's salary band was used to estimate prices for each unit of labor. Quantities—the amount of labor necessary to complete each task—were estimated via semistructured interviews with laboratory directors and other key personnel and direct observation.

Labor costs are based on the average amount of time required to complete the tasks necessary to process a case—not the time elapsed from the beginning until the end of a case or the beginning to the end of a particular task. For example, time elapsed while a machine analyzes DNA is not counted as a labor cost because the forensic scientist can complete other tasks while the machine runs. Rather, the evaluation documents only the time to prepare the samples in the case for robotic analysis and the time required to document the results of the analysis for any single case. Therefore, the time required to process DNA that this research reports does not describe the time that must elapse before the results of DNA testing are available.

Through a process known as batching, a large number of samples can be analyzed simultaneously. Labor costs are highly sensitive to the degree to which the laboratory processes samples in batches. For example, the elapsed time from collection until processing may be quite lengthy if a laboratory technician waits until a threshold number of samples are available prior to completing extraction, quantification, and amplification. Batching may achieve substantial economies of scale, where the costs of processing each case are reduced because many cases are processed simultaneously. To account for this, the evaluation estimates the per-sample cost of batched tasks as the total labor cost of analyzing the batch divided by the number of samples in the batch.

Nonlabor Costs

The variable cost of supplies and tools was estimated using a combination of administrative budgets and semistructured interviews. Key stakeholders were asked to identify the supplies used to analyze a typical sample during each stage of the forensic analysis process. The cost of supplies was obtained via semistructured interviews and through analysis of administrative budget data. In cases where a particular item could be reused over a given number of samples, the per-sample cost was obtained by dividing the item's cost by the number of samples for which the item is typically used. In order to estimate the cost of processing DNA evidence for an average case, per-sample costs were multiplied by the site-specific average number of samples per case.

There is one notable exception to this general approach to counting costs of processing DNA evidence. If a site outsources DNA analysis to a private lab, all private lab costs are attributed to the preliminary testing stage because the first two stages ("preliminary testing" and "generation of profile") are paid for at the time of preliminary testing by the local lab regardless of whether a sample actually passes preliminary testing. As a result, sites with a private lab tend to pay for costs earlier in the case process than sites that analyze DNA in house.

Impact Analysis

The impact analysis identifies the causal impact of the analysis of DNA evidence on key case outcomes. Three outcomes are specified: whether a case resulted in a suspect identification, whether a case resulted in an arrest, and whether a case was ultimately accepted for prosecution. Because randomized experiments assign cases to treatment and control conditions at random, in theory, potentially confounding covariates are unrelated to treatment assignment and will not impact the magnitude or the sign of the treatment coefficient in a multivariate impact model. As a result, while causal impacts in quasi-experiments are ordinarily identified using multivariate methods, this study will examine bivariate measures of impact where adherence to randomization was achieved. In order to assess fidelity to randomization, for each site, potential independent variables theoretically related to key outcomes are compared across treatment and control to test whether randomization failed to achieve balance across groups. The following variables were tested:

Case Characteristics

- Type of offense (residential burglary, commercial burglary, theft from auto, other offense);
- Point of entry into the crime scene (window, door, car, other point of entry);
- Property not stolen, a dummy variable coded as zero if property is stolen and one if not;
- Crime scene was unlocked, a dummy variable coded as one if the crime scene was unlocked and zero if not.

Investigatory (Evidence Collection) Practices

- Mode of collection (whether the sample was collected a whole item or swabbed for DNA);
- Fingerprints collected, a dummy variable coded as one if fingerprints were collected at the crime scene and zero if not;
- Type of DNA collector, coded as one if the collector was a forensic specialist and zero if not.

Nature of the Evidence

- Type of sample collected (blood, cells collected from items that were touched or handled, cells collected from articles worn, cells that were orally transmitted to the scene, and other materials).

Additional Control Variables

- Shift during which responding officer reported to the crime scene (daytime, 2 PM to 10 PM; night, 10 PM to 6 AM; morning, 6 AM to 2 PM);
- Time of year (summer, fall, winter, spring);
- Sample was among the first half of samples analyzed, a dummy variable coded as one if the sample was among the first half of samples analyzed and zero if not. This variable is designed to capture any temporal effects associated with learning over time.

In four of the five sites, there were no variables for which significant differences were detected at $p < 0.05$. In Denver, several variables were found to be significantly different despite randomization, and these variables were included as covariates in a logistic regression model of the following form:

$$\text{Log}(Y_j/(1\text{-}Y_j)= \varphi T_j + \gamma^* Z_j \qquad (2.2)$$

In (2.2), Y_j is one of three sample outcomes (suspect identification, arrest, accepted for prosecution) for case *j* and Z_j is the vector of independent variables that are significantly different within a given site. T_j is a binary measure of treatment and is equal to one if a case is assigned to the treatment group and zero if it is assigned to the control group. φ, the coefficient on T_j, is the impact of treatment on outcomes, controlling for variables in Z.

Cost-Effectiveness Analysis

Cost-effectiveness analysis (CEA) is an economic analysis that compares relative costs to relative outcomes for two or more experimental conditions. A CEA yields a ratio of costs to outcomes, which can be interpreted as the amount of money necessary to achieve one unit of a particular outcome. Equation (2.2) shows how cost-effectiveness ratios are calculated:

$$CE_k = (C_T - C_C) \;/\; (O_T - O_C) \qquad (2.3)$$

In (2.3), CE_k is the cost-effectiveness ratio for outcome *k*. C_T is the cost of an average treatment case and C_C is the cost of an average control case. O_T is the incidence of a given outcome (e.g., number of arrests) in the treatment group and O_C is the incidence of a given outcome in the control group. The resulting ratio is the amount of money required to achieve an additional unit of outcome *k*. For each site, outcomes are translated into cost-effectiveness ratios using equation (2.3). Cost-effectiveness ratios are calculated for three outcome variables: the cost per suspect identified, the cost per arrest, and the cost per case accepted for prosecution.

Outcome Analysis

The outcome analysis identifies best practices in DNA collection by examining a series of theoretically important predictors of whether or not DNA samples result in forensic profiles, profiles suitable for upload into CODIS and, ultimately, in CODIS hits and offender matches. In order to identify best practices, site-level databases were concatenated and statistical analyses were run on the 1,841 samples collected and analyzed across 1,074 test cases in all five sites. After examining descriptive statistics, multivariate models were specified to isolate the effect of individual predictors, holding constant the impact of other predictors on outcomes. Three binary outcome variables are considered, each of which tests a different goal underlying the collection and processing of DNA evidence.

- Did the sample yield a DNA profile?
- Did the sample yield a profile suitable for CODIS upload?
- Did the sample ultimately yield a CODIS hit?

Multivariate models were specified to identify the independent effects of a large number of predictors on each of these three sample-level outcomes. As each of the outcomes is binary, all models are logistic regression models of the form outlined in equation (2.3):

$$\mathrm{Log}(Y_i/(1-Y_i)) = \psi^*\mathrm{SITE}_i + \gamma^*X_i \qquad (2.3)$$

In (2.3), Y_i is one of three sample outcomes (DNA profile obtained, CODIS upload, CODIS hit) for sample *i,* and SITE_i is a vector of site dummy variables that control for site-specific variation in the dependent variable. X_i is a vector of independent variables theoretically related to sample outcomes and includes three sets predictors capturing various aspects of case processing: aspects of the offense and the crime scene, decisions made by crime scene investigators, and contextual information not directly related to characteristics of the crime or decisions made by crime scene personnel. These variables capture seasonal effects or possible impact of the time of day the scene is processed.

CHAPTER 3—BEST PRACTICES

Though the DNA Field Experiment was designed to test the degree to which analysis of DNA evidence collected at high-volume crime scenes was a cost-effective means of identifying and capturing high-volume offenders, the rich database of over 1,800 samples collected at 1,074 crimes scenes across five jurisdictions allows us to test a variety of hypotheses related to successful collection of evidence at the sample-level. This chapter describes the results of a multivariate analysis examining the association between attributes of samples tested in the experiment and the outcomes of those cases. For each outcome (profile obtained, CODIS upload, suspect identified by CODIS), we tested whether various evidence collection and case processing characteristics were more or less likely to yield probative samples. Each sample attribute describes a characteristic of the sample associated with the collection of that piece of evidence, such as who collected the evidence, what kind of evidence was collected, and where the evidence was found. The goal of this analysis is to provide law enforcement, state and local laboratories, and prosecutors with information of more effective practices associated with the collection of DNA from high-volume crimes.

Jurisdictions have long regarded DNA evidence as a key means of linking crime scenes to known offenders in the CODIS database. The success of DNA evidence relies on the quality and quantity of the DNA collected and the degree to which proper procedures are followed at all stages of collection, testing, and prosecution. In 2005, the Association of Chief Police Officers published a DNA Good Practice Manual outlining operational guidance in the use of DNA for the detection and prosecution of offenders in the United Kingdom. The guide discusses best practices for crime scene preservation, the recovery and transportation of samples, how to collect samples from individuals, and the investigation of a NDNAD match (ACPO 2005). The importance of evidence-based implementation of programs is to provide law enforcement, laboratories, and prosecutor's offices with empirically driven guidance on how to allocate resources optimally to fight crime.

Because case outcomes are ultimately dependent upon the efficacy of practices used to collect and analyze individual samples, it is fair to consider whether the attributes of evidence collection may affect intermediate outcomes, such as whether a profile was obtained and whether or not a sample yielded a profile suitable for CODIS upload and a subsequent CODIS search. There is substantial variation across evidence collection protocols that may affect these outcomes. This experiment enrolled cases from several types of high-volume crimes (residential burglary, commercial burglary, theft from auto, and motor vehicle theft) and hypotheses can be tested about the relative effectiveness of DNA evidence collection in the investigation of these crimes. Sites in this study varied on which types of personnel collect DNA evidence. Most of the experimental sites trained patrol officers or detectives who had relatively little if any prior experience with this type of evidence collection and also relied on forensic specialists and crime scene investigators with more experience to collect evidence. Some sites limited the number of samples collected and encouraged evidence collectors to be parsimonious in selecting the most probative samples, while other sites left sample screening to lab personnel. The actions of the offender also varied across cases, including variation in the suspect's point of entry and whether the entry was forced.

The first stage of successful DNA collection is to determine whether or not the sample collected yields a sufficient amount of DNA to generate a profile that identifies a unique individual in the population. For a sample to yield a profile, the sample must contain human DNA. This means that a forensic specialist must determine whether a sample present at a crime scene is actually sweat or blood and not water or red paint. The forensic specialist must also determine whether items a suspect might have touched were handled for a long enough period of time and with enough force to have left behind DNA.

The second stage of successful DNA collection is to determine whether the sample yields a profile that meets a state's criteria for upload into its CODIS database. That is, the profile not only must contain human DNA, it also must be likely to contain the DNA of the suspect as opposed to another individual who might have been present at the crime scene prior to the commission of the crime. For example, while swabbing the outside doorknob of a commercial establishment that has been burglarized might be likely to yield one or more DNA profiles, such a sample may be less likely to meet the requirements for CODIS upload as it could reasonably belong to an employee or a customer and not the suspect. As a result, best practices in DNA collection demands that evidence collectors search not only for places where DNA evidence might be found, but that they spend their time searching for and collecting evidence likely to meet the threshold for CODIS upload.

The third stage of successful DNA collection is the identification of a sample that ultimately leads to a CODIS hit. Naturally, this outcome is, to an extent, outside the control of a forensic specialist. That is, the probability of obtaining a CODIS hit is, in part, a function of whether the suspect's DNA is in the CODIS database in the first place. However, by measuring the impact of various best practices on the probability of a CODIS hit, it is easier to understand the importance of adherence to best practices in evidence collection.

DATA AND METHODS

This analysis identifies best practices in DNA collection by examining a series of theoretically important predictors of whether DNA samples result in forensic profiles, profiles suitable for CODIS upload, and, ultimately, in CODIS hits and offender matches. To identify best practices, site-level databases were concatenated and statistical analyses were run on 1,841 samples collected and analyzed across 1,074 test cases in all five sites. Multivariate models were specified to isolate the effect of individual predictors, holding constant the impact of other predictors on outcomes. Three binary outcome variables are considered, each of which tests a different goal underlying the collection and processing of DNA evidence.

- Did the sample yield a DNA profile?
- Did the sample yield a profile suitable for CODIS upload?
- Did the sample ultimately yield a CODIS match?

Multivariate Models

Multivariate models were specified to identify the independent effects of a large number of predictors on each of these three sample-level outcomes. As each of the outcomes is binary, all models are logistic regression models of the form outlined in equation (3.1):

$$\mathrm{Log}(Y_i/(1-Y_i)) = \psi{*}SITE_i + \gamma{*}X_i \qquad (3.1)$$

In (3.1), Y_i is one of three sample outcomes (DNA profile obtained, CODIS upload, CODIS hit) for sample *i* and $SITE_i$ is a vector of site dummy variables that control for site-specific variation in the dependent variable. X_i is a vector of independent variables theoretically related to sample outcomes and includes three sets predictors capturing various aspects of case processing: (1) aspects of the offense and the crime scene, (2) decisions made by crime scene investigators, (3) contextual information not directly related to characteristics of the crime or decisions made by crime scene personnel. These variables capture seasonal effects or possible impact of the time of day the scene is processed.

In addition to the variables listed in chapter 2, in models where the dependent variable is CODIS hit, a final covariate—the size of the DNA database at the time of CODIS upload—is included to capture the probability of a CODIS hit as a function of the number of known offender samples against which the sample is searched. The size of the database varies both across states and over time as new offender profiles are uploaded into state databases.

In analyzing outcomes at the sample level, we used a mixture of independent variables measured at the sample-level (e.g., type of sample collected, mode of collection) and the case-level (e.g., point of entry to the crime scene, type of offense). When data are hierarchically arranged (as when samples are nested within cases), samples within the same case are not truly independent of one another and may have correlated errors—hence, the independent and identically distributed (iid) assumption underlying most types of regression models is violated. One solution to the problems inherent in estimating models using nested data is to use hierarchical linear modeling (HLM), which allows for cross-level relationships to be modeled directly. Unfortunately, as HLM is likely to produce biased coefficients when groups (samples per case) are very small, it is inappropriate for the present analysis (Maas and Hox 2002). Instead, to allow for within-case correlations at the sample level and develop a conservative estimate of standard errors, all models were run using robust clustered standard errors, an approach to modeling contextual information that does not produce markedly different results compared with HLM under most conditions (Primo, Jacobsmeier, and Milyo 2007). The practical impact of using the clustered standard errors is to raise the standard errors that are yielded by a standard logistic regression model and lower the probability of making a Type I error when attributing statistical significance.

RESULTS

Tables 3.1–3.5 present descriptive statistics for each of the three outcome dependent variables, each independent variable included in the multivariate models, and several independent variables that were considered but not entered into final models. Each dependent variable is valid for all 1,841 samples in the database. Unless otherwise indicated, each independent variable is also valid for all 1,841 samples.[5]

Table 3.1. Sample-Level Outcomes, Dependent Variables

	Mean	Standard Deviation
DNA Profile Obtained	0.55	0.50
CODIS Upload	0.37	0.48
CODIS Match	0.15	0.35

Source: Urban Institute. *Notes:* Sample size is 1,841 samples. All samples were assigned to the test condition.

Overall, a DNA sample was obtained in 55 percent of samples tested, 37 percent of samples were suitable for CODIS upload, and 15 percent of samples yielded a CODIS hit (table 3.1). Another way to examine these data is to consider what percentage of cases that make it to one level of processing successfully progress to the next level. Here, about 67 percent of cases where a DNA profile is obtained are successfully uploaded into CODIS. Of cases successfully uploaded into CODIS, about 41 percent yield a CODIS match.

[5] Due to listwise deletion, the overall analytic sample used in multivariate models is n = 1,841 -- 85 percent of the original sample.

Table 3.2. Sample-Level Outcomes, Case Characteristics

		Mean	Standard Deviation
Type of Offense	Residential Burglary	0.57	0.49
	Commercial Burglary	0.29	0.44
	Theft From Auto	0.13	0.36
	Other	0.01	0.08
Point of Entry (n=1,735)	Door	0.36	0.48
	Car	0.12	0.33
	Window	0.33	0.47
	Other	0.17	0.37
Crime Scene Unlocked		0.17	0.38
Item Stolen	Automobile, Automobile Parts	0.04	0.20
	Cash, Checks, Credit Cards, Bank Notes	0.11	0.32
	Drugs, Alcohol	0.01	0.11
	Electronics	0.38	0.48
	Jewelry	0.13	0.32
	Tools	0.06	0.24
	Nothing	0.09	0.29
	Other	0.18	0.38

Source: Urban Institute. *Notes:* Sample size is 1,841 samples unless otherwise noted. All samples were assigned to the test condition.

Table 3.2 provides descriptive statistics for case characteristics. The majority of crime scenes from which samples were collected (57 percent) were residential burglaries, with the remainder of samples coming from commercial burglaries (29 percent) and thefts from automobiles (13 percent). Points of entry into the property varied, though nearly 70 percent of intruders entered through doors or windows. Seventeen percent of the time, the property was unlocked. The most common items stolen were electronics (38 percent), followed by jewelry (13 percent) and cash or a cash substitute (11 percent). In 9 percent of cases, nothing was stolen.

Table 3.3. Sample-Level Outcomes, Investigatory Practices

		Mean	Standard Deviation
Mode of Collection (n=1,816)			
	Swab	0.58	0.49
	Whole Item	0.35	0.48
	Both	0.07	0.35
Evidence Collector			
	Forensic Specialist	0.58	0.50
	Police Officer	0.40	0.50
	Detective	0.02	0.15
	Other	0.00	0.06
Fingerprints Collected (n=1,715)		0.38	0.49

Source: Urban Institute. *Notes:* Sample size is 1,841 samples unless otherwise noted. All samples were assigned to the test condition.

Table 3.3 presents descriptive statistics for investigative practices at the sample level. The majority of evidence was swabbed at the scene rather than having a whole item collected. Evidence collection was handled fairly evenly by both forensic specialists and front-line officers across all of the samples collected in this experiment. Detectives and other collectors, such as the victim, had far fewer evidence items submitted in this experiment with 2 and less than 1 percent, respectively. Even though biological material was collected at every crime scene, fingerprints were only collected at less than 40% of crime scenes.

Table 3.4. Sample-Level Outcomes, Type of Sample Collected

	Mean	Standard Deviation
Blood	0.21	0.41
Cells—Item Touched/Handled	0.59	0.49
Cells—Item Worn	0.04	0.18
Cells—Oral	0.14	0.34
Other	0.05	0.21

Source: Urban Institute. *Notes:* Sample size is 1,841 samples unless otherwise noted. All samples were assigned to the test condition.

Table 3.4 describes the type of samples collected at the crime scenes. The sample type that was collected most often (59 percent) was skin or epithelial cells that had been left by a suspect from their contact with an item, such as an object handled by a burglar. The second most common sample type collected at a crime scene was blood evidence (21 percent). Cells carried orally to the scene, which are cells left behind for example from a cigarette or a drinking container, were present in 14 percent of cases, and cells collected from an item worn by the perpetrator were present in 4 percent of cases.

Table 3.5. Sample-Level Outcomes, Temporal Characteristics

		Mean	Standard Deviation
Season	Spring	0.30	0.46
	Summer	0.22	0.42
	Fall	0.19	0.39
	Winter	0.29	0.45
Shift	Morning	0.43	0.50
	Day	0.43	0.49
	Night	0.14	0.35

Source: Urban Institute. *Notes:* Sample size is 1,841 samples unless otherwise noted. All samples were assigned to the test condition.

Calls for service occurred mostly during the morning shift (43 percent) or the day shift (42 percent). Only about 14 percent of samples were collected during the night shift (10 PM to 6 AM).

Table 3.6. Sample Distribution, by Site

	Mean	Standard Deviation
Denver	0.20	0.40
Los Angeles	0.19	0.39
Orange County	0.31	0.46
Phoenix	0.20	0.40
Topeka	0.10	0.30

Source: Urban Institute. *Notes:* Sample size is 1,841 samples unless otherwise noted. All samples were assigned to the test condition.

The samples were distributed fairly evenly across the five sites, with Topeka contributing the least amount of samples (10 percent) to the database and Orange County contributing 31 percent.

Table 3.7. Logistic Regression of Case Attributes on Outcomes

	DNA Profile Obtained		CODIS Upload		CODIS Hit	
	(1)	(2)	(3)	(4)	(5)	(6)
Offense Characteristics (reference group is residential burglary)						
Commercial burglary	1.04 (0.16)	1.10 (0.17)	0.82 (0.13)	0.89 (0.14)	0.92 (0.19)	0.98 (0.21)
Theft from auto	0.77 (0.41)	0.70 (0.37)	0.51 (0.25)	0.43 (0.20)	0.22 (0.21)	0.17** (0.15)
Other	0.27 (0.28)	0.19 (0.20)	0.23 (0.22)	0.14 (0.13)	- -	- -
Point of Entry (reference group is window)						
Door	0.96 (0.14)	0.97 (0.14)	0.93 (0.15)	0.97 (0.15)	1.18 (0.25)	1.25 (0.26)
Car	1.13 (0.63)	1.59 (0.91)	2.01 (1.07)	2.53 (1.06)	6.06* (6.07)	7.61** (6.99)
Other	1.25 (0.23)	1.24 (0.23)	1.06 (0.22)	1.05 (0.22)	1.70* (0.47)	1.82** (0.51)
Sample Type (reference group is cells touched or handled)						
Blood	7.52*** (1.66)	6.16*** (1.41)	9.47*** (1.75)	6.33 (1.25)	6.43*** (1.32)	3.02*** (0.71)
Cells - worn	2.06** (0.58)	1.52 (0.43)	3.14*** (0.94)	2.46 (0.78)	3.57*** (1.31)	2.12* (0.86)
Cells - oral	3.54*** (0.66)	3.10*** (0.61)	4.26*** (0.72)	3.36 (0.67)	4.06*** (0.91)	2.06*** (0.53)
Other	0.42*** (0.14)	0.32*** (0.11)	1.10 (0.34)	0.83 (0.25)	1.53 (0.62)	0.88 (0.34)
Shift (reference group is morning)						
Day	0.71** (0.10)	0.73** (0.10)	0.68*** (0.10)	0.72 (0.10)	0.90 (0.17)	0.91 (0.17)
Night	1.08 (0.19)	1.07 (0.19)	1.08 (0.20)	1.08 (0.21)	0.96 (0.23)	0.88 (0.22)
Season (reference group is summer)						
Fall	0.77 (0.14)	0.72 (0.13)	1.03 (0.20)	0.91 (0.18)	1.22 (0.31)	1.13 (0.30)
Winter	0.92 (0.17)	0.93 (0.17)	1.13 (0.19)	1.15 (0.20)	1.17 (0.27)	1.45 (0.36)
Spring	1.10 (0.19)	1.04 (0.18)	1.37* (0.24)	1.27 (0.23)	0.98 (0.23)	1.03 (0.25)
Other Characteristics						
DNA collector is a forensic specialist	1.42** (0.23)	0.80 (0.19)	1.02 (0.15)	0.91 (0.19)	0.85 (0.15)	0.77 (0.20)
Mode of collection is swab	0.71** (0.12)	1.00 (0.18)	0.50*** (0.07)	0.79 (0.12)	0.52*** (0.09)	0.83 (0.16)
Fingerprints collected	1.00 (0.13)	1.02 (0.14)	0.84 (0.12)	0.91 (0.13)	0.88 (0.16)	1.13 (0.21)
No property was stolen	1.07 (0.26)	1.10 (0.27)	1.19 (0.25)	1.34 (0.27)	0.67 (0.23)	0.99 (0.31)
Property was unlocked	0.90 (0.14)	0.93 (0.17)	0.57*** (0.10)	0.64 (0.12)	0.60** (0.15)	0.66 (0.17)
Sample was among first half of samples tested	1.40*** (0.18)	1.41*** (0.18)	1.97*** (0.25)	1.94 (0.25)	2.42*** (0.41)	2.39*** (0.41)
Sample Size	1,841	1,841	1,841	1,841	1,841	1,841
Pseudo R^2	0.130	0.153	0.197	0.220	0.166	0.192
Site Dummies	No	Yes	No	Yes	No	Yes

Notes: Models (1) and (2) report Odds Ratios from a logistic regression on whether or not a DNA profile was obtained. Models (3) and (4) report Odds Ratios from a logistic regression on whether or not a CODIS upload was yielded. Models (5) and (6) reports Odds Ratios from a logistic regression on whether or not a CODIS hit was yielded. Robust-clustered standard errors are reported in parentheses. Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Type of evidence collected may sum to more than one, as multiple samples may have been collected from different types of evidence.

Table 3.7 displays the results for six multivariate models. Models (3.1) and (3.2) test the impact of each independent variable on the odds of obtaining a DNA profile, models (3.3) and (3.4) test the impact of each independent variable on the odds of uploading to CODIS, and models (3.5) and (3.6) test the impact of each independent variable on the odds that a sample yields a CODIS hit. For each of the three dependent variables, two models are specified: one without site dummies and a second that includes the site dummies.

The tables report odds ratios, which report the ratio of the odds of an event occurring in one group to the odds of it occurring in another group. For example, referring to table 3.7, the odds ratio of 7.52 on a blood sample in model (3.1) indicates that a blood sample has approximately eight times the odds of yielding a DNA profile compared with a sample of cells that have been touched or handled (the reference group). An odds ratio of one indicates no difference in the odds of an event between the two groups, while an odds ratio greater than one indicates higher odds and an odds ratio lower than one indicates lower odds.

In all but one of the six models, a blood sample is a highly significant and empirically large predictor of sample outcomes. Blood samples have six to eight times the odds of obtaining a DNA profile, six to eight times the odds of obtaining a profile suitable for CODIS upload, and three to five times the odds of yielding a CODIS hit when compared to cells collected from items that were touched or handled. Among the types of samples collected, cells transmitted orally to the crime scene were also significantly related to sample outcomes, with more than three times the odds of obtaining a DNA profile, a CODIS upload, and a CODIS hit.

Swabbed items had significantly lower odds of yielding a DNA profile and yielding an uploadable filed when compared with items that were transported whole from the scene to process at the local lab. However, this effect is washed out when site dummies are added to the model. Similarly, when the property burglarized was unlocked, the odds of a CODIS upload and a CODIS hit fall in four of six models. Finally, there is evidence that samples collected at crime scenes responded to during the day shift (6 AM to 2 PM) have lower odds of yielding a profile or a profile suitable for CODIS upload.

Discussion

This chapter highlights the relative importance of various crime scene and evidence collector attributes in the collection of DNA samples amenable to forensic analysis and ultimately to identifying a suspect. The analysis has important implications for police departments that want to expand the role of officers and detectives at crime scenes and forensic laboratories whose staff identify, collect and analyze DNA evidence. The analysis produces four main findings. First, we find no evidence that DNA that is collected by crime scene technicians is more likely to yield a DNA profile or subsequent CODIS hit than DNA evidence that is collected by police officers or detectives. This finding holds true even after accounting for site dummy variables and after allowing for samples within the same cases to have correlated error terms. Since crime scene technicians in our sample generally receive higher wages than officers responding to burglary scenes, resources allocated towards training police officers to collect DNA evidence – for instance, training in the police academy – may yield substantial cost savings in the long run, as DNA evidence begins to play a more important role in investigating and clearing high volume crimes.

Second, blood and saliva samples are significantly more likely to yield usable profiles when compared with samples consisting of cells from items that were touched or handled. As blood samples have between three and five times the odds of yielding a CODIS hit, locating and analyzing blood samples is considerably more cost-effective than the alternative.

Third, whenever possible, evidence collectors would be well served to collect whole items rather than swab the evidence item for DNA, a practice that maximizes the probability of obtaining a DNA profile. For instance, items such as soda cans can be used to search for multiple types of DNA evidence (touch samples and cells left on the mouthpiece of the can) as well as for fingerprinting. In all, items which were swabbed had 30% lower odds of yielding a profile and 50% lower odds of yielding an uploadable profile and a subsequent CODIS match.

Finally, it is important to consider the specific elements of the crime scene. Crime scenes in which the stolen property was unlocked and therefore did not require the suspect to break a window or pry open a door tended to have lower odds of yielding a probative sample. Likewise, crime scenes that were responded to during the day shift (and therefore were probably perpetrated during the early morning hours) had lower odds of yielding probative samples. Several factors are associated with the day shift that may influence the ability of the officers and forensic specialists to collect probative samples. For example, due to the intense demands on officer's time during the morning shift, officers and forensic technicians may not be able to spend a great deal of time on scene searching for the best DNA evidence. Likewise, longer response times (as might be expected during the day shift) may lead victims to clean up the crime scene, especially if they do not expect that DNA will be collected. In departments where DNA expansion has become a priority, it is important that deployment considerations be fully explored to ensure officers are clear on the ways in which their job demands coincide with DNA collection protocols.

Limitations

There are several limitations associated with this analysis. First, though this study identifies the evidence processing characteristics that are correlated with successful case outcomes, the data do not allow us to identify the proportion of crime scenes that contain DNA evidence. As such, this study is unable to identify how effective various types of evidence collectors and search protocols are in locating DNA evidence present at a scene.

Second, though the explanatory power of the models is consistent with that found in the majority of micro-level studies, we cannot rule out the possibility that parameter estimates are biased by the omission of important contextual variables that we were unable to observe. For example, the experience or conscientiousness of individual evidence collectors is not explicitly captured by the model. Likewise, although we capture several important attributes of the crime, we cannot possibly hope to capture all important crime scene information using a small number of variables. If there are additional crime scene attributes that are correlated with both successful case outcomes and the variables captured in the model, then study results will be biased.

Third, although models account for variation in sample outcomes due to site-specific effects, because crime scenes within the same site are processed similarly, site dummies are moderately correlated with evidence collection protocols such as which type of personnel collect evidence and what proportion of samples consisted of swabbed evidence versus whole items. Similarly, this study is not able to test the efficacy of analysis conducted by a contracted forensic lab versus analysis done in-house as this variable is perfectly collinear with site dummies. As a result, we are unable to isolate the effect of outsourcing from site-level contextual effects.

Finally, though the significance of coefficients is robust to specification, the precise magnitude of predictors is often sensitive to model specification and, as a result, it is difficult to provide precise estimates of subsequent sample outcomes associated with one type of sample versus another.

Conclusion

As the use of DNA evidence plays a more prominent role in investigating and clearing high volume crimes, police departments and forensic labs will need to consider cost-effective strategies to maximize the usefulness of DNA evidence. This study identifies several evidence collection characteristics that are associated with successful case outcomes and provides empirical guidance on where scarce resources devoted to evidence collection might be allocated. Blood and saliva samples are significantly more likely to achieve successful case outcomes than putative cells collected from items that were handled or touched. Likewise, evidence items that are swabbed are less likely to yield probative evidence than those items that were collected and transported to the forensic lab. Contrary to conventional wisdom, evidence collected by crime scene technicians was no more likely to yield probative samples than evidence collected by police officers, providing insight into a means of reducing the cost of evidence collection without eroding its usefulness.

CHAPTER 4—DENVER, COLORADO

Prior to the beginning of the demonstration project, the city of Denver had substantial experience using biological evidence to identify, capture and prosecute violent offenders. The city's Crime Laboratory Bureau (CLB), which is responsible for the analysis of forensic evidence, had primarily used DNA evidence as an investigative tool in sexual assaults (80 percent) and homicides (15 percent) and was processing about 600 DNA cases per year. To expand their capacity to process biological material from high-volume crimes, the CLB used the demonstration award to hire an additional forensic analyst who was responsible solely for the analysis of cases in this study ,to purchase one multi-capillary genetic analyzer and to purchase a robotic DNA extraction machine. These additional positions were used to analyze evidence from 500 of the 7,500 property crimes that occur annually in this city of 550,000.

