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Biotechnology: A New Tool in Safety and Security

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Introduction

The author has more than ten years experience in the DNA industry working with child support enforcement agencies and the courts to resolve questions of paternity, and with family law attorneys in establishing familial relationships in immigration cases and estate settlement. She has also assisted in training law enforcement on the types of biological specimens that can be tested, and proper collection techniques of biological evidence collected at a crime scene. The objective is to improve the preservation of genetic material thus optimizing the outcome of the DNA result in the laboratory. In 2006, the author along with her colleague, Lisa Wennersten identified a need to make available to corporate America and multi-national corporations, a combination of science that has been used by the military, government agencies and law enforcement for decades. This biotechnology is known as bio-identity preservation, which combines both DNA profiling with biometrics.

The events of 9/11 and Hurricane Katrina magnified the challenges in identifying victims in mass casualty disasters. In both disasters, families had to wait weeks and in some cases years to receive confirmation that their loved one's remains had been identified. Even in smaller scale disasters resulting in fewer victims the process of identifying victims can sometimes prove challenging. This was evident in the explosion that occurred at the BP Refinery in Texas City, Texas and in the Virginia Tech massacre. The uncertainty and not knowing of what happened to a loved one or any delay in identifying a victim is agonizing for a family and impedes closure for their loss.

Globalization has increased business opportunities for many multi-national corporations, while increasing the potential threats against personnel and projects. These threats include kidnapping, extortion, physical and financial threats or even death. Employees are often unaware of their vulnerability. Those most at risk appear to be employees and expatriates working for high profile companies in hostile regions of the globe including those in the oil and gas, chemical refining, mining, telecommunications, and engineering sectors. Terrorist groups are targeting non-government organizations (NGO's), while armed pirates are seizing ships for its cargo and taking the crew hostage, all motivated by financial gain for a high ransom. Any company can become a target. Terrorists and militia groups don't always discriminate against their victims, however key targets are identified for the size of the potential ransom. Daily news reports reflect the increasing violence toward people and projects with concerns of increasing risks towards Westerners.

Many EH&S officers are being asked to add the responsibility of security into their routine of managing the health and safety of their employees. Corporate responsibility poses the question, "Is there something more that companies, safety and security officers can do to protect their workforce"? With increasing violence toward employees working abroad and the typical risk of working in volatile industries, companies are beginning to look to science to enhance their safety and security programs. This paper will provide an introduction to bio-identity preservation by utilizing DNA profiling with biometrics. We'll discuss the available biotechnologies, reasons for preserving your identity, five case studies: Imperial Sugar Plant explosion, 9/11, Hurricane Katrina, the BP Refinery explosion in Texas City, Texas and the VA Tech massacre, the legal ramifications of implementing this type of program, and the benefits to the employer and employee.

Available Biotechnology

There are two forms of biotechnology offered today; DNA and biometrics. Each of these technologies has been available since the 1980's and has been proven in the courts as a valid means to confirm an individuals' identity. It is the combination of both technologies that provides for the most comprehensive means of identification. The definition is: **DNA** - deoxyribonucleic acid; a genetic blueprint measuring an individuals' uniqueness. **Biometrics** – the measurement of physical characteristics (hand geometry, fingerprints, facial recognition, dental, iris scan).

There are two ways an individual can preserve their DNA. The first is profiling in which an AABB *(American Association of Blood Banks)* accredited laboratory will conduct a genetic test identifying the individuals' genetic markers. The test performed includes a battery of markers or loci, typically thirteen, and are the same markers used by the FBI and local law enforcement in criminal case work. The second means of preservation is through DNA banking. The individual can contract with an AABB accredited laboratory to store their DNA in a secure location within the lab for a given period of time for a set fee. The banked DNA sample can be retrieved at anytime by providing the security code issued by the laboratory at the time the donor stored their sample. Today, a buccal swab is the standard specimen collected for DNA analysis, in which a soft swab is used to collect cells from inside the donors' cheeks.

