

# **Research Bulletin**

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## Forensic DNA evidence: 21st century criminal justice tool

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ne of the best crime-solving tools of the 21st century, DNA, or deoxyribonucleic acid, represents the intersection of science and criminal justice.<sup>1</sup> Forensic DNA evidence has the ability to solve criminal cases—and even prevent future crime—but the use of DNA to identify and convict criminal offenders is relatively new. In 1987 the first person arrested through DNA evidence was linked to evidence from two rape cases in England.<sup>2</sup> The first American convicted using DNA evidence was Tommy Lee Andrews in Florida, also in 1987, for a sexual assault.<sup>3</sup> Since its introduction as evidence in the courts, forensic DNA testing is one of the most thoroughly scrutinized and



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validated techniques in the history of forensic science.<sup>4</sup> In addition to its crime solving capabilities, DNA can exonerate wrongly convicted offenders and identify human remains.

DNA, the fundamental building block for an individual's entire genetic makeup, is the same in every cell and is unique to each individual, except in the case of identical twins, who share identical DNA. Biological samples that contain DNA include blood, skin, semen, hair, and saliva, all of which constitute crime scene evidence. Because of DNA's uniqueness to individuals, DNA testing is a valuable criminal justice tool that can identify or rule out criminal suspects.

Forensic DNA testing for criminal justice has received much attention from the media, legislators, and the criminal justice system. DNA-related legislation is continually proposed, and millions of dollars are being allocated for DNA testing. In 2005, President Bush's DNA initiative, Advancing Justice through DNA Technology, provided \$1 billion over five years to improve states' abilities to use DNA evidence by eliminating testing backlogs, supporting research and development, improving crime lab capacity, offering training, and conducting testing to identify the missing.

This *Research Bulletin* focuses on how DNA is being used and examines future trends in the criminal justice system as technology improves and individual DNA profiles are captured in the FBI's national database.

#### Forensic DNA technology

#### DNA analysis methods

Technological advances allow testing of very small samples of DNA for forensic purposes. Test types include the polymerase chain reaction technique and short tandem repeat technique for samples containing nuclear DNA. For samples not containing nuclear DNA, which include hair, bones, and teeth, the mitochondrial DNA technique is utilized.

The polymerase chain reaction technique makes millions of exact copies of amounts of DNA that are invisible to the naked eye. Short tandem repeat technology analyzes specific regions (or loci) found on nuclear DNA. The FBI uses a standard of 13 core short tandem repeat technology loci to compare individual DNA profiles to each other. Prior to short tandem repeat technology, a technique called restriction fragment length polymorphism was used, but this required large quantities of DNA samples to test. If appropriate, DNA evidence from older cases not tested using the newer techniques-polymerase chain reaction and short tandem repeat technology–can now be tested using them.<sup>5</sup>

For old or highly degraded biological samples there may be no nuclear DNA for analysis, and mitochondrial DNA testing, which analyzes DNA from the mitochondrion of a cell, is employed. This testing is often used on unidentified remains and for investigations of missing persons.<sup>6</sup> Since mitochondrion in cells are passed from a mother to her children, mitochondrial DNA can only link individuals through maternal relatives.

#### Illinois State Police Division of Forensic Services Forensic Sciences Command

After collection, DNA samples are sent to a forensic laboratory for analysis. The Illinois State Police (ISP) Division of Forensic Services Forensic Sciences Command, established in 1942, is the third largest crime lab system in the world, following the United Kingdom Forensic Science Service and the FBI. By statute, ISP provides crime scene and forensic science services to 1,500 criminal justice agencies in Illinois (725 ILCS 5/116 5).<sup>7</sup> The ISP system consists of eight testing labs and a research and development lab. The crime lab has five indices: forensic, offender, missing person, relatives of missing person, and unidentified human: that contain different DNA profile types. The unidentified human index stores the DNA profiles from living persons who cannot identify themselves, such as babies and coma patients, and from the remains of dead persons whose identification is unknown.<sup>8</sup>

#### National DNA database

The Combined DNA Index System (CODIS) is an FBI laboratory's computer software program that stores DNA profiles and allows federal, state, and local crime labs to compare DNA profiles electronically. The FBI provides this system software and its installation, training, and user support free to state and local law enforcement labs performing DNA analysis. The Illinois State Police crime laboratory uploads the state's DNA profiles to the CODIS database. As of December 2005, the Illinois database held a total of 175,390 offender profiles and 16,179 crime scene profiles.<sup>10</sup>