Given the experience of the police, prosecutor and lab with DNA evidence collection in investigation and prosecution, Denver chose to use demonstration funding to target cases with characteristics expected to be cost-effective. That is, the CLB sought to increase the collection of blood or other bodily fluids with the expectation that these samples would have higher rates of suspect identification rather than experiment with other types of evidence, such as touch samples. Thus, Denver used the demonstration funding to identify and prosecute more burglars rather than as an evaluation of the cost-effectiveness of DNA evidence collection in burglaries.

In addition to expanding the CLB's capacity via equipment and staff, the demonstration award funded two other important staff expansions. First, a position of 'study coordinator' was created in the District Attorney's office. This person was responsible for communicating with the Urban Institute to assign cases to the treatment and control conditions, entering data into the study's database, and regularly meeting with Denver and Urban Institute staff to overcome any obstacles to the demonstration and the evaluation. This position was funded for twenty hours per week. The second staff modification was funding 75 percent of a Deputy District Attorney's position, who was responsible for prosecuting cases in the study and who served as a liaison between the District Attorney's office and the study's other stakeholders.

Although there was no direct funding of staff in the Denver Police Department (DPD), a detective in the property crimes unit was assigned to be the primary representative of the DPD in this study. This detective worked closely with the study coordinator, the CLB, the District Attorney's office, and other officers in the DPD to monitor and facilitate the study's progress.

CONTEXT FOR THE DNA DEMONSTRATION

Protocols (Proposed)

The protocol for the demonstration was as follows. Police (including patrol officers, detectives, sergeants, and senior personnel) were trained on DNA evidence and the demonstration project. Patrol officers were trained to identify biological materials at a crime scene. If a whole item was observed with potential DNA material, the patrol officer would collect the entire item and deliver it to the Property Bureau. A detective then reviewed the item in the Property Bureau and sent a request for analysis to the crime lab. Otherwise, patrol officers would call for a CSI for collection when bodily fluids (including blood) were observed at the crime scene submitted directly to the CLB. The crime lab notified the Urban Institute and the case was assigned to either the treatment or control condition. At this point, the CLB began processing the biological evidence with the purpose of deriving a DNA profile from the evidence.

Protocols (Implemented)

As implemented, Denver's protocol deviated very little from the proposed approach. The demonstration began in December 2005. Before beginning to collect and process evidence, Denver implemented a series of trainings for patrol officers, detectives, crime scene investigators (CSI's), and the newly hired forensic analyst in the CLB. By March 1, 2006 initial training was complete and the collection of cases began. The first cases enrolled in the study were those identified by the study coordinator who reviewed all property crime files that occurred between December 1, 2005 and March 1, 2006. Those cases which were appropriate for the study (i.e. biological evidence was submitted but not yet analyzed by the CLB) were then enrolled in the sample.

Training

Denver relied primarily on crime scene investigators (CSIs), detectives, and patrol officers to collect biological evidence from crime scenes. DPD launched several initiatives to train detectives and officers to identify and collect biological evidence from crime scenes. A similar training initiative was launched in the CLB.

An initial training of senior DPD personnel (detectives, police sergeants, and senior police officers) was conducted on the identification and collection of biological evidence from property crime scenes. These trainings were three hours long and were conducted by the lead analyst in the CLB, the District Attorney, and a Deputy District Attorney. The purpose of this training was to provide firsthand information to senior DPD personnel on how to properly identify, collect, and process biological evidence at property crime scenes in a manner consonant with the study's protocol. The Director of the CLB described the forensic utility of DNA evidence, the District Attorney discussed its utility in prosecuting cases, and the Deputy District Attorney detailed protocol compliance. Officers were trained to preserve the crime scene until a CSI arrived, to avoid contamination of potential DNA evidence, and to preserve fingerprint evidence when both types of evidence were available for collection. These trainings were repeated four times in order to reach all upper-level officers in the DPD. Approximately eighty officers were present at each session.

A similar initial training for CSI's in the CLB was conducted by the same Deputy District Attorney and the head of the CLB. This training lasted for two hours because CSI's were already familiar with how to identify and collect biological evidence. This roundtable discussion briefed them on the protocol changes that might be involved in collecting such evidence from property crime scenes versus the more violent crime scenes that they were accustomed to collecting from.

An initial training was held for all patrol officers and detectives in the DPD. These trainings were held during the roll call prior to each shift of duty and lasted for an average of twelve minutes. They were conducted by the same Deputy District Attorney and the detective assigned as the representative of the DPD for this study. The trainings provided instructions on what they were permitted to collect (i.e. evidence items) and when they needed to call a CSI to collect evidence (i.e. bodily fluids). Once the study was underway, follow-up trainings were conducted in precincts which were identified as having lower rates of collection. Detectives were trained for an additional thirty to 45 minutes while patrol officers were trained for 10 to 15 more minutes.

A DVD was produced by the aforementioned DPD detective that explained how to identify and collect biological evidence from crime scenes. These videos were seven minutes in length and all officers were required to view these videos three times within one month. The video was created and viewed during the summer months of 2006, about halfway through the demonstration project. The goal was to provide a refresher course for officers and detectives on proper collection procedures.

During the fall of 2006, the National Institute of Justice provided laminated index cards containing instructions on how to properly collect biological evidence from property crime scenes. These cards were distributed to all patrol officers, detectives, and CSI's. Denver's stakeholders identified a need for such cards because they realized that many of the involved employees' questions could be easily answered if they had constant access to a brief overview of the proper protocol for handling biological evidence in the study.

In addition to these defined training efforts, there were several ongoing initiatives to support crime scene personnel in their collection of biological evidence and later in the use of probative results to apprehend suspects. These efforts included:

- The deputy District Attorney's ongoing accessibility to detectives who were using probative biological evidence in the investigation of a case in the study.
- The head of the CLB providing updates to the DPD's district commanders and chiefs on the status of the study during their monthly meetings.

Sidebar 1- A Case Study of a Residential Burglary

On **December 12, 2006** an apartment residence was burglarized in the downtown section of Denver. The crime was estimated to have occurred between 8:45am and 6:30pm. Upon arrival at the crime scene – at 8:30 pm - a patrol officer identified a reddish substance on a window that appeared to have been broken to gain entrance to the residence. This officer called the CLB to request a CSI to collect potential biological evidence. After recording the necessary case details, the patrol officer left the crime scene and instructed the victim to preserve the crime scene as much as possible. At 9:30am on **December 13, 2006**, a CSI arrived and noticed the reddish substance as it was described in the patrol officer's report. The CSI took two cotton swabs and wiped the substance then placed them in a plastic bag. Upon returning to the CLB, the CSI submitted the swabs for processing. The following day, the study coordinator found this submitted evidence and sent the case identifier to the Urban Institute for assignment to the study's condition. One hour later, the study coordinator received an email stating that the case was assigned to experimental condition.

Upon receipt of the two swabs, a forensic analyst in the CLB began preliminary testing of the substance. Analyses revealed that the substance was indeed human blood and that it yielded a robust DNA profile that met standards for submission to CODIS. Since, the CLB 'batches' cases together for preliminary testing, this case was held until the rest of the cases in the batch all faced preliminary testing. Preliminary testing was completed on **January 20, 2007** for the entire batch. This case was then uploaded into the LDIS, SDIS, and NDIS indices for potential forensic and/or offender matches. On **January 21, 2007** the forensic analyst was informed of an offender match in the SDIS index. The detective assigned to the case received a phone call from this analyst informing him that a suspect had been identified as the perpetrator of the burglary. The detective then searched the DPD's criminal records database for the suspect and found that he had a lengthy criminal record – primarily consisting of property crimes. This database search also yielded the suspect's address. The detective then met with the deputy District Attorney to obtain an arrest warrant. On **January 25, 2007** an arrest warrant was issued for the suspect and the detective apprehended and arrested him at his residence. He was taken into custody and interviewed by the detective. The detective asked him if he would grant permission for a reference sample of his biological evidence was obtained – via an oral swab. John Smith granted permission stating that he wanted to cooperate with the detective.

On **January 26, 2007** the suspect's reference sample was sent to the CLB to test whether it matched the DNA profile obtained from the crime scene evidence. A match was confirmed and the forensic analyst phoned the detective to notify him. Later that day, the deputy District Attorney opened a case against the suspect. On **March 25, 2007** a court hearing was held where the deputy District Attorney presented the probative forensic evidence against the suspect. The judge issued a verdict of guilty and he was sentenced to one year of incarceration.

CASE PROCESSING

Police

When a property crime was reported, a patrol officer reported to the crime scene. If the officer observed biological material, the officer could collect the evidence if it is a whole item, or call for a CSI from CLB if blood or bodily fluids were observed. In addition, a detective could ultimately collect the biological evidence if the material was first observed during routine investigation. Officers were also provided with laminated cards that contained information for victims (mainly on preservation of evidence pre-collection) and for officers (the basics of DNA evidence collection). The laminated cards also had phone numbers of people they should contact with questions.

Biological evidence collected by detectives or patrol officers was sent to the Denver Police Department's Property Bureau for storage. At the same time, a detective was assigned to a property crime case by a police sergeant. The detective examined biological evidence in the Property Bureau and submitted requests for DNA analysis to the crime laboratory (and other forensic analyses where appropriate). If the DNA evidence was collected by a CSI then it was submitted directly to the CLB instead of the Property Bureau. Once the case was assigned to the CLB, Denver's study coordinator emailed the Urban Institute for assignment of each case to the experimental or comparison study condition.

Traditional investigative procedures were employed for cases in both study conditions. That is, regardless of whether the DNA evidence was processed, DPD detectives continued to work on the case in the usual manner. Typical activities included searching pawnshop serial number databases for matches to stolen property or interviewing witnesses. Typically, a detective de-activated the case after 15 days due to a lack of investigative leads, but the detective could re-activate the case if new evidence, such as a CODIS hit, was received.

If the crime scene DNA matched a known offender in one of the databases, detectives attempted to locate and apprehend the suspect(s). Common methods for locating known suspects included checking to see if the person is already under community supervision (e.g. probation or parole) or incarcerated, searching drivers' license databases for the suspect's address, and attempting to obtain tips from residents on the suspect's whereabouts.

Lab

In Denver, cases in both the test and control groups were processed through the generation of a DNA profile. At that point, DNA profiles for control cases had no additional processing until sixty days had elapsed from the day the treatment cases were uploaded into CODIS. The study coordinator and Director of the CLB monitored these control cases to ensure they were not processed before the waiting period expired. Thus, sixty days after the generation of profiles in both conditions, DNA profiles for cases in the control group were eligible to be submitted to CODIS.

To generate a DNA profile, each sample in a case passed through multiple stages. In some instances, samples were submitted to the Forensic Biology Department of the CLB for DNA presumptive testing to verify the evidence is human DNA. In the next stage, quantification tests were undertaken to determine that there is enough DNA for subsequent processing. The biological evidence proceeded through several additional steps to amplify the observable DNA and develop a DNA profile. If the profile was generated and the additional 'control' samples did not yield a match to the presumed forensic DNA profile then it was considered ready to be uploaded into CODIS.

Depending upon how many loci were present on the generated DNA profile, it was entered into the local (LDIS), state (SDIS), and/or national (NDIS) digital index systems to search for a forensic or offender match. If a hit occurred in any of these index systems, detectives were notified by phone and given a copy of the match report generated by CODIS.

Prosecution

If a forensic hit (i.e. the crime scene DNA matches another crime scene's DNA in one of the databases but no suspect is identified) occurred the detective and District Attorney's office are notified. In many cases in Denver, a 'John Doe' case was filed when there was probative forensic evidence but a suspect had yet to be identified. The purpose of filing these cases was to eliminate the statute of limitations for these cases. Thus, if a suspect was identified and apprehended in the future, the case could still be prosecuted.

In the event of an arrest, the CODIS match was confirmed by taking another sample from the suspect to compare with the crime scene DNA. If the match was confirmed, the District Attorney determined how the case was prosecuted.

Among the four states in the demonstration project, the sentencing guidelines in Colorado mandate the most severe sentences. Typically, a suspect identified by a CODIS match was offered a plea bargain to a third or fourth degree felony with a sentence that permitted the judge's discretion (with a maximum sentence for third degree sentences of eight years and 12 years for fourth degree felonies). This latter feature was important because a judge could allow mediating circumstances (e.g. short criminal history) to reduce the sentence. If the suspect rejected the plea bargain and the case proceeded to trial, the suspect may face a much longer sentence. For those with at least three prior felony convictions, the prosecutor likely charged the suspect as a habitual offender, with a minimum mandatory sentences of 36 to 48 years depending on the severity of the prior felonies.

Collaboration

In order to effectively utilize biological evidence from crime scenes there must be a high level of synergy between three of the involved agencies: the police department, the crime laboratory, and the District Attorney's office. First, the police department must communicate with the crime laboratory in an effective and timely manner in regard to the collection of biological evidence and transporting it to the crime laboratory. Next, the crime laboratory must be capable of processing this evidence quickly enough so as not compromise the police department's investigation of the case. This second aspect requires good communication between the crime laboratory and the police department's officers and detectives. Finally, the police department and crime laboratory must experience the District Attorney's office as supportive in their efforts to use probative biological evidence in the prosecution stages of case processing.

Denver had outstanding cooperation across all three of their participating agencies. For instance, the deputy District Attorney's position as a trainer indicates a high level of commitment to the use of biological evidence in prosecution by the District Attorney's office. Another example of such commitment on the part of the DPD is their identification of precincts with lower rates of collection and targeting these precincts for follow-up training. Finally, the participation of the head of the CLB in so many aspects of the training process and their continual support of the DPD and District Attorney's office, was indicative of this agency's commitment to the success of the project.

DESCRIPTIVE STATISTICS

COST

The cost analysis of the use of DNA evidence in burglary investigations estimated the costs for each case enrolled in the Denver experimental sample. For each case, a cost was attached to each of six stages of case processing. The costs describe the average expenditure of completing each stage. The progress of each case was observed in administrative data, and a cost was assigned to a case only if each stage was completed. The cost estimates for each stage include only the costs of processing an individual case; the fixed costs of operating a police agency or a crime laboratory and the costs of capital purchases (such as robotics in the crime lab) are not included. Thus, the costs described here reflect the costs to a police department with a mature crime lab that expands processing of biological material to high-volume property crimes such as residential burglary. The costs to a municipality to set-up a crime lab or to begin collecting DNA for the first time will be substantially higher.

A description of each of the six stages of case processing used in the cost analysis can be found in Table 2.2. For each of these stages, a cost was estimated for Denver, and the progress of each sample in each case was observed from administrative data.

Cost Data Collection

Cost data were collected via semistructured interviews with key stakeholders—forensic scientists in the Denver Crime Laboratory Bureau and the Denver Bureau of Investigation, and police officers and detectives in the Denver Police Department. For each of the three stakeholders, the unit costs of processing a case were estimated from the time the evidence was delivered from the property locker to the local lab until the case concluded, including suspect identification, apprehension and arrest if the case progressed that far. For each stakeholder and each stage of case processing, labor and nonlabor (capital) costs were estimated separately. The cost collection process began in December 2006 with follow-up meetings occurring throughout the study period. All prices and quantities were gathered in FY 2006 and costs and benefits are expressed in 2006 dollars.

Some costs associated with DNA case processing in Denver are not included in this evaluation. For example, the costs of training personnel to identify and collect biological material are not included. In addition, the costs of additional time at a crime scene are also not included. In this evaluation, cases are randomly assigned after each of these activities had occurred. Thus, the costs for cases in both groups are the same (a descriptive analysis of these costs is included later in this chapter). In addition, if the use of DNA in burglary investigations changes the likelihood that offenders will be arrested and convicted, other important costs and benefits will not be include. For instance, if more offenders are arrested and incarcerated, than the state will have to pay substantial additional costs to incarcerate those individuals. But, because these offenders were incarcerated, there may be substantial benefits to the community and its residents from reductions in offending.

A detailed discussion of how labor and nonlabor costs were calculated can be found in Chapter 2.

Costs by Stage

Table 4.1 details the costs of each stage of processing in Denver. The total cost to all stakeholders of processing a case that results in an arrest is $1033, 87 percent of which is comprised of labor costs with the remaining 13 percent comprising nonlabor costs, including the cost of supplies, reagents and other disposable items. The cost of case processing differ with the stage of processing with 41 percent of the costs accruing to the local forensic lab during the first three stages of processing and approximately half of the costs accruing after the beginning of the burglary investigation. The following section details the manner in which costs accrue in each stage.

Table 4.1. Cost of Processing by Stage in Denver, Colorado

	Labor Costs	Nonlabor Costs	Total
Preliminary testing	$83	$3	$86
Generation of profile	$165	$76	$241
CODIS Entry	$92	$0	$92
Case verification	$68	$10	$78
Investigation	$372	$0	$372
Post-Arrest	$117	$47	$164
Total	$897	$136	$1,033

Source: Urban Institute

Stage 1—Preliminary testing

In Denver, preliminary testing consists of an initial examination of the items(s) collected and an FBIO screening to detect the presence of DNA. This process takes approximately 1.75 hours to complete and consumes an additional $3 in nonlabor costs, for a total cost of $86.

Stage 2—Generation of profile

Profiles are generated in batches, requiring approximately 1.2 hours per sample analyzed to conduct extraction, quantitation, amplification and gene mapping. Given an average of 1.6 samples tested per case, the entire process consumes approximately $90 in wages and an additional $76 in supplies and reagents for a cost of $165. In addition, a report is written detailing the findings of the DNA analysis, a process tha t takes approximately one hour and another half hour for technical and administrative review, and costs a total of approximately $75 to complete. The total cost of processing for this stage is $241.

Stage 3—CODIS entry

Given that a profile is generated, the CODIS administrator must review the profile and available evidence and decide whether or not the sample may be uploaded into CODIS. CODIS review and upload takes another half hour. In total, the cost of this phase of processing is $92 and is entirely comprised of labor costs.

Stage 4—Case verification

Once a profile is uploaded into CODIS, the CODIS database is used to search for an offender match within the state's database. If an offender match is found, it must be verified by the state crime lab at the Bureau of Forensic Analysis at the Colorado Bureau of Investigation. The state lab verifies the CODIS hit to the offender profile on record. At the state crime lab, a forensic scientist re-analyzes existing samples in batches for a labor cost of $80 per batch, resulting in $22 in labor costs and an additional $10 in nonlabor costs. In addition, once a match is complete, a forensic scientist will spend approximately 80 minutes engaging in a technical review of the match and drafting a report. In all, the case verification stage consumes approximately $78 in resources.

Stage 5—Investigation

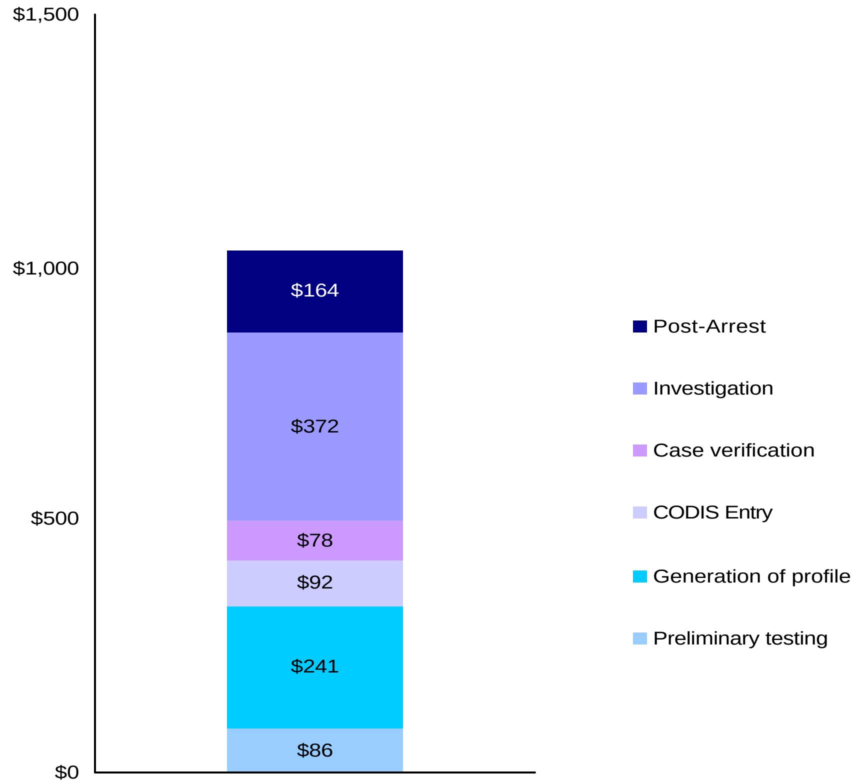
Once the match has been confirmed by the state lab, the investigative process increases in intensity. Upon notification of a DNA match, the detective assigned to the case will attempt to locate the suspect using one of several extant databases, generally including data maintained by the Departments of Parole, Probation, Prisons and Motor Vehicles, a cost of $33. Once the suspect has been located the lead investigator obtains an arrest warrant, creating and executing a plan to apprehend the suspect (usually conducted by two detectives), questioning the suspect and obtaining a confirmation sample from the suspect. Finally, the detective must write up the case notes and prepare for an eventual trial, a process that takes approximately an hour. Including time spent in transit, this process takes approximately 7.5 person-hours and costs approximately $372.

Stage 6—Post-Arrest

Once the suspect has been arrested and booked, a detective will draw a confirmation sample which is sent to the local lab for analysis. Analysis of a confirmation sample requires that all steps after the initial screening and prior to the CODIS upload must be repeated for the confirmation sample. This comprises approximately 2.2 hours of labor cost plus an additional hour and a half to produce a report describing the results of confirmatory testing as well as to conduct a preliminary review, for a total cost of $117 plus an additional $47 in nonlabor costs.

The total cost of a case processing is described in Figure 4.1. These costs are not the average cost per case. Rather, these costs simply sum the cost of each stage of case processing. Thus, they are applicable only to a case that proceeds through all of the six stages of processing. A description of the average cost of a case in Denver follows in the next section.

Figure 4.1. The Costs of Processing a Case with Biological Evidence, by Stage (Denver, CO)



Source: Urban Institute.

Processing an Average Case

The total cost of processing the average case depends on the quality of the evidence collected and whether or not a profile or a match is obtained. In cases where evidence is collected but does not contain DNA, case processing ends after preliminary testing and, as a result, the costs of processing the case are small. In cases where a profile is obtained and a suspect is identified and apprehended, the costs are substantially higher. Ultimately, the cost of an average case depends on how many of the six cost stages cases complete during the analysis and investigation process. In order to calculate the cost of an average case, we first compute the *average marginal cost* of each stage of the DNA analysis process. In order to estimate the cost of processing an average case, a processing cost is assigned to each of the 255 cases in the experimental group. A detailed discussion of the cost methodology can be found in Chapter 2.

Table 4.2 provides descriptive statistics on the cost of processing a case in Denver, using both the paired analysis, in which experimental cases are followed for the same length of time as its paired control case and the unpaired analysis which compares experimental and control cases regardless of the period of available observation. As the paired analysis censors the accrual of costs at the last date on which outcomes from the control case are observed, costs are lower in the paired analysis.

Table 4.2. Cost of Processing an Average Case in Denver, Colorado

	Unpaired Analysis	Paired Analysis
Mean	$654	$647
Standard Deviation	$324	$316
Minimum	$277	$277
25th percentile	$334	$334
Median (50th percentile)	$656	$656
75th percentile	$948	$888
Maximum	$1,475	$1,475
Sample Size	255	255

Source: Urban Institute.

In Denver, the cost of processing an average case was $654 in the unpaired analysis and $647 in the paired analysis. The middle 50 percent of cases had a cost between $334 and $888 ($948).

Costs for different agencies involved in case processing

Next we estimate how the costs of processing a case are distributed across each agency that participates in the burglary investigation. The cost of processing cases is shared by three different agencies: the local crime lab, the state crime lab and the police department. The share of the burden borne by each agency depends upon the stage in processing a case reaches. For cases that reach only Stage 1 (preliminary testing), Stage 2 (generation of profile) or Stage 3 (CODIS upload), the costs are borne entirely by the local crime lab. The costs of Stage 4 (case verification) are borne entirely by the state crime lab. The costs of Stage 5 (investigation) are borne primarily by the police department and the costs of Stage 6 (Post-Arrest) are borne entirely by the local lab. For a case that advances through the entire process, 58 percent of the costs are borne by the local lab, 8 percent of the costs are borne by the state crime lab and the remaining 36 percent of the costs are borne by the police department.

Table 4.3. Cost of Processing by Stage and Stakeholder (Denver, Colorado)

	Overall	Local Lab	State Lab	Police
Preliminary testing	$86	$86	$0	$0
Generation of profile	$241	$241	$0	$0
CODIS Entry	$92	$92	$0	$0
Case verification	$78	$0	$78	$0
Investigation	$372	$0	$0	$372
Post-Arrest	$164	$164	$0	$0
Total	$1,033	$583	$78	$372

Source: Urban Institute.

Other Costs

There are additional costs involved in collecting and processing DNA evidence that are not included in these estimates. These include the cost of training personnel to observe and collect DNA evidence at crime scenes and the cost of locating, collecting and transporting evidence to the crime lab. These costs are not considered in our analysis because they occur prior to random assignment in the crime lab. Since they occur prior to random assignment, these are costs that are equal for treatment and comparison cases. Nevertheless, these costs are relevant to policymakers who are interested in determining the amount of funding necessary to collect and process DNA from high-volume crimes scenes in their jurisdiction.

Training

Denver relied primarily on crime scene investigators (CSIs), detectives, and patrol officers to collect biological evidence from crime scenes. DPD launched several initiatives to train detectives and officers to identify and collect biological evidence from crime scenes. A similar training initiative was launched in the CLB. An initial training of senior DPD personnel (detectives, police sergeants, and senior police officers) was conducted on the identification and collection of biological evidence from property crime scenes. These trainings were three hours long and were conducted by the lead analyst in the CLB, the District Attorney, and a Deputy District Attorney. The purpose of this training was to provide first hand information to senior DPD personnel on how to properly identify, collect, and process biological evidence at property crime scenes in a manner consonant with the study's protocol. The Director of the CLB described the forensic utility of DNA evidence, the District Attorney discussed its utility in prosecuting cases, and the Deputy District Attorney detailed protocol compliance. Officers were trained to preserve the crime scene until a CSI arrived, to avoid contamination of potential DNA evidence, and to preserve fingerprint evidence when both types of evidence were available for collection. These trainings were repeated four times in order to reach all upper-level officers in the DPD. Approximately eighty officers were present at each session. The total cost of this training was approximately $30,000.

An initial training was held for all patrol officers and detectives in the DPD. These trainings were held during the roll call prior to each shift of duty and lasted for an average of twelve minutes. They were conducted by the same Deputy District Attorney and the detective assigned as the representative of the DPD for this study. The trainings provided instructions on what they were permitted to collect (i.e. evidence items) and when they needed to call a CSI to collect (i.e. bodily fluids). Once the study was underway, follow-up trainings were conducted in precincts which were identified as having lower rates of collection. Detectives were trained for an additional thirty to 45 minutes while patrol officers were trained for 10 to 15 more minutes. A DVD was produced by the DPD detective that explained how to identify and collect biological evidence from crime scenes. These videos were seven minutes in length and all officers were required to view these videos three times within one month. The video was created and viewed during the summer months of 2006, about halfway through the demonstration project. The goal was to provide a refresher course for officers and detectives on proper collection procedures.

In addition to these defined training efforts, there were several ongoing initiatives to support crime scene personnel in their collection of biological evidence and later in the use of probative results to apprehend suspects. These efforts included:

- The deputy District Attorney's ongoing accessibility to detectives who were using probative biological evidence in the investigation of a case in the study.
- CLB updates DPD district commanders and chiefs on the study's status at monthly meetings.

In total, we estimate the cost of training to be approximately $30,000 or $120 per case in Denver's experimental group. In addition, one Assistant District Attorney allocated approximately three quarters of his time to advising police officers, detectives and CLB on these cases, an additional training cost of $66,000, or $266 per case.

Evidence Recovery

In order to secure DNA evidence, patrol officers report that they must remain on scene for an additional hour. In addition, a detective is generally called to the scene, spending an additional hour on scene and in transport. As officers do not collect DNA, a DNA collection technician must spend approximately two hours in transport and at the crime scene locating, collecting and securing DNA, for a cost of $82. Finally, an officer must spend approximately one hour transporting the DNA to the evidence room. In total, we estimate that collecting DNA at burglary scenes costs an additional $227 in labor costs—cost that would not have accrued had DNA not been searched for and collected.

OUTCOMES

Forensic specialists and patrol officers typically collected evidence of bodily fluids (i.e. blood and saliva/sweat) from whole items at residential, commercial and auto-related property crime scenes in Denver. The evidence collected from treatment cases yielded impressive results: about nine out of ten cases yielded a DNA profile, eight in ten cases had a profile uploaded into CODIS, and about half of these cases resulted in a CODIS match—typically in the offender index. Twice as many cases resulted in a suspect identification in the treatment group than in the control group (55 vs 27 percent). Treatment cases also had twice as many arrests (29 vs 14 percent) as control cases and three times as many cases accepted for prosecution (46 vs 17 percent). In sum, DNA evidence was competently collected to yield robust results in the crime laboratory and these results translated into effective suspect identification, apprehension and prosecution by the police department and District Attorney's office.

The majority of crime scenes were comprised of residential burglaries in Denver. Treatment cases were comprised of significantly less residential burglaries than control group cases. Commercial and auto-related burglaries each made up about one-fifth of crime scenes in the study. Treatment cases had significantly more crime scenes where a window was the point of entry and significantly less scenes where the door was a point of entry. Fifteen percent of all cases had a point of entry which was unlocked at the time of the crime. On average, about one and a half samples were taken from crime scenes.

Descriptive Statistics

The crime scene attributes (table 4.4) are the characteristics of a crime scene, e.g., how did the perpetrator gain entry, what type of crime was committed, who collected the biological material, etc. In all of the cases in Denver, the variables described in crime scene characteristics describe case characteristics pre- randomization. Thus, the data in table 4.4 (and in tables 4.5 and 4.6 described below) can be used to determine whether the integrity of the random assignment process was maintained. Theoretically, if cases were assigned randomly to each experimental condition, there should be no differences in case attributes between groups. As is shown below, there are significant differences between the test and control groups on several variables. In order to account for this possible threat to the assumptions underlying the randomized protocol, multivariate analyses were also conducted whether variables that were significantly different across the study's groups were included as covariates and the study's condition was the predictor.

Table 4.4. Descriptive Statistics for Crime Scene Attributes of Cases Processed in Denver.

	Attribute	Treatment Group	Control Group	Full Sample
Crime Type	Residential	50% (50%)	58% (50%)	54% (50%)
	Commercial	23% (42%)	20% (40%)	21% (41%)
	Auto-Related Crime	26% (44%)	20% (40%)	23% (42%)
	Other	1% (11%)	2% (15%)	2% (13%)
Point of Entry	Door	27%* (45%)	38% (49%)	33% (47%)
	Window	39%* (49%)	30% (46%)	35% (48%)
	Car	25% (43%)	20% (40%)	22% (42%)
	Other	9% (29%)	12% (32%)	10% (31%)
Point of Entry was Unlocked		13% (34%)	17% (37%)	15% (35%)
Average Number of Samples Collected		1.79 (1.38%)	1.72 (1.14)	1.58 (0.84
Evidence Collector	Patrol Officer	29%** (45%)	43% (50%)	36% (48%)
	Detective	4% (20%)	5% (21%)	5% (21%)
	Forensic Specialist	67%** (47%)	52% (50%)	60% (49%)
Any Fingerprints Collected		24% (43%)	22% (41%)	23% (42%)
Number of Offenders Searched Against in SDIS		57,958.90 (8732.70)		
Item Stolen	Electronics	42%** (49%)	28% (45%)	35% (48%)
	Other	58%** (50%)	72% (45%)	65% (48%)
	Nothing	1% (9%)	0% (6%)	1% (8%)

Source: Urban Institute. Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group.
Significance: * $p < 0.05$, ** $p < 0.01$

As would be expected from their protocol, Forensic Specialists conducted the majority of evidence collection (60 percent). These individuals collected evidence from significantly more treatment case crime scenes while patrol officers—who overall collected evidence from about a third of the study's crime scenes—collected evidence from significantly fewer treatment case crime scenes. Detectives rarely collected evidence from crime scenes (5 percent). Fingerprints were collected in about a quarter of all crime scenes. In addition, the average number of samples in Colorado's SDIS was slightly more than fifty thousand. Electronics were more likely to be stolen from treatment case crime scenes while other types of items were significantly more likely to be taken from control case crime scenes.