In the event of a fatality the most common means or modality used by medical examiners to identify a victim are dental records and fingerprints. It is estimated that 30% of the U.S. population does not have a dental record. Thus fingerprints become a key means to quickly identify a decedent. Today's technology preserves a copy of the digital prints in both PDF format for easy viewing of the image and a NIST (National Institute of Standards Technology) record. These digital fingerprints are collected using the same technology used by law enforcement and that with the TWIC card (Transportation Workers Identification Credential). The difference between the NIST record preserved in a bio-identity profile and the TWIC card is in the ease to upload or ability to read the data. The NIST record is the standard format used by law enforcement agencies. The TWIC card requires a specific reader to view the data. Local police departments and medical examiner's offices may or may not have access to the necessary equipment to retrieve the data from a TWIC card. The next means of identification is DNA, but this is typically reserved as a last resort due to cost and the time involved in the identification process. This type of DNA analysis tested is known as familial reconstruction or reverse paternity testing in which the DNA of family members is compared to the decedent to confirm a relationship.

In the event of abduction, biometrics plays an important role in confirming an individuals' identity for "proof of life" matters. The removal of an ear has been used as a means of torture for the victim and a message to the family to follow through on the extortion. The ear however is a powerful means of identification due to the uniqueness in various features. These features include the overall size and shape of the ear and the folds and ridges, whether the lobe is attached or detached, is the ear pinned or extended, and unusual markings such as freckles, moles, and cosmetic changes such as piercings. The ear is so unique, it is considered to be almost as powerful as fingerprints. Other forms of physical features that can assist in identification include, scars, birth marks, tattoos, and prosthetics such as a pace maker, metal plate or pins.

How this bio data is preserved is important and will determine the ease and quickness in which corporate security teams, law enforcement and medical examiners can utilize the data in a time of crisis. Digital preservation can provide for immediate access to an individuals' total identity. Common means of preserving this bio data include flash drives with an encryption level AES 256, and virtual safety deposit boxes also with AES 256 encryption and SSL during data transmission. This sensitive bio data should be protected and provided only to trusted individuals and agencies and returned to the donor or their designee following the completion of the identification process.

Reasons for Preserving Your Identity

There are three reasons to consider preserving your bio-identity; (1) preservation for family lineage that can be used in genealogy studies and estate settlements, (2) preservation of genetic traits that can provide for a baseline record of inherited diseases that may prove beneficial in determining future treatment programs, and (3) identification confirmation that can be used in proof of life matters for kidnapped victims, missing persons and fatalities. Identification is the only reason a company is permitted to have access to this sensitive data. There are federal and state laws in effect to protect donor privacy and prohibiting unauthorized persons, companies and insurance companies from having access to key components of genetic information considered to be confidential.

External factors and considerations for multi-national corporations to implement a bio-identity preservation program for key employee groups include: threats of terrorism, corporate abductions against high profile and western companies, and fatalities resulting from unforeseen industrial or natural disasters.

The benefits of having a bio-identity preservation program in place will provide corporate security teams and disaster recovery teams with immediate access to multiple forms of bio data stored in a single source secure format. This single source profile can save valuable time and help to expedite the identification process of victims who have been abducted or killed on the job. This confirmation will help to bring closure to the employees' family and coworkers. In addition this biotechnology can assist in revenue protection for both companies and families by providing the confirmation necessary to settle K & R (kidnapping and ransom) and life insurance policies.