A "hit" occurs when CODIS uncovers identical DNA samples. DNA from a crime scene is matched to a previously convicted offender's DNA or evidence from another crime scene. CODIS produced 29,100 hits in its database as of January 2006, assisting 30,985 nationwide investigations and 3,578 Illinois investigations.<sup>11</sup> In state fiscal year 2004 there were 367 CODIS hits, averaging 31 hits per month or one per day.<sup>12</sup> CODIS' use and the amount of hits it produces is increasing due to advancements in technology and growing awareness of its capabilities by law enforcement, the courts, and federal, state, and local governments, and the public.

#### **Forensic DNA collection**

#### Crime scene DNA collection

Law enforcement officers are responsible for collecting forensic DNA evidence at crime scenes. The first responding officer must secure the crime scene, identify potential evidence, and preserve that evidence. This task can be challenging because potential evidence containing DNA may not always be visible. *Table 1* outlines possible location and sources of DNA evidence.

DNA evidence collection procedures are in place to ensure officer safety, reduce contamination, and protect the safety of officers. Contamination occurs when DNA from another source or other materials are combined with the sample. Officers can be exposed to biological materials that contain hazardous pathogens such as HIV or the Hepatitis B virus. Precautions for handling evidence include wearing gloves, using new or clean instruments, and using paper bags or envelopes rather

Location of DNA evidence	Source of DNA
Bite mark, area licked	Saliva
Fingernail scrapings	Blood, skin cells
Condom	Skin cells, semen
Blankets, sheets, pillows	Semen, sweat, hair, saliva
Clothing	Hair, semen, blood, sweat
Hat, bandana, mask	Sweat, skin cells, hair, saliva
Tissue, washcloth	Saliva, semen, hair, skin cells, blood
Cigarette butt, toothpick, drinking glass, can	Saliva
Dental floss	Skin cells, saliva
Tape, ligature	Skin cells, saliva, hair

Table 1Potential crime scene DNA evidence

Source: National Institute of Justice, Identifying Victims Using DNA: A Guide for Families, Washington D.C.: U.S. Department of Justice, April 2005, NCJ 209493.

than plastic bags (wet evidence can breed bacteria and contaminate the sample). Evidence gathering technicians also need to avoid sneezing, coughing, or touching the face when handling items.<sup>13</sup>

In addition, collection procedures require that chain of custody records be kept documenting individuals in possession of evidence to ensure its integrity.

A national study found a significant proportion of law enforcement agencies were unaware of the potential benefits of DNA testing. Many agencies did not submit DNA evidence in cases lacking a suspect, or when a suspect was identified but not charged, or when a guilty plea was expected.<sup>14</sup> Law enforcement agencies may regard DNA as a tool for prosecution rather than investigation, but DNA is important for both.<sup>15</sup> Prosecutors can use DNA evidence to identify a defendant but also to corroborate or challenge testimony and validate or refute evidence.<sup>16</sup> For the potential of DNA to be realized, training for criminal justice personnel is crucial.

#### Convicted offender DNA collection

All convicted felony offenders, including juveniles, have been required to submit DNA samples in Illinois since 2002. At the time of booking, buccal swabs are used to scrape the inside of the cheek to collect DNA. Convicted offender samples are then submitted to CO-DIS. In 2005 Illinois State Police labs received 60,375, and analyzed 108,928, convicted offender samples.<sup>17</sup>

#### Victim DNA collection

Victim service providers, crime scene technicians, nurse examiners, and other medical personnel are expected to know how to identify, collect, transport, and store DNA evidence from sexual assault victims. Victims should not change clothes, shower, or wash their body until a medical professional collects evidence. An elimination sample should be taken from anyone who had consensual sex with the victim within 72 hours of the alleged assault, as well as a reference sample from the victim. The careful collection of evidence and additional samples will help clarify DNA test results.<sup>18</sup>

Sexual assault nurse examiners have advanced training and clinical preparation in the forensic examination of sexual assault victims. They complete forensic and physical examinations and training in the use of the Illinois State Police Sexual Assault Evidence Collection Kit. Additionally, they qualify as expert witnesses in a criminal trial and are a part of a sexual assault response team. Sexual assault response teams are multidisciplinary groups made up of sexual assault advocates, police, and prosecutors, who work together to care for a victim and hold an offender accountable by the criminal justice system.

