The Genetic Information Nondiscrimination Act

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Science and technology in the 21st century are advancing at a rapid pace, especially in the fields of biology and genetics. Due to these rapid advances, the need for legislation to protect individuals from genetic discrimination was urgent. With the Human Genome Project and its successful completion in April of 2003 [42], scientists and other advocates supported the creation of legislation to protect individuals from genetic discrimination. The Genetic Information Nondiscrimination Act (GINA) is an act that prohibits discrimination against individuals on the basis of genetic information. With the sequencing of the human genome, scientist could now study the genetic make-up of an individual and help identify genetic predispositions for particular diseases. This scientific advancement could represent great success in preventing or better treating genetic conditions that an individual may present later on in his or her life. This advancement also presented the question of whether genetic discrimination of an individual by insurance companies and employers could take place. With these two thoughts in mind the creation of a law became imminent. GINA was first introduced to the 104th Congress in 1995 by Democratic Representative Louise Slaughter from New York. GINA found support in the Senate in the hands of
Senator Olympia Snowe in 1996. After 13 years of up and downs with acceptance and rejection of the act, in May 21st, 2008 GINA was signed into law by president George W. Bush [23]. Title I of the law went into effect on May 21, 2009 and Title II on November 21, 2009 [23]. As quoted from Senator Kennedy “This bill opens a new frontier in medicine in which we read the genetic make up of a patient to stop diseases before they even happen. It’s the first civil rights bill of the new century new genetic technology and protecting the basic rights of every American.” [23]

The introduction of this bill to Congress aims to protect individuals from genetic discrimination and encourages the public to take part in genetic research. Genetic information as defined by Annas et al., “includes information about an individual or a family member’s genetic tests, information about a manifestation of a disease in a family member, information about receipt of genetic services and information about participation in clinical research that involves genetic services” [14]. As scientists continue to make new discoveries in the life sciences, particularly in genetics, public participation is critical and most needed. Participation in genetic research is indispensable in allowing scientists to find cures, treatments, and better procedures when treating patients suffering from genetic disorders. Even though information about the genetic make up of an individual may bring answers and solutions to many questions medicine and science currently have, it also brings with it a series of questions to the individual. Genetic information is only available after an individual has been tested under a genetic test [14]. When this test can help a person, family, and even medical professionals, fear of what can happen next has created hesitance in partaking of such a test. Individuals and families expressed fear of knowing what
the results of genetic test may be. The fear revolves around some specific areas, mainly involving privacy, insurance, and employment. Individuals may opt not to have a test for fear of knowing of a potential genetic disease and then have to live with the knowledge of what may be awaiting them in the future. A large majority of people fear that the information could be revealed to other entities, causing violation of privacy, and potentially harm their career path and access to insurance. In a study done by Change Wave a survey of 550 Americans showed the following when asked who they would share the information from a genetic test with. The results were: “72% would share with their spouse, 71% with their physician, and 22% would share it with a research institution. But only 3% would share it with their health insurer, 2% with their current employer, and only 1% with a prospective employer” [14]. The public fear that such genetic information may be used against them is widespread. It is because of such concern that the proposers of GINA crafted the bill that, “prohibits covered employers with fifteen or more employees from requesting, requiring, or purchasing their employees’ genetic information and from using it to make employment-related decision.” [21]

GINA is the first major American anti-discrimination statute in over a decade [39]. It is a new type of legislation and in its novelty it is not without fault. GINA is a law that in comparison to some of the previous anti-discrimination acts did not look at previous discrimination claims to become a law. Among employment discrimination statutes prior to GINA were Title VII of the Civil Rights Act, the age Discrimination in Employment Act, the Rehabilitation Act, and the Americans with Disabilities Act. All these acts “looked at discrimination that took place in the past to provide and
justify protection for the future” [89]. These acts are what is considered retrospective, since they looked at prior claims to avoid future ones. In comparison to GINA which is considered a preemptive act; GINA aims to avoid discrimination before it happens.

In the following chapter we aim to review the political, ethical, technological, and economical perspectives and how they play a role in GINA as a nondiscriminatory act.
Chapter 1

Politics

This chapter focuses on the political aspect of GINA as a nondiscriminatory act. The process by which GINA became a law after a long period of 13 years will be examined. The first two titles of the act will be explored, since they present the major significance to our interest. Also included is a review of some of the provisions and limitations this act presents to legislation. Lastly, the fact that GINA broke new ground as a preemptive law will be considered, what that means, and how it played a role in the development of GINA into law.