Scientifically it is always easier to compare you to your own bio data than it is to recreate you from living family members or a known reference sample. Both familial reconstruction and testing a known reference sample such as hair, buccal cells (e.g. cheek cells) from a tooth brush and other tissue cells from frequently worn clothing and other items (sunglasses, baseball cap, cigarette butt, tobacco pipe etc.) can prove valuable in helping to identify a victim. However, there is no guarantee that DNA testing will yield a conclusive result due to social and environmental factors. Unfortunately, social factors involving questions of paternity have an impact in the identification process when performing familial reconstruction. There are

approximately four million births in the United States annually, and in twenty-five percent of these births there is a question of paternity. That is one million children with the question of who is their biological father. The industry exclusionary rate averages 33% in paternity testing. That means every year in the United States there are an estimated 330,000 men who think they are going to be a father when in fact they are not. If we look at this data across an extended period such as a decade or three; that means in the past ten years there are 3.3 million men who are not the father of a child and 10 million over the past thirty years. These numbers are staggering and this helps us to recognize the challenges in identifying victims when familial reconstruction becomes necessary. Individuals who have been adopted and who have no children of their own should carefully consider preserving their identity given they have no familial link to compare as a means of identification. Environmental factors can create two potential problems when testing known reference samples as a means of confirming identification, these are sample degradation and a lack of chain of custody or proof the sample is that from the victim. Determining the quantity and quality of the DNA to be tested is the first step performed by the laboratory before any testing begins. Like evidence found at a crime scene, DNA can quickly become degraded due to environmental factors leading to bacteria destroying the DNA strand. The most common known reference sample used to identify a victim is a tooth brush, in which buccal cells have been adhered to the brush. Unfortunately, there is a high level of bacteria in the oral cavity that can quickly destroy any DNA found on the tooth brush. Hair from a victims' hair brush is typically the second form of reference sample provided for testing. Like that of a tooth brush, hair can also have bacteria that can destroy the DNA sample. The other complication with hair is the amount or quantity of DNA that can be retrieved from hair. Although there are minute traces of DNA in the hair shaft, it is the root where the majority of DNA is stored. The root of each hair varies in size and thus varying in the amount of DNA stored in each root. Scientists throughout the industry recommend a minimum of five hair strands to be collected thus optimizing the quantity of DNA to be tested.

Revenue protection for both the corporation and the employee is another reason to consider bio-identity preservation. Multi-national corporations are often targets for kidnapping and extortion. *Proof of Life* of the abducted employee may be required before any pay out of ransom is made from a Kidnapping & Ransom policy. A bio-identity profile can confirm that the proof of life provided is authentic and not a hoax from a corpse or substitute. A bio-identity profile can also prove valuable in resolving questions of paternity from unknown third parties who may chevy an opportunity in a wrongful death suit following an industrial disaster. Family members who have lost a loved one in a mass casualty disaster or an industrial accident can find closure and confirmation that can also help to expedite the settlement of a life insurance policy or wrongful death suit. Without confirmation of an individuals' death an insurance company can take between seven and ten years to settle the policy. If the family of the presumed decedent fails to continue paying on the life insurance policy, the policy will become void.

Case Studies

We will review the following case studies: Imperial Sugar Plant explosion, 9/11, Hurricane Katrina, the BP industrial explosion in Texas City, Texas and the VA Tech Massacre – revealing the modalities used to identify each victim in these disasters. Each disaster is different in the modalities that were selected by the medical examiners' office to confirm victim identification. Having this information will help to provide an awareness of this process and more importantly the need for those working in volatile industries and hostile regions of the globe to consider bio-identity preservation.