#### Missing persons DNA collection

To potentially identify missing persons, DNA recovered from biological remains is compared to DNA originating from a victim or the victim's relatives. The victim's DNA can be taken from medical specimens or personal items such as a toothbrush or hairbrush. Family members who are close blood relatives from a victim's immediate family can provide comparison samples. In the case of mass fatalities the medical examiner or coroner will oversee the utilization of DNA to identify large numbers of victims, while taking into account available resources.

#### Forensic DNA testing

Forensic DNA test results can be interpreted as inclusive, exclusive, or inconclusive. When the DNA profile of a victim or suspect is consistent with the DNA profile from a crime scene, the person is included as a possible source of evidence. If no suspect exists the samples are entered into CODIS and may produce a hit. When a DNA profile of a victim or suspect is inconsistent with DNA taken at the crime scene, an individual is excluded as the donor of the evidence. Exclusion does not imply innocence. Results are inconclusive if testing can neither include nor exclude an individual as the source of biological evidence, possibly because the quality or quantity of DNA was insufficient, or the sample was a mixture of DNA from several individuals.<sup>22</sup>

DNA evidence neither eliminates the need for traditional investigation techniques nor guarantees an arrest or subsequent conviction. Many crime scenes either have no DNA evidence or the evidence has been contaminated or destroyed. DNA evidence cannot inform when the perpetrator was at the crime scene or for how long. In addition, legitimate reasons may exist for a person's DNA to be at a crime scene. Findings are interpreted in the context of other evidence in the case.

#### Post-conviction DNA testing

Forensic DNA also may exonerate an innocent individual. Typically, defense attorneys screen cases to determine whether DNA testing could help exonerate their clients. After consulting with the defense, the prosecutor decides if it is appropriate to notify the victim or victim's family of the re-opening of a case. If warranted, a judge can order old evidence tested, in addition to ordering DNA samples from relatives or third parties. If results are favorable to the inmate and no alternative explanation exists, the judge may grant a request to vacate the conviction.

In the United States, 180 individuals have been exonerated by post-conviction DNA testing.<sup>24</sup> Illinois has exonerated 20 individuals through DNA.<sup>25</sup> The National Institute of Justice studied 28 cases including five from Illinois in which DNA helped exonerate individuals. Most were sexual assault cases from the mid to late 1980s. These cases often relied on eyewitness identification and forensic evidence to convict. Many defendants had previous encounters with local law enforcement. In addition, these cases alleged government misconduct such as perjury, withholding evidence from the defense, and erroneous lab tests. Before exoneration, the defendants spent an average seven years in prison.<sup>26</sup>

#### The future of DNA

Expansion of DNA collection, reduction of untested evidence backlogs, re-opening of cold cases, new legal approaches, and advances in technology are all trends impacting the future of forensic DNA in the nation and the state.

#### DNA collection expansion

In the late 1980s and early 1990s, states began passing legislation to allow the collection of DNA samples from convicted offenders of certain violent crimes. Now all states have laws requiring that DNA be collected from certain categories of offenders, and 38 states, including Illinois, collect DNA from all felony offenders. California, Louisiana, Minnesota, Texas, and Virginia have enacted laws requiring the testing of all offenders arrested. Evidence has shown that states with broad collection statues are solving far more crimes than those with narrow collection statutes.<sup>27</sup> However, some entities, such as the American Civil Liberties Union, have raised privacy concerns regarding DNA collection expansion, particularly the testing of those arrested but never convicted of a crime.