Table 4.5. Descriptive Statistics for Temporal Attributes of Cases Processed in Denver.

	Attribute	Treatment Group	Control Group	Full Sample
Case Assigned During First Half of Study		49% (50%)	51% (50%)	50% (50%)
Case Assigned (Season)	Fall	24% (43%)	29% (46%)	27% (44%)
	Winter	25% (44%)	25% (43%)	25% (43%)
	Spring	28% (45%)	27% (44%)	28% (45%)
	Summer	22% (42%)	19% (40%)	21% (41%)
Case Assigned (Time of Day)	Day Shift (2PM-10PM)	37% (48%)	42% (50%)	40% (49%)
	Night Shift (10PM-6 AM)	19% (39%)	16% (37%)	18% (38%)
	Morning Shift (6 AM- 2PM)	44% (50%)	41% (49%)	43% (50%)

Source: Urban Institute. Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group.
Significance: : * p < 0.05, ** p < 0.01

Cases were assigned proportionately across the four seasons. About 40 percent of crime scenes were arrived at during the day or morning shifts with the remainder visited during the night shift.

Table 4.6. Descriptive Statistics for Attributes of Samples Processed in Denver.

	Attribute	Treatment Group	Control Group	Full Sample
Sample Type	Blood	35%** (48%)	56% (50%)	45% (50%)
	Handled/ Touched (Cells)	7% (26%)	11% (31%)	9% (29%)
	Oral (Cells)	41% (49%)	40% (49%)	40% (49%)
	Worn (Cells)	9%** (29%)	21% (41%)	15% (36%)
	Other	4% (18%)	3% (17%)	3% (18%)
Mode of Collection	Swab	43%** (50%)	24% (43%)	34% (47%)
	Whole Item	57%** (50%)	75% (43%)	66% (47%)
	Both	0% (0%)	0% (0%)	0% (0%)

Source: Urban Institute. Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Type of evidence collected may sum to more than one, as multiple samples may have been collected from different types of evidence. Significance: * p < 0.05, ** p < 0.01

Blood was collected from about one-third of treatment cases—significantly less than the number of control cases where blood was collected (56 percent). Cells that were orally transferred to the crime scene (e.g., saliva) were collected from 40 percent of rimes scenes. Cells that were presumably worn to the crime scene were significantly less likely to be collected from treatment than control crime scenes. Treatment case evidence was significantly more likely to be collected via swabs than control cases and significantly less likely to be collected as whole items. Overall, whole items were collected from crime scenes nearly twice as much as swabs.

Table 4.7. Descriptive Statistics for Intermediate Outcomes of Cases Processed in Denver.

	Attribute	Treatment Group
DNA Profile Obtained		86% (34%)
DNA Profile Uploaded into CODIS		82% (38%)
CODIS Match Obtained	Total	46% (50%)
	Offender Hit	30% (46%)
	Forensic Hit	16% (36%)

Source: Urban Institute. Data are reported at the case level.

The vast majority (86 percent) of treatment cases yielded at least one DNA profile. Almost all cases resulting in a DNA profile were uploaded into CODIS. Nearly half of all treatment cases yielded a CODIS match. Two-thirds of these matches occurred in the offender indices (30 percent) and the remaining one-third occurred in the forensic indices.

Table 4.8. Suspects identified, arrested, and prosecuted in Denver

	Treatment	Control
Suspect Identified	56%** (50%)	18% (39%)
Suspect Arrested	29%** (46%)	14% (34%)
Number of Arrests	74	36
Case accepted for prosecution	46%** (50%)	17% (38%)
Sample Size	255	255

Source: Urban Institute.
Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$

Table 4.8 shows case outcomes for Denver. There were significant differences between the treatment and control group with these case outcomes. In the treatment group there were significantly more suspects identified than in the control group. In the treatment group, 56 percent of the cases had a suspect identified compared to 18 percent of the control samples. The cases in the treatment group were also significantly more likely to have an arrest and have a case be accepted for prosecution. In the treatment group, 29 percent of the cases had a suspect arrested and 46 percent of the cases accepted for prosecution while the control group had 14 percent of the suspects arrested and 17 percent of the cases accepted for prosecution.

Table 4.9. Method used to identify a suspect in Denver

	Treatment	Control
Suspect identified	56%** (50%)	18% (39%)
Traditional Investigation	19% (39%)	18% (39%)
CODIS Hit	29% (46%)	
Forensic Hit/Investigative Lead	7% (26%)	
Sample Size	255	255

Source: Urban Institute.
Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$

Table 4.9 shows how suspects were identified in Denver. Both conditions had some cases closed by traditional means 19 percent for the treatment group and 18 percent for the control group. For cases with DNA that was tested, 29 percent of the treatment cases were aided by an offender hit and 7 percent had a suspect identified through the leads provided by a forensic hit.

Multivariate Analysis

A large number of descriptive variables significantly differed between the treatment and comparison groups. Such differences can be problematic in a randomized controlled trial because the random assignment to conditions is meant to eliminate such differences. When such differences emerge, it is useful to employ alternative statistical methods to test whether group membership has an effect on the intended outcome when the differences between groups are held constant. Multivariate regression is one such method. Since the outcomes in this section of the report are binary (i.e. yes or no) we employed logistic regressions to determine the effect of being assigned to the treatment group when the variables which yielded significant differences are included in the model as covariates. That is, what is the treatment effect when possible confounding variables are controlled? In order to be as rigorous as possible in this analysis, we raised the level of statistical significance to $p<0.01$ as the threshold for whether a variable was included in this model. This modification, resulted in the type of offense being added to the variables that were already significant at the $p<0.05$ level or below.

Since several variables were found to be significantly different despite randomization, and these variables were included as covariates in a logistic regression model of the following form:

$$Y_j = \beta 0 + \varphi T_j + \gamma^* Z_j + \varepsilon_j \qquad (4.1)$$

In (4.1), Y_j is one of three sample outcomes (suspect identification, arrest, accepted for prosecution) for case *j* and Z_j is the vector of independent variables that are significantly different within a given site. T_j is a binary measure of treatment and is equal to one if a case is assigned to the treatment group and zero if it is assigned to the control group. φ, the coefficient on T_j, is the impact of treatment on outcomes, controlling for variables in Z.

Table 4.10 contains results of the logistic regressions performed on three outcomes: whether a suspect was identified, whether a suspect was arrested, and whether the case was accepted for prosecution. Two analyses are presented for each outcome: 1) the effect of treatment without any covariates and 2) the treatment effect when covariates are included. Table 4.11 contains the same analyses using the restricted follow-up period for treatment cases when appropriate.

Table 4.10 Multivariate Logistic Analysis of the impact of DNA analysis on three outcomes							
		Suspect Identified		Suspect arrested		prosecution	
		(1)	(2)	(3)	(4)	(5)	(6)
	Average treatment effect	3.07**	2.84**	2.62**	2.37**	4.25**	3.47**
		(0.19)	(0.20)	(0.23)	(0.24)	(0.21)	(0.22)
Crime Type (reference group= Residential)	Other		1.56		2.02		1.15
			(1.27)		(0.96)		(0.96)
	Commercial		1.81*		0.94		1.46
			(0.26)		(0.30)		(0.27)
	Auto-Related Crime		2.08		1.15		1.61
			(1.07)		(0.61)		(0.62)
Point of Entry (reference group=Window)	Door		0.82		0.90		0.59*
			(0.25)		(0.28)		(0.27)
	Car		0.57		0.42		0.76
			(1.09)		(0.70)		(0.67)
	Other		0.69		0.92		0.53
			(0.36)		(0.36)		(0.36)
Evidence Collector (reference group= Patrol Officer)	Detective		1.35		2.22		1.77
			(0.55)		(0.53)		(0.52)
	Forensic Specialist		0.94		1.12		0.86
			(0.26)		(0.30)		(0.28)
Item Stolen (reference group=Other)	Electronics		1.47		1.38		1.41
			(1.33)		(0.25)		(0.23)
Sample Type (reference group=Blood)							
	Handled/ Touched (Cells)		0.93		0.81		0.57
			(0.36)		(0.45)		(0.43)
	Oral (Cells)		1.35		2.02**		1.06
			(0.22)		(0.25)		(0.24)
	Other		0.89		0.93		0.57
			(0.58)		(0.68)		(0.67)
Mode of Collection	Swab		1.72*		1.65		1.92*
			(0.27)		(0.31)		(0.29)
Log-Likelihood		-328.50	-297.17	-256.47	-245.88	-291.74	-277.43
N		510	510	510	510	510	510

Table 4.10 shows that treatment cases were significantly more likely to result in a suspect's identification. This treatment effect remained when the covariates were included suggesting a robust effect. Columns (3) and (4) also demonstrate that treatment cases enjoyed higher odds of resulting in an arrest than control cases. Finally, the same results occurred for whether a case was accepted for prosecution. The same results occurred when a restricted follow-up period was employed for appropriate treatment cases (Table 4.11). In sum, when the differences in groups along the above covariates were controlled for, the treatment group still resulted in significantly higher odds of yielding a suspect's identification, arrest, and case that was prosecuted.

Table 4.11 Multivariate Logistic Analysis of the impact of DNA analysis on three outcomes (paired)							
		Suspect Identified		Suspect arrested		prosecution	
		(1)	(2)	(3)	(4)	(5)	(6)
	Average treatment effect	3.06**	2.80**	2.33**	2.50**	1.19**	2.69**
		(0.19)	(0.20)	(0.23)	(0.24)	(0.21)	()
Crime Type (reference group= Residential)	Other		1.78		2.20		0.91
			(1.28)		(0.96)		(0.98)
	Commercial		1.87*		0.98		1.38
			(0.26)		(0.30)		(0.28)
	Auto-Related Crime		2.24		1.25		0.89
			(1.07)		(0.62)		(0.68)
Point of Entry (reference group=Window)	Door		0.76		0.79		0.61
			(0.25)		(0.29)		(0.27)
	Car		0.52		0.38		1.38
			(1.09)		(0.70)		(0.73)
	Other		0.58		0.84		0.52
			(0.37)		(0.37)		(0.37)
Evidence Collector (reference group= Patrol Officer)	Detective		1.49		2.57		2.28
			(0.55)		(0.54)		(0.52)
	Forensic Specialist		0.95		1.23		0.89
Item Stolen (reference group=Other)			(0.27)		(0.31)		(0.29)
	Electronics		1.49		1.31		1.45
			(1.34)		(0.26)		(0.23)
Sample Type (reference group=Blood)							
	Handled/ Touched (Cells)		1.00		0.90		0.66
			(0.36)		(0.45)		(0.43)
	Oral (Cells)		1.30		2.19**		1.28
			(0.22)		(0.26)		(0.24)
	Other		0.68		0.62		0.41
			(0.62)		(0.79)		(0.78)
Mode of Collection	Swab		1.73*		1.70		1.75
			(0.27)		(0.31)		(0.29)
Log-Likelihood		-326.50	-293.57	-250.87	-238.87	-287.32	-274.02
N							

Source: Urban Institute. Data are reported at the case level. Logistic Regression Models were specified for each outcome. Odds ratios and standard coefficients are reported.
Significance: * $p < 0.05$, ** $p < 0.01$

Cost-Effectiveness

Cost-effectiveness analysis (CEA) is an economic analysis that compares relative costs to relative outcomes for two or more experimental conditions. A CEA yields a ratio of costs to outcomes, which can be interpreted as the amount of money that is necessary to achieve one unit of a particular outcome. A detailed description of the cost-effectiveness method can be found in

Chapter 2. Cost-effectiveness ratios are calculated for three outcome variables: (1) the cost per suspect identified, (2) the cost per arrest, and (3) the cost per case accepted for prosecution.

Cost-Effectiveness Analysis

Table 4.12 Cost effectiveness of DNA analysis for property crimes in Denver (unpaired)

Domain	Denver
Expected Cost per suspect identification	$1,466
Expected Cost per arrest	$3,679
Expected Cost per case accepted for prosecution	$1,903

Table 4.13 Cost effectiveness of DNA analysis for pro4erty crimes in Denver (paired)

Domain	Denver
Expected Cost per suspect identification	$1,420
Expected Cost per arrest	$3,942
Expected Cost per case accepted for prosecution	$5,124

Denver had the lowest cost per outcome amongst all of the other sites. Table 4.12 shows that the occurrence of so many case prosecutions without an artificially imposed follow-up period resulted in an extremely low cost per case accepted for prosecution. Upon introduction of the restricted follow-up period for appropriate treatment cases the cost per prosecution elevated to nearly two and one half times that cost in the 'unpaired 'analysis. The cost of an average case, including cases where no DNA profile was obtained and those cases where a suspect was arrested was $654.

CHAPTER 5—LOS ANGELES, CALIFORNIA

In 2004, the Los Angeles Police Department (LAPD) was only processing DNA for a burglary case in exceptional circumstances. Due to inadequate staffing, the Scientific Investigation Division of the LAPD has an existing DNA backlog of homicide and sexual assault evidence, which effectively meant that only the most severe cases were able to be tested for DNA evidence. When participants in the DNA Field Experiment from NIJ were solicited, the Los Angeles Police Department saw the project as an opportunity to begin to test DNA in high-volume crimes that would normally go untested for DNA. The original project was aimed at focusing entirely on residential burglaries. With the large backlog in violent crime cases waiting DNA typing, the only viable option for the lab was to use grant funding to pay for outsourcing the DNA typing in burglaries. In February 2006, the first piece of biological evidence was collected from a residential burglary. They collected biological samples from a total of 391 cases, not quite reaching the 500 case mark.

CONTEXT FOR THE DNA DEMONSTRATION

Los Angles is comprised of nearly 4 million residents living within 468 square miles. It is the second largest city in the United States. The Los Angeles Police Department (LAPD) has approximately 9,500 sworn personnel and 3,000 civilian staff. The Scientific Investigation Division of LAPD houses the Criminalistics Laboratory which analyzes DNA evidence. The Criminalistics Laboratory planned to outsource the majority of the burglary cases that were analyzed under this grant. The majority of the evidence collected at a burglary crime scene was outsourced to an ASCLD/LAB accredited or FQS-I certified private laboratory for screening and DNA analysis. The Operations-Valley Bureau in conjunction with the LAPD Criminalistics Laboratory and the Los Angeles County District Attorney's Office participated in the DNA Expansion and Demonstration project.

In 2004, the Los Angeles Police Department (LAPD) had 14,113 residential burglaries. This project was focused in the Valley Bureau of the LAPD. The San Fernando Valley represents 32 percent of the city's population, 47 percent of its landmass and approximately 34 percent of its residential burglaries. Within the Valley Bureau there are six Community Policing Areas that are populated by approximately 1.27 million people over 221.8 square miles.

Protocols (proposed)

The proposed DNA collection protocol was designed so that the Preliminary Investigating Officer (PIO) would assess the residential burglary crime scene for potential DNA evidence. Patrol notified the Scientific Investigation Division (SID) and a CSI technician responded to the crime scene. The CSI technicians were responsible for collecting potentially probative DNA evidence, latent print collection and photo documentation of the scene. The CSI technician did a walk-through of the home to collect prints and potential DNA evidence. Digital photographs were taken to document the potential DNA evidence prior to its collection. Potential DNA evidence items were either collected as a whole or part of an object (hat, piece of carpet) or with a swab. Each item was then individually packaged (unless swabbed from the same stain) in coin envelopes and transferred to Property. The evidence was taken to be booked into the property system by the CSI Technician.

The Forensic Print Specialists and Photographers received in-house training in the proper collection of potential DNA evidence. The Criminalists provided the new CSI technicians with instruction in Basic Crime Scene and Evidence Collection. The CSI technicians were trained to properly identify potential DNA sources in the context of a burglary scene. The CSI technicians were trained to collect blood, saliva, perspiration, skin cells, and hairs and how to evaluate which types of evidence are known to produce high levels of typable DNA. Emphasis was placed on identifying and collecting only samples sources with a high probability of being left by the suspect exclusively. Proper collection procedures were stressed during training to minimize the possibility of contamination. Training also included safety issues concerning the use of proper precautions and blood-borne pathogen awareness. The CSI technicians were also trained in the proper documentation of evidence collection necessary for chain of custody. Training included repackaging and proper final storage conditions in order to preserve the sample's integrity for future analysis.

Protocols (Implemented)

Some planned protocols for the experiment project proved to be sub-optimal. The trained CSI technicians were not able to find DNA evidence at enough residential crime scenes, so the project had to expand to collecting DNA from commercial burglaries and thefts from vehicles. A second issue arose from a combination of union issues and a lack of volunteer Print Specialists and Photographers willing to be trained to collect DNA evidence. There were shifts when no trained CSI technicians were available to collect DNA and in some instances, the PIO just collected whole evidence items themselves. Instead of it being a smooth process of a PIO requesting someone to come collect potential DNA, collection was hindered by a lack of available trained personnel and a disconnect in communication between detectives (who might be aware of evidence that was collected by the PIO) and the lab. The original protocol called for the CSI technician to collect evidence and notify the lab whenever they collected an item for DNA testing. The training materials for officers only indicated that they were to request for collection from the lab. At this point there was no mechanism in place to notify the lab when a PIO had collected DNA evidence themselves. Some of these obstacles were resolved throughout the process as the lab became more aware that officers were collecting evidence themselves. A shortage of trained personnel who were available to collect DNA at a high-volume crime scene was a consistent issue throughout the project. When a CSI technician was available to collect evidence, the process ran well. An unforeseen issue also arose with the amount of time evidence was spending at the outsource lab and how long it sat in the in-house lab before being reviewed and profiles uploaded. These problems were both contractual (with the outsource lab) and a function of scarcity of available time at LAPD's lab to analyze the data once it came back from the lab.

CASE PROCESSING

Police

In Los Angeles, the responding officers are responsible for assessing the residential burglary crime scene for potential DNA evidence. They then notify the Scientific Investigation Division (SID) and a CSI technician will respond to the crime scene. Once the officer leaves the scene, the report is moved to a burglary detective for follow-up. Most burglary cases, unless there is a viable lead, are considered a Category II case. Under normal circumstances, the detective is responsible for any lab requests, including asking the lab to process DNA found at the crime scene. During the experimental period, detectives were precluded from making these requests and the random selection process identified cases to be processed. If a detective submitted a request, the lab determined if the case was in the treatment or control group. Requests for lab processing of control group cases were held until the experimental period expired. While the lab is processing any forensic evidence, the detective continues their traditional investigation, which can include a range of activities from calling victims, checking pawnshops, fingerprint evidence, while biological evidence is being processed for any additional leads in the lab. If there is a CODIS hit, detectives are notified that a hit occurred only after the state lab provided the suspect(s) name and information. A CODIS hit moves a Category II case up to a Category I case, with a written follow-up expected within 30 days. Once the detective is provided with the suspect's name and information, they will follow-up the lead to decide if this suspect is worth investigating further. The suspects are some times found to currently be incarcerated and detectives can investigate accordingly. In some instances, the suspect had a reason to be in the residence, so is less likely to be a suspect or was out of town at the time of the incident. If the individual identified by the CODIS hit continues to be a suspect after the initial investigation, the detective will present the case to prosecution for an arrest warrant and/or prosecution (if the suspect is already in custody). Officers were also provided with laminated cards that contained information for victims (mainly on preservation of evidence pre-collection) and for officers (the basics of DNA evidence collection). The laminated cards also had phone numbers of people they should contact with questions.

Crime Lab

The crime lab played a major role in the collection of DNA evidence during this project. The newly trained CSI technicians were responsible for collecting potentially probative DNA evidence, latent print collection and photo documentation of the scene. The CSI technician is in charge of doing a walk-through of the home with the victim to collect prints and potential DNA evidence. The technician would book the evidence for further analysis.

Sidebar 1 – A Case Study of a Residential Burglary

The first case study describes a residential burglary that was a part of the DNA Expansion/ Demonstration project took place on **October 28**. At 11:15pm a 911 call for service came into the Los Angeles Police Department for a residential burglary. After this call was logged, officers in the field were notified of the crime and once an officer was available to respond, an officer was dispatched to the scene. Upon arriving at the scene, the officer walked through the home with the victim to see where the suspect may have entered the residences, any items taken or broken and to estimate what time frame the crime took place in. In this instance, the suspect(s) had entered the home by using an unknown tool to force their way into the home. It was determined that the suspect(s) had entered the home during the evening hours that same night. The suspect(s) had removed jewelry from the home. While doing the walk through, the patrol officer collected seven pieces of evidence including a bottle, a cup and a straw that the suspect(s) had possibly used. The victim stated that the items had not been placed by the victim and did not belong there. The officer then wrote up the case report and booked the evidence. The case was assigned to a burglary detective on **October 30**. While the forensic evidence is being processed in the lab, the detective began their investigation using traditional methods including interviews of victim and/or neighbors, reviewing similar cases and checking pawn shops. In this case, the reporting officer also collected fingerprint evidence found at the scene.

The case was then sent to the Urban Institute to be randomized on **May 11** by a police department employee. It was assigned to the Test Group the same day. The lab was notified on **June 8** that there was a case with possible DNA evidence. The lab reviewed the evidence and decided that it was potentially probative and should be included in this study. Once the lab was notified that it was a Test case, a lab technician then sent the items collected by the officer to the outsource lab for analyzing. Once the evidence was returned to LAPD SID, the criminalist reviewed all materials from the outsource lab. The criminalist wrote up a technical report and noted that there was a CODIS eligible profile obtained from the submitted sample. The DNA profile was available for CODIS entry on **August 2** and was uploaded into CODIS on **August 2**. The profile hit on an offender in the SDIS database on **October 2**. The lab was then notified of the hit. The state lab then confirmed the hit and provided the LAPD crime lab with **suspect info**. No suspect has been arrested in this case.

The lab would screen evidence and then package the evidence appropriately (most often sending whole items) for shipping to the outsource lab. Once the data was returned to the LAPD lab from the outsource lab, SID reviewed the data and any profile that was obtained. If a profile is obtained and it is CODIS quality, which is determined by the CODIS manager, it will be uploaded into CODIS. Some reasons profiles will not be uploaded into CODIS include having too few loci and not being reasonably sure the profile belongs to a suspect. In cases where the manager is unsure if the profile belongs to the suspect, they will advise the detective that elimination samples are necessary before CODIS upload. If the profile has been entered into CODIS and has a forensic or offender hit, the lab is notified by the state lab that a hit has occurred. Once the hit has been verified by the state lab, SID receives that information and notifies the detective that a hit has occurred. If a suspect is found and a confirmation sample is obtained, SID will then send the suspect reference sample to the outsource lab confirm the hit.

Sidebar 2- A Case Study of a Residential Burglary

This case study describes a residential burglary that was a part of the DNA Field Experiment project took place on September 19. At 5:17pm a 911 call for service came into the Los Angeles Police Department for a residential burglary. After this call was logged, officers in the field were notified of the non-emergency case and once an officer was available to respond, an officer was dispatched to the scene. Upon arriving at the scene, the officer walked through the home with the victim to see where the suspect may have entered the home, any items taken or broken and to estimate what time frame the crime took place in. In this instance, the suspect(s) had entered the single-family home by forcing their way through a ground level window. It was discovered that once inside the home, the suspect(s) had taken banking items belonging to the victim. After walking through the home, the officer called for a CSI technician to report to the crime scene. The officer then informed the home owner that a crime scene specialist would be returning to their home to collect evidence and that the victim should not clean or touch any potential evidence. The officer then left the scene. The officer wrote the crime report for this case and submitted it for review. The case was assigned to a burglary detective on September 20. While the forensic evidence is being processed in the lab, the detective began their investigation using traditional methods including interviews of victim and/or neighbors, reviewing similar cases and checking pawn shops. The CSI technician reported to the crime scene to collect biological evidence on September 20 at 10:11am. While at the victim's home, the specialist collected fingerprints and swabbed what they believed to be a drop of blood from the crime scene.

The case was then sent to the Urban Institute to be randomized on October 5 by a police department employee. It was assigned to the Test Group the same day. The lab was notified on October 13 that there was a case with possible DNA evidence. The lab reviewed the evidence and decided that it was potentially probative and should be included in this study. Once the lab was notified that it was a Test case, a lab technician packaged the blood swab to be sent to the outsource lab for analyzing. Once the evidence was returned to LAPD SID, the lab technician reviewed all materials from the outsource lab. The lab technician wrote up a technical report and noted that there was a CODIS eligible profile obtained from the submitted sample. The DNA profile was available for CODIS entry on November 16 and was uploaded into CODIS on November 16. A suspect was identified through a traditional investigation in this case and arrested on March 30 on burglary charges. No suspect has been arrested.

Prosecution

The Los Angeles County District Attorney's Office becomes involved in the DNA project once a suspect (or suspect profile) is identified. The prosecution may be willing to file a John Doe warrant on a case where a profile has been uploaded but no suspect has been identified by name. The more common way the prosecution becomes involved in a burglary case is when a detective presents their case to the DA's office once they are prepared to move forward with an arrest. The prosecution will review the case to see if it meets the legal requirements to issue an arrest warrant. If not, they will return the case to the detective for further follow-up. If the suspect is already in custody, the prosecution will make the decision whether or not to file criminal charges.

In California, the statutes for each burglary violation are such that for a first time residential burglary a defendant can receive two, four or six years in state prison. It is possible that a defendant can be sentence to probation and receive anywhere from one day to one year in county jail. In a case where a defendant had a prior serious felony then there is an additional five year enhancement to the sentence. Since California is a three strikes state, a defendant's sentence can double with one prior serious felony conviction or cause the sentence to increase to 25 years to life for a defendant with two prior felony convictions. In a commercial burglary, once convicted a defendant can face a sentencing range from 16 months, two years or three years but can also be sentenced to probation and receive anywhere from one day to one year in county jail. There are no five year enhancements that can be added on to the sentence but the three strike law applies to commercial burglary convictions. For both commercial and residential burglaries, a defendant can be sentenced to an additional one year in state prison for every conviction that resulted in a prior state prison commitment.

Collaboration

Communication between the lab and the police department became an issue during this project as officers and investigators had to wait long periods of time to hear any results about CODIS hits. Many officers became discouraged and stopped calling the lab for DNA collection since oftentimes officers would not be aware if a Forensic Specialist collected anything or if they responded to the scene. In other instances officers just collected evidence items themselves and communication broke down between the detective who was aware that potential DNA evidence was collected and the lab. These cases were included in our study later, once it was discovered that potential DNA evidence existed in these cases. Throughout the project, as these issues came to light, each of the parties tried to work on these communication issues but because of busy schedules, communication issues continued.

DESCRIPTIVE STATISTICS

COST

The cost analysis of the use of DNA evidence in burglary investigations estimated the costs for each case enrolled in the Los Angeles experimental sample. For each case, a cost was attached to each of six stages of case processing. The costs describe the average expenditure of completing each stage. The progress of each case was observed in administrative data, and a cost was assigned to a case only if each stage was completed. The cost estimates for each stage include only the costs of processing an individual case; the fixed costs of operating a police agency or a crime laboratory and the costs of capital purchases (such as robotics in the crime lab) are not included. Thus, the costs described here reflect the costs to a police department with a mature crime lab that expands processing of biological material to high-volume property crimes such as residential burglary. The costs to a municipality to set-up a crime lab or to begin collecting DNA for the first time will be substantially higher.

The six stages of case processing observed in the cost analysis are presented in Table 2.2. For each of these stages, a cost was estimated for Los Angeles, and the progress of each sample in each case was observed from administrative data.

Cost Data Collection

Cost data were collected via semistructured interviews with key stakeholders—forensic scientists in the Los Angeles Criminalistics Laboratory of the Scientific Investigation Division (SID), the California Department of Justice's Forensic Services Bureau, and police officers and detectives in the Los Angeles Police Department. For each of the three stakeholders, the unit costs of processing a case were estimated from the time the evidence was delivered from the property locker to the local lab until the case concluded, including suspect identification, apprehension and arrest if the case progressed that far. For each stakeholder and each stage of case processing, the labor and nonlabor (capital) costs were estimated separately. The cost collection process began in December 2006 with follow-up meetings occurring throughout the study period. All prices and quantities were gathered in FY 2006 and costs and benefits are expressed in 2006 dollars.

Some costs associated with DNA case processing in Los Angeles are not included in this evaluation. For example, the costs of training personnel to identify and collect biological material are not included. In addition, the costs of additional time at a crime scene are also not included. In this evaluation, cases are randomly assigned after each of these activities had occurred. Thus, the costs for cases in both groups are the same (a descriptive analysis of these costs is included later in this chapter). In addition, if the use of DNA in burglary investigations changes the likelihood that offenders will be arrested and convicted, other important costs and benefits will not be include. For instance, if more offenders are arrested and incarcerated, than the state will have to pay substantial additional costs to incarcerate those individuals. But, because these offenders were incarcerated, there may be substantial benefits to the community and its residents from reductions in offending.

A discussion of how labor and non-labor costs were calculated can be found in Chapter 2. There is one notable exception to this general approach to counting costs of processing DNA evidence. Since Los Angeles outsources DNA analysis to a private lab than all private lab costs are attributed to the preliminary testing stage because each of the first two stages ("preliminary testing" and "generation of profile") are paid for at the time of preliminary testing by the local lab regardless of whether a sample actually passes preliminary testing. As a result, sites with a private lab tend to pay for costs earlier in the case process than sites that analyze DNA in-house.

Case Processing in Los Angeles

Table 5.2 details the costs of each stage of processing in Los Angeles. The total cost to all stakeholders of processing a case that results in an arrest is $2,481. Thirty-two percent of costs are labor costs, and the remainder is nonlabor including the cost of supplies, reagents and other disposable items. The cost of case processing is not divided equally between the six stages of processing, with 46 percent of costs accruing to the local lab prior to CODIS upload and nearly half the costs accruing during the post-arrest stage of case processing. The following section details the manner in which costs accrue in each stage.

Table 5.1. Cost of Processing by Stage in Los Angeles, California

	Labor Costs	Nonlabor Costs	Total
Preliminary testing/ Generation of Profile	$113	$867	$980
CODIS Entry	$167	$0	$167
Case verification	$165	$30	$195
Investigation	$300	$0	$300
Post-Arrest	$54	$785	$838
Total	$799	$1,682	$2,481

Source: Urban Institute

Stages 1 and 2—Preliminary testing and generation of profile

In Los Angeles, preliminary testing consists of an initial examination of the items(s) collected, the creation of a manifest of these items and the packaging of the evidence item for shipment to Cellmark, a private lab in Dallas, Texas with whom Los Angeles SID has a contractual agreement to analyze DNA samples. This process is conducted by a Forensic Scientist I and takes approximately 90 minutes to complete, for a labor cost of $57. In addition, prior to shipment, both a technical and administrative review are conducted, requiring approximately one half hour of staff time, a cost of $44. The cost of postage adds approximately $19 to the cost of this stage of processing. Los Angeles pays Cellmark a fee of $400 per sample tested, regardless of whether or not the sample passes presumptive testing. Given that 2.1 samples are tested on average, the average case consumes $980 in resources, which accrues to SID.