Case Study: Imperial Sugar Plant explosion

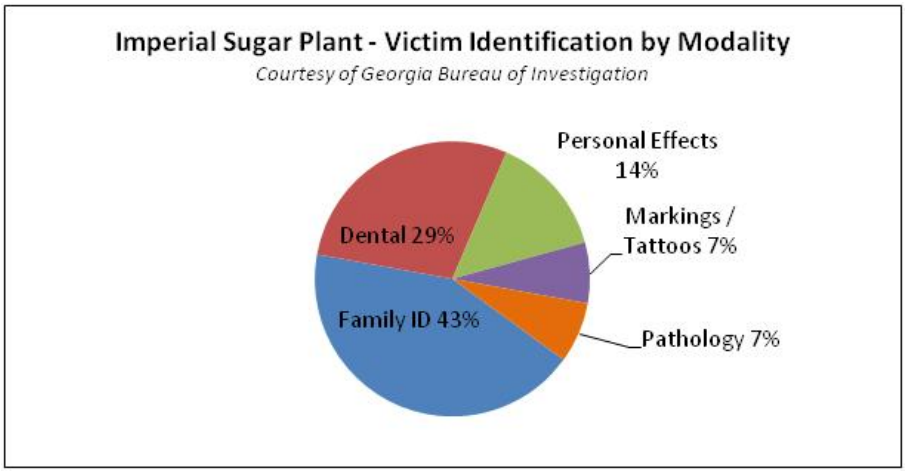

Figure 1. Imperial Sugar Plant Victim Identification by Modality

Figure 1 reveals the modalities utilized to identify the victims recovered from the Imperial Sugar Plant following an explosion that killed 14 and injured 38. Many of the victims were identified by family members while receiving emergency care, but who later died of their injuries. Due to significant thermal damage several victims were identified by personal effects including a steel toe from a specific type of work boot known to have been worn by one of the victims, belt buckles and eyeglass frames.

Case Study: 9/11–World Trade Center

Table 1 provides an overview of the number of victims and the remains recovered from the World Trade Center. In the days following the collapse of the WTC, those who had lost loved ones began to collect biological material of their missing family member consisting mostly of tooth brushes and hair from hair brushes to present to emergency response teams with the hopes of recovering their loved one. The mass number of victims and remains that were recovered presented a challenge to the office of chief medical examiner and to the DMORT (Disaster Mortuary Operational Response Teams) team as to how to efficiently coordinate the identification process of victims. This is still an ongoing process to identify the victims. Between April 2007 and January 2009 which is reflected in the tables below, an additional 509 remains have been recovered and an additional 19 victims identified.

Terrorist Attack – 9/11 World Trade Center Victim Data	
Reported Missing	2,752
Victims who died outside NYC (transported out)	3
Victims identified	1,623

Victims not identified	1,126
Remains recovered	21,744
Remains identified	12,596
Remains not identified	9,148

Table 1. Number of victims and the remains recovered from the World Trade Center

The remains listed in Table 1 reflect 42% of the victims who cannot be identified. This assumes both social and environmental factors and confirms the need to introduce and to encourage bio-identity preservation particularly with high risk groups.

Table 2 below reflects the type of death certificates issued in wake of this tragedy. A DX or judicial decree was issued so that those families who had not received confirmation of their loved one's death could have some closure. Between April 2007 and January 2009 reflected in the below table, an additional 17 DM certificates were issued after a DX certificate had been previously issued.

NYC Death Certificate Breakdown	
DX (Judicial Decree) Certificate Only	1,126
DM (Physical Remains) Certificate Only	411
DM after DX Issued	1,212

Table 2. Type of death certificates issued in World Trade Center Tragedy

Figure 2 below indicates that a single modality was used to confirm a victims' identity, enough to issue a DM death certificate. Figure 3 indicates that two or more modalities were used to confirm a victims' identity. The need for multiple modalities was evident by the numerous remains recovered. The primary means of identifying victims ordinarily is with fingerprints and dental records. DNA is typically used as a last resort to identify a victim due to the time and cost to perform familial reconstruction and there is no guarantee of a conclusive result given the social factors previously discussed. Yet DNA was the primary modality used in this disaster.