Illinois appears to be following the national trend of collection expansion as DNA-related legislation continues to be introduced (*Table 2*). These bills require the

Table 2
Proposed forensic DNA-related legislation in Illinois (as of September 1, 2006)

Date introduced	Bill number	Description
Feb. 2, 2005	HB 779	Provides that those arrested for felonies supply a sample of saliva or tissue for DNA fingerprinting analysis. The offense of obstructing justice includes destroying, altering, concealing, disguising or otherwise tampering with evidence collected for DNA fingerprinting analysis.
Jan. 11, 2006	HB 4607	
Jan. 18, 2006	SB 2383	Appropriates \$100,000 for FY07 from the general revenue fund to the state police for law enforcement agencies to expedite DNA testing in cases involving the murder of children less than 17 years old.
Jan. 20, 2006	SB 2737	Provides that forensic testing of evidence secured in relation to a trial, which resulted in a defendant's conviction but which was not subject to the testing which is now requested because the technology for the testing was not available at the time of the trial, may be allowed by the court.
Jan. 20, 2006	SB 2985	Provides that a person convicted or found guilty of any offense requiring registration under the Sex Offender Registration Act shall submit samples of blood, saliva, or tissue for DNA testing.
Jan.11, 2006	HB 4608	
Feb. 15, 2006	SB 333	Provides that every person arrested for committing a felony shall have a sample of saliva or tissue taken for DNA fingerprinting analysis for the purpose of determining identity and for certain other specified purposes.
July 21, 2006	HB 5806	Provides that the Illinois Department of State Police shall, within 30 days after sentencing, collect and analyze DNA samples required to be submitted by a person who has been convicted of a felony.

Source: Retrieved September 1, 2006 from the Illinois General Assembly website, on the World Wide Web: http://www.ilga.gov.

collection of DNA from a person arrested for a felony and from anyone who must register as a sex offender. States are recognizing the benefits of having nonviolent offenders in the database, as DNA profiles have the potential to stop repeat and violent offenders. Collection of DNA of those convicted of minor crimes, particularly property crimes, discourages offenders and may even prevent them from committing future, more serious offenses. In fact, DNA from a prior no-suspect murder scene often matched the DNA from a no-suspect burglary case in CODIS.<sup>28</sup> In 2005 the Department of Justice awarded \$2 million to five jurisdictions (Denver, Orange County, Calif., Los Angeles, Phoenix, and Topeka, Kan.) for pilot programs to assess the cost-effectiveness of expanding DNA collection from serious crimes to property crime.

#### Reduction of backlogs

The backlog of untested evidence is a problem for the criminal justice system. A national study determined that 52,000 homicide and 169,000 rape cases were waiting testing at labs and law enforcement agencies, and that the total number of backlogged cases exceeded 500,000.<sup>30</sup> Insufficient resources, lack of trained staff to collect crime scene DNA evidence, and DNA analysis cost in time and money, contribute to the backlog. Also, due to DNA's success in solving cases, more states are enacting broader offender collection statutes, resulting in heightened demand for evidence analysis.<sup>31</sup>

In state fiscal year 2004 (FY04), Illinois Gov. Rod Blagojevich directed \$2.6 million for the hiring of new DNA evidence technicians and the outsourcing of DNA analysis to private labs to reduce the burden on state labs. By the end of FY05 the ISP had spent \$14.8 million for the analysis of DNA casework and offender samples, and had eliminated the backlog. But by Dec. 31, 2006, 3,063 DNA samples of convicted offenders awaited testing. To further reduce the backlog, the governor's FY07 budget includes \$1.8 million for planning and design of a \$17 million ISP project that includes establishing a DNA Institute for recruiting and training forensic experts; hiring eight additional forensic scientists; expanding lab capacity at the Chicago State Police Laboratory and the CODIS Laboratory in Springfield; and limiting to 30 days the amount of time it takes to complete DNA analysis.

The state budgeted \$500,000 for the 2006-07 academic year to establish up to 15 graduate forensic science program scholarships at participating state universities. Scholarship recipients will have the opportunity to participate in paid internships within the ISP lab system, and will be required to work in Illinois forensic labs for at least four years. In-house DNA processing is expected to reduce costs, cut down on turn-around time of DNA analysis, and provide greater quality assurance over the entire process.