Stage 3—CODIS entry

Once the results of the testing are delivered to SID, an analyst completes a technical and administrative review of the analysis prior to recording the profile, a process that takes approximately three hours to complete, given an average of 1.4 profiles obtained per case. Upon completing the technical and administrative review, the analyst will ensure that each sample meets state guidelines for CODIS upload and will enter each sample into CODIS. The total cost of this phase is $167, the entirety of which is comprised by labor costs.

Stage 4—Case verification

Once a profile is uploaded into CODIS, the CODIS database is used to search for an offender match within the state's database. If an offender match is found, it must be verified by the state crime lab at the Bureau of Forensic Services at the California Department of Justice. The state lab verifies the CODIS hit to the offender profile on record. At the state crime lab, a forensic scientist re-analyzes existing samples in batches for a labor cost of $80 per batch ($50 in labor costs and $30 in nonlabor costs). In addition, a criminalist will spend approximately one half hour engaging in a technical review of the match. Once the match is confirmed, a latent fingerprint examiner will spend approximately one half hour reviewing the suspect's fingerprints to verify the suspect's identity. In total, the case verification stage consumes approximately $195 in resources at the California Department of Justice.

Stage 5—Investigation

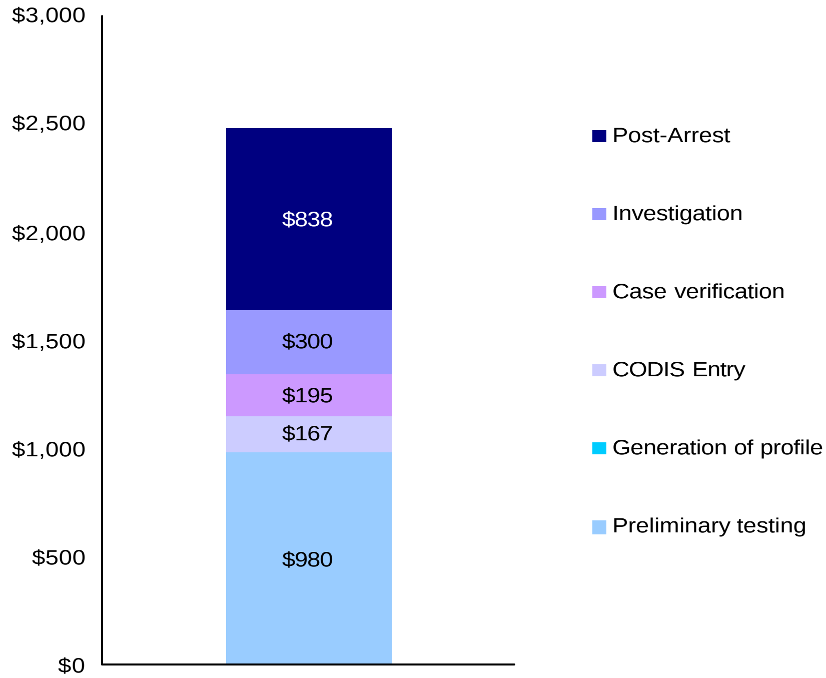
Once the match to the profile of the convicted offender has been verified, the investigative process increases in intensity. Upon notification of a DNA match, the detective assigned to the case will attempt to locate the suspect using one of several extant databases, generally including data maintained by the Departments of Parole, Probation, Prisons and Motor Vehicles. This process takes approximately one half hour and has a cost of $20. Once a suspect has been located, the detective creates a plan to apprehend the suspect. This process includes obtaining an arrest warrant, creating and executing a plan to apprehend the suspect (usually conducted by two detectives), questioning the suspect and obtaining a confirmation sample from the suspect. Finally, the detective must write up the case notes and prepare for an eventual trial, a process that takes approximately an hour. Including time spent in transit, this process takes approximately 7.5 person-hours and costs $300.

Stage 6—Post-Arrest

Once the suspect has been arrested and booked, a detective will collect a confirmation sample which is sent to SID for analysis. Analysis of a confirmation sample requires that all steps after the initial screening and prior to the CODIS upload must be repeated for the confirmation sample. In Los Angeles, analysis of the confirmation sample is contracted out to Cellmark, at a cost of $400 per sample analyzed plus a shipping cost of $38 to rush the sample to Cellmark's Dallas laboratory. In addition, because confirmation samples must be analyzed within ten business days of filing the criminal complaint, if the suspect is not already in custody, an additional payment of $800 to Cellmark is required in order to ensure that the sample is processed in a timely manner. Once the sample is processed by Cellmark, a report is sent to SID. This rush fee is incurred in 43% of cases. This report is subjected to both technical and administrative review at SID, at a cost of $45. In total, the cost of this stage of processing is $838, of which $800 is attributed to the expedited analysis of the confirmation sample in 43% of cases.

The total cost of a case processing is described in figure 5.1. These costs are not the average cost per case. Rather, these costs simply sum the cost of each stage of case processing. Thus, they are applicable only to a case that proceeds through all of the six stages of processing. A description of the average cost of a case in Los Angeles follows in the next section.

Figure 5.1. Costs of Processing a Case by Stage (Los Angeles, CA)



Source: Urban Institute.

Processing an Average Case

The total cost of processing the average case depends on the quality of the evidence collected and whether or not a profile or a match is obtained. For example, in cases where evidence is collected but does not yield a profile, the costs of processing the case are small relative to a case where a match is obtained. In cases where a profile is obtained and a suspect is identified and apprehended, the costs are substantially higher. Ultimately, the cost of an average case depends on how many of the six cost stages cases are completed during the analysis and investigation process. A complete discussion of how costs were calculated can be found in Chapter 2.

Table 5.2 provides descriptive statistics on the cost of processing a case in Los Angeles, using both the paired analysis, in which experimental cases are followed for the same length of time as its paired control case and the unpaired analysis which compares experimental and control cases regardless of the period of available observation. Costs are identical in the paired analysis.

Table 5.2. Cost of Processing an Average Case in Los Angeles, California

	Unpaired Analysis	Paired Analysis
Mean	$1,490	$1,490
Standard Deviation	$888	$888
Minimum	$0	$0
25th percentile	$631	$631
Median (50th percentile)	$1,186	$1,186
75th percentile	$1,964	$1,964
Maximum	$6,224	$6,224
Sample Size	193	193

Source: Urban Institute.

In Los Angeles, the cost of processing an average case was $1,490. The middle 50 percent of cases had a cost between $631 and $1,964.

Costs for different agencies involved in case processing

Next we estimate how the costs of processing a case are distributed across each agency that participates in the burglary investigation. The cost of processing cases is shared by three different entities: the local crime lab (SID), the state crime lab (the Forensic Services Bureau of the California Bureau of Investigation) and the Los Angeles police department's detective divisions. For a given case, the share of the burden borne by each entity depends upon the stage in processing the case reaches. For cases that reach only Stage 1 (preliminary testing), Stage 2 (generation of profile) or Stage 3 (CODIS upload), the costs are borne entirely by the *local* crime lab. The costs of Stage 4 (case verification) are borne almost entirely by the *state* crime lab. The costs of Stage 5 (investigation) are borne primarily by the police department and the costs of Stage 6 (Post-Arrest) are borne entirely by SID. In Los Angeles, for a case that advances through the entire process, 80 percent of the costs are borne by SID, 8 percent of the costs are borne by the state crime lab and the remaining 12 percent of the costs are borne by detectives.

Table 5.3. Cost of Processing by Stage and Stakeholder (Los Angeles, California)

	Total	Local Lab	State Lab	Police
Preliminary Testing / Generation of Profile	$980	$980	$0	$0
CODIS Entry	$167	$167	$0	$0
Case verification	$195	$0	$195	$0
Investigation	$300	$0	$0	$300
Post-Arrest	$838	$838	$0	$0
Total	$2,481	$1,995	$195	$300

Source: Urban Institute.

Other Costs (not included in cost estimates)

There are additional costs involved in collecting and processing DNA evidence that are not included in these estimates. These include the cost of training personnel to observe and collect DNA evidence at crime scenes and the cost of locating, collecting and transporting evidence to the crime lab. These costs are not considered in our analysis because they occur prior to random assignment in the crime lab. Since they occur prior to random assignment, these are costs that are equal for treatment and comparison cases. Nevertheless, these costs are relevant to policymakers who are interested in determining the amount of funding necessary to collect and process DNA from high-volume crimes scenes in their jurisdiction.

Training

Prior to implementation of the intervention, police officers and detectives were trained to search for DNA at burglary scenes to which they were called. 200 police officers and 25 police sergeants were each given approximately 45 minutes of training in evidence identification, a per-case cost of $21, when the costs are allocated only across the 190 cases in the experimental group. In addition, six SID photo technicians each received sixteen hours of training, a cost of approximately $4,000. Finally, the cost of trainer time as well as the cost of producing a training video that was shown to officers and detectives was approximately $41 per case (allocated over 190 test cases). In total, the cost of training was approximately $12,000.

Evidence Recovery

In Los Angeles, the responding officers are responsible for assessing the residential burglary crime scene for potential DNA evidence. They then notify the Scientific Investigation Division (SID) and a CSI technician will respond to the crime scene. The CSI technicians are responsible for collecting potentially probative DNA evidence, latent print collection and photo documentation of the scene. The CSI technician is in charge of doing a walk-through of the home with the victim to collect prints and potential DNA evidence. Digital photographs are taken to document the potential DNA evidence prior to its collection. The technician would book the evidence for further analysis. The lab would screen evidence and then package the evidence appropriately (most often sending whole items) for shipping to the outsource lab. As officers do not collect DNA, a DNA collection technician must spend approximately 90 minutes in transport and at the crime scene locating, collecting and securing DNA and, later, writing a report, for a total cost of approximately $100. Finally, an officer must spend approximately one hour transporting the DNA to the evidence room, a cost of approximately $25. In total, we estimate that collecting DNA at burglary scenes costs an additional $100 in labor costs—cost that would not have accrued had DNA not been searched for and collected.

OUTCOMES

Los Angeles had a number of interesting findings from their implementation of the DNA experiment. Residential burglaries were the most often visited crime scene with DNA being collected from 73 percent of the cases in this study. A mix of police officers and forensic specialists collected DNA from the crime scenes. Although the original protocol had only forensic specialists collecting DNA evidence, 38 percent of DNA was collected by a patrol officer or detective. In Los Angeles, 89 percent of test cases yield a DNA profile. Once a profile was obtained, 65 percent had the profiles uploaded into CODIS. Of these uploaded profiles, 27 percent had a CODIS hit. Of the CODIS hits, 86 percent had an offender hit in CODIS and 14 percent had a forensic hit in CODIS. Treatment cases were significantly more likely than control cases to have a suspect identified. These cases were also significantly more likely to have a suspect arrested and have a case accepted for prosecution. The control cases had a suspect identified in 22 percent of the cases and 14 percent of their cases lead to an arrest. This is compared to 40 percent of treatment cases that had a suspect identified and 22 percent of the cases accepted for prosecution.

Descriptive Statistics

The crime scene attributes (table 5.4) are the characteristics of a crime scene, e.g., how did the perpetrator gain entry, what type of crime was committed, who collected the biological material, etc. In all of the cases in Los Angeles, the variables described in crime scene characteristics describe case characteristics pre- randomization. Thus, the data in table 5.4 (and in tables 5.5 and 5.6 described below) can be used to determine whether the integrity of the random assignment process was maintained. Theoretically, if cases were assigned randomly to each experimental condition, there should be no differences in case attributes between groups. As in table 5.5 , there are small differences between the test and control groups but none of these differences are significant.

Table 5.4. Descriptive Statistics for Crime Scene Attributes of Cases Processed in Los Angeles.

	Attribute	Treatment Group	Control Group	Full Sample
Crime Type	Residential	76% (43%)	73% (44%)	73% (44%)
	Commercial	23% (42%)	25% (43%)	24% (43%)
	Auto-Related Crime	1% (7%)	1% (10%)	1% (9%)
	Other	0% (0%)	2% (12%)	1% (9%)
Point of Entry	Door	38% (49%)	43% (50%)	41% (49%)
	Window	50% (50%)	41% (49%)	46% (50%)
	Car	2% (13%)	3% (16%)	2% (14%)
	Other	9% (29%)	13% (33%)	11% (32%)
Point of Entry was Unlocked		16% (37%)	20% (40%)	18% (39%)
Average Number of Samples Collected		2.12 (1.31)	1.02 (.16)	2.19 (1.81)
Evidence Collector	Patrol Officer	34% (47%)	35% (48%)	35% (48%)
	Detective	3% (17%)	3% (16%)	3% (17%)
	CSI technician	62% (48%)	61% (49%)	62% (49%)
Any Fingerprints Collected		35% (48%)	38% (49%)	37% (48%)
Number of Offenders Searched Against in SDIS		659,013 (137834)		
Item Stolen	Electronics	30% (46%)	23% (42%)	27% (44%)
	Other	56% (50%)	64% (48%)	60% (49%)
	Nothing	13% (34%)	13% (34%)	13% (34%)

Source: Urban Institute. Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group.
Significance: : * $p < 0.05$, ** $p < 0.01$

The crime scene attributes (Table 5.4) are the characteristics of a crime scene, e.g., how did the perpetrator gain entry, what type of crime was committed, who collected the biological material, etc. In all of the cases in Los Angeles, the variables described in crime scene characteristics describe case characteristics pre- randomization. Across all conditions (test and control) the majority of cases where DNA was collected were residential burglaries (73 percent), with fewer commercial burglaries

(24 percent), and virtually no other property crimes - auto-related offenses (1 percent) and other offenses (1 percent). In these offenses, the four main points of entry were a door (41 percent), window (46 percent), car (2 percent) and other (11 percent). In 18 percent of all the cases, the point of entry was unlocked. Victims reported that 27 percent had electronics stolen, and 13 percent had nothing stolen. While the original protocol had DNA being collected by a CSI technician, over the course of the project it was discovered that police officers were collecting DNA evidence as well. Throughout the project, a police officer or detective collected 38 percent of the DNA and 62 percent of the DNA was collected by the CSI technician. Fingerprints were collected at 37 percent of the cases. There were an average of 2.2 samples collected at each crime scene.

Table 5.5. Descriptive Statistics for Evidence Attributes of Cases Processed in Los Angeles.

	Attribute	Treatment Group	Control Group	Full Sample
Case Assigned During First Half of Study		50% (50%)	49% (50%)	50% (50%)
Case Assigned (Season)	Fall	14% (34%)	18% (38%)	16% (36%)
	Winter	13% (33%)	12% (32%)	12% (33%)
	Spring	34% (49%)	33% (49%)	41% (49%)
	Summer	26% (47%)	24% (46%)	32% (47%)
Case Assigned (Time of Day)	Day Shift (2PM-10PM)	48% (50%)	41% (49%)	45% (50%)
	Night Shift (10PM-6 AM)	14% (34%)	19% (39%)	16% (37%)
	Morning Shift (6 AM- 2PM)	38% (49%)	39% (49%)	39% (49%)

Source: Urban Institute.

Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: : * $p < 0.05$, ** $p < 0.01$

There were several other case characteristics describing temporal factors that were hypothesized to be related to case outcomes (Table 5.5). Over the course of the study, 16 percent of the DNA collection took place during the fall, 12 percent during the winter, 41 percent during the spring and 32 percent during the summer. In Los Angeles, there were the concerns about the availability of CSI technicians to collect DNA, especially at night, and this is reflected in the case characteristics were 45 percent of cases were reported during the day shift (2pm-10pm), 16 percent during the night shift (10pm-6am) and 39 percent during the morning shift (6am-2pm).

Table 5.6. Descriptive Statistics for Temporal Attributes of Cases Processed in Los Angeles.

	Attribute	Treatment Group	Control Group	Full Sample
Sample Type	Blood	15% (40%)		
	Handled/ Touched (Cells)	59% (49%)		
	Oral (Cells)	17% (38%)		
	Worn (Cells)	9% (29%)		
	Other	2% (14%)		
Mode of Collection	Swab	35% (48%)	32% (47%)	34% (47%)
	Whole Item	50% (50%)	51% (50%)	51% (50%)
	Both	15% (35%)	16% (36%)	15% (36%)

Source: Urban Institute. *Notes:* Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * p < 0.05, ** p < 0.01. Type of evidence collected may sum to more than one, as multiple samples may have been collected from different types of evidence.

Table 5.6 describes the type of DNA that is being collected at crime scene's in Los Angeles. In the test group, 15 percent of the cases had blood evidence present at the scene, 59 percent had cell evidence from items handled by the suspect, 17 percent had oral cells, 9 percent had cells collected from an item worn by the perpetrator and 2 percent had other DNA evidence collected. Across both the test and control groups, 34 percent of the cases had the DNA swabbed at the scene, 51 percent had the whole item collected and 15 percent of scenes had both collected.

Table 5.7. Descriptive Statistics for Intermediate Outcomes of Cases Processed in Los Angeles.

	Attribute	Treatment Group
DNA Profile Obtained		89% (31%)
DNA Profile Uploaded into CODIS		65% (48%)
CODIS Match Obtained	Total	27% (45%)
	Offender Hit	22% (42%)
	Forensic Hit	4% (19%)

Source: Urban Institute. Data are reported at the case level.

The test cases in this experiment had intermediate outcomes (Table 5.7) that took place once the DNA had been processed by the outsource lab and returned to the Los Angeles Police

Department laboratory. Of the test cases, 89 percent had a profile obtained from the DNA collected at the crime scene. Once a profile was obtained, 65 percent had profiles that were eligible for upload into CODIS. With the test cases, 27 percent had a CODIS hit. Of these 22 percent had an offender hit in CODIS and 4 percent had a forensic hit in CODIS. The conditional probabilities demonstrate that of all profiles obtained, 73 percent were CODIS eligible. Of the CODIS eligible profiles, 42 percent yielded a CODIS hit.

Table 5.8. Suspects identified, arrested, and prosecuted in Los Angeles

	Treatment	Control
Suspect Identified	41%** (49%)	22% (41%)
Suspect Arrested	29%** (46%)	14% (35%)
Number of Arrests	56	28
Case accepted for prosecution	22%** (41%)	10% (30%)
Sample Size	193	198

Source: Urban Institute.
Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$

Table 5.8 shows case outcomes for Los Angeles. There were significant differences between the treatment and control group with these case outcomes. In the treatment group there were significantly more suspects identified than in the control group. In the treatment group, 41 percent of the cases had a suspect identified compared to 22 percent of the control samples. The cases in the treatment group were also significantly more likely to have an arrest and have a case be accepted for prosecution. In the treatment group, 29 percent of the cases had a suspect arrested and 22 percent of the cases accepted for prosecution while the control group had 14 percent of the suspects arrested and 10 percent of the cases accepted for prosecution.

Table 5.9. Method used to identify a suspect in Los Angeles

	Treatment	Control
Suspect identified	41%** (49%)	22% (41%)
Traditional Investigation	17% (37%)	22% (41%)
CODIS Hit	22% (41%)	
Forensic Hit/Investigative Lead	3% (16%)	
Sample Size	193	198

Source: Urban Institute. *Notes:* Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$

Table 5.9 describes the different methods for a suspect being identified in a case. In Los Angeles, 17 percent of suspects identified in the test condition were identified by traditional investigation. Twenty-two percent were identified by a DNA offender hit and three percent was identified by a forensic lead.

Cost-Effectiveness

Cost-effectiveness analysis (CEA) is an economic analysis that compares relative costs to relative outcomes for two or more experimental conditions. A CEA yields a ratio of costs to outcomes, which can be interpreted as the amount of money that is necessary to achieve one unit of a particular outcome. A complete description of the method used to calculate cost-effectiveness can be found in Chapter 2. Cost-effectiveness ratios are calculated for three outcome variables: (1) the cost per suspect identified, (2) the cost per arrest and (3) the cost per case accepted for prosecution.

Table 5.10 Cost effectiveness of DNA analysis for property crimes in Los Angeles (unpaired)

Domain	Los Angeles
Expected Cost per suspect identification	$8,147
Expected Cost per arrest	$10,319
Expected Cost per case accepted for prosecution	$12,899

Table 5.11 Cost effectiveness of DNA analysis for property crimes in Los Angeles (paired)

Domain	Los Angeles
Expected Cost per suspect identification	$7,906
Expected Cost per arrest	$10,319
Expected Cost per case accepted for prosecution	$12,899

In Los Angeles, the costs accruing to all stakeholders are $8,147 per suspect identified, $10,319 per arrest and $12,899 per case accepted for prosecution. The cost of an average case across all cases, including cases where no DNA profile was obtained and those cases where a suspect was arrested was 1,613.

CHAPTER 6—ORANGE COUNTY, CALIFORNIA

In 2004, the Orange County Sheriff's Department (OCSD) began to expand the capacity of its lab to start collecting DNA evidence from high-volume crimes, including residential and commercial burglaries. The DNA Field Experiment allowed the Sheriff's Department to further expand the capacity of its lab and to explore the potential of DNA to help solve high-volume crimes. One of Orange County's main interests in expanding its DNA capacity was to test the probative nature of touch samples. OCSD wanted to examine the types of profiles that could be obtained from testing a variety of nontraditional source areas for biological evidence, including computer cords, jewelry boxes, and door handles. In December 2005, OCSD collected its first piece of biological evidence from a residential burglary. They collected biological samples from their last (500th) case in early February 2007.

Orange County, California, is made up of 34 incorporated cities and unincorporated areas with a population of over 2.9 million people. Within Orange County, there are 22 law enforcement agencies (21 municipal agencies and one county sheriff). The largest of these police agencies is the Orange County Sheriff's Department (OCSD), which has 3,850 sworn and professional staff members. The DNA Field Experiment was a joint effort between OCSD and OCDA and the project was focused in their South Operations Division, whose 400 sworn and professional staff members serve more than 500,000 residents.

The Forensic Science Services Division (Sheriff's Crime Lab) provides all public agencies in Orange County with services for the collection and evaluation of crime scene evidence. The lab employs over 150 staff members and is authorized by the California Department of Justice and the Federal Bureau of Investigation, under its DNA quality assurance standards, to submit profiles to the state and national databases (SDIS and NDIS); it is also accredited by the American Society of Crime Laboratory Directors/Laboratory Accreditation Board. The South Operations division, in conjunction with the Sheriff's Crime Lab and the Orange County District Attorney's Office, participated in the DNA Field Experiment in Orange County.

In 2004, the Orange County Sheriff's Department reported 1,277 residential burglaries. In South Patrol Operations, where the study was focused, approximately 950 residential burglaries are reported annually. Prior to the start of the DNA Field Experiment, the Sheriff's Crime lab had expanded their capacity to perform DNA testing on serious high-volume crimes. The lab analyzed samples from over 400 burglary and robbery scenes in 2004—about 22 percent of completed DNA cases. In total, these robbery and burglary DNA cases aided 63 investigations and yielded 41 cold hits.

In Orange County, there were only minor differences between the test and control cases in their case characteristics. Thus, the differences in bivariate outcomes report the effect of the use of DNA on case outcomes. In Orange County, there were no significant differences between the treatment and control group with case outcomes. Across both of the conditions, 16 percent of cases had a suspect identified and 7 percent had an AFIS hit. In both conditions, 8 percent of cases had a suspect identified through traditional methods. Finally, in both the test and control conditions, there was an arrest in 9 percent of all the cases and 9 percent had a case filed with prosecution. In Orange County, the average cost of DNA processing was $12,858 per suspect identified and $19,287 per arrest.

THE DNA FIELD EXPERIMENT IN ORANGE COUNTY, CALIFORNIA

Protocols (Proposed)

The systematic protocols that were put in place for this project (many of which had existed previously) stayed relatively consistent throughout the whole project. The proposed protocol is as follows: when a call for service for a burglary is received, a deputy is dispatched to the crime scene. Once on scene, the responding deputy is required to call the Sheriff's Crime Lab to describe the burglary crime scene. Once the deputy has spoken with a forensic specialist and he or she determines potentially probative evidence exists, the deputy will inform the victim that a forensic specialist will be arriving at their home or business to collect possible DNA evidence. The time between the deputy calling for a forensic specialist and the time when one could respond on scene could range from a few hours to a day. Upon arrival at the crime scene, the forensic specialist will either collect the whole item of interest and submit it to the laboratory for testing or collect a swab from the item of interest at the scene. Due to the extensive training of the forensic specialists, the prescreening process is effectively completed at the crime scene. The original protocol of the forensic specialist expressly omitted taking elimination samples at the initial processing of the scene. The rationale for this approach was that, until there was better empirical data to support the collection of touch samples, having the detective follow up to collect elimination samples was a better use of resources than having the forensic specialists perform the collection. The biological evidence collected at the scene would then be submitted into evidence by the forensic specialist for analysis in the Sheriff's Crime Lab.

Protocols (Implemented)

During the project, the OCSD implemented a few changes to their DNA collection protocols to increase the percentage of profiles that were eligible for CODIS upload. Two main issues were encountered in Orange County, both of which resulted from the sites experimentation with touch samples and the need for effective collection of elimination samples (samples collected from individuals who were not suspects in the case). At the end of the project, OCSD recommended a change in protocol to limit the number of samples collected at crime scenes, particularly commercial burglaries with multiple employees and places with public access. Since many individuals have legitimate access to areas where DNA evidence was collected, it was often found that a large number of elimination samples were required to isolate the suspect's profile. At the end of the project, OCSD also recommended a change in the collection protocol to direct the responding forensic specialist to collect elimination samples at the scene during the initial collection. In addition, OCSD recommended a change in protocol that lead to a reduction in the types of touch samples being collected. Over the course of the experiment, the lab made the determination that items with multiple people having access to them, such as computer cables and door knobs, especially in commercial burglaries, were not providing uploadable profiles without a high number of elimination samples. Since collecting a large number of elimination samples is complicated and time consuming, touch samples of this type were limited in high-traffic areas.

CASE PROCESSING

Police

In Orange County, deputies at the Sheriff's Department were tasked with informing the lab of each burglary scene they visited and describing the crime scene to a forensic specialist. Once the deputy left the scene, they wrote the initial crime scene report which was given to a burglary investigator for follow-up. While the biological evidence was being processed in the lab, investigators would continue the investigation following business as usual protocols, which included a range of activities from calling victims, checking pawn shops, to requesting that fingerprint evidence be processed. If the biological evidence collected at the crime scene yielded a CODIS hit, investigators were provided with suspect's name and information. Once the investigator was provided with the suspect's name and information, they followed the lead to decide if this suspect was worth investigating further. Sometimes, suspects were found to be already incarcerated and investigators investigated accordingly—in some instances, this involved going to the jail or prison to interview and attempt to collect a sample from the offender. If the individual continued to be a strong suspect, the investigator may go forward to present the case to prosecution. In some cases, individuals were eliminated as suspects because they had legitimate reasons to be in the residence or were out of town at the time of the incident. If the individual identified by the CODIS hit continued to be a suspect after the initial investigation, the investigator presented the case to the District Attorney's office for an arrest warrant and/or prosecution (if the suspect was already in custody).

Crime Lab

The Sheriff's Crime Lab was tasked with the collection and analysis of biological evidence found at burglary crime scenes. When the lab received a call from an deputy on-scene, they were required to discuss the crime scene with the deputy to make a determination whether a forensic specialist should be sent to collect potentially probative biological evidence. Once on the scene, the forensic specialist spoke with the home/business owner and walked through the scene to collect any evidence that may contain DNA. The forensic specialist swabbed objects or collected whole items. The forensic specialist wrote up the evidence report and the items and/or swabs were then booked into evidence.

The lab then pulled the evidence from storage to begin analyzing the evidence. If a profile was obtained, the Forensic Scientist (DNA analyst) then determined whether it met the requirements of being uploaded to CODIS quality; if so, the Scientist/ DNA analyst would enter the profile into CODIS and the CODIS manager would upload the profile to SDIS. Some reasons profiles would not be uploaded into CODIS include the profile having too few loci or not being reasonably sure the profile belongs to a suspect. In cases where the DNA analyst was unsure if the profile belonged to the suspect, they advised the investigator that elimination samples were necessary before the profile could be uploaded to CODIS. Initially, Orange County had relatively low rates of CODIS uploads compared with the other experimental sites, due to the collection of touch samples in areas where few to many individuals may have had contact with the scene. Once more elimination samples were collected, a higher percentage of samples were uploaded into CODIS.

Sidebar 1 – A Case Study of a Residential Burglary

One of the first cases that was enrolled into the DNA Field Experiment occurred on **December 6, 2006**. At 8:00 pm, a home owner called 911 to report a residential burglary to the South Operations Division. Once the call was recorded, an officer was dispatched to the scene to speak to the victim and write the report. Upon arriving at the scene, the deputy walked through the house with the victim to discuss the case, determine where the suspect may have entered the home, identify any items taken or broken, and estimate what time-frame the crime took place in. In this instance, the suspect(s) had forced their way through a ground level window with a cutting tool. It was discovered from the victim that once the suspects were inside the home, they had taken loose cash and a credit card from the home. The deputy then phoned the Sheriff's crime lab, described the crime scene, and it was mutually decided that a visit by a forensic specialist was warranted. The deputy then informed the homeowner to leave any items touched or moved by the suspect(s) where they were found so that the forensic specialist could collect or swab them. The deputy finished writing up his report and submitted it to his Sergeant. The case was given to the South Operations Division's Investigation's Sergeant who noted that the case involved DNA collection and stamped it as a DNA case. The case was then assigned to a burglary detective on December 6. While the forensic evidence was being processed in the lab, the investigator began the investigation using traditional methods, including interviews of the victim and/or neighbors, reviewing similar cases, and checking pawn shops.

The forensic specialist arrived at the victim's home on **December 7** at 12:52 pm to speak with the victim and to walk through the home again. This time the walkthrough was meant to discover and collect potential biological, trace, and imprint evidence. The forensic specialist asked questions to determine what items the suspect(s) might have come into contact with—especially places where they may have cut themselves, left bodily fluids, or handled a particular item. The forensic specialist then collected three swabs from a jewelry box that had been handled by the suspect(s) using sterile cotton swabs. During the walkthrough, the forensic specialist also noticed some places that could be dusted for fingerprints, so fingerprints were also collected at the scene. The DNA samples were sent to the crime lab and assigned a forensic report (FR) number by one of the lab technicians. This FR number was sent to the Urban Institute to be randomized on **December 12** and returned the same day. This case was assigned to the test group. One of the samples from the jewelry box was run through quantitation and contained sufficient DNA for typing. The sample then underwent amplification and was typed. This sample provided an uploadable profile for CODIS. The profile was obtained on **January 23, 2007,** and was entered into CODIS the same day. Seven days later, the profile was found to match an offender in the SDIS database, and the lab was then notified of the hit. The state lab then confirmed the hit and provided the Sheriff's Crime lab with the suspect's name. The suspect was arrested and charged on **April 4, 2007**.

If the profile was entered into CODIS and yielded a forensic or offender hit, the lab was notified by the state lab that a hit had occurred. Once the local lab is provided with suspect or case information from the hit by the state lab (which can be several weeks after the original hit), the lab forwards this information to the investigator for further investigation and notifies the District Attorney's office. If a suspect is found and a confirmation sample is obtained, the local lab would then test this to confirm the hit.

Prosecution

The Orange County District Attorney's Office was involved with the DNA project early on. A Deputy District Attorney would review the case early in the process to ensure it was potentially a fileable case. Once notification was received by the crime lab of the hit, the District Attorney filed the case if appropriate. Once the case was filed, the District Attorney's Office prosecuted the defendant. The District Attorney office described their role as not being not completely integrated into the case processing. For example, the District Attorney's Office was permitted access to police reports but lab reports were not provided. Other recommendations for policies and procedures were not implemented.