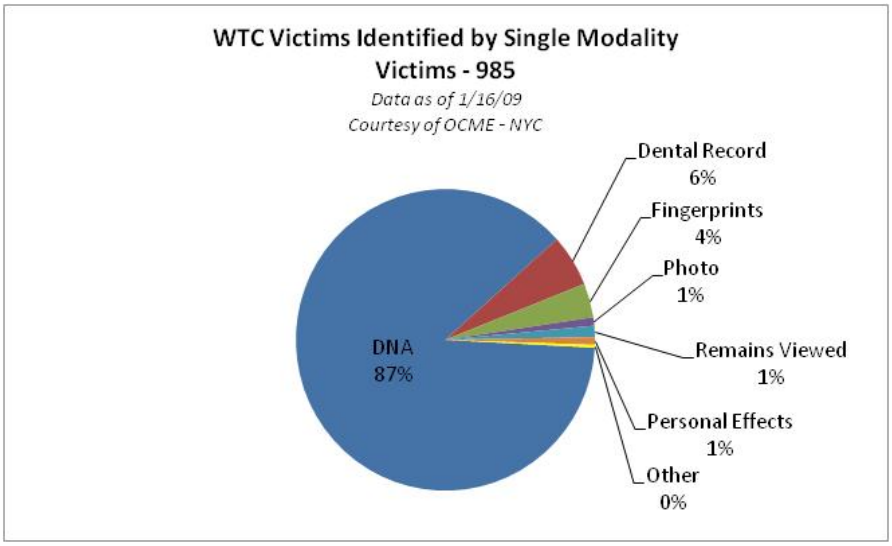

Figure 2. WTC Victims Identified by Single Modality (*Source:* OCME, New York City)

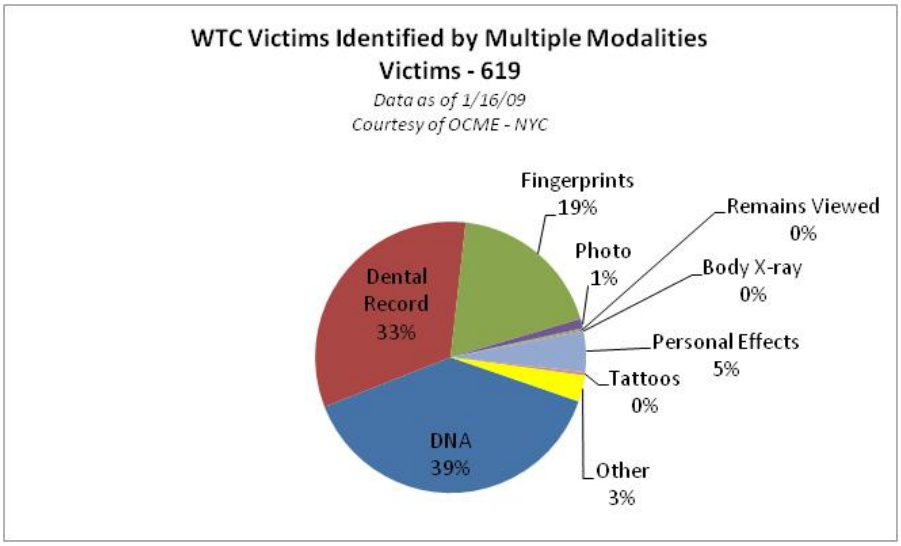

Figure 3: WTC Victims Identified by Multiple Modalities (*Source:* OCME, New York City)

Source of data noted in Tables 1 and 2 and Figures 1 and 2 were presented courtesy of the Office of Chief Medical Examiner (OCME) NYC. Data can be retrieved at: http://www.nyc.gov/html/ocme//downloads/pdf/public_affairs_ocme_pr_february_2009.pdf

Case Study: Hurricane Katrina

Figure 4 reveals a different means of confirming victim identification. In this disaster the Office of Chief Medical Examiner and the DMORT team relied on field notes from investigators, personal effects on the victims and known pathology. Because of the flood waters the decay process on the body destroyed the fingerprints of many victims. You will notice that the typical three means of confirming identity (dental record, fingerprints, DNA) were used least in this

disaster. Many victims were found in their homes at an address provided to authorities by concerned family members outside the disaster zone. Many were found with their personal ID still on their body. In other cases family members confirmed the victim had a known pathology such as a pace maker, a metal plate in their forearm etc.