#### Cold case evidence

Most law enforcement agencies have "cold cases," unsolved crimes with no potential leads or suspects, that the advancements in DNA collection and testing might resolve. DNA testing may never have been completed in these cases, or the technology may not have existed or it did not yield a match. Testing can be attempted again because DNA samples from old cases can be stored for years without degradation, even at room temperature.<sup>32</sup>

Before testing a cold case, the statute of limitations, condition of evidence, other evidence in the case, and available resources are to be considered. A victim or the victim's family may not want a case reopened, as it might cause renewed trauma.<sup>33</sup>

#### Legal approaches

Filing of a "John Doe" indictment or warrant, based on an unknown individual's DNA profile obtained as crime scene evidence, nullifies the statute of limitations for that case. The statute of limitations varies by offense and sets a time limit for prosecution. Case time restrictions originally were established to protect defendants from less reliable evidence, such as eyewitness accounts.  $^{\rm 35}$ 

A Wisconsin prosecutor obtained the first John Doe warrant in 1999, and since then other states have passed legislation allowing the use of this type of warrant.<sup>36</sup> In 2003 New York City began the John Doe Indictment Project, supported in part by a grant from the U.S. Department of Justice. Prosecutors issued indictments against suspected perpetrators of unsolved sex crimes committed in the previous 10 years.<sup>37</sup> In 2004 in DuPage County, five separate indictments were issued based on DNA profiles.<sup>38</sup>

The statute of limitations for various sexual assault crimes was extended in Illinois from five to 10 years if the victim reported the crime to law enforcement within two years of the offense. Legislation was passed to eliminate the statute of limitations for prosecution of certain sexual assault crimes when a DNA profile of the offender is entered into the State Police DNA database within 10 years of the offense.

#### Technology advancements

Technology is becoming smaller, faster, and less costly. The time needed to determine a sample's DNA profile has dropped from six to eight weeks to a matter of days. Future advancements may decrease this time to as little as a few hours or even a few minutes.<sup>39</sup> Within the next five years, portable miniaturized instrumentation may be available to analyze evidence at the crime scene for rapid identification and elimination of suspects.<sup>40</sup> DNA laboratory automation using robotics and sophisticated computer systems has the ability to further reduce DNA analysis and identification.<sup>41</sup> Faster turnaround times will significantly reduce the backlogs of untested DNA evidence and ultimately lead to more crimes solved and prevented. In addition, there have been substantial improvements in DNA technology for use with remains from mass fatalities due in part to the lessons learned from the Sept. 11 attacks and Hurricane Katrina.

#### Conclusion

Television crime dramas such as *Crime Scene Investigations*, as well as high profile criminal trials, have contributed to bringing forensic DNA into the public eye. Over the past 15 years DNA has become accepted as a standard criminal investigation tool and as evidence in court trials. As more convicted offender and crime scene DNA samples are analyzed and entered in CODIS, hits will occur more frequently and more crimes will be solved. According to one study, DNA testing could save an estimated \$12.9 billion through early apprehension of serial sex offenders. This figure represents a savings through future crime prevention amounting to 35 times that of the investment.<sup>42</sup>

Current trends in DNA analysis predict expanded DNA collection and increased use of DNA analysis by prosecutors. Projected overall trends include decreases in crime rates, personnel expenditures, property losses, and societal costs. Increased demands on DNA testing will require additional funding and training of justice system personnel, and it is anticipated that the federal government will continue to provide DNA resources to the states.

#### Notes

<sup>1</sup>National Institute of Justice Staff, "DNA's Link to Corrections," Corrections Today 66 (5) (August 2004): 1.

<sup>2</sup> National Commission on the Future of DNA Evidence, Post-Conviction DNA Testing: Recommendations for Handling Requests, U.S. Department of Justice, National Institute of Justice, 1999.

<sup>3</sup> See Andrews v. State, 533 So. 2d 841, 843 (Fla. Dist. Ct. App. 1988).

 $^4$  Hogan, Steve and Steve Swinton, "Meeting Defense Challenges to DNA Evidence," American Prosecutors Research Institute Silent Witness 8 (1) (2003): 1.

<sup>5</sup> Kreeger, Lisa R. and Danielle M. Weiss, "DNA Evidence Policy Considerations for the Prosecutor," Special Topics Series, American Prosecutors Research Institute (September 2004): 11.

<sup>6</sup> National Commission on the Future of DNA Evidence, Using DNA to Solve Cold Cases, Special Report, Washington DC: U.S. Department of Justice, National Institute of Justice, July 2002, NCJ 194197.

<sup>7</sup> Illinois State Police, "2005 DNA Testing Accountability Report," Illinois State Police, (2006): 1.

 $^8$  Illinois State Police, "DNA and CODIS: Division of Forensic Services," Illinois State Police, (January 2005).