In California, the statutes for each burglary violation are such that for a first-time residential burglary, a defendant can receive two, four, or six years in state prison. A defendant may be sentenced to probation and receive anywhere from one day to one year in county jail. In a case where a defendant had a prior serious felony, there is an additional five-year enhancement to the sentence. Since California is a three-strikes state, a defendant's sentence can double with one prior serious felony conviction or increase to 25 years to life with two prior felony convictions. In a commercial burglary, once convicted, a defendant can face a sentence from 16 months to two years or three years but can also be sentenced to probation and receive anywhere from a day to a year in county jail. No five-year enhancements can be added on to the sentence but the three-strikes law applies to commercial burglary convictions. For both commercial and residential burglaries, a defendant can be sentenced to an additional year in state prison for every conviction that resulted in a prior state prison commitment.

Sidebar 2 – A Case Study of a Commercial Burglary

This case study describes the investigation of a burglary at a commercial property when a small business owner returned to their store on November 7 at 9:30am to the realization that the business had been burglarized and money had been taken. The owner then called dispatch and a deputy arrived at the scene at 10:40am. Once on scene, the deputy did a walkthrough with the owner, noting that some items in the business had been disturbed. Once the deputy had spoken to the owner about the details of the case, such as where the suspect(s) may have entered the business, what was taken, and what items were disturbed, the deputy radioed the lab and described the scene. After talking with the store owner about preserving the scene for the forensic specialist, the deputy finished writing up his report and submitted it. The case was given to the South Operations Division's South Investigations Sergeant who noted that the case involved DNA collection and stamped it as a DNA case. The case was then assigned to a burglary investigator on November 7. While the forensic evidence was processed in the lab, the investigator continued the investigation using traditional methods, including interviews of the victim and/or neighbors. The traditional investigation yielded no usable leads.

After the lab was notified that a forensic specialist would be needed to check the crime scene for biological evidence, a forensic specialists reported to the scene at 1:23 pm. The forensic specialist walked through the business with the owner, this time to examine the crime scene in detail and look for any biological evidence the suspect might have left behind. The forensic specialist noticed that the suspect looked to have handled a piece of furniture. The forensic specialist then took one swab from the item of furniture in the business that had been handled. The walkthrough did not provide any places where fingerprints could be distinguished and no fingerprints were taken. After the forensic specialist left the scene, the DNA sample was sent to the lab and a FR number assigned. This FR number was then sent to the Urban Institute to be randomized on November 21 and returned the same day with the case assignment of test group to the lab. The sample then began its processing in the lab. First, the sample was run through DNA extraction and quantitation and contained sufficient DNA for typing. The sample then underwent amplification and was typed. This sample provided a usable profile on December 9 but was not eligible for upload into CODIS above the LDIS level. Since the sample had been recovered from a commercial business, where any number of people have access to the furniture from which the sample was taken, the Forensic Scientist (DNA analyst) did not think that entering the profile into CODIS above the LDIS level was an appropriate action without the necessary elimination samples. No suspect was arrested in this case.

Collaboration

The lab, OCSD South Investigations and the deputy DA assigned to the project had developed an effective strategy in some areas prior to the beginning of this project and maintained a high level of communication. The strong communication between the lab and the sheriff's department is demonstrated through the well-maintained roles of each partner. Each partner has a clear idea of the other's responsibilities, and there was little to no confusion about protocol between the two partners. The OCSD South Investigators are able to reach lab personnel to discuss a burglary scene and the lab personnel are able to communicate CODIS hits and forensic evidence results back to the investigators. The District Attorney's office was invested in this experiment and worked with crime lab personnel and investigators in preparing cases. The District Attorney's office was willing to discuss a case with investigators throughout the investigative process. As lessons were learned regarding touch samples, important procedural changes could be implemented in terms of what officers and forensic specialists looked for at crime scenes.

COST

The cost analysis of the use of DNA evidence in burglary investigations estimated the costs for each case enrolled in the Orange County experimental sample. For each case, a cost was attached to each of six stages of case processing. The costs describe the average expenditure of completing each stage. The progress of each case was observed in administrative data, and a cost was assigned to a case only if each stage was completed. The cost estimates for each stage include only the costs of processing an individual case; the fixed costs of operating a police agency or a crime laboratory and the costs of capital purchases (such as robotics in the crime lab) are not included. Thus, the costs described here reflect the costs to a police or Sheriff's department with a mature crime lab that expands processing of biological material to high-volume property crimes, such as residential burglary. The costs to a municipality to set up a crime lab or to begin collecting DNA for the first time will be substantially higher.

The six stages of case processing used in the cost analysis can be found in Table 2.2. For each stage, a cost was estimated for Orange County, and the progress of each sample in each case was observed from administrative data.

Cost Data Collection

Cost data were collected via semi-structured interviews with key stakeholders—forensic scientists in the Orange County Sheriff's Forensic Sciences Services Division and the California Department of Justice's Bureau of Forensic Analysis and deputies and investigators in the Orange County Sheriff's Office. For each of the three stakeholders, the unit costs of processing a case were estimated from the time the evidence was delivered from the property locker to the local lab until the case concluded, including suspect identification, apprehension and arrest if the case progressed that far. For each stakeholder and each stage of case processing the labor and nonlabor (capital) costs were estimated separately. The cost collection process began in December 2006 with follow-up meetings occurring throughout the study period. All prices and quantities were gathered in FY 2006 and costs and benefits are expressed in 2006 dollars.

Some costs associated with DNA case processing in Orange County are not included in this evaluation. For example, the costs of training personnel to identify and collect biological material are not included. In addition, the costs of additional time at a crime scene are also not included. In this evaluation, cases are randomly assigned after each of these activities had occurred. Thus, the costs for cases in both groups are the same (a descriptive analysis of these costs is included later in this chapter). In addition, if the use of DNA in burglary investigations changes the likelihood that offenders will be arrested and convicted, other important costs and benefits will not be include. For instance, if more offenders are arrested and incarcerated, than the state will have to pay substantial additional costs to incarcerate those individuals. But, because these offenders were incarcerated, there may be substantial benefits to the community and its residents from reductions in offending.

A discussion of how labor costs and non-labor costs were calculated can be found in Chapter 2.

Case Processing in Orange County

Table 6.1 details the costs of each stage of processing in Orange County. The total cost to all stakeholders of processing a case that results in an arrest is $1,149; 87 percent of which is comprised of labor costs with the remaining 13 percent comprising nonlabor costs, including the cost of supplies, reagents and other disposable items. The cost of case processing is back-loaded with just 36 percent of the costs accruing to the local forensic lab during the first three stages of processing 56 percent of costs accruing after the beginning of the burglary investigation. The following section details the manner in which costs accrue in each stage.

Table 6.1. Cost of Processing by Stage in Orange County (CA)

	Labor Costs	Nonlabor Costs	Total
Preliminary testing	$13	$10	$23
Generation of profile	$221	$50	$271
CODIS Entry	$67	$13	$80
Case verification	$165	$30	$195
Investigation	$370	$0	$370
Post-Arrest	$177	$33	$210
Total	$1,014	$136	$1,149

Source: Urban Institute

Stage 1—Preliminary testing

In Orange County, preliminary testing consists of an initial examination of the items(s) collected and preparation for DNA extraction. This process takes approximately 20-25 minutes and consumes an additional $10 in nonlabor costs, for a total cost of $23.

Stage 2—Generation of profile

Profiles are generated in batches of twenty, requiring 45 minutes per sample analyzed to conduct extraction, quantitation, amplification and gene mapping. Given an average of 1.5 samples tested per case, the entire process consumes approximately $67 in wages and an additional $50 in supplies and reagents. In addition, a report is written detailing the findings of the DNA analysis, a process that takes approximately 1.5 hours and another half hour for technical and administrative review. In sum, this stage of processing costs a total of $271 to complete.

Stage 3—CODIS entry

Given that a profile is generated, a DNA analyst must review the profile and case information and decide whether or not the sample may be uploaded into CODIS. In some cases, elimination samples had to be tested before a profile was able to be uploaded. On average, approximately 0.4

elimination samples were tested per case. This process added a cost of $13 to each case. The total cost of the CODIS entry stage is an estimated $80.

Stage 4—Case verification

Once a profile is uploaded into CODIS, the CODIS database is used to search for an offender match within the state's database. If an offender match is found, it must be verified by the state crime lab at the Bureau of Forensic Analysis at the California Department of Justice. Generally, before the match verification process begins, the local forensic lab in Orange County will confirm that the process is worthwhile, a process that takes approximately ten minutes and costs $10. Next, the state lab verifies the CODIS hit to the offender profile on record. At the state crime lab, a forensic scientist re-analyzes existing samples in batches for a labor cost of $80 per batch ($50 in labor costs and $30 in nonlabor costs). In addition, once a match is complete, a criminalist will spend approximately one half hour engaging in a technical review of the match. Once the match is confirmed, a latent fingerprint examiner will spend approximately one half hour reviewing the suspect's fingerprints to verify the suspect's identity. In total, the case verification stage consumes approximately $195 in resources at the California Department of Justice.

Stage 5—Investigation

Once the match has been confirmed by the state lab, the investigative process increases in intensity. Upon notification of a DNA match, the investigator assigned to the case will attempt to locate the suspect using one of several extant databases, generally including data maintained by the Departments of Parole, Probation, Prisons and Motor Vehicles. This process takes approximately one half hour and is associated with a cost of $25. Once a suspect has been located, the investigator creates a plan to apprehend the suspect. This process includes obtaining an arrest warrant, creating and executing a plan to apprehend the suspect (usually conducted by two investigators), questioning the suspect and obtaining a confirmation sample from the suspect. Finally, the investigator must write up the case notes and prepare for an eventual trial, a process that takes approximately an hour. Including time spent in transit, this process takes approximately 6.5 person-hours and costs approximately $370.

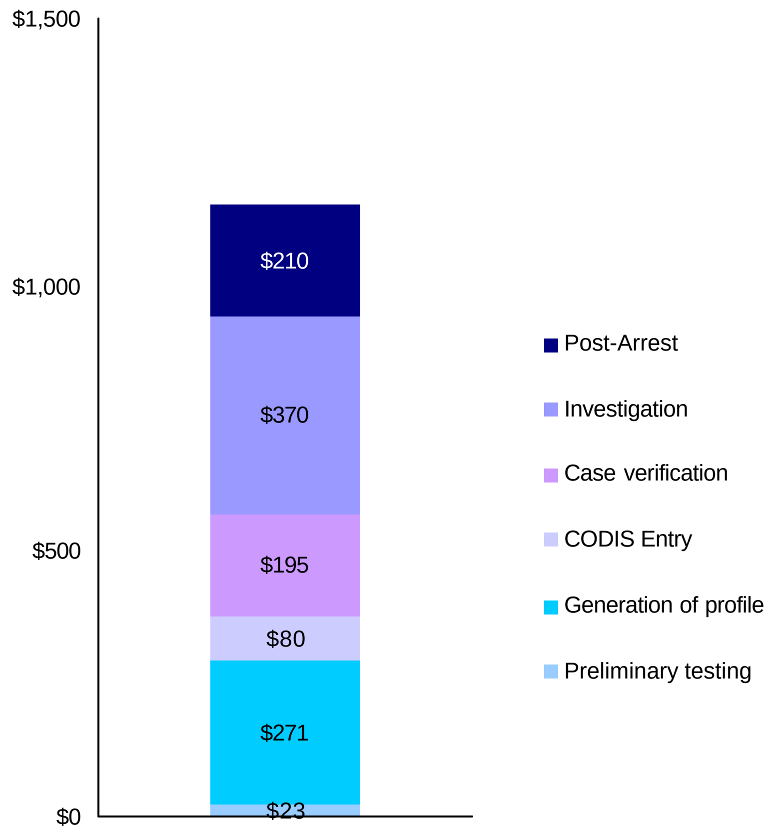
Stage 6—Post-Arrest

Once the suspect has been arrested and booked, an investigator will draw a confirmation sample which is sent to the Orange County Forensic Sciences Service's Division for analysis. Analysis of a confirmation sample requires that all steps after the initial screening and prior to the CODIS upload must be repeated for the confirmation sample. This comprises approximately 1.6 hours of labor cost plus an additional hour and a half to produce a report describing the results of confirmatory testing as well as to conduct a preliminary review, for a total cost of $177 plus an additional $33 in nonlabor costs.

The total cost of a case processing is described in Figure 4.1. These costs are not the average cost per case. Rather, these costs simply sum the cost of each stage of case processing. Thus, they are applicable only to a case that proceeds through all of the six stages of processing. A description of the average cost of a case in Orange CA follows in the next section.

Figure 6.1

The Costs of Processing a Case with Biological Evidence, by Stage (Orange County (CA))



Source: Urban Institute.

Processing an Average Case

The total cost of processing the average case depends on the quality of the evidence collected and whether or not a profile or a match is obtained. In cases where evidence is collected but does not contain DNA, case processing ends after DNA extraction and quantitation and, as a result, the costs of processing the case are small. In cases where a profile is obtained and a suspect is identified and apprehended, the costs are substantially higher. Ultimately, the cost of an average case depends on how many of the six cost stages cases complete during the analysis and investigation process. A complete discussion of how costs were calculated can be found in Chapter 2.

Table 6.2 provides descriptive statistics on the cost of processing a case in Orange County, using both the paired analysis, in which experimental cases are followed for the same length of time as its paired control case and the unpaired analysis which compares experimental and control cases regardless of the period of available observation. Costs are identical in the paired analysis.

Table 6.2. Cost of Processing an Average Case in Orange County California

	Unpaired Analysis	Paired Analysis
Mean	$586	$586
Standard Deviation	$293	$293
Minimum	$294	$294
25th percentile	$294	$294
Median (50th percentile)	$514	$514
75th percentile	$672	$672
Maximum	$1,997	$1,997
Sample Size	249	249

Source: Urban Institute.

In Orange County, the cost of processing an average case was $429 in the unpaired analysis and $416 in the paired analysis. The middle 50 percent of cases had a cost between $294 and $472.

Distribution of Costs by Stakeholder

Next we estimate how the costs of processing a case are distributed across each agency that participates in the burglary investigation. The cost of processing cases is shared by three different agencies: the local crime lab, the state crime lab and the police department. The share of the burden borne by each agency depends upon the stage in processing a case reaches. For cases that reach only Stage 1 (preliminary testing), Stage 2 (generation of profile) or Stage 3 (CODIS upload), the costs are borne entirely by the local crime lab. The costs of Stage 4 (case verification) are borne entirely by the state crime lab. The costs of Stage 5 (investigation) are borne primarily by the police department and the costs of Stage 6 (Post-Arrest) are borne entirely by the local lab. For a case that advances through the entire process, 45 percent of the costs are borne by the local lab, 19 percent of the costs are borne by the state crime lab and the remaining 36 percent of the costs are borne by the police department.

Table 6.3. Cost of Processing by Stage and Stakeholder (Orange County, California)

	Overall	Local Lab	State Lab	Police
Preliminary testing	$23	$23	$0	$0
Generation of profile	$271	$271	$0	$0
CODIS Entry	$80	$80	$0	$0
Case verification	$195	$0	$195	$0
Investigation	$370	$0	$0	$370
Post-Arrest	$210	$210	$0	$0
Total	$1,149	$584	$195	$370

Source: Urban Institute.

Other Costs

There are additional costs involved in collecting and processing DNA evidence that are not included in these estimates. These include the cost of training personnel to observe and collect DNA evidence at crime scenes and the cost of locating, collecting and transporting evidence to the crime lab. These costs are *not* considered in our analysis because they occur prior to random assignment in the crime lab. Since they occur prior to random assignment, these are costs that are equal for treatment and comparison cases. Nevertheless, these costs are relevant to policymakers who are interested in determining the amount of funding necessary to collect and process DNA from high-volume crimes scenes in their jurisdiction.

Training

As police deputies and investigators have had prior training in the collection of DNA evidence, no additional specialized training was performed prior to the evaluation.

Evidence Recovery

In Orange County, evidence recovery begins when a deputy is called to a burglary scene. Upon arriving at the scene, the deputy will observe the crime scene and, if applicable, will speak to the property owner. Next, he will call the Orange County Sheriff's Forensic Sciences Services Division in order to speak with a forensic specialist. If warranted, a forensic specialist will travel to the crime scene, where he will search for evidence—including DNA as well as fingerprints and other items of evidentiary value. In total, it is estimated that the forensic specialist spends approximately one half hour in transport to and from the crime scene and an additional 45 minutes searching for DNA and packaging DNA for analysis in scenes where DNA is collected. In addition, we estimate that a forensic specialist spends an additional ten minutes writing a report in cases where DNA evidence is located. We estimate that the added cost of collecting DNA evidence is approximately $40 per case, all of which accrues to the Forensic Sciences Services Division.

OUTCOMES

Orange County had a number of interesting findings from their implementation of the DNA experiment. Residential burglaries were the most often visited crime scene with DNA being collected from 59 percent of the cases in this study. The goal outlined by Orange County in the beginning of the experiment was to examine the probative nature of touch samples. Over the course of the project, 54 percent of the DNA samples collected were touch samples, and 97 percent of the evidence was swab evidence. There were no significant different between case outcomes for having a suspect identified, having a suspect arrested and having a case accepted for prosecution.

The crime scene attributes (table 6.4) are the characteristics of a crime scene, e.g., how did the perpetrator gain entry, what type of crime was committed, who collected the biological material, etc. In all of the cases in Orange County, the variables described in crime scene characteristics describe case characteristics pre-randomization. Thus, the data in table 6.4 (and in tables 6.5 and 6.6 described below) can be used to determine whether the integrity of the random assignment process was maintained. Theoretically, if cases were assigned randomly to each experimental condition, there should be no differences in case attributes between groups. As is shown below, while there are small differences between the test and control groups on some variables, only one of these differences are significant. In that variable, test cases were more likely to be collected from a door than a window, as compared to the control group.

Descriptive Statistics

Table 6.4. Descriptive Statistics for Crime Scene Attributes of Cases Processed in Orange County.

	Attribute	Treatment Group	Control Group	Full Sample
Crime Type	Residential	58% (49%)	60% (49%)	59% (49%)
	Commercial	41% (49%)	38% (49%)	39% (49%)
	Auto-Related Crime	0% (0%)	0.4% (6%)	0.2% (4%)
	Other	1% (11%)	1% (11%)	1% (11%)
Point of Entry	Door	55%* (50%)	43% (50%)	49% (50%)
	Window	31% (46%)	39% (49%)	35% (48%)
	Car	0% (0%)	0.4% (7%)	0.2% (5%)
	Other	14% (35%)	17% (38%)	16% (36%)
Point of Entry was Unlocked		28% (45%)	26% (44%)	27% (44%)
Average Number of Samples Collected		3.81 (3.42)	3.60 (2.19)	3.70 (2.88)
Evidence Collector	Deputy	0% (0%)	0% (0%)	0% (0%)
	Investigator	0% (0%)	0% (0%)	0% (0%)
	Forensic Specialist	100% (0%)	100% (0%)	100% (0%)
Any Fingerprints Collected		55% (50%)	52% (50%)	54% (50%)
Number of Offenders Searched Against in SDIS		1,457,317 (2231432)	1,451,824 (2191022)	1,455,570 (2209314)
Item Stolen	Electronics	37% (48%)	43% (50%)	40% (49%)
	Other	53% (50%)	47% (50%)	50% (50%)
	Nothing	10% (30%)	10% (30%)	10% (30%)

Source: Urban Institute.

Notes Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: : * $p < 0.05$, ** $p < 0.01$

Across all conditions (test and control) the majority of crime scenes where DNA was recovered were residential burglaries (59 percent), followed by commercial burglaries (39 percent), and (1 percent) of other offenses. In these offenses, the four main points of entry were a door (49 percent), window (35 percent), car (>1 percent) and other (16 percent). The test cases had significantly more doors as their point of entry than control cases. In 26 percent of all the cases, the point of entry was unlocked. Victims reported that 40 percent had electronics stolen, and 10 percent had nothing stolen. Fingerprints were collected at 54 percent of the cases for evidentiary purposes. There were an average of 3.70 samples collected at each crime scene. There is no variation in who collected the DNA evidence as only forensic specialists collected DNA evidence.

Table 6.5. Descriptive Statistics for Temporal Attributes of Cases Processed in Orange County.

	Attribute	Treatment Group	Control Group	Full Sample
Case Assigned During First Half of Study		49% (50%)	51% (50%)	50% (50%)
Case Assigned (Season)	Fall	24% (43%)	27% (45%)	26% (44%)
	Winter	39% (49%)	35% (48%)	37% (48%)
	Spring	22% (41%)	16% (37%)	19% (39%)
	Summer	15% (36%)	22% (41%)	18% (39%)
Case Assigned (Time of Day)	Day Shift (2PM–10PM)	40% (49%)	40% (49%)	40% (49%)
	Night Shift (10PM–6AM)	14% (35%)	14% (35%)	14% (35%)
	Morning Shift (6AM–2PM)	46% (50%)	47% (50%)	46% (50%)

Source: Urban Institute.

Notes Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: : * $p < 0.05$, ** $p < 0.01$

There were several other case characteristics that this project examined to see how they affect case outcomes (Table 6.5). One of the characteristics looked at was the time of the year that cases were collected. Over the course of the study, 26 percent of the DNA collection took place during the fall, 37 percent during the winter, 19 percent during the spring and 18 percent during the summer. Another area of interest was the time of day that a deputy responded to a crime. In Orange County, 40 percent of cases were reported during the day shift (2pm–10pm), 14 percent during the night shift (10pm–6am) and 46 percent during the morning shift (6am–2pm). Again, no significant differences were observed in these variables.

Table 6.6. Descriptive Statistics for Evidence Attributes of Cases Processed in Orange County.

	Attribute	Treatment Group	Control Group	Full Sample
Sample Type	Blood	6% (25%)	6% (23%)	6% (24%)
	Handled/ Touched (Cells)	89% (32%)	92% (26%)	90% (30%)
	Oral (Cells)	8% (25%)	9% (28%)	8% (28%)
	Worn (Cells)	4% (21%)	4% (20%)	4% (20%)
	Other	9% (29%)	0% (0%)	5% (21%)
Mode of Collection	Swab	96% (21%)	98% (13%)	97% (17%)
	Whole Item	2% (13%)	0.4% (6%)	1% (10%)
	Both	3% (17%)	1% (9%)	2% (13%)

Source: Urban Institute. Data are reported at the case level. *Notes*: Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$. Type of evidence collected may sum to more than one, as multiple samples may have been collected from different types of evidence.

Table 6.6 reports the type of DNA that is being collected at crime scene's in Orange County. In keeping with Orange County's experiment with touch evidence, cases in Orange County were overwhelmingly touch samples. In the test group, 6 percent of the cases had blood evidence present at the scene, 89 percent had touch evidence, 8 percent had oral (buccal) cells, 4 percent had skin or epithelial cells collected from items worn by the perpetrator, and 9 percent had other DNA evidence collected. Across both the test and control groups, 97 percent of the cases had the DNA swabbed at the scene, 1 percent had the whole item collected and 2 percent of scenes had both collected.

Table 6.7. Intermediate Outcomes of Cases Processed in Orange County.

	Attribute	Treatment Group
DNA Profile Obtained		65% (48%)
DNA Profile Uploaded into CODIS		27% (44%)
CODIS Match Obtained	Total	6% (24%)
	Offender Hit	4% (21%)
	Forensic Hit	2% (12%)

Source: Urban Institute. Data are reported at the case level.

Table 6.7 reports intermediate outcomes for test cases. Among the test cases, 65 percent had a profile obtained from the DNA collected at the crime scene, 27 percent had profiles that were eligible for upload into CODIS and 6 percent of test cases ultimately yielded a CODIS hit. Among these 4 percent had an offender hit in CODIS and 2 percent had a forensic hit in CODIS. The conditional probabilities column reports the probability that a case proceeds to the next level of processing once it has made it through the prior stage of processing. Among the 65 percent of cases where a profile was obtained, 42 percent were uploaded into CODIS. Among those cases that were uploaded, 22 percent yielded a hit.

Table 6.8. Suspects identified, arrested, and prosecuted in Orange County

	Treatment	Control
Suspect Identified	19%* (39%)	11% (31%)
Suspect Arrested	10% (30%)	8% (27%)
Number of Arrests	25	20
Case accepted for prosecution	9% (28%)	9% (28%)
Sample Size	249	248

Source: Urban Institute.
Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$

The main outcome to this experiment are described in table 6.8.[6] In the test cases a suspect identified was identified 19 percent of the time. A suspect was identified in 11 percent of control cases. The difference is statistically significant. Other differences in outcomes are not significantly

[6] Paired analyses were also estimated for Orange County. There is little substantive difference and these numbers are not reported here. Data are available from the author's upon request.

different. A suspect was arrested in 10 percent of test cases and 8 percent of control cases. Nine percent of cases in both conditions were accepted for prosecution.

Table 6.9. Method used to identify a suspect in Orange County

	Treatment	Control
Suspect identified	19%* (39%)	11% (31%)
Traditional Investigation	14% (35%)	11% (31%)
CODIS Hit	4% (21%)	
Forensic Hit/Investigative Lead	<1% (6%)	
Sample Size	249	248

Source: Urban Institute.
Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$

Table 6.9 describes the different methods for a suspect being identified in a case. In Orange County, 14 percent of suspects identified in the test condition were identified by traditional investigation. Four percent were identified by a DNA offender hit and less than one percent was identified by a forensic lead.

Cost-Effectiveness

Cost-effectiveness analysis (CEA) is an economic analysis that compares relative costs to relative outcomes for two or more experimental conditions. A CEA yields a ratio of costs to outcomes, which can be interpreted as the amount of money that is necessary to achieve one unit of a particular outcome. A complete description of the method used to calculate cost-effectiveness can be found in Chapter 2. Cost-effectiveness ratios are calculated for three outcome variables: (1) the cost per suspect identified, (2) the cost per arrest and (3) the cost per case accepted for prosecution.

Table 6.10 Cost effectiveness of DNA analysis for property crimes in Orange County (unpaired)	
Domain	**Orange County**
Expected Cost per suspect identification	$4,882
Expected Cost per arrest	$19,287
Expected Cost per case accepted for prosecution	n/a

Table 6.11 Cost effectiveness of DNA analysis for property crimes in Orange County (paired)	
Domain	**Orange County**
Expected Cost per suspect identification	$5,454
Expected Cost per arrest	$19,287
Expected Cost per case accepted for prosecution	n/a

In Orange County, the costs accruing to all stakeholders are $4,882 per suspect identified, and $19,287 per arrest. The cost of an average case across all cases, including cases where no DNA profile was obtained and those cases where a suspect was arrested, averaged $429.

CHAPTER 7—PHOENIX, ARIZONA

In 2004, the last full year before DNA Field Experiment, the Phoenix Police Department (PPD) collected and processed biological evidence from 86 burglary cases. Ten of these cases were processed on-site at the Phoenix Police Department's Laboratory Services Bureau Forensic Biology division and 76 were outsourced to a private laboratory. These cases eventually yielded 10 forensic hits and 12 offender hits. At the same time, the Arizona Department of Public Safety reported that 38 percent of DNA hits obtained statewide in some way helped solve a burglary cases. Thus, the goal for PPD in participating in the DNA Field Experiment was to expand the department's ability to collect and process DNA in high-volume crime scenes to replicate these results on a larger scale. In December of 2005, PPD collected the first piece of biological evidence for this study from a larceny from motor vehicle case, and collected the 500th piece of evidence in June 2007.

CONTEXT FOR THE DNA DEMONSTRATION

Phoenix, Arizona is comprised of 516.28 square miles with a population of over 1.5 million people. The Phoenix Police Department has over 3,100 sworn and professional staff members. In 2004, PPD responded to 16,469 burglaries with a 5.3 percent clearance rate. The DNA Field Experiment focused on two police precincts in the city of Phoenix: Desert Horizon and Maryvale. The Desert Horizon Precinct patrols the northeast section of Phoenix, where there are 405,393 residents spread out over 144.8 square miles. In 2004, Desert Horizon represented 15.5 percent of all homicides and 21.4 percent of all burglaries in Phoenix. The Maryvale Precinct patrols the western part of the city and has 265,460 residents in 54.4 square miles. In 2004, Maryvale investigated 21.5 percent of all homicides and 15.8 percent of all burglaries in Phoenix.

The PPD Laboratory Services Bureau (LSB) which led the Field Experiment in Phoenix, collects and evaluates crime scene evidence on behalf of the PPD. Following the LSB policies and procedures, any items selected for DNA analysis were shipped by the Forensic Biology Section of the LSB to accredited laboratory for screening and DNA analysis. Thus, the Field Experiment in Phoenix was a joint collaboration between the PPD divisions in Maryvale and Desert Horizon the PPD's Laboratory Services Bureau Division and the Maricopa County Attorney's Office.

Protocols (Proposed)

The Phoenix Police Department established a protocol for collecting DNA at high-volume crimes in 2004 and that protocol was initially used in the processing of experimental cases. If a responding officer identified the presence of biological materials during a routine burglary call, the responding officer had three options. If the responding officer has been trained in the collection of DNA, they could swab and collect possible biological evidence themselves. If the responding officer had not been trained, they could call for either a trained officer/detective to report to the scene to do the collection or they could call for a crime scene specialist to come collect the evidence. This protocol was designed to limit the amount of time crime scene specialist had to spend at these crime scenes in order to conserve that scarce resource for more serious crimes. Prior to the Field Experiment, police officers and detectives who expressed an interest in DNA identification and collection were trained in the identification and collection of DNA by the crime lab.

Protocols (Implemented)

Several problems with the extant protocols emerged early in the experiment that reduced the initial flow of cases into the study. First, patrol officers in Phoenix were required to remain at a crime scene until all evidence has been collected. Given that officers were under pressure to be available to respond to new calls, officers were reluctant to call for a trained evidence collector to respond to the crime scene. With relatively few trained officer/detective/crime scene specialist to be available to respond initially, there were long wait times for a trained collector exacerbating the problem. In order to make the DNA collection flow at a better pace, additional training was conducted so that more trained officers/detectives were available to collect DNA.

Initially, supply problems also hindered timely DNA collection. In one precinct, DNA collection supplies were kept at the precinct office requiring officers to return to the building to collect evidence collection kits before returning to the crime scene to collect evidence. In addition, a general shortage of supplies and DNA kits was also cited by officers as to why early collection rates were so low, which was resolved adding kits for officers to keep in their cars.

The strain resulting from the increased workload for crime scene specialist led to another change in protocol. Instead of responding to crime scenes, crime scene specialist were available to work with an officer or detective over the phone to help walk them through a scene if they had concerns or questions.

Finally, during the first few months of the project, it also became apparent that there was a disconnect between the filling of a burglary report by a patrol officers that identified the collection of DNA at a Crime scene and detectives being informed that DNA had been collected. Initially, a reporting system was used that allowed officers to leave reports verbally on an answering machine-style reporting system (the voice writer) that would later be transcribed and delivered to detectives. Once this issue was discovered, a new protocol was put into place that required that a case manager routinely check the voice writer for burglary cases with DNA.

Training

The Laboratory Services Bureau Forensic Biology Division conducted several training sessions for police officers and detectives in the identification, collection and preservation of DNA evidence. These training sessions took place in four hour blocks in December 2005 and January 2006 and over the course of these two months a total of 80 officers were trained. During these training sessions, lab personnel taught patrol officers proper collection methods including where to look for probative evidence, which tools to use to collect potential DNA, how to package evidence and how to dry and store samples once they were brought back to the precincts. The training also sought to increase patrol officer's ability to make sound decisions about which items of DNA evidence to collect. At the end of the session, officers were provided with kits that contained all the tools necessary for DNA evidence collection. Officers were also provided with laminated cards that contained information for victims (mainly on preservation of evidence pre-collection) and for officers (the basics of DNA evidence collection). The laminated cards also had phone numbers of people they should contact with questions.