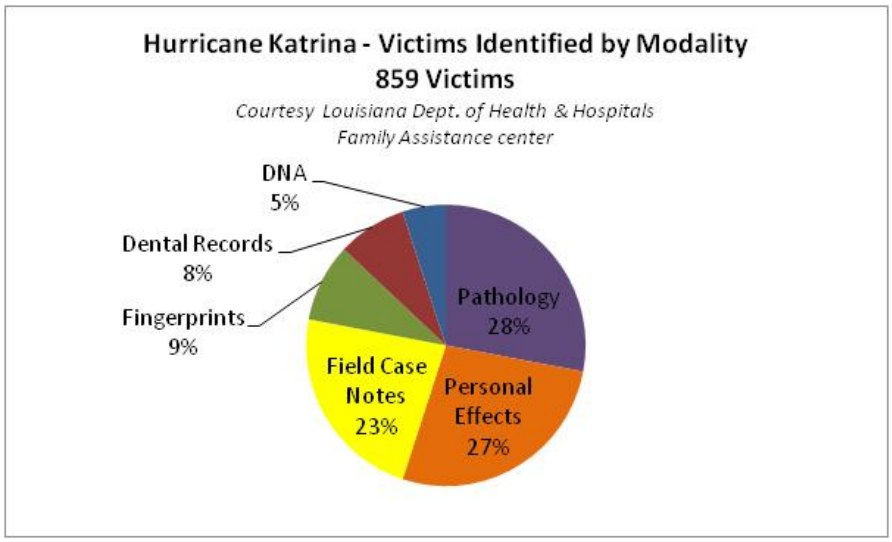

Figure 4. Hurricane Katrina Victims Identified by Modality (*Source*: Louisiana Department of Health and Hospitals, Family Assistance Center)

Source of data presented courtesy of the State of Louisiana Department of Health and Hospitals, Family Assistance Center. http://www.dhh.louisiana.gov/offices/?ID=303

Case Study: BP Industrial Explosion

Figure 5 reveals the typical modalities used to identify victims (dental records, fingerprints, and DNA) were used in this disaster. There were fifteen (15) victims, but 16 cases required to confirm victim identification. Four victims were burned beyond recognition – dental records were used to confirm their identity. Fingerprints were used to identify six victims comparing the victims' prints, to their Texas drivers' license record. Five victims were identified by family records such as photographs and personal ID including that of a female victim who had been decapitated. By law the medical examiner could not release this female victim to her family until they had a confirmed identification using DNA analysis matching her entire body. This process was outsourced to a private DNA laboratory and the results were not completed for six months due to the time needed to perform familial reconstruction.