1.0.1 Background

After the Human Genome Project was initiated in 1990 people found it necessary to introduce legislation that may prevent the use of genetic information to be used against the individual. Supporters of GINA believed that, while scientific advances could help us understand the way in which diseases are treated and understood, they
could also create new ways to discriminate [39]. The concerns were raised when the realization was made that the Health Insurance Portability Accountability Act, HIPAA, which prevents genetic discrimination on an individual basis, did not prevent health insurers from using genetic information in deciding whether to accept the group as a whole or in setting the group’s premiums [39]. Also under HIPAA “the law does not prohibit group health insurers from requesting genetic information or requiring genetic testing” [39]. In addition it did not protect an individual outside the health group or individual health insurance. An example of this situation is HIPAA of 1996 “which provides that health insurance plans cannot establish rules for eligibility for a plan based on an individual’s presymptomatic genetic status but permits employers to not offer health insurance at all” [28]. With this in mind one of the main purposes of GINA is to provide comfort and security to Americans when deciding to undergo a genetic test [28].

GINA was first introduced to the 104th Congress on 1995 by Representative Slaughter, a microbiologist who has a Masters in Public Health, and Senator Snowe [39]. The bill found many more supporters in the years to follow in both the Senate and the House of Representatives. In the years following the initial introduction of GINA, there were many more bills introduced to try and reach GINA’s approval. A total of twenty three more bills were introduced from the 105th to the 110th Congress [39]. The business community opposed the bill greatly. The Genetic Information Nondiscrimination Act of 2007 was introduced on January of 2007 by Representative Slaughter with the support of more than one hundred cosponsors [39]. The unanimous vote was stopped by Senator Coburn who “feared that employers who provided their
own health insurance could be sued twice under GINA” [39]. Once the matter was resolved the bill was amended and approved in the Senate. The bill was then approved by the House of Representative and to the joy and success of all the supporters it was signed into law by President George W. Bush on May 21, 2008 [39].

1.0.2 Definitions

This section will focus on defining parts of what is considered genetic information and genetic testing under GINA. First let’s start with what is Genetic Information. Genetic information, “includes genetic information about an individual or a family member’s genetic test, information about manifestation of a disease in a family member, information about a receipt of genetic services and information about participation in clinical research that involves genetic services” [14]. This means that if an individual or a family member of such an individual takes a genetic test that is recommended by a primary physician, the results obtained from genetic testing are considered genetic information. Also, if a member of the family expresses a certain genetic condition, such a condition is recorded as genetic information as direct family members inherit the genetic material of the parents through generations. A genetic test is defined as, “the analysis of human DNA, RNA, chromosomes, proteins, or metabolites that detect the genotype, mutations, or chromosomal changes” [39] in an individual. This means that an analysis of a protein test that does not detect any changes in the human gene that may indicate a disease or the study of a test that is directly related to a manifested disease is not considered a genetic test [39]. Genetic discrimination therefore is defined as “the differential and adverse treatment
of asymptomatic individuals based solely on their or their relative’s actual or presumed genetic characteristics” [28]. What this means is that any type of differential treatment to an individual based on the knowledge that he/she or a member of his/her family has a genetic condition is a discriminatory action. Although to this day there have not been cases reported of genetic discrimination, the assumption is that with facilitating genetic tests to the public for more than 1500 genetic diseases, the cases of discrimination may become more prominent.

1.0.3 GINA

The Genetic Information Nondiscriminatory Act, GINA, is made of three sections or titles. This next section will focus on analyzing Title I and Title II. As genetic information has become more available to scientists through genetic testing in the last decade, public concerns about how that information could be used increased. Major concerns include the privacy of one’s health records, pre-employment requirements and ability to receive insurance coverage for a person and/or his/her family [12]. GINA protects the public from the misuse of Genetic Information as a result of a genetic test or family manifestation. The Titles were crafted to address future discrimination in health insurance and employment. Title I as stated in the bill H.R. 493, “Prohibits a group health plan from requesting or requiring an individual or family member of an individual from undergoing a genetic test. Provided that such prohibition does not: (1) limit the authority of a health care professional to request an individual to undergo a genetic test; or (2) preclude a group health plan from obtaining or using the results of a genetic test in making a determination regarding payment.
Requires the plan to request only the minimum amount of information necessary to accomplish the intended purpose.” [3] Title I deals with genetic information and health insurance coverage. This section of the Titles has a major exception. Under GINA genetic information can be obtained legally in cases where the employee is part of clinical research, or enrolled in a wellness program and the employee has provided authorization. [28]