CASE PROCESSING

Police

In Phoenix, the police department's role in the DNA Field Experiment grew over the course of the project. The original goal was to have some trained officers and detectives as well as crime scene specialist available to collect DNA evidence at burglary cases. Once time constraints on patrol officers and crime scene specialist became apparent, more officers and detectives needed to be trained to collect DNA. As more officers were trained, more of the evidence collection became the responsibility of the police department and was less of a responsibility for lab personnel.

The officers during this project were required to do the initial crime report for each burglary and either collect the biological material or call someone to collect any biological evidence (all patrol officers were previously trained to collect fingerprint evidence). Once the patrol officer left the scene, the report was moved to a burglary detective for follow-up. The detective was responsible for any lab requests, including asking the lab to process DNA found at the crime scene. While the lab was processing any forensic evidence, the detective continued their traditional investigation, which could include a range of activities from calling victims, checking pawn shops, and requesting that fingerprint evidence be examined.

In the case of a CODIS hit, detectives were notified that a hit occurred after the match was confirmed or immediately if the match was from PPD's local investigative index. With this notification, the detectives were provided with suspect(s) name and any other relevant case information. Once the detective was provided with the suspect's name and information, they followed up the lead to decide if further investigation was warranted. For instance, in some instances the CODIS-identified suspect had a legitimate reason to be at the scene of the crime. If the individual identified by the CODIS hit continues to be a suspect after the initial investigation, the detective will present the case to the CA's office for an arrest warrant and/or prosecution (if the suspect is already in custody). Cases where a suspect identified by a CODIS hit was already in custody, the investigation proceeded along the same course of investigation, although the prosecutor may determine not to pursue new charges in the interests of justice.

Sidebar 1 – A Case Study of a Residential Burglary

This case study describes the collection and processing of biological evidence associated with a residential burglary that took place on **April 13**. At 12:47pm a 911 call for service came into the Phoenix Police Department for a residential burglary. After this call was logged, officers in the field were notified of the non-emergency case. Once an officer was available to respond, an officer was dispatched to the scene and arrived about two hours after the original call. Upon arriving at the scene, the officer walked through the home with the victim to determine where the suspect may have entered the home, whether any items had been taken or broken, and to estimate when crime took place. In this instance, the suspect(s) had entered the single-family home by forcing their way through a ground level window with a screwdriver. The screwdriver was left at the scene by the suspect(s). It was also discovered that once inside the home, the suspect(s) had taken electronic items belonging to the victim. After walking through the home, the officer retrieved the DNA collection kit from their patrol car and collected (rather then swabbed) the screwdriver. The officer left the scene, wrote the crime report for this case, and submitted it for review. The officer also booked the screwdriver into evidence so that it could be tested for fingerprint and/or DNA evidence. The case was assigned to a burglary detective on **May 5**. While the forensic evidence was being processed in the lab, the detective began their investigation using traditional methods including interviews of victim and/or neighbors, reviewing similar cases and checking pawn shops. In this case there was no fingerprint evidence found at the scene.

The lab was notified on **May 11** that there was a case with possible DNA evidence. The lab reviewed the evidence and decided that it was potentially probative and should be included in this study. The case was then sent to the Urban Institute to be randomized on **May 11**. It was assigned to the Test Group the same day. Once the lab was notified that it was a Test case, a forensic specialist swabbed the screwdriver. This swab was then packaged to be sent to the outsource lab for processing. Once the evidence was returned to PPD LSD, the forensic specialist reviewed all materials from the outsource lab. The forensic specialist wrote up a technical report and noted that there was a CODIS eligible profile obtained from the submitted sample. The DNA profile was available for CODIS entry on **August 21** and was uploaded into CODIS on **September 16** after a technical and administrative review. The profile hit on an offender in the SDIS database on **October 3**. The lab discovered the hit. The state lab then confirmed the hit and provided the PPD crime lab with **suspect info**. As of December 31, 2007 the County Attorney furthered the case awaiting additional evidence and no suspect had been arrested.

Prosecution

The Maricopa County Attorney's Office became involved in the DNA project once a suspect (or suspect profile) was identified. The prosecution was willing to file a John Doe warrant on a case where a profile had been uploaded but no suspect has been identified by name. Typically, however, the prosecution becomes involved in a burglary cases when a detective sends their case to the CA's office indicating that the detective's were prepared to move forward with an arrest or search warrant. Prosecutors reviewed the case and either secured an arrest warrant for the detective or return the case for additional follow-up. If the suspect was already incarcerated, the prosecutor reviewed the case to determine whether to proceed with the additional burglary charge. Once a suspect was a rrested, the prosecution moved forward with the defendant's prosecution.

In Arizona a suspect is charged with burglary in the third degree if they enter or remain unlawfully in or on a nonresidential structure or in a fenced commercial, residential yard, or a motor vehicle with the intent to commit any theft or any felony. Burglary in the third degree is a class 4 felony with a sentencing range of 1 year to 4 years for a first offense up to 6 years to 15 years for someone one with two historical priors depending on the number of aggravating and mitigating factors. If a person enters or remains unlawfully in or on a residential structure the charge is a burglary in the second degree, which is a class 3 felony with a sentencing range of 2 years to 8.75 years for first time offenders and 7.5 years to 20 years for those with two historical priors. The charge of burglary in the first degree occurs if the suspect knowingly possesses explosives, a deadly weapon or a dangerous instrument in the course of committing any theft or any felony. Burglary in the first degree of a nonresidential structure is a class 3 felony with sentences equal to that of burglary in the second degree. If the burglary is committed in a residential structure, it is a class 2 felony with a sentence range of 3 years to 12.5 years for first offenses and 10.5 years to 35 years for an individual with two historical priors.

Collaboration

Communication between the police department and the lab personnel was strong throughout this whole project. The lab worked with patrol officers to train officers in the collection of DNA and how to testify in court. They were also available to answer questions throughout the entire project. Changes in the availability of crime scene specialists to respond to crime scenes resulted in the need for more officers needed to be trained. This was brought to the lab's attention by officers and commanders in the police department. Communication between the police department and the county attorney's office was not easily observed but the County Attorney's office made it clear to the project stakeholders that they were invested in the project. The biggest communication issue was within the police department. Untrained police officers had to wait on-scene until a trained officer or detective could come collect the DNA evidence. Long wait periods and miscommunication about who they should call caused long delays and officers became discouraged. Once more officers became trained, this did not pose much of a problem.

Sidebar 2 – A Case Study of a Commercial Burglary

This case study describes the collection and processing of biological evidence associated with a commercial burglary that took place on **February 11**. At 7:28am a 911 call for service came into the Phoenix Police Department for a commercial burglary. After this call was logged, officers in the field were notified of the non-emergency case and once an officer was available to respond, an officer was dispatched to the scene. The officer was on-scene at the victim's business approximately two hours later. Upon arriving at the scene, the officer walked through the business with the victim to see where the suspect may have entered, whether any items had been taken or broken, and to estimate when the crime took place. In this instance, the suspect(s) had entered the business (that was one of a series of buildings in a strip mall) by prying the back door of the business and had stolen cash. It was determined that the suspect(s) had entered this and two other businesses in the overnight hours the previous night. Since the responding officer was not trained to collect DNA evidence himself, the officer called for a trained officer or detective to report to the scene. A trained burglary detective responded on the same day to collect any DNA evidence and the responding officer departed the scene. While on-scene the burglary detective spoke with the store owner and walked through the business to collect any available evidence. In the course of this walk through, the detective chose to swab the handle of the safe that had been tampered with by the suspect(s). Footprint evidence was also collected from the scene but no fingerprints were discovered. The officer and responding detective both submitted reports on the crimes and the detective booked the evidence. The case was assigned to a burglary detective on **February 13**. While the forensic evidence was being processed in the lab, the detective began their investigation using traditional methods including interviews of victim and/or neighbors, reviewing similar cases and checking pawn shops.

The lab was notified on **February 17** that there was a case with possible DNA evidence. The lab reviewed the evidence and decided that it was potentially probative and should be included in this study. The case was then sent to the Urban Institute to be randomized on **March 9**. It was assigned to the Test Group the same day. Once the lab was notified that it was a Test case, a forensic specialist collected the swab. This swab was then packed to be sent to the outsource lab for analysis. Once the evidence was returned to PPD LSB, the lab technician reviewed all materials from the outsource lab. The forensic specialist wrote up a technical report and noted that there was no profile obtained from the submitted sample. As of December 31, 2007 no suspect had been identified in this case.

DESCRIPTIVE STATISTICS

COST

The cost analysis of the use of DNA evidence in burglary investigations estimated the costs for each case enrolled in the Phoenix experimental sample. For each case, a cost was attached to each of six stages of case processing. The costs describe the average expenditure of completing each stage. The progress of each case was observed in administrative data, and a cost was assigned to a case only if each stage was completed. The cost estimates for each stage include only the costs of processing an individual case; the fixed costs of operating a police agency or a crime laboratory and the costs of capital purchases (such as robotics in the crime lab) are not included. Thus, the costs described here reflect the costs to a police department with a mature crime lab that expands processing of biological material to high-volume property crimes such as residential burglary. The costs to a municipality to set-up a crime lab or to begin collecting DNA for the first time will be substantially higher.

A description of each of the six stages of case processing used in the cost analysis can be found in table 2.2. For each of these stages, a cost was estimated for Phoenix, and the progress of each sample in each case was observed from administrative data.

Cost Data Collection

Cost data were collected via semistructured interviews with key stakeholders—forensic scientists in the Phoenix Police Department's Laboratory Services Bureau and the Arizona Department of Public Safety's State Crime Lab, and police officers and detectives in the Phoenix Police Department. For each of the three stakeholders, the unit costs of processing a case were estimated from the time the evidence was delivered from the property locker to the local lab until the case concluded, including suspect identification, apprehension and arrest if the case progressed that far. For each stakeholder and each stage of case processing, the labor and nonlabor (capital) costs were estimated separately. The cost collection process began in December 2006 with follow-up meetings occurring throughout the study period. All prices and quantities were gathered in FY 2006 and costs and benefits are expressed in 2006 dollars.

Some costs associated with DNA case processing in Phoenix are not included in this evaluation. For example, the costs of training personnel to identify and collect biological material are not included. In addition, the costs of additional time at a crime scene are also not included. In this evaluation, cases are randomly assigned after each of these activities had occurred. Thus, the costs for cases in both groups are the same (a descriptive analysis of these costs is included later in this chapter). Finally, if the use of DNA in burglary investigations changes the likelihood that offenders will be arrested and convicted, other important costs and benefits will not be included. For instance, if more offenders are arrested and incarcerated, then the state will have to pay substantial additional costs to incarcerate those individuals. But, because these offenders were incarcerated, there may be substantial benefits to the community and its residents from reductions in offending.

A discussion of how labor and nonlabor costs were calculated can be found in Chapter 2.

Case Processing in Phoenix

Table 7.1 details the costs of each stage of processing in Phoenix. The total cost to all stakeholders of processing a case that results in an arrest is $1,470, divided evenly in labor and nonlabor costs. The cost of case processing is front-loaded with 54 percent of the costs accruing to the local forensic lab during the first two stages of processing. The following section details the manner in which costs accrue in each stage.

Table 7.1. Cost of Processing by Stage in Phoenix, Arizona

	Labor Costs	Nonlabor Costs	Total
Preliminary Testing / Generation of Profiles	$149	$580	$729
CODIS Entry	$14	$0	$14
Case verification	$19	$50	$69
Investigation	$370	$8	$378
Post-Arrest	$231	$50	$281
Total	$782	$688	$1,470

Source: Urban Institute

Stages 1 and 2—Preliminary testing and Generation of profile

In Phoenix, preliminary testing consists of an initial examination of the items(s) collected and the packaging of the DNA for shipment to Identigene, Inc., a private forensic laboratory with whom Phoenix has a contractual agreement. This process is completed by a Forensic Scientist I and takes approximately 45 minutes to complete, for a labor cost of $15. Supplies necessary to inspect and package the DNA and postage adds an additional $66 in cost per sample analyzed to this stage. In 15 percent of cases, in which a screening is required, the local lab pays Identigene $595 for a case containing up to two samples. In the remaining 85 percent of cases, no screening is required and the local lab pays a fee of $500. On average, this fee is $514 across all cases. Upon receipt of the analytic results, a forensic scientist will conduct a technical and administrative review of the results, a process which takes approximately 40 minutes to complete. In total, the cost of processing a sample until the CODIS entry phase is $729.

Stage 3—CODIS entry

Upon completing the technical and administrative review, a Forensic Scientist II will ensure that each sample meets state guidelines for CODIS upload and will enter each sample into CODIS. This process takes approximately 15 minutes to complete per sample for a total cost of $14 (given an average of 1.2 samples tested per case).

Stage 4—Case verification

Once a profile is uploaded into CODIS, the CODIS database is used to search for an offender match within the state's database. If an offender match is found, it must be confirmed by the state crime lab at the Arizona Department of Public Safety. The state lab verifies the CODIS hit to the offender profile on record. At the state crime lab, a forensic scientist re-analyzes existing samples in batches of eighty-one. Each batch takes approximately twenty hours to fully process for a per sample labor cost of $9 and an additional $50 in supplies. Next, the forensic scientist spends 15 minutes generating a report which will be sent electronically to the local lab in Phoenix, which costs an additional $10.

Stage 5—Investigation

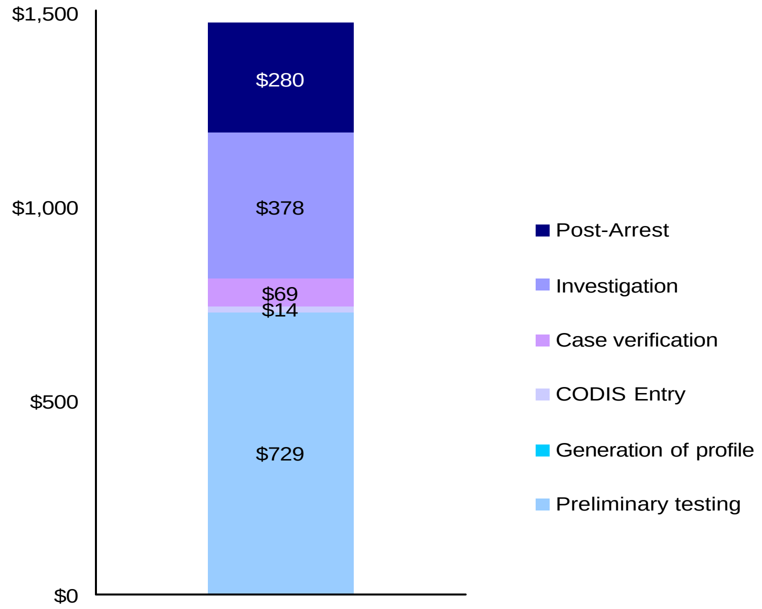
Once the match has been confirmed by the state lab, the investigative process increases in intensity. After the local lab is informed of the suspect identification, a forensic scientist will prepare a formal report identifying the defendant and send that report to the burglary investigator in charge of the case, a process that requires thirty minutes to complete for a cost of $23. In addition, in 10 percent of cases, the local lab will re-run the analysis completed by Identigene for quality assurance. This process requires two hours of time from a Forensic Scientist I and two hours of time from a Forensic Scientist III. In addition to the labor costs, the process consumes $75 in reagents and supplies, for a total cost of $215. Since this cost accrues in only 10 percent of cases, it adds only $25 to the expected costs of the average case. Upon notification of a DNA match, the detective assigned to the case will attempt to locate the suspect using one of several databases, generally including data maintained by the Departments of Parole, Probation, Prisons and Motor Vehicles. This process takes approximately one half hour and has a cost of $25. Once a suspect has been located, the detective creates a plan to apprehend the suspect. This process includes obtaining an arrest warrant (1 hour of detective time), creating and executing a plan to apprehend the suspect (usually conducted by two detectives), questioning the suspect and obtaining a confirmation sample from the suspect. Including time spent in transit, this process takes approximately 2.5 hours (five person-hours) and costs $221. Finally, the detective must write up the case notes and prepare for an eventual trial, a process that takes approximately an hour. In total, the cost of investigation to the police department is approximately $309, with an additional $69 accruing to the Laboratory Services Bureau.

Stage 6—Post-Arrest

Once the suspect has been arrested and booked, a detective will collect a confirmation sample which is sent to the local lab for analysis. Analysis of a confirmation sample requires that all steps after the initial screening and prior to the CODIS upload must be repeated for the confirmation sample. This process requires two hours of analyst time and costs $92. In addition, a Forensic Scientist III must spend approximately one hour generating a report, a second Forensic Scientist III must spend one hour technically reviewing the report and another hour administratively reviewing it, for a cost of $138. In total, this stage of processing has a cost of $231.

The total cost of a case processing is described in Figure 6.1. These costs are not the average cost per case. Rather, these costs simply sum the cost of each stage of case processing. Thus, they are applicable only to a case that proceeds through all of the six stages of processing. A description of the average cost of a case in Phoenix follows in the next section.

Figure 7.1. The Costs of Processing a Case with Biological Evidence, by Stage (Phoenix, AZ)



Source: Urban Institute.

Processing an Average Case

The total cost of processing the average case depends on the quality of the evidence collected and whether or not a profile or a match is obtained. In cases where evidence is collected but does not contain DNA, case processing ends after preliminary testing and, as a result, the costs of processing the case are small. In cases where a profile is obtained and a suspect is identified and apprehended, the costs are substantially higher. Ultimately, the cost of an average case depends on how many of the six cost stages cases complete during the analysis and investigation process. A detailed explanation of how costs were calculated can be found in Chapter 2.

Table 7.2 provides descriptive statistics on the cost of processing a case in Phoenix, using both the paired analysis, in which experimental cases are followed for the same length of time as its paired control case and the unpaired analysis which compares experimental and control cases regardless of the period of available observation. As the paired analysis censors the accrual of costs at the last date on which outcomes from the control case are observed, costs are lower in the paired analysis (please see Chapter 2 for a discussion of why paired and unpaired analysis were used in this evaluation and how the paired estimates were constructed).

Table 7.2. Cost of Processing an Average Case in Phoenix, Arizona

	Unpaired Analysis	Paired Analysis
Mean	$814	$814
Standard Deviation	$232	$232
Minimum	$673	$673
25th percentile	$673	$673
Median (50th percentile)	$685	$685
75th percentile	$775	$775
Maximum	$2,107	$2,107
Sample Size	251	251

Source: Urban Institute

In Phoenix, the cost of processing an average case was $814. The middle 50 percent of cases had a cost between $673 and $775, indicating very little variation in the cost of case processing.

Costs by Stage and Stakeholder

Next we estimate how the costs of processing a case are distributed across each agency that participates in the burglary investigation. The cost of processing cases is shared by three different agencies: the Laboratory Services Bureau, the state crime lab and the police department. The share of the burden borne by each agency depends upon the stage in processing a case reaches. For cases that reach only Stage 1 (preliminary testing), Stage 2 (generation of profile) or Stage 3 (CODIS upload), the costs are borne entirely by the local crime lab. The costs of Stage 4 (case verification) are borne entirely by the state crime lab. The costs of Stage 5 (investigation) are borne primarily by the police department and the costs of Stage 6 (Post-Arrest) are borne entirely by the local lab. For a case that advances through the entire process, 72 percent of the costs are borne by the local lab, 5 percent of the costs are borne by the state crime lab and the remaining 23 percent of the costs are borne by the police department.

Table 7.3. Cost of Processing by Stage and Stakeholder (Phoenix, Arizona)

	Total	Local Lab	State Lab	Police
Preliminary testing	$729	$729	$0	$0
Generation of profile	$0	$0	$0	$0
CODIS Entry	$14	$14	$0	$0
Case verification	$69	$0	$69	$0
Investigation	$378	$69	$0	$309
Post-Arrest	$280	$280	$0	$0
Total	$1,470	$1,092	$69	$309

Source: Urban Institute.

Other Costs

There are additional costs involved in collecting and processing DNA evidence that are not included in these estimates. These include the cost of training personnel to observe and collect DNA evidence at crime scenes and the cost of locating, collecting and transporting evidence to the crime lab. These costs are not considered in our analysis because they occur prior to random assignment in the crime lab. Since they occur prior to random assignment, these are costs that are equal for treatment and comparison cases. Nevertheless, these costs are relevant to policymakers who are interested in determining the amount of funding necessary to collect and process DNA from high-volume crimes scenes in their jurisdiction.

Training

Officers and detectives in several burglary divisions of the Phoenix Police Department were provided with a one-day training course in a classroom setting taught by forensic scientists in the Phoenix Police Department's Laboratory Service Bureau. Training consisted of several hours discussing techniques and processes used to locate and collect DNA at residential burglary scenes and several hours spent providing officers with guidance on testifying in court as to their activities collecting DNA at crime scenes. Creation of training materials and the labor costs involved in offering these training sessions sum to approximately $26,000 or $100 for each of the 250 cases in Phoenix's experimental group.

Evidence Recovery

In order to secure DNA evidence, patrol officers report that they must remain on scene for, on average, an additional hour in order to secure the crime scene. Given that two officers generally investigate a burglary scene, at a fully loaded rate of $29 per hour, this equals approximately $59 in labor cost. In addition, if the event that a detective is generally called to the scene, he will, on average, spend an additional hour on scene, a cost of $44. While some officers are trained to collect DNA, it often the case that an officer will call for a crime scene specialist who will spend approximately two hours in transport and at the crime scene locating, collecting and securing DNA, a cost of $53. Finally, an officer will generally spend approximately one hour transporting the DNA to the evidence room, a cost of $23. In total, we estimate that collecting DNA at burglary scenes costs an additional $182 in labor costs—costs that would not have accrued had DNA not been searched for and collected.

OUTCOMES

Phoenix had a number of interesting findings from their implementation of the DNA experiment. Over 50 percent of crime scenes visited in Phoenix were residential burglaries. In Phoenix a case that had DNA collected and tested was significantly more likely to have a suspect identified than a control case. The treatment group had 16 percent of cases with a suspect identified compared to 4 percent of control cases that had a suspect identified. The treatment cases were also significantly more likely to have a suspect arrested than a control case. In the treatment cases, there was a 3 percent arrest rate as compared to the less than 1 percent of control cases that had a suspect identified. Cases that were in the treatment group were also significantly more likely to have a case accepted for prosecution. Of the treatment group 7 percent of the cases had a case accepted for prosecution while less than 1 percent of the control cases had a case accepted for prosecution. These outcomes are maintained for the paired cases with 16 percent of the cases having a suspect identified before a control case had their DNA uploaded into CODIS.

Descriptive Statistics

The crime scene attributes (Table 7.4) are the characteristics of a crime scene, e.g., how did the perpetrator gain entry, what type of crime was committed, who collected the biological material, etc. In all of the cases in Phoenix, the variables described in crime scene characteristics describe case characteristics pre- randomization. Thus, the data in Table 6.4 (and in Table 6.5 and 6.6 described below) can be used to determine whether the integrity of the random assignment process was maintained. Theoretically, if cases were assigned randomly to each experimental condition, there should be no differences in case attributes between groups. As is shown below, while there are small differences between the test and control groups on some variables, only the number of samples collected were significantly different.

Table 7.4. Descriptive Statistics for Crime Scene Attributes of Cases Processed in Phoenix.

	Attribute	Treatment Group	Control Group	Full Sample
Crime Type	Residential	53% (50%)	58% (50%)	55% (50%)
	Commercial	22% (42%)	21% (41%)	22% (41%)
	Auto-Related Crime	25% (43%)	21% (41%)	23% (42%)
	Other	0% (0%)	0% (0%)	0% (0%)
Point of Entry	Door	31% (46%)	34% (48%)	32% (47%)
	Window	33% (47%)	35% (48%)	34% (47%)
	Car	24% (43%)	20% (40%)	22% (41%)
	Other	13% (34%)	11% (31%)	12% (32%)
Point of Entry was Unlocked		6% (24%)	7% (26%)	7% (25%)
Average Number of Samples Collected		1.65 (1.19)	2.07** (2.01)	1.86 (1.69)
Evidence Collector	Patrol Officer	96% (19%)	98% (14%)	97% (16%)
	Detective	.4% (6%)	1% (11%)	1% (1%)
	Forensic Specialist	2% (13%)	0.4% (6%)	1% (1%)
Any Fingerprints Collected		27% (45%)	26% (44%)	26% (44%)
Number of Offenders Searched Against in SDIS		488,958 (724,809)		
Item Stolen	Electronics	39% (49%)	33% (47%)	36% (48%)
	Other	55% (50%)	59% (49%)	57% (50%)
	Nothing	6% (24%)	7% (26%)	7% (25%)

Source: Urban Institute. Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group.
Significance: : * p < 0.05, ** p < 0.01

The crime scene attributes (Table 7.4) are the characteristics of a crime scene, e.g., how did the perpetrator gain entry, what type of crime was committed, who collected the biological material, etc. In all of the cases in Phoenix, the variables described in crime scene characteristics describe case characteristics pre- randomization. Across all conditions (test and control) the majority of cases were DNA was collected were residential burglaries (55 percent), with about an equal number of commercial burglaries (22 percent) and auto-related offenses (23 percent). In these offenses, the four main points of entry were a door (32 percent), window (34 percent), car (22 percent) and other (12 percent). In 7 percent of all the cases, the point of entry was unlocked. Victims reported that 39 percent had electronics stolen, and 7 percent had nothing stolen. Following the collection protocol, the experiment had 97 percent of the DNA in their cases collected by a trained patrol officer, 1 percent by a trained detective and 1 percent by a crime scene specialist. At 26 percent of the cases, fingerprints were collected for evidentiary purposes. One difference between the test and control groups was seen in the number of samples collected at the scene. There was an average of 1.86 samples collected at each crime scene. Control cases had significantly more samples collected than a test case with 2.07 samples compared to 1.65 samples.

Table 7.5. Descriptive Statistics for Temporal Attributes of Cases Processed in Phoenix.

	Attribute	Treatment Group	Control Group	Full Sample
Case Assigned During First Half of Study		49% (50%)	48% (50%)	48% (50%)
Case Assigned (Season)	Fall	16% (36%)	20% (40%)	18% (38%)
	Winter	29% (46%)	26% (44%)	28% (45%)
	Spring	37% (48%)	34% (48%)	36% (48%)
	Summer	18% (39%)	19% (40%)	19% (39%)
Case Assigned (Time of Day)	Day Shift (2PM-10PM)	38% (49%)	35% (48%)	37% (48%)
	Night Shift (10PM-6 AM)	11% (31%)	17% (37%)	14% (34%)
	Morning Shift (6 AM- 2PM)	51% (50%)	48% (50%)	50% (50%)

Source: Urban Institute. Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group.
Significance: : * $p < 0.05$, ** $p < 0.01$

There were several case characteristics associated with time that were examined to determine if significant differences existed between the treatment and control conditions (Table 7.5). Officers in Phoenix had stated that they were concerned about how the high summer heat might degrade DNA, leaving less to be recovered. Over the course of the study, 18 percent of the DNA collection took place during the fall, 28 percent during the winter, 36 percent during the spring and 19 percent during the summer. Another area of interest was the time of day that an officer responded to a crime. That is, there was concern that the requirement that officer's remain on scene until a crime scene specialist arrived to collect the DNA evidence would make it difficult to collect evidence during periods with a high call for service volume. This is reflected in the collection statistics where 37 percent of cases were reported during the day shift (2pm-10pm), 14 percent during the night shift (10pm-6am) and 50 percent during the morning shift (6am-2pm).

Table 7.6. Descriptive Statistics for Evidence Attributes of Cases Processed in Phoenix.

	Attribute	Treatment Group	Control Group	Full Sample
Sample Type	Blood	22% (41%)	N/A	N/A
	Handled/ Touched (Cells)	76% (47%)	N/A	N/A
	Oral (Cells)	4% (17%)	N/A	N/A
	Worn (Cells)	0.4% (6%)	N/A	N/A
	Other	1% (11%)	N/A	N/A
Mode of Collection	Swab	33% (47%)	34% (48%)	34% (47%)
	Whole Item	62% (49%)	60% (49%)	61% (49%)
	Both	4% (21%)	6% (23%)	5% (22%)

Source: Urban Institute. Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Type of evidence collected may sum to more than one, as multiple samples may have been collected from different types of evidence. Significance: * p < 0.05, ** p < 0.01

Table 7.6 reports the type of DNA that is being collected at crime scene's in Phoenix. In the test group, 22 percent of the cases had blood evidence present at the scene, 76 percent had touch evidence, 4 percent had oral cells, less than 1 percent had cells collected from an item worn by the perpetrator and 1 percent had other DNA evidence collected. Across both the test and control groups, 34 percent of the cases had the DNA swabbed at the scene, 61 percent had the whole item collected and 5 percent of scenes had both collected.

Table 7.7. Descriptive Statistics for Intermediate Outcomes of Cases Processed in Phoenix.

	Attribute	Treatment Group
DNA Profile Obtained		58% (49%)
DNA Profile Uploaded into CODIS		57% (50%)
CODIS Match Obtained	Total	16% (37%)
	Offender Hit	12% (33%)
	Forensic Hit	4% (19%)

Source: Urban Institute. Data are reported at the case level.

The test cases in this experiment had intermediate outcomes (Table 7.7) that were determined in the Phoenix Police Department laboratory. Of the test cases, 58 percent had a profile obtained from the DNA collected at the crime scene. Once a profile was obtained, 57 percent had profiles that were eligible for upload into CODIS. With the test cases, 16 percent had a CODIS hit. Of these 12 percent had an offender hit in CODIS and 4 percent had a forensic hit in CODIS.

If a DNA profile was obtained, there was a 98 percent probability that the profile obtained was CODIS eligible and uploaded. Of the cases that were CODIS eligible, 28 percent had a hit in CODIS.

Table 7.8. Suspects identified, arrested, and prosecuted in Phoenix

	Treatment	Control
Suspect Identified	16%** (36%)	4% (18%)
Suspect Arrested	3%* (17%)	0% (6%)
Number of Arrests	8	0
Case accepted for prosecution	7%** (25%)	0% (6%)
Sample Size	251	257

Source: Urban Institute.
Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$

Table 7.8 shows the percentages of a suspect being identified, arrested and prosecuted in Phoenix. In the treatment group, 16 percent of cases had a suspect identified. This number was significantly different than the 4 percent of suspects identified in the control group. The cases in the treatment group were also significantly more likely to have an arrest and have a case be accepted for prosecution. There was an arrest in 3 percent of the treatment cases and 7 percent had a case filed with prosecution.

Table 7.9. Method used to identify a suspect in Phoenix

	Treatment	Control
Suspect Identified	16%** (36%)	4% (18%)
Traditional Investigation	2% (13%)	4% (18%)
CODIS Hit	12% (33%)	
Forensic Hit/Investigative Lead	2% (14%)	
Sample Size	251	257

Source: Urban Institute.
Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$

Table 7.9 shows how suspects were identified in Phoenix. Both conditions had some cases closed by traditional means two percent for the treatment group and four percent for the control group. Twelve percent of the treatment cases were aided by an offender hit and two percent had a suspect identified through the leads provided by a forensic hit.

Cost-Effectiveness

Cost-effectiveness analysis (CEA) is an economic analysis that compares relative costs to relative outcomes for two or more experimental conditions. A CEA yields a ratio of costs to outcomes, which can be interpreted as the amount of money that is necessary to achieve one unit of a particular outcome. A detailed description of how the cost-effectiveness ratios were calculated can be found in Chapter 2. For each site, outcomes are translated into cost-effectiveness ratios using equation (2). Cost-effectiveness ratios are calculated for three outcome variables: (1) the cost per suspect identified, (2) the cost per arrest and (3) the cost per case accepted for prosecution.