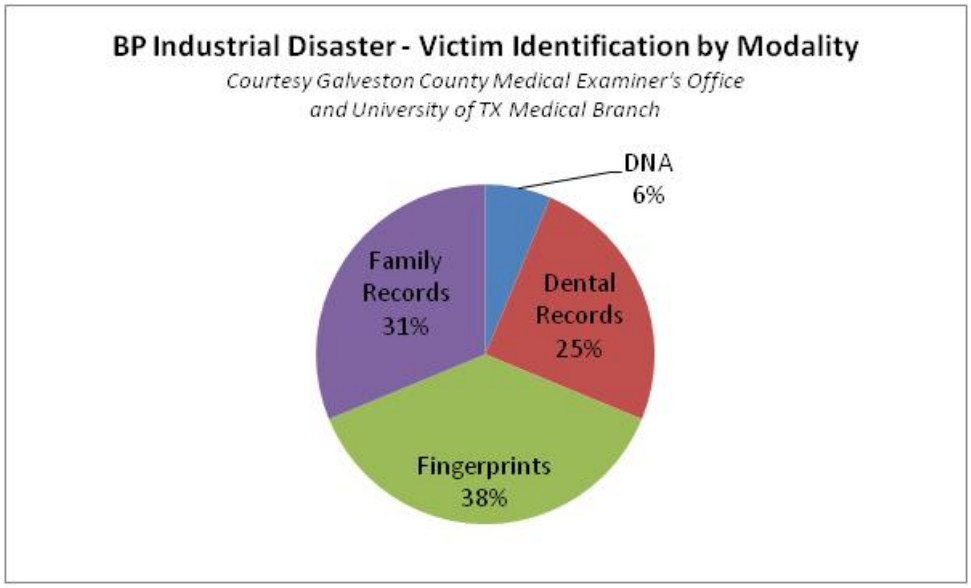

Figure 5. BP Industrial Disaster Victim Identity by Modality (*Source:* Office of Chief Medical Examiner, Galveston, TX and University of Texas Medical Brance)

Source data presented courtesy of the Office of Chief Medical Examiner of Galveston County, Texas City, Texas and the University of Texas Medical Branch

Case Study: Virginia Tech Massacre

Figure 6 reveals that two of the typical means of identification (dental records and fingerprints) were used to confirm victim identification. There were 33 fatalities – 5 faculty and 28 students including the shooter, and another 17 students wounded. The majority of identification was made using fingerprints. Because this was a university the victims standard ID's were not utilized to verify fingerprints due to the potential risk of having fake ID's used for under- age drinking. Thus 100 law enforcement officers, including those from the State Police, Secret Service and surrounding law enforcement agencies, volunteered their time to collect fingerprints from the victims' residence. Prints were collected from computer key boards, school books, soda cans, high traffic surface areas and countertops, which were then compared to the victims. One victim, an elderly male professor at the university had no fingerprints due to the aging process on the body. Just as children do not develop fingerprints until approximately six years of age, elderly persons will lose their fingerprints as they lose elasticity in their skin. In this particular case the professor was identified by a tattoo on his wrist. Dental records were used to identify five (5) victims. In three cases other means such as tattoos, birth marks, scars etc. were used to confirm identification of the victim. Many victims had multiple gunshot wounds making it difficult to confirm their identity using photographs thus the above means were utilized.

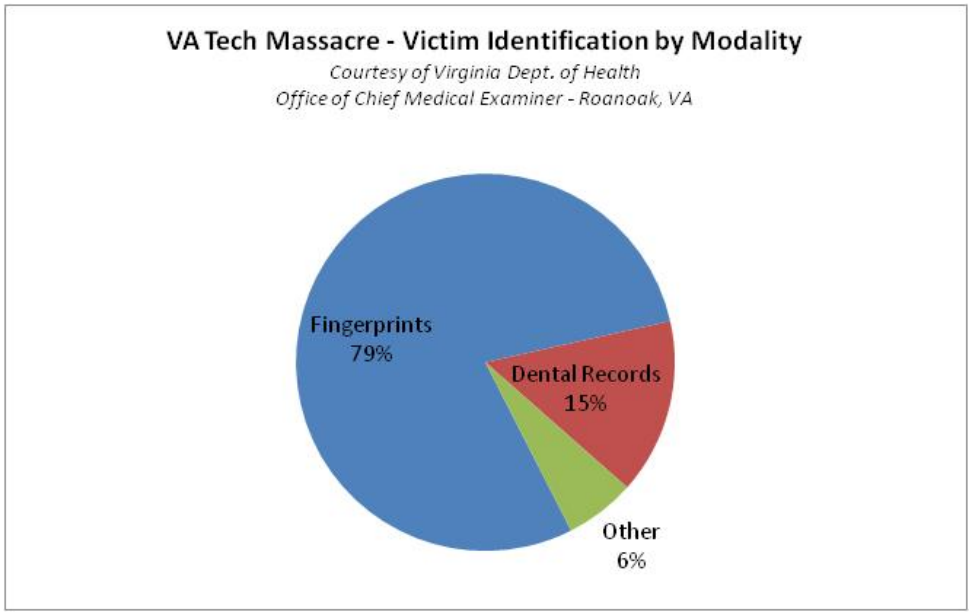

Figure 6. VA Tech Massacre Victim Identification by Modality (*Source:* Office of Chief Medical Examiner, Virginia Department of Health)

Source data presented courtesy of the Virginia Department of Health – Office of Chief Medical Examiner, Roanoke, Virginia; Ph# 804-786-3174.