Title II prohibits genetic discrimination in the area of employment. As stated in the bill it, “Prohibits, as an unlawful employment practice, an employer, employment agency, labor organization, or joint labor-management committee from discriminating against an employee, individual, or member because of genetic information” [3]. Perhaps this is the section that some people were most concerned about. From the study made by Change Wave, only about 1% of individuals would share their genetic information with a prospective employer. While 2% would share with their current employer. People’s concerns revolved around the thought of possibly being discriminated against because of asymptomatic test results. This section of the bill includes five main points: Title II prohibits employment discrimination on the basis of genetic information, it includes:

“(1) for an employer, by failing to hire or discharging an employee or otherwise discriminating against an employee with respect to the compensation, terms, conditions, or privileges of employment; (2) for an employment agency, by failing or refusing to refer an individual for employment; (3) for a labor organization, by excluding or expelling a member from the organization; (4) for an employment agency, labor organization, or joint
labor-management committee, by causing or attempting to cause an employer to discriminate against a member in violation of this Act; or (5) for an employer, labor organization, or joint labor-management committee, by discriminating against an individual in admission to, or employment in, any program established to provide apprenticeships or other training or retraining.”

Both titles work together in concert to provide protection to individuals that feel they may be discriminated against at the work place. It is important to notice that there have not been any cases documented of genetic discrimination using GINA as the anti-discriminatory basis for support. As mentioned before, GINA is a fairly new legislation and it is not without fault.

1.0.4 Provisions and Limitations

As a genetic nondiscriminatory law GINA was strongly questioned. The opponents to the law saw GINA as unnecessary legislation. Opponents saw that while trying to provide protection for the future, supporters were establishing ground for problems. GINA provides protection to many but in its structure it still presents some loopholes. A list of the provisions and protections provided under GINA is shown in Table 1.1 on the facing page.

At the same time GINA, in its novelty, shows some limitations. These limitations are represented in Table 1.2 on page 8. These limitations are probably some of the effects of being a law that covers such a wide range of individuals. This is because as many nondiscriminatory laws target specific associated groups, GINA does not.
Table 1.1: Protections and mandates included in the Genetic Information Nondiscrimination Act [23]

- Prohibits individual and group health insurers from using a persons genetic information to determine eligibility or premiums.
- Prohibits health insurers from requiring or requesting a genetic test except under strict conditions, such as BRCA1 status to determine coverage for prophylactic mastectomy. In these exceptional cases, only a minimal amount of information should be provided.
- Prohibits employers from using a persons genetic information to make employment decisions, such as firing, hiring, promoting, or changing job assignments.
- Prohibits employers from requiring, requesting, or purchasing genetic information about a person or members of his or her family. The law also applies to employment agencies, labor organizations, and training programs.
- Does not prevent medical providers from recommending genetic testing.
- Does not require insurance coverage for any particular test or treatment.
- Does not forbid medical underwriting based on current health status.
- Protects genetic information and information about manifested diseases in an individuals family (i.e., family history).
- Prohibits health insurers and Medicare from using genetic information as a preexisting condition.
- Does not interfere with an employees ability to qualify for family or medical leave under Family and Medical leave laws, or to participate in wellness programs.
- Mandates employers to keep any genetic information they possess in a separate file and treated as a confidential medical record.
- Allows employers to request genetic testing only if “... the information involved is used for genetic monitoring of the biological effects of toxic substances in the workplace.”
- Assures individuals who participate in studies involving their genetic information that their results cannot be used against them by employers or health insurers.
- Mandates health insurers and employers comply with the highest level of protection provided by legislation. GINA does not override state antidiscrimination laws that provide more extensive protections.
Table 1.2: *Limitations of the Genetic Information Nondiscrimination Act* [23]

- Does not cover life, disability, or long-term care insurance.
- Does not apply to members of the military, veterans obtaining care through the Veterans Administration, or individuals receiving care through Indian Health Services.
- Does not cover a disease or condition that an individual develops and/or with which he/she is diagnosed.
- Does not address the regulation regarding the reliability or safety of genetic testing.
- Does not address regulation of marketing of genetic tests to consumers and healthcare providers.