Table 7.10 Cost effectiveness of DNA analysis for property crimes in Phoenix (unpaired)

Domain	Phoenix
Expected Cost per suspect identification	$6,170
Expected Cost per arrest	$27,378
Expected Cost per case accepted for prosecution	$10,785

Table 7.11 Cost effectiveness of DNA analysis for property crimes in Phoenix (paired)

Domain	Phoenix
Expected Cost per suspect identification	$6,152
Expected Cost per arrest	$27,301
Expected Cost per case accepted for prosecution	$10,785

In Phoenix, the costs accruing to all stakeholders are $6,170 per suspect identified, $27,378 per arrest and $10,785 per case accepted for prosecution. The cost of an average case across all cases and including cases where no DNA profile was obtained and those cases where a suspect was arrested, was $716.

CHAPTER 8—TOPEKA, KANSAS

The goal of the experiment in Topeka was to determine whether patrol officers could be successfully trained to collect high-quality biological evidence from crime scenes. In addition, the Kansas Bureau of Investigation (KBI) sought to collect empirical evidence to support their hypothesis that 'touch' samples are less likely to yield CODIS-uploadable profiles and should be a lower collection priority. In a typical year, there are about 2,700 property crimes in Topeka. Prior to the beginning of the experiment, KBI estimated that two percent, or about 60, of these crime scenes had bodily fluids (e.g. blood) recovered from the crime scene. Thus, it was considered unlikely that Topeka would yield 500 cases for this experiment if collection was limited to blood, and KBI proposed to meet the 500 case criteria by also collecting touch samples. The Topeka Police Department (TPD) and KBI already had experience collecting and analyzing biological evidence from crime scenes prior to this study. The KBI DNA supervisor estimated that the majority of cases were from sexual assaults, with the remainder divided equally between property and violent offenses.

The director of the KBI wrote the proposal for the demonstration funding and served as the center of initiative throughout the study. The majority of funding was earmarked for upgrading the DNA-processing equipment in the KBI's crime laboratory. An ABI Avant Genetic Analyzer was modified to increase the amount of samples it can process and supplies were purchased (e.g. Disposables and Reagents). The ABI analyzer allowed KBI to process four samples per half hour when it used to take thirty minutes for a single sample. The Topeka Police Department (TPD) also purchased supplies for patrol officers to collect biological evidence.

CONTEXT FOR THE DNA DEMONSTRATION

Protocols (proposed)

When a property crime was reported, a patrol officer reported to the crime scene. If the officer observed biological material or an item thought to have been handled, the officer would take their kit from the patrol car and collect the evidence. If he or she was unsure about how to collect the evidence then he or she could call the Special Investigations Unit (SIU) to come collect it.

After collecting the evidence, the SIU or patrol officer submitted it to the property bureau in the TPD. The sergeant in charge of the property bureau reviewed the evidence to identify cases that were eligible for this study. If he identified a case, then he would set it aside for the weekly transport of biological evidence to the KBI. In addition two crime analysts in the TPD would be notified about the case and one of them would email the Urban Institute for assignment to the test or comparison condition. Upon receipt of the case's assignment, one of the crime analysts would write the case condition on the form connected to the evidence. These crime analysts were also responsible for entering data into the study's database.

Protocols (Implemented)

The experiment in Topeka generally followed the proposed protocol with one notable adjustment during the course of the project. Existing protocol called for KBI to file a report with the TPD case records department if a hit occurred in any of the CODIS index systems. The detective assigned to the case was then responsible for checking the records department for results of the DNA analysis. This protocol resulted in significant amounts of time elapsing before the detective became aware of the results. In July 2006, TPD and KBI changed the protocol to ensure that case detectives were directly notified when a CODIS match occurred.

Training

The KBI DNA Supervisor and an analyst conducted three 150-minute training sessions with the TPD's senior police officers and detectives. The TPD were taught how CODIS functions, how to properly collect biological evidence, and the proper protocols for submitting a case to the study. Specifically, they were told where to look for biological evidence at crime scenes, how to take swabs of bodily fluid or skin cells and how to properly package the swab or evidence item for submission to the KBI. Proper packaging was a particular concern since prior to the study KBI invested considerable resources re-packaging submitted evidence according to their protocol and proper packaging allowed more efficient evidence processing. In addition, each patrol car was outfitted with a metal briefcase containing swabs, required paper forms, instructions on how to collect the evidence, and plastic bags. The instruction on how to collect biological evidence referenced these kits. The analyst from KBI demonstrated how to properly collect bodily fluids and touch samples from different crime scene scenarios. Each session contained mostly similar information however some officers and detectives attended more than one. After being trained by the KBI, the senior officers and detectives trained the remaining patrol officers during in-service days. During the fall of 2006 the same KBI analyst returned to the TPD to conduct follow-up training sessions with senior officers and detectives who had not attended the initial sessions.

No training activities involved the District Attorney's office.

CASE PROCESSING

Police

As discussed above, police officers in Topeka were responsible for identifying, collecting, transporting and submitting biological evidence from the crime scene to the crime lab. Once the biological material had been submitted, the case proceeded in a "business as usual" investigative fashion. These business as usual investigative procedures were employed for cases in both study conditions. That is, regardless of whether the DNA evidence was processed, TPD detectives continued to work on the case in the usual manner. Typical activities included searching pawnshop serial number databases for matches to stolen property and or interviewing witnesses.

Sidebar 1 – A Case Study of a Residential Burglary

On **December 6, 2006** a single-family detached home was burglarized in the downtown section of Topeka. The crime was estimated to have occurred between 8:45am and 6:30pm. Upon arrival at the crime scene – at 7:15 pm - a patrol officer was told by the victim that a screwdriver was left by the burglar. The patrol officer returned to his patrol car and carried the kit back to the residence. He put on sterile gloves and placed the screwdriver into a plastic bag then completed the necessary paperwork. Upon return to the TPD the officer submitted the screwdriver to the property bureau. Two days later the police sergeant in charge of the property bureau identified this case as suitable for the study. Later that day a crime analyst came to the property bureau to see if any cases needed to be assigned. The sergeant told the crime analyst about this case and the analyst emailed Urban Institute for its case assignment. Upon finding out that the case was assigned to the experimental condition, the crime analyst wrote the case's assignment on the paperwork. On Thursday of that week, the evidence was transported to the KBI.

Upon receipt of the screwdriver, a forensic analyst in the CLB swabbed it for skin cells Since, the KBI 'batches' cases together for preliminary testing, this case was held until the rest of the cases in the batch all faced preliminary testing. DNA testing was completed on **January 20, 2007** for the entire batch. This case was then uploaded into the SDIS, and NDIS indices for potential forensic and/or offender matches. On **January 21, 2007** the forensic analyst was informed of an offender match in the SDIS index. Three days later the analyst completed writing the report of these results and sent them to TPD case records department. No suspect was arrested in this case.

Topeka implemented different procedures for investigating cases where a suspect was identified through CODIS. If the crime scene DNA matched a known offender in one of the databases, the detective was informed of the suspect's identity. The detective would attempt to locate the suspect by examining available data to determine if the suspect was already under community supervision (e.g. probation or parole) or incarcerated, searching drivers' license databases for the suspect's address, and attempting to obtain tips from neighbors on the suspect's whereabouts.

In Topeka, a CODIS identification was not sufficient grounds for an arrest. Thus, after locating a suspect, detectives would attempt to obtain a voluntary confirmation sample via an oral swab. If the suspect refused to provide a sample, the detective applied for a search warrant to obtain the sample (incarcerated suspects were required to provide a sample). Upon receipt of the search warrant and obtaining the sample from the suspect, it was submitted to KBI to determine if it matched the evidence collected from the crime scene. If a match was obtained, the detective would apply for an arrest warrant and the District Attorney's office would provide it. Finally, the detective would serve the arrest warrant and arrest the suspect.

Lab

In Topeka, cases in both the test and control groups were processed through the generation of a DNA profile. At that point, DNA profiles for control cases had no additional processing until ninety days elapsed from the day the cases were assigned to their group conditions. Thus, ninety or more days after the generation of profiles in both conditions, DNA profiles for cases in the control group were eligible to be submitted to CODIS.

To generate a DNA profile, each sample in a case passed through multiple stages. In some instances, samples were submitted to the KBI for DNA presumptive testing to verify the evidence was human DNA. In the next stage, quantitation tests were undertaken to determine that there was enough DNA for subsequent processing. The biological evidence proceeded through several additional steps to amplify the observable DNA and develop a DNA profile. If the profile was generated and the additional 'control' samples did not yield a match to the presumed forensic DNA profile then it was considered ready to be uploaded into SDIS and NDIS.

If ten loci were present on the forensic sample or thirteen present on the offender profile it was entered into the state (SDIS), and national (NDIS) digital index systems to search for a match. The KBI DNA Supervisor exercised some discretion in how many loci she required for submission to SDIS. She reported that she would submit a sample to Kansas's SDIS if it had as few as eight loci.

Prosecution

Prosecutors in Topeka did not become involved in the case until a suspect was identified. As noted above, Topeka arrest policies differed from the other experimental sites as Topeka did not consider a CODIS match sufficient grounds for an arrest warrant. Thus, if voluntary consent was not provided by a suspect for a confirmation sample, a search warrant was necessary.

The other notable difference in practice in Topeka was that sentencing guidelines in Kansas were less strict than in the other sites. If a burglary suspect was not on probation supervision then the maximum sentence upon conviction was probation. Offenders were incarcerated only if they were on probation at the time of arrest.

Collaboration

The relationship between the KBI and the other two involved agencies—the Topeka Police Department (TPD) and the Shawnee County District Attorney's Office (DA)—was unique to the other sites. The TPD did not have a local crime laboratory but relied on the statewide KBI as its processor of biological evidence. As such, the relationship between these two agencies was that of two separate bureaucracies and required police officers and detectives to interface much more directly with the state laboratory than was required in any of the other four sites. This organizational structure also posed recurring challenges to establishing effective communication channels between the KBI and TPD as well as the KBI and the DA.

The lack of a crime laboratory under the TPD's chain of command also explains why one goal of the study was to develop a successful training program for patrol officers to collect biological evidence. Since TPD was so limited in the number of CSI's at their disposal it was necessary for patrol officers to share responsibility for collecting biological evidence from property crime scenes. This was a change in protocol because prior to the study, TPD's special investigations unit was solely responsible for collecting biological evidence. Shifting this responsibility to patrol officers required high morale and motivation on the officers' parts to take on this added task.

Finally, the DA's office had rigorous requirements to issue an arrest warrant based on a CODIS hit. If a CODIS hit was reported from KBI, the detective assigned to the case had to obtain a confirmation sample from the suspect that matched the biological evidence at the crime scene in order for the DA's office to issue the arrest warrant. This led to two common situations: 1) the detective would locate the suspect and the suspect to voluntarily submit a confirmation sample via an oral swab, or 2) the suspect would refuse to submit a sample and the detective would request a search warrant from the DA's office to obtain the suspect's sample. If the confirmation sample matched the crime scene's then the DA's office would issue an arrest warrant for the suspect. This procedure was also in contrast to the remaining four sites where a CODIS hit was sufficient for an arrest warrant. It lengthened the amount of time required to arrest a suspect off of biological evidence and TPD interviewees report that it reduced TPD's perception of DNA analysis as an effective forensic tool.

COST

The cost analysis of the use of DNA evidence in burglary investigations estimated the costs for each case enrolled in the Topeka experimental sample. For each case, a cost was attached to each of six stages of case processing. The costs describe the average expenditure of completing each stage. The progress of each case was observed in administrative data, and a cost was assigned to a case only if each stage was completed. The cost estimates for each stage include only the costs of processing an individual case; the fixed costs of operating a police agency or a crime laboratory and the costs of capital purchases (such as robotics in the crime lab) are not included. Thus, the costs described here reflect the costs to a police department with a mature crime lab that expands processing of biological material to high-volume property crimes such as residential burglary. The costs to a municipality to set-up a crime lab or to begin collecting DNA for the first time will be substantially higher.

A description of each of the six stages of case processing used in the cost analysis can be found in Table 2.2. For each of these stages, a cost was estimated for Topeka, and the progress of each sample in each case was observed from administrative data.

Cost Data Collection

Cost data were collected via semistructured interviews with key stakeholders—forensic scientists in the Kansas Bureau of Investigation (which serves as Kansas's state forensic lab as well as Topeka's local forensic lab) and police officers and detectives in the Topeka Police Department. For each of the three stakeholders, the unit costs of processing a case were estimated from the time the evidence was delivered from the property locker to the local lab until the case concluded, including suspect identification, apprehension and arrest if the case progressed that far. For each stakeholder and each stage of case processing, labor and nonlabor (capital) costs were estimated separately. The cost collection process began in December 2006 with follow-up meetings occurring throughout the study period. All prices and quantities were gathered in FY 2006 and costs and benefits are expressed in 2006 dollars.

Some costs associated with DNA case processing in Topeka are not included in this evaluation. For example, the costs of training personnel to identify and collect biological material are not included. In addition, the costs of additional time at a crime scene are also not included. In this evaluation, cases are randomly assigned after each of these activities had occurred. Thus, the costs for cases in both groups are the same (a descriptive analysis of these costs is included later in this chapter). In addition, if the use of DNA in burglary investigations changes the likelihood that offenders will be arrested and convicted, other important costs and benefits will not be include. For instance, if more offenders are arrested and incarcerated, than the state will have to pay substantial additional costs to incarcerate those individuals. But, because these offenders were incarcerated, there may be substantial benefits to the community and its residents from reductions in offending.

A discussion of how labor and nonlabor costs were calculated can be found in Chapter 2.

Case Processing in Topeka

Table 8.1 details the costs of each stage of processing in Topeka. The total cost to all stakeholders of processing a case that results in an arrest is $815. Eighty-five percent of the total costs are labor costs. The remainder of the costs, including the cost of supplies, reagents and other disposable items. The cost of case processing is heavily back-loaded with just 20 percent of the costs accruing to the local forensic lab during the first three stages of processing and over 60 percent of the costs accruing after the beginning of the burglary investigation. The following section details the manner in which costs accrue in each stage.

Table 8.1. Cost of Processing by Stage in Topeka, Kansas

	Labor Costs	Nonlabor Costs	Total
Preliminary testing	$23	$5	$287
Generation of profile	$91	$35	$126
CODIS Entry	$5	$0	$5
Case verification	$79	$58	$137
Investigation	$412	$0	$412
Post-Arrest	$86	$22	$108
Total	$696	$119	$815

Source: Urban Institute
Notes: Rows and columns may not add due to rounding.

Stage 1—Preliminary testing

In Topeka, preliminary testing consists of an initial examination of the items(s) collected and an screening procedure to detect the presence of DNA as appropriate. This process takes approximately 50 minutes to complete and consumes an additional $5 in nonlabor costs, for a total cost of $28.

Stage 2—Generation of profile

Profiles are generated in batches, requiring approximately two hours per sample analyzed to conduct extraction, quantitation, amplification and gene mapping. Given an average of 1.6 samples tested per case, the entire process consumes approximately $21 in wages and an additional $35 in supplies and reagents. Once the profile has been generated, the analyst must spend approximately one hour writing a report of the findings and a second analyst must spend approximately one half hour reviewing the report. The total cost of this stage of processing is $126.

Stage 3—CODIS entry

Given that a profile is generated, the CODIS administrator must review the profile and available evidence and decide whether or not the sample may be uploaded into CODIS. This process takes approximately ten minutes for a total cost of $5.

Stage 4—Case verification

Once a profile is uploaded to CODIS, KBI must verify the match in the state database prior to issuing a suspect identification to investigators. This process is conducted in smaller batches than is the process of analyzing DNA. As a result, the per sample analysis time is 2.7 hours and costs $79 plus an additional $58 in nonlabor costs. Overall, this stage of processing costs $137.

Stage 5—Investigation

Once the match has been confirmed by the state lab, the investigative process increases in intensity. Upon notification of a DNA match, the detective assigned to the case will attempt to locate the suspect using one of several extant databases, generally including data maintained by the Departments of Parole, Probation, Prisons and Motor Vehicles, a process which takes approximately one hour to complete. Once the suspect has been located the lead investigator will create and execute a plan to question the suspect (usually conducted by two detectives). If the suspect is questioned, this process takes approximately 2.5 hours to complete. If there is sufficient cause, the detective will then spend another hour and a half obtaining a search warrant to search the suspect's possessions. Finally, the detective must write up the case notes and prepare for an eventual trial, a process that takes approximately a full day. Including time spent in transit, the entire investigatory process takes approximately 13 person-hours and costs approximately $412.

Stage 6—Post-Arrest

Once the suspect has been arrested and booked, a detective will draw a confirmation sample which is sent to the local lab for analysis. Analysis of a confirmation sample requires that all steps after the initial screening and prior to the CODIS upload must be repeated for the confirmation sample. This comprises approximately one half hour of labor cost plus an additional hour to produce a report describing the results of confirmatory testing, for a total cost of $42 plus an additional $22 in nonlabor costs.

The total cost of a case processing is described in Figure 8.1. These costs are not the average cost per case. Rather, these costs simply sum the cost of each stage of case processing. Thus, they are applicable only to a case that proceeds through all of the six stages of processing. A description of the average cost of a case in Topeka follows in the next section.

Figure 8.1 The Costs of Processing a Case with Biological Evidence, by Stage (Topeka, KS)

Source: Urban Institute.

Processing an Average Case

The total cost of processing the average case depends on the quality of the evidence collected and whether or not a profile or a match is obtained. In cases where evidence is collected but does not contain DNA, case processing ends after preliminary testing and, as a result, the costs of processing the case are small. In cases where a profile is obtained and a suspect is identified and apprehended, the costs are substantially higher. Ultimately, the cost of an average case depends on how many of the six cost stages cases complete during the analysis and investigation process. In order to calculate the cost of an average case, we first compute the *average marginal cost* of each stage of the DNA analysis process. A complete description of the cost methodology can be found in Chapter 2.

Table 8.2 provides descriptive statistics on the cost of processing a case in Topeka, using both the paired analysis, in which experimental cases are followed for the same length of time as its paired control case and the unpaired analysis which compares experimental and control cases regardless of the period of available observation. The costs are identical in the paired analysis.

Table 8.2. Cost of Processing an Average Case in Topeka, Kansas

	Unpaired Analysis	Paired Analysis
Mean	$260	$259
Standard Deviation	$246	$245
Minimum	$97	$97
25th percentile	$97	$97
Median	$102	$102
75th percentile	$388	$388
Maximum	$1,432	$1,432
Sample Size	131	131

Source: Urban Institute.

In Topeka, the cost of processing an average case was $260 in the unpaired analysis and $259 in the paired analysis. The middle 50 percent of cases had a cost between $97 and $388.

Costs for different agencies involved in case processing

Next we estimate how the costs of processing a case are distributed across each agency that participates in the burglary investigation. The cost of processing cases is shared by two different agencies: the state crime lab and the police department. The share of the burden borne by each agency depends upon the stage in processing a case reaches. For cases that reach only Stage 1 (preliminary testing), Stage 2 (generation of profile), Stage 3 (CODIS upload), Stage 4 (case verification) and Stage 6 (Post-Arrest) are borne entirely by the state crime lab. The costs of Stage 5 (investigation) are borne primarily by the police department. For a case that advances through the entire process, 33 percent of the costs are borne by the local lab, 17 percent of the costs are borne by the state crime lab and the remaining 50 percent of the costs are borne by the police department.

Table 8.3. Cost of Processing by Stage and Stakeholder (Topeka, Kansas)

	Total	State Lab	Police
Preliminary testing	$28	$28	$0
Generation of profile	$126	$126	$0
CODIS Entry	$5	$5	$0
Case verification	$137	$137*	$0
Investigation	$412	$0	$412
Post-Arrest	$108	$108	$0
Total	$815	$404	$412

Source: Urban Institute.

Notes:: In other sites, a local lab processes the DNA, and the only costs to the state lab are those of case verification. In Topeka, all lab tasks were performed by the state lab. Rows and columns may not add due to rounding.

Other Costs

There are additional costs involved in collecting and processing DNA evidence that are not included in these estimates. These include the cost of training personnel to observe and collect DNA evidence at crime scenes and the cost of locating, collecting and transporting evidence to the crime lab. These costs are not considered in our analysis because they occur prior to random assignment in the crime lab. Since they occur prior to random assignment, these are costs that are equal for treatment and comparison cases. Nevertheless, these costs are relevant to policymakers who are interested in determining the amount of funding necessary to collect and process DNA from high-volume crimes scenes in their jurisdiction.

Training

The biology supervisor of KBI and an analyst conducted three 150-minute training sessions with the TPD's senior police officers and detectives. The TPD was taught how CODIS functions, how to properly collect biological evidence, and the proper protocols for submitting a case to the study. Specifically they were told where to look for biological evidence at crime scenes, how to take swabs of bodily fluid or skin cells and how to properly package the swab or evidence item for submission to the KBI. After being trained by the KBI, the senior officers and detectives trained the remaining officers during their in-service days. During the fall of 2006 the same KBI analyst returned to the TPD to conduct follow-up training sessions with senior officers and detectives who had not attended the initial sessions. In total, we estimate the cost of training to be approximately $5,000, or $38 per case in Topeka's experimental condition.

Evidence Recovery

In order to secure DNA evidence, patrol officers report that they must remain on scene for an additional hour. In addition, a detective is generally called to the scene, spending an additional hour on scene and in transport. As officers do not collect DNA, a DNA collection technician must spend about two hours in transport and at the crime scene locating, collecting and securing DNA, for a cost of $82. Finally, an officer must spend approximately one hour transporting the DNA to the evidence room. In total, we estimate that collecting DNA at burglary scenes costs an additional $227 in labor costs—cost that would not have accrued had DNA not been searched for and collected.

OUTCOMES

Patrol officers in Topeka collected the majority of biological evidence with swabs from residential and auto-related crime scenes. In most instances, they collected touch samples followed by blood and sweat samples. About half of treatment cases resulted in at least one DNA profile and a third of treatment cases were uploaded into CODIS. These uploads yielded a match once out of every five uploads. Matches tended to occur most in the offender index. The CODIS hits were helpful to investigations as illustrated by the significantly higher rates of suspect identification, arrest and prosecution. These results were achieved with and without a restricted follow-up period for the treatment cases. In sum, officers collected evidence of decent quality that led to a one in five chance of obtaining a CODIS match. When matches occurred, investigations were aided greatly.

Topeka's patrol officers and CSI's collected biological evidence primarily from residential and automobile-related property crime scenes. The remaining fifth of crime scenes were comprised of commercial burglary scenes. At non auto-related crime scenes, doors were the most frequent points of entry, followed by windows. More than 80 percent of crime scenes had evidence of forced entry to the property.

Descriptive Statistics

The crime scene attributes (table 8.4) are the characteristics of a crime scene, e.g., how did the perpetrator gain entry, what type of crime was committed, who collected the biological material, etc. In all of the cases in Topeka, the variables described in crime scene characteristics describe case characteristics pre- randomization. Thus, the data in table 8.4 (and in tables 8.5 and 8.6 described below) can be used to determine whether the integrity of the random assignment process was maintained. Theoretically, if cases were assigned randomly to each experimental condition, there should be no differences in case attributes between groups. As is shown below, while there are small differences between the test and control groups on some variables, none of these differences are significant.

Table 8.4. Descriptive Statistics for Crime Scene Attributes of Cases Processed in Topeka.

	Attribute	Treatment Group	Control Group	Full Sample
Crime Type	Residential	40% (49%)	38% (49%)	39% (49%)
	Commercial	17% (38%)	19% (39%)	18% (38%)
	Auto-Related Crime	44% (50%)	43% (50%)	43% (50%)
	Other	0% (0%)	1% (9%)	0% (6%)
Point of Entry	Door	33% (47%)	29% (46%)	31% (46%)
	Window	19% (39%)	21% (41%)	20% (40%)
	Car	43% (50%)	43% (50%)	43% (50%)
	Other	6% (24%)	6% (24%)	6% (24%)
Point of Entry was Unlocked		18% (38%)	16% (36%)	17% (37%)
Average Number of Samples Collected		1.88 (1.26)	1.86 (1.52)	1.86 (1.39)
Evidence Collector	Patrol Officer	89% (31%)	91% (29%)	90% (30%)
	Detective	3% (17%)	1% (9%)	2% (14%)
	Forensic Specialist	8% (27%)	9% (28%)	8% (27%)
Any Fingerprints Collected		21% (41%)	15% (36%)	18% (38%)
Number of Offenders Searched Against in SDIS		552,201 (786,416.00)		
Item Stolen	Electronics	39% (49%)	45% (50%)	42% (49%)
	Other	53% (50%)	49% (50%)	51% (50%)
	Nothing	8% (27%)	6% (24%)	7% (25%)

Source: Urban Institute.

Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: : * p < 0.05, ** p < 0.01

Crime scene personnel collected nearly two samples of biological evidence at the crime scenes. True to their intention for the study, patrol officers did nearly all of the evidence collection. CSI's comprised less than ten percent of the cases and detectives collected a handful (2 percent) of cases. Fingerprints were collected at about one-fifth of the crime scenes. Test cases with a DNA profile were submitted to an SDIS Kansas database that had an average of half a little more than 40,000 samples including all of the system's indices. Burglars stole electronics in about four out of ten crime scenes. The randomization of the study held its integrity as no significant differences occurred in any of these metrics between the test and control groups.

Table 8.5. Descriptive Statistics for Temporal Attributes of Cases Processed in Topeka.

	Attribute	Treatment Group	Control Group	Full Sample
Case Assigned During First Half of Study		47% (50%)	53% (50%)	50% (50%)
Case Assigned (Season)	Fall	17% (38%)	19% (39%)	18% (38%)
	Winter	30% (46%)	26% (44%)	28% (45%)
	Spring	25% (43%)	25% (43%)	25% (43%)
	Summer	28% (45%)	30% (46%)	29% (46%)
Case Assigned (Time of Day)	Day Shift (2PM-10PM)	40%*** (49%)	25% (43%)	33% (47%)
	Night Shift (10PM-6 AM)	18% (39%)	26% (44%)	22% (41%)
	Morning Shift (6 AM- 2PM)	41% (49%)	50% (50%)	45% (50%)

Source: Urban Institute. Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$

Cases were dispersed evenly across the four seasons (table 8.5), and the smaller number of cases in the fall was due to project timing. Biological evidence was less likely to be collected during the night shifts than during the day shifts. This result may reflect that most residential burglaries occur when the residents are not at home. As such, less property crimes are reported during the night shift when most residents are at home.

Table 8.6. Descriptive Statistics for Collection Attributes of Samples Processed in Topeka.

	Attribute	Treatment Group	Control Group	Full Sample
Sample Type	Blood	28% (45%)	24% (43%)	26% (44%)
	Handled/ Touched (Cells)	52% (50%)	60% (49%)	56% (50%)
	Oral (Cells)	23% (42%)	18% (38%)	20% (40%)
	Worn (Cells)	0% (0%)	0% (0%)	0% (0%)
	Other	0% (0%)	1% (9%)	0% (6%)
Mode of Collection	Swab	63% (48%)	63% (49%)	63% (48%)
	Whole Item	37% (48%)	37% (48%)	37% (48%)
	Both	0% (0%)	0% (0%)	0% (0%)

Source: Urban Institute. Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Type of evidence collected may sum to more than one, as multiple samples may have been collected from different types of evidence. Significance: * $p < 0.05$, ** $p < 0.01$

In addition to patrol officers collecting biological evidence, the other stated aim of Topeka's study was to test whether touch samples yield usable DNA evidence. More than half of all samples collected were in this category. Blood evidence was collected from about a quarter of the crime scenes and oral fluid (e.g. saliva) evidence comprised about one-fifth of the cases. Patrol officers readily used their DNA "kits" to swab suspected biological evidence in about sixty percent of cases. At the remaining crime scenes whole items were collected and submitted to the KBI where they were swabbed.

Table 8.7. Descriptive Statistics for Intermediate Outcomes of Cases Processed in Topeka.

	Attribute	Treatment Group
DNA Profile Obtained		46% (50%)
DNA Profile Uploaded into CODIS		34% (47%)
CODIS Match Obtained	Total	20% (40%)
	Offender Hit	15% (35%)
	Forensic Hit	6% (24%)

Source: Urban Institute. Data are reported at the case level.

Amongst the test cases, 46 percent resulted in at least one DNA profile and 34 percent were uploaded into SDIS and NDIS. Twenty percent of cases resulted in a match—offender or forensic—with offender hits comprising the majority of the hits (15 vs. 6 percent).

Table 8.8. Suspects identified, arrested, and prosecuted in Topeka

	Treatment	Control
Suspect Identified	24%** (43%)	8% (27%)
Suspect Arrested	6% (24%)	2% (12%)
Number of Arrests	8	3
Case accepted for prosecution	7% (25%)	2% (15%)
Sample Size	131	129

Source: Urban Institute.
Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$

Probative DNA evidence may contribute to the higher proportion of test cases where a suspect was identified than cases in the control group. About one in four cases in the treatment group resulted in an identification. Fifteen percent of treatment cases obtained a CODIS match and a suspect identification.

Table 8.9. Method used to identify a suspect in Topeka

	Treatment	Control
Suspect Identified	24%** (43%)	8% (27%)
Traditional Investigation	8% (28%)	8% (27%)
CODIS Hit	15% (35%)	
Forensic Hit/Investigative Lead	2% (12%)	
Sample Size	131	129

Source: Urban Institute.
Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Significance: * $p < 0.05$, ** $p < 0.01$

Cost-Effectiveness

Cost-effectiveness analysis (CEA) is an economic analysis that compares relative costs to relative outcomes for two or more experimental conditions. A CEA yields a ratio of costs to outcomes, which can be interpreted as the amount of money that is necessary to achieve one unit of a particular outcome. A detailed description of the cost-effectiveness method can be found in Chapter 2. Cost-effectiveness ratios are calculated for three outcome variables: (1) the cost per suspect identified, (2) the cost per arrest and (3) the cost per case accepted for prosecution.

Table 8.10 Cost effectiveness of DNA analysis for property crimes in Topeka (unpaired)

Domain	Topeka
Expected Cost per suspect identification	$1,244
Expected Cost per arrest	$5,223
Expected Cost per case accepted for prosecution	$4,178

Table 8.11 Cost effectiveness of DNA analysis for property crimes in Topeka (paired)

Domain	Topeka
Expected Cost per suspect identification	$1,297
Expected Cost per arrest	$6,930
Expected Cost per case accepted for prosecution	$4,158

Topeka was second least expensive site (after Denver) in this study when monetary values were assigned to the three important outcomes. It is relatively less expensive to identify a suspect but about twice as expensive to arrest and prosecute that individual. Table 8.11 employs the restricted follow-up period on appropriate treatment cases and there is an impact of this change in analytic strategy. The rise in expected cost per arrest is due to the arrests which occurred beyond some treatment cases' follow-up periods. When fewer arrests occur, a smaller denominator is created from which the total costs of arrests must be divided. The cost of an average case, including cases where no DNA profile was obtained and those cases where a suspect was arrested was $259.

CHAPTER 9 – CROSS-SITE ANALYSIS AND DISCUSSION

OVERVIEW

This final chapter aggregates the data from each of the five sites and presents combined results. Considerable caution is warranted in interpreting this analysis. In four of the five sites, the DNA Field Experiment and associated demonstration funding was used to experiment with data collection protocols. For example, Orange County used the demonstration as a means of testing whether the collection and processing of touch samples was cost-effective. Thus, the DNA Field Experiment is best understood as a project that sought to test different approaches to the use of DNA as an investigative tool in high volume property crimes, and *not* as a test of established best practices. Denver was the site that most closely followed practices (e.g. the best practices as empirically determined in Chapter 3). Not coincidentally, Denver had the best results from among the five sites. Thus, it is fair to interpret the cross-site results as a lower-bound estimate of the efficacy of the use of DNA in property crime investigation. Jurisdictions employing evidence-based best practices in the future will very likely have even better results than the positive outcomes reported here.