Legal Ramifications

Many states consider genetic information personal and private property. Thirty-four states have implemented genetic privacy laws and in 2008 the U.S. Congress passed HR 493 / S 358, known as the GINA bill (Genetic Information Nondiscrimination Act) became the umbrella to protect an individuals' right to genetic privacy. The general definition of these laws prohibits employers from asking employees for DNA or genetic material that could be accessed by a company's health insurance provider which could lead to discrimination of health insurance benefits. The type of DNA analysis performed in bio-identity preservation does not reveal predisposition to medical traits, thus protecting the genetic privacy of the donor and their family.

Many companies with federal contracts, particularly those working in a war zone, have begun to follow the military by having their employees and expatriates preserve their DNA before departing for the job. DNA can be preserved in two ways – banking or profiling with an accredited laboratory. Employers considering implementing employee bio-identity preservation programs should recognize that this must be a voluntary program agreed to by the employee. It should also be understood that by state and federal laws an employer may not possess an original source of DNA or any genetic information that could reveal predisposition to medical traits.

Implementing a Bio-identity Program

When implementing a bio-identity preservation program companies should consider the following: (1) program management, (2) employee eligibility, (3) choice of modalities and (4) vendor selection criteria.

How a company will manage the program is the most challenging aspect of the implementation process. Program management requires that a custodian be assigned to ensure

privacy and protection of this intimate information. A company may choose to handle this program like any other sensitive personnel records such as drug screening. The bio-identity profile should be kept in a secure area, corporate safe or virtual safety deposit box with restricted access, and readily available in the event of an employee abduction or disaster involving fatalities. Some companies will ask the employee to manage the security of their own bio-identity profile with instructions to their family as to whom the family should deliver the profile in the event of a crisis requiring identification of their loved one. It is recommended that the employee keep the bio-identity profile in a safety deposit box, virtual safety deposit box and / or home safe device. If the company acts as the custodian for the profile, they will need to consider what steps to take with managing the profile if the employee resigns or is terminated from the job. Many companies will simply turn the profile over to the employee.

Once the management process is in place, you will need to decide if all or specific employee groups will be offered the opportunity to participate in this program. Some companies may choose to offer this program at the company's expense to executives and those employees working in high risk areas and hostile regions of the globe, while extending the program to all other employees and their families at their own expense at the corporate discount.

Choosing which modalities you will implement is the easiest choice, but will have the biggest impact in the identification process in the event of a disaster. Will you choose DNA only or DNA combined with multiple forms of biometrics? Remember something is always better than nothing, but the more comprehensive the bio-identity profile is, this will allow security teams, law enforcement and medical examiners to use the quickest means to expedite the identification process.

A company should carefully consider which vendor you partner with when implementing a bio-identity program. Is the DNA laboratory accredited by the American Association of Blood Banks and ASCLD Lab-*International*? Does your biometric vendor follow and utilize standards set forth by NIST *(National Institute of Standards and Technology)?* Does the vendor have any experience with law enforcement, Department of Homeland Security or other federal agencies requiring security clearance? What security procedures are in place to ensure the protection and privacy of the employee's bio data?

Conclusion

Given today's economic crisis combined with the increased threat of violence toward people and projects companies are seeking alternatives to better protect the investment of their employees. Science, specifically bio-identity preservation, provides for this new alternative by offering to companies what the military, government agencies and law enforcement have used for decades to help resolve unanswered questions of identity.