<sup>9</sup> Illinois State Police, "2005 DNA Testing Accountability Report," Illinois State Police, (2006): 5-8.

<sup>10</sup> Retrieved March 7, 2006 from FBI Website on the World Wide Web: http://www.fbi.gov/hq/lab/codis/index1.htm. Illinois had the third highest number of investigations aided through CODIS for a state after Florida and New York.

<sup>11</sup> Illinois State Police, "2004 DNA Testing Accountability Report," Illinois State Police, (2005): 2.

<sup>12</sup> National Commission on the Future of DNA Evidence. What Every Law Enforcement Officer Should Know About DNA Evidence. BC000614. Washington, DC: U.S. Department of Justice, National Institute of Justice, 1999. <sup>13</sup> Lovrich, Nicholas, et. al., "National Forensic DNA Study Report," Washington State University and Smith Alling Lane, P.S, December 12, 2003: 3.

<sup>14</sup> National Institute of Justice Staff, "DNA's Link to Corrections," Corrections Today 66 (5) (August 2004).

<sup>15</sup> Kreeger, Lisa R. and Danielle M. Weiss, "DNA Evidence Policy Considerations for the Prosecutor," Special Topics Series, American Prosecutors Research Institute (September 2004): 18.

<sup>16</sup> Illinois State Police, "2005 DNA Testing Accountability Report," Illinois State Police, (2006): 8.

<sup>17</sup> National Commission on the Future of DNA Evidence, Understanding DNA Evidence: A Guide for Victim Service Providers. BC000657. Washington, DC: U.S. Department of Justice, National Institute of Justice.

<sup>18</sup> National Commission on the Future of DNA Evidence, Understanding DNA Evidence: A Guide for Victim Service Providers. BC000657. Washington, DC: U.S. Department of Justice, National Institute of Justice.

<sup>19</sup> As of June 12, 2006. The Innocence Project: http://www.innocenceproject.org.

 $^{20}$  As of September 1,2004, the number of DNA exonerations in Illinois had reached 20. Center on Wrongful Convictions, http://www.law.northwestern.edu.

<sup>21</sup> Connors, Edward, Thomas Lundregan, Neal Miller, and Tom McEwan, Convicted by Juries, Exonerated by Science: Case Studies in the Use of DNA Evidence to Establish Innocence After Trial, Research Report, Washington, DC: U.S. Department of Justice, National Institute of Justice, 1996.

 $^{22}$  National Institute of Justice Staff, "DNA's Link to Corrections," Corrections Today 66 (5) (August 2004): 2.

<sup>23</sup> Office of Justice Programs, Partnerships for Safer Communities, DNA in "Minor" Crimes Yields Major Benefits in Public Safety, In Short: Toward Criminal Justice Solutions, Washington DC: U.S. Department of Justice, National Institute of Justice, November 2004, NCJ 207203.

<sup>24</sup> Lovrich, Nicholas, et. al., "National Forensic DNA Study Report," Washington State University and Smith Alling Lane, P.S, December 12, 2003; 3.

<sup>25</sup> Illinois State Police, "2005 DNA Testing Accountability Report," Illinois State Police, (2006): 5-8.

<sup>26</sup> National Commission on the Future of DNA Evidence, Understanding DNA Evidence: A Guide for Victim Service Providers. BC000657. Washington, DC: U.S. Department of Justice, National Institute of Justice.

<sup>27</sup> National Commission on the Future of DNA Evidence, Using DNA to Solve Cold Cases, Special Report, Washington DC: U.S. Department of Justice, National Institute of Justice, July 2002, NCJ 194197.

<sup>28</sup> National Commission on the Future of DNA Evidence, Using DNA to Solve Cold Cases, Special Report, Washington DC: U.S. Department of Justice, National Institute of Justice, July 2002, NCJ 194197.

<sup>29</sup> Cormier, Karen, Lisa Calandro, and Dennis Reeder, "Evolution of DNA: Evidence for Crime Solving: A Judicial and Legislative History," 9(3) Forensic Magazine (June/July 2005): 2.

<sup>30</sup> Colb, Sherry F., "John Doe Indictments in New York: An Opportunity to Examine Statutes of Limitations," Findlaw.com (August 13, 2003).



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