In this chapter, we first present cross-site descriptive statistics on the outcomes by case processing and the rates of suspects identified, arrested and cases arrested for prosecution. Second, we examine the relative effectiveness of DNA compared to fingerprints. Third, we present the cross-site cost data. Fourth, we present cross-site cost-effectiveness estimates. This is followed by a discussion of the results and the policy implications of this study.

RESULTS

Outcomes of Cases with DNA Evidence

As seen in Table 9.1, a suspect was identified in 31 percent of cases where biological evidence was present and that evidence underwent DNA analysis. In the control sites where the biological evidence was not tested, a suspect was identified in 12 percent of cases, which is very similar to the FBI's estimate that 12.7 percent of burglary cases are cleared. In the treatment group, there was an arrest in 16 percent of case. In the control group there was an arrest in eight percent of cases. Across the five sites, there were 173 arrests in the treatment sites, 87 more than in the control sites.[7]

[7] Throughout the analysis we conduct analyses on both paired and unpaired cohorts, using the latter to account for the fact that some control cases were tested before test cases had completed case processing (see Chapter 2 for an explanation of this method). Across all five sites, when treatment and control cases were paired based on date of randomization, and the period of observation was censored for the treatment case on the date the control case was tested, there was little effect on the outcomes of interest. We

Table 9.1. Suspects identified, arrested, and prosecuted in all sites

	Treatment	Control
Suspect Identified	31%**	12%
Suspect Arrested	16%**	8%
Number of Arrests	173	86
Case accepted for prosecution	19%**	8%
Sample Size	1,079	1,081

Source: Urban Institute. *Notes:* Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. Some sites considered the issuance of a warrant to be a case accepted for prosecution. The use of John Doe warrants – where the suspects name is not know, is also included in this total. Significance: * $p < 0.05$, ** $p < 0.01$

Table 9.2 displays the investigative method used to identify a suspect. In the treatment group, a CODIS hit identified a suspect in about half of cases where a suspect was identified (16 percent). In an additional three percent of cases, biological evidence provided an investigative lead that eventually identified a suspect. In both groups, a suspect was identified in twelve percent of cases using traditional investigative techniques, including fingerprints.

Table 9.2. Method used to identify a suspect

	Treatment	Control
Suspect identified	31%**	12%
Traditional Investigation	12%	12%
CODIS Hit	16%	
Forensic Hit/Investigative Lead	3%	
Sample Size	1,079	1,081

Source: Urban Institute.
Notes: Data are reported at the case level. Significance testing is based on independent sample t-tests comparing each treatment group to the comparison group. CODIS Hits and Forensic Hit/Investigative Lead were observable in the data – the number of suspects identified using traditional investigation is calculated as the remainder. Significance: * $p < 0.05$, ** $p < 0.01$

THE CONTRIBUTION OF DNA EVIDENCE TO CASE OUTCOMES

In Table 9.3, we evaluate the contribution of DNA evidence to case outcomes by estimating the proportion of all treatment cases that successfully complete each stage of case processing. Across all

observe, for instance, only nine fewer arrests in the paired analysis compared to the unpaired analysis. Thus, we only present results from the paired analysis. Estimates from the paired analysis are available from the author.

sites, a profile was generated from forensic material collected at a crime scene in treatment cases 70.3 percent of cases. More than half of treatment cases in the study yielded a profile that was uploaded into CODIS, 23.3 percent of cases resulted in a CODIS hit and 20.6 percent yielded a suspect identification via that CODIS hit. In 14.4 percent of all test cases an arrest was made on a suspect identified in CODIS. In 13.0 percent of all test cases, the prosecutor accepted a case against a defendant who was identified by a CODIS hit.

Table 9.3. Outcomes of Treatment Cases by Stage of Case Processing

	All Sites	Denver	Topeka	Phoenix	Los Angeles	Orange County
Generation of profile	70.3%	86.3%	45.8%	58.2%	89.1%	64.7%
CODIS Entry	54.7	82.4	33.6	57.4	65.3	26.5
CODIS Hit	23.3	45.9	19.8	15.9	27.5	6.0
Suspect Identified (via CODIS hit)	20.6	39.2	16.0	14.7	26.4	5.2
Suspect Arrested (via CODIS hit)	14.4	33.7	3.8	6.8	20.7	2.8
Case Accepted for Prosecution (via CODIS hit)	13.0	32.2	3.1	6.8	16.1	2.4
Sample Size	1,079	255	131	251	193	249

Source: Urban Institute.

These data can also be used to identify aspects of case processing where the demonstration sites were more and less successful processing cases. Table 9.4 describes the percentages of cases that advanced to the next stage of processing. Overall, 77.5 percent of all test cases yielded a profile that was uploaded into CODIS. Of cases where a profile was uploaded into CODIS, 42.5 percent of profiles yielded a CODIS hit. A suspect was identified from the CODIS hit 88.4 percent of the time.[8] Given that a suspect was identified, an arrest was made in 69.8 percent of cases.[9] If an arrest was made, the case was accepted for prosecution in 90.3 percent of cases.

[8] CODIS hits may identify an individual who is not a suspect in the case, such as a homeowner or a law enforcement officer. In addition, communication problems between the lab and the police may result in a suspect not being recorded by the police.

[9] An identified suspect may not be arrested for a variety of reasons. The suspect might not be located. The suspect may be serving time on an unrelated matter which is serious enough that processing the burglary case is not in the interest of justice, and, in Topeka, a CODIS hit is not sufficient for an arrest warrant.

Table 9.4. Percentages of Test Cases Progressing to the Next Stage of Case Processing

	All Sites	Denver	Topeka	Phoenix	Los Angeles	Orange County
CODIS Entry	77.7%	95.5	73.3	98.6	73.3	41.0
CODIS Hit	42.5	55.7	59.1	27.8	42.1	22.7
Suspect Identified (via CODIS)	88.4	85.5	80.8	92.5	96.2	86.7
Suspect Arrested (via CODIS)	69.8	86.0	23.8	45.9	78.4	53.8
Case Accepted for Prosecution (via CODIS)	90.3	95.3	80.0	100.0	77.5	85.7
Sample Size	1,079	255	131	251	193	249

Source: Urban Institute.

There is substantial variation across the sites, reflecting the differences in practice. In Phoenix and Denver almost all DNA profiles are uploaded into CODIS. In Orange County, where they collected a substantial amount of touch evidence and evidence from commercial burglary's, only 41 percent of cases were uploaded, reflecting the difficulty in obtaining probative samples from these sources. Orange County also had the lowest rate of CODIS hit, and anecdotal evidence suggests this may have been due to a higher percentage of juvenile offenders. Topeka had the highest CODIS hit rate, but the lowest rate of identifying suspects via a CODIS hit.

The largest cross-site variation in these data are in the proportion of identified suspects who are arrested. Denver, which reported the presence of policies that encouraged aggressive follow-up of suspect identification, arrested 86 percent of known suspects. By contrast, the rate in Topeka was 23.8 percent. This is likely due to a policy unique to Topeka where a CODIS hit is not considered sufficient for an arrest warrant. For all sites combined, if an arrest is made in the case, the case was accepted for prosecution in 90 percent of cases.[10]

Comparing Outcomes for Fingerprint and Biological Evidence

Biological evidence was collected for every case in both the treatment and control groups. Thus, we are able to test whether there are differences in case outcomes between biological evidence and fingerprint evidence, conditional on the collection of biological evidence. The effectiveness of fingerprint evidence can be evaluated in two ways. First, in order to be as effective as DNA, fingerprint evidence would have to be collected about as often as DNA evidence was collected. Second, the probability of identifying a suspect would have to be the same for fingerprints as DNA (or higher if fingerprints were collected less often). Our data does not support either of those hypotheses.

[10] In some instances, cases may be accepted for prosecution outside the period of observation for this study.

Table 9.5. Effectiveness of biological and fingerprint evidence

	Percentage of cases where evidence collected	Percentage yielding identification of suspect	Percentage yielding an arrest
Biological Evidence	100%	16%	9%
Fingerprint Evidence (all cases)	33%	3%	1%
Fingerprint Evidence (cases where fingerprints collected)	100%	8%	3%

Source: Urban Institute

We find that in cases where biological evidence was collected, fingerprint evidence was collected only one-third of the time. In all cases, a suspect was identified by biological evidence in 16 percent of cases. Individuals were identified by fingerprint in only three percent of cases. An arrest was made following CODIS identification in nine percent of cases. An arrest was made following a fingerprint identification in one percent of cases. When considering only those cases where both fingerprints and biological evidence were collected, suspects were identified by CODIS (16 percent) at twice the rate they were identified by AFIS (eight percent). Suspects were arrested following a CODIS hit at three times the rate (nine percent) they were arrested following an AFIS hit (three percent).

COST OF DNA PROCESSING IN HIGH VOLUME CRIMES

The cost of processing and investigating a case with DNA evidence is dependent on a number of factors – the wage structure of forensic scientists in local and state forensic laboratories and of police officers and detectives in local police departments, the relative labor-intensity of case processing, the cost of capital (non-labor) and the number of samples that are analyzed in an average case. Higher wages, a higher degree of labor intensity and a higher number of samples analyzed per case are all associated with higher costs per case. There are also differences in costs due to outsourcing. The two sites that outsourced DNA analysis – Los Angeles and Phoenix – incurred the highest costs. In Phoenix, the cost of case processing to the local lab was $1,093, over double the average cost of local lab processing in Denver, Orange County and Topeka. In Los Angeles, the cost of case processing is over three times higher the average of Denver, Orange County and Topeka, and more than twice as high even after removing the most expensive cost element – the cost of expediting analysis of confirmation samples.

The cost estimates presented in this report the additional costs of processing a case with DNA evidence over and above the costs of processing a case using traditional investigative procedures. We conducted semi-structured interviews with police, prosecutors and crime lab staff to develop estimates of the additional cost of processing steps that are either not performed in traditional investigations, or that occur more often in cases where biological evidence is processed. We note that since randomization occurred after biological evidence was collected, costs of training and evidence collection are not included in these totals. In addition, because our period of observation was limited, costs associated with prosecution and incarceration are also not included.

The Cost of Processing a Case by Stage

Table 9.6 presents the cost of complete processing. Overall, the cost of processing a case with DNA evidence from the time the evidence is delivered to the local forensic laboratory until the time that a suspect's confirmation sample is tested ranges from $815 in Topeka to $2,481 in Los Angeles. When each site's average cost estimate is weighted by its number of test cases, the average cost of processing a case from beginning to end is $1,394. As shown, there is considerable variation in the cost of each stage by site.

Table 9.6. Costs of Processing a Case By Stage

	Denver	Topeka	Phoenix	Los Angeles	Orange County	All Sites*
Preliminary testing	$86	$28	$729	$980	$23	$374
Generation of profile	$241	$126	N/A	N/A	$271	$135
CODIS Entry	$92	$5	$14	$167	$80	$74
Case verification	$78	$137	$69	$195	$195	$131
Investigation	$372	$412	$378	$300	$370	$365
Post-Arrest	$164	$108	$280	$838	$210	$315
Total	$1,033	$815	$1,470	$2,481	$1,149	$1,394

Source: Urban Institute. *The all sites column reports weighted averages across the sites.

For the sites that do not outsource DNA analysis, the cost of preliminary testing and analysis through the generation of a profile varied from $154 in Topeka to $327 in Denver. In experimental sites that outsource case processing, Phoenix and Los Angeles incurred a cost of $729 and $980, respectively. The high degree of variation in the cost of the CODIS entry phase is due primarily to the length of the process needed to determine whether a sample is eligible for CODIS upload and whether or not a large number of elimination samples were typically tested at this stage. Overall, the weighted average cost of the CODIS upload phase was $74. In all, approximately 37% of the costs of processing a case with DNA evidence are incurred prior to CODIS upload. This ranges from 20% in Topeka to 55% in Phoenix.

Verification of the hit to a convicted offender profile at the state lab, added on average, $131 to the cost of case processing. The cost of investigating offender hits demonstrated considerably less variation compared to each stage of lab processing. On average, the cost of investigation is $365, ranging from $300 in Los Angeles to $412 in Topeka. Finally, once a suspect is apprehended, the local lab must analyze a confirmation sample drawn from the suspect, the cost of which is highly dependent on whether or not analysis is done in-house. In the four sites that analyze confirmation samples in-house, costs range from $108 in Topeka to $280 in Phoenix. However, in Los Angeles, where confirmation samples are sent to Cellmark for analysis, the cost of analysis is $400, as per contractual agreement. In addition, due to rules imposed by the court system, for cases in which the suspect is not currently in custody, Los Angeles pays an $800 rush fee for processing within five business days, a cost which considerably adds to the total cost of analysis.

Costs to crime labs and police agencies

The cost of processing cases is shared by three different agencies: the local crime lab, the state crime lab and the police department. For a given case, the share of the burden borne by each agency depends upon the stage in processing the case reaches. For cases that reach only Stage 1 (preliminary testing), Stage 2 (generation of profile) or Stage 3 (CODIS upload), the costs are borne entirely by the local crime lab (or the state lab if no local lab is involved). The costs of Stage 4 (case verification) are borne almost entirely by the state crime lab. The costs of Stage 5 (investigation) are borne primarily by the police department and the costs of Stage 6 (Post-Arrest) are borne entirely by the local crime lab (or the state lab if no local lab is involved).

Table 9.7. Costs of Processing a Case by Stakeholder

	Denver	Topeka	Phoenix	Los Angeles	Orange County
Local Lab Subtotal	$583	$267	$1,093	$1,986	$584
State Lab Subtotal	$78	$137	$69	$195	$195
Police Subtotal	$372	$412	$309	$300	$370
Total	$1,033	$815	$1,470	$2,481	$1,149

Source: Urban Institute.

Across all sites, for a case that advances through the entire process, 66% of the costs are borne by the local lab (or the state lab if no local lab is involved), 9% of the costs are borne by the state crime lab and the remaining 25% of the costs are borne by the police department.

Cost-Effectiveness

Table 9.8 Cost-Effectiveness of DNA Case Processing. Unpaired analysis.

	Denver	Topeka	Phoenix	Los Angeles	Orange County	All Sites*
Expected Cost Per Suspect Identified	$1,466	$1,244	$6,170	$8,147	$4,822	$4,502
Expected Cost per Arrest	$3,679	$5,223	$27,378	$10,319	$19,287	$14,169
Expected Cost per Case Accepted for Prosecution	$1,903	$4,178	$10,785	$12,899	n/a	$6,169

Source: Urban Institute. The all sites column reports a weighted average across the five sites.

Across all five sites, the cost per suspect identified was approximately $4,500, ranging from a low of approximately $1,466 in Denver to a high of approximately $8,147 in Los Angeles. On average, the cost per arrest was approximately $14,000 and the cost per case accepted for prosecution was about $6,200.

Again, it should be noted that these costs are not simply the expected cost per suspect identified, arrested and prosecuted. Instead, they are the added costs of identifying, arresting and prosecuting burglars who otherwise would not have been caught.

Characteristics of Suspects in High Volume Property Crimes

Table 9.9 Criminal History of Arrested Offenders

	N	Number of Prior Felony Convictions	N	Number of Prior Felony Arrests	N	Number of Prior Misdemeanor Convictions	N	Number of Prior Misdemeanor Arrests
Treatment (All)	198	2.5** (3.0)	186	4.5** (4.6)	183	2.1** (2.6)	180	2.6** (3.1)
Treatment (CODIS ID)	147	2.9** (2.4)	138	5.6** (4.7)	132	2.2** (3.3)	132	3.0** (3.2)
Control (No CODIS ID)	50	0.9 (1.7)	50	1.7 (2.6)	50	1.6 (1.9)	49	1.0 (2.5)

Source: Urban Institute Analysis of primary data. Notes: This table reports data on the criminal history of suspects identified in experimental cases. There may be multiple suspects for any particular case. T-tests separately compare differences between each cohort of the test group to the control group. * $p<0.05$, ** $p< 0.01$

Overall, we find that suspects identified within the test cohort were significantly more likely to have additional prior felony convictions, more prior felony arrests, more prior misdemeanor convictions, and more prior misdemeanor arrests. For cases where a suspect was identified and criminal justice histories were available, test cases averaged 4.5 prior felony arrests and 2.5 felony convictions. In the sub-group of cases where the suspect was identified via a CODIS hit, cases in the test condition averaged 5.6 prior felony arrests and 2.9 prior felony convictions. The differences between this group and the control group were also significant across all four measures.

Two caveats should be noted when interpreting these data. First, a criminal history was only available after a suspect had been identified (or in many cases only after a suspect had been arrested). For many cases, given the short period of observation, no arrest records were available at the time data collection was completed. Thus, criminal histories are only available for 43 percent of suspects identified (and criminal history data were available for 64 percent of arrestees).

- In Denver, criminal history data were available for 101 test cases (including 82 identified via CODIS) and 24 control cases. Prior felony arrests average 4.2 for the all test group cases, 4.7 for test cases with a CODIS identification, and 2.3 for the control group. Prior felony convictions average 2.4 for all cases in the test group, 2.8 for test cases with a CODIS identification, and 1.3 for the control group.
- In Orange County, criminal history data were available for 33 test cases (including five identified via DNA) and 25 control cases. Prior felony arrests average 1.2 for the all test group cases, 4.0 for test cases with a CODIS identification, and 0.5 for the control group. Prior felony convictions average 0.9 for all cases in the test group, 3.2 for test cases with a CODIS identification, and 0.4 for the control group.
- In Los Angeles, criminal history data were available for 47 test cases (46 identified via CODIS) and one control case. Prior felony arrests average 7.5 for all test cases and 7.5 for test cases with a CODIS identification. Prior felony convictions average 2.6 for the all test cases and 2.7 for test cases with a CODIS identification.
- There were 12 suspects identified in Phoenix, all through CODIS. They averaged 4.2 prior felony arrests and 3.8 prior felony convictions.
- The were six suspects identified in Topeka, with complete criminal histories available for only two.

DISCUSSION

The main findings of this report is that DNA can solve more burglaries and potentially other property crimes as well:

– Property crime cases where DNA evidence is processed had twice as many suspects identified, twice as many suspects arrested, and more than twice as many cases accepted for prosecution as compared to traditional investigation;

– DNA was at least five times as likely to result in a suspect identification compared to fingerprints;

– Suspects identified by DNA had at least twice as many prior felony arrests and convictions as those identified by traditional investigation;

– Blood evidence results in better case outcomes than other biological evidence, particularly evidence from items that were handled/touched. Evidence collected by forensic technicians and police officers are equally as likely to result in a suspect identification.

The evidence supports the conclusion that DNA is more effective than traditional investigation in solving high-volume property crimes. Thus, this research supports the expansion of the use of

DNA in property crime investigations. Furthermore, it appears that this can be implemented cost-effectively, if police agencies allocate resources optimally.

Patrol officers who are adequately trained in DNA evidence identification and collection appear to do as well as more specialized forensic personnel in collecting probative evidence, in terms of yields per sample submitted. The study did not analyze whether CSIs were more expert in collecting other forensic samples, both in terms of quality and quantity.

There are substantial opportunities to improve the process of training patrol officers. In many expert interviews, we were told that the most effective police training would be to include DNA investigatory training as part of the police academy curriculum. For officers already on duty, the most effective training appeared to be an intensive initial training followed by frequent short refresher training events.

We also find that obtaining buy-in from detectives, sergeants and investigators can also help to encourage more, and better, evidence identification and collection. The study did not systematically examine training protocols or evidence collection practices, however, and there is need for more research in this area.

There are substantial differences among crime scene attributes and case outcomes. Evidence collected from items that were handled or touched was less cost-effective than other sources of biological material. Changes in patrol officer incentives may also help to increase the effectiveness of DNA in property crimes. The 2-10PM shift had the least favorable outcomes. This suggests that there are additional burdens on police time from collecting biological evidence that need to be accounted for in police policies.

Collaboration of each of the actors in the system—the police, the crime lab, and the prosecutors—matters. Police need to be adequately trained by the lab in identification and evidence collection practice. Labs need to provide feedback to police officers on the effectiveness of their attempts to collect evidence. Prosecutors need to work with both the police and the lab so personnel are comfortable serving as witnesses at trial, should they be called upon. The three agencies need to work collaboratively to design protocols that focus resources on collecting evidence with the highest likelihood of yielding a probative sample.

Case processing information must be shared between agencies. Prosecutors need to notify police and lab personnel about case outcomes. Police must provide data on the incidence and prevalence of evidence collection so that training can be targeted appropriately. Police agencies would also benefit from putting into place policies where officers can be identified as being in need of additional training without being stigmatized for prior practice. Forensic labs should provide data to police describing the attributes of evidence collected that are associated with a higher probability of suspect identification, and, the attributes of evidence that are not.

DNA can only be effectively integrated into investigations if suspects are ultimately held accountable for crimes. in jurisdictions where police units—individually and collectively—focus on obtaining and actively using the evidence, and prosecutors act upon the results, outcomes will be positive. Where barriers to this collaboration are built—such as the requirement that a confirmation sample is collected from a CODIS-identified suspect before an arrest is made—results will be worse.

The DNA Field Experiment results suggest that DNA is cost-effective in burglary investigations. If the results of this study prove to be applicable to cities and counties throughout the United States, there is likely to be additional pressure on crime laboratories to expand their processing of DNA evidence. Such an expansion would likely require substantial time and resources to implement, as the infrastructure for expansion does not appear to be in place.

LIMITATIONS

The DNA Field Experiment is best understood as a project that sought to test different approaches to the use of DNA as an investigative tool in high volume property crimes, and not as a test of established best practices. With only five sites in the demonstration and with variation in who the experiment was conducted, it is difficult to compare results across sites, and therefore some caution is warranted in interpreting the cross-site results. In four of the five sites, the DNA Field Experiment and associated demonstration funding was used to experiment with data collection protocols. For example, Orange County used the demonstration as a means of testing whether the collection and processing of touch samples was cost-effective. However, it is worth noting that the site that most closely followed the empirically derived best practices (Denver) had the best outcomes from among the five sites.

It is also important to note limitations in the external validity of the study. The sites included in the sample were not randomly selected from all police agencies, so we can not speculate as to how representative these sites are compared to all police agencies. At least two of the sites -- Denver and Orange County -- had substantial experience using DNA in high volume crime investigations. This may have produced atypical results. The sample size of five also does not allow for pooled analysis, so each sites outcomes are reported independently. Thus, the effects reported here are averages, and do not account for site-level or other effects. However, since the study was conducted using randomized assignment, and the integrity of that randomization was maintained throughout the study, our confidence in these results is relatively high, despite these limitations.

CHAPTER 10 -IMPLICATIONS FOR POLICY AND PRACTICE

The effectiveness of DNA in solving crimes that have not traditionally been investigated using DNA technology may well have profound impacts on criminal case processing in the future. If the identification, collection and processing of DNA evidence becomes business as usual in criminal investigations for property crimes, the criminal justice system will be deluged with cases as a result. Our research suggests that large numbers of offenders who could be identified via DNA today are not being identified by traditional investigations. In most cases, resource constraints prevent local authorities from using DNA to identify and prosecute offenders in property crimes. Currently, the capacity of police and labs to identify and collect DNA is limited, crime laboratories are severely constrained in their ability to process biological evidence in volume, and prosecutors have not prepared for the impact of large numbers of cases where DNA evidence is the primary source of offender identification. Without substantial attention to the potential impacts of DNA on criminal justice processing—both intended and unintended—police, labs and prosecutors may not fully exploit this new technology.

This chapter describes the implications of the study. First, we identify issues raised by the study that must be resolved for each key actor in the criminal processing of cases with DNA evidence—the police, crime laboratories, and prosecutors—to cost-effectively implement expanded collection and processing policies for cases with DNA evidence. Next, we suggest some areas for additional investigation—including broader questions about the effect of processing large numbers of DNA-aided cases on criminal justice systems. Finally, this section identifies areas where future research could inform more cost-efficient policy-making.

CHANGES IN POLICING

One finding of this report is that in the five study sites, forensic technicians were no more effective than patrol officers in collecting biological evidence as forensic technicians. As a result, police may well have an increased role not only in locating and apprehending offenders identified via DNA, but in the collection of that evidence as well. How much training in DNA evidence identification and collection should patrol officers receive? Should that training occur in police academies and how much of an additional investment would this require? Or, should communities focus on training additional forensic technicians to aid collection, or even train civilian volunteers?

The opportunity cost of a patrol officer's time and a forensic specialist's time is critical to understanding where new resources should be applied. That is, in making these decisions, local jurisdictions need to ask what else these officers and technicians would be doing if they were not collecting biological evidence, and what the costs are of those other tasks not being completed. For example, the explicit use of patrol officers as investigators searching for biological evidence as opposed to maintaining order and safety has profound implications. How will deployment decisions be affected by the need to have officers trained in DNA evidence identification and collection available to respond to crime scenes? What are the implications of the additional time on scene that will be required for police officers? How will the prioritization of calls for service be affected by these decisions?

DEMAND FOR LABORATORY SERVICES

Many questions must be answered to determine how quickly crime laboratories can be equipped with the resources to meet the increased demand for DNA processing. In order to increase the number of cases solved by DNA, what is the necessary additional investment in expanding laboratory capacity? What types of capital investments in new technology are required? How many additional evidence collectors are needed and of what type (police, criminalist, other technicians, or DNA collectors)? Should jurisdictions seek to increase their in-house laboratory capacity or rely on outsourced, private labs? Our research demonstrates that outsourcing is more expensive than in-house processing, but we are not able to account for major fixed costs of purchasing robotics and other technology and other capital expenditures. Realizing the potential of DNA processing to solve twice as many crimes as traditional investigation will require substantial increases in resources.

INVESTIGATION AND PROSECUTION

A concern about focusing resources on the investigation of crimes—including high volume crime such as burglary—is that there will be spillover effects on the investigation and prosecution of other crimes. Does a focus on forensic investigation cause other crimes to be under-investigated due to limited resources? Does the higher closure rate for DNA-led investigations incentivize more investment in those cases and reduced investments in crimes that can only be investigated using traditional investigative approaches, such as drug crimes, sex crimes where consent is at issue, domestic violence and robbery? What is the impact on resources available for other forensic investigations (such as traditional detective work, fingerprint collection or other forensics such as footprints)?

In the longer-term, there are also a set of important trade-offs that must be considered as the criminal justice system responds to the increase in DNA-led investigations. Does increased reliance on forensic-led investigations incentivize more reactive policing at the expensive of proactive approaches? Will growing reliance on DNA lead to a trade-off away from labor (detectives) in favor of capital investments (such as laboratory robotics)? Will the resources invested in the investigation of different types of crimes change as crimes that are more amenable to DNA processing receive a greater share of resources? If crimes with a DNA investigation prove to be easier to convict, will crimes that are not aided by DNA (such as domestic violence, drug offenses, and acquaintance rape cases where consent is the issue) receive less criminal justice system attention?

COLLABORATION

Evidence from this study suggests that profound changes in the way police, prosecutors and crime laboratories interact is required to efficiently use DNA in investigations. To this end, it is important to consider how inter-organizational communication among police, the lab, and the prosecutor would need to change to facilitate this expansion. Can agency goals be aligned to allow critical and timely information to be shared? Can critical data be shared internally to demonstrate the effectiveness of DNA and promote more and better biological evidence collection? Can barriers to policing—such as the rule in some jurisdictions that suspects identification via DNA is not sufficient grounds for an arrest—be removed?

ISSUES IN NEED OF FURTHER EXPLORATION

As noted, the study was unable to estimate the costs of training additional evidence collectors nor the extra time spent on scene by responders because the costs were identical for both the treatment and control groups (since randomization occurred after evidence collection). However, we note across the five sites that additional training was conducted and the costs appear to be equivalent to a day or two of officer time (or other evidence collectors time), plus the cost of the trainers (a cost that could be reduced using standardized training tools, such as a DVD). In addition, since training appears to be most effective when it is ongoing, jurisdictions would need to account for those costs as well. We also note that some additional time on scene is required to identify and collect biological evidence. The implications of this additional time on scene are not trivial, since the opportunity cost of an officer's time could be high. Additional research could determine whether the benefits of more suspect identifications outweighs these opportunity costs.

This latter point highlights a policy challenge for jurisdictions expanding their use of DNA in burglaries. That is, in this study the cost of patrol officer collections was slightly lower than the cost of a forensic technician collection. This may not be true in other jurisdictions. Regardless, the critical issue for other jurisdictions is the opportunity cost of the evidence collector’s time. Even if wages of patrol officers are lower than forensic technicians, the opportunity cost of having an officer remain at a scene to identify and collect evidence rather than engaging in other policing activities may be greater than the savings in wages.

The study does not factor in estimates of costs of the crimes that are prevented. Put another way, while the costs of incorporating DNA analysis into burglary investigations is priced in to the model, the benefits from preventing future harms are not. Further research could build upon the data collected for this study by following our cases, observing the ultimate case disposition, and estimating the number of crimes and associated harms prevented by incapacitating burglars. We note that the incarceration of burglars adds another cost to using DNA in burglaries, since jail and prison are costly. As an extension of this project, further research to determine whether or not the benefits from incarcerating burglars outweighs the cost would be instructive. Given the substantial variation in sentencing practices for burglars across the demonstration sites, it is clear that perceptions about the harms from burglary vary substantially.

The study randomized assignment of cases once biological material had been collected. As a result, the study does not answer the compelling question of “how many burglary cases potentially yield a biological sample?” If the number of scenes yielding biological evidence is small, than DNA profiles are going to be rare, and the average cost of a profile will be high. Nevertheless, it is an important—and unanswered research question. If the percentage is relatively high, given the results of our study, then the implications for practice are to identify substantial additional resources that can be assigned to evidence collection. If the ratio is relatively low, then an appropriate response would be to establish screening mechanisms to identify in a low cost way cases that are most likely to yield biological material. One approach might be to have 911 call centers screen for high probability crimes (“do you see blood? Do you see any items that have been partially eaten, a container that has been used for drinking, a cigarette butt that you cannot account for? Was your point of entry unlocked?”). Given that this question can not be answered, establishing some screening processes now would likely yield the largest short term gains in evidence collection.

Finally, there are several findings here that would benefit from more in-depth research. We note that detectives did not know whether the DNA collected in the case was analyzed or not. Thus, differences in outcomes may be in part due to the quality of the detective in interviewing an identified suspect. Future research should consider how to train detectives and investigators to maximize the use of DNA in suspect interviews[11]. Also, we note that there is no clear explanation why DNA processing is superior to fingerprint identification in identifying suspects. The AFIS database is substantially larger than CODIS, so the finding that DNA is more effective is somewhat counter-intuitive. We also note that there is no clear explanation for why DNA was found at so many more crime scenes than fingerprints. The evidence collector in most instances was trained in collecting fingerprints as well (in Los Angeles, for example, latent print technicians were used to collect some evidence). Thus, it is not clear why DNA was collected and fingerprints were not.

CONCLUSION

The main finding of the report is that the use of DNA in the investigation of property crimes increases the rate at which suspects are identified, arrested and prosecuted for property crimes. We find that DNA is more effective than fingerprints in identifying suspects. Other investigative tools, from eye witness testimony to impression evidence, have recently been subject to criticism. In combination, this suggests that the reliability of DNA evidence means that DNA-led investigations may become a more common means of identifying suspects in criminal cases. The implications of that shift would be substantial. DNA analysis is much more expensive than fingerprint analysis, and the resources needed to fund an expansion of capacity would be large. In addition, the use of DNA appears to be very effective in identifying suspects in some kinds of cases—homicide, stranger rape,

[11] We thank an anonymous reviewer for identifying this issue.

and property crimes—but less so in other kinds of crimes—domestic violence and drug crimes. If the large investments in capacity to analyze DNA evidence that are necessary to move this investigatory tool into the mainstream are made, the mix of crimes that are investigated may change as well. In short, if DNA causes a revolution in policing as some predict, local jurisdictions would do well to remember that while DNA is a reliable and effective investigative tool in some crimes, resources must remain available to investigate other criminal matters.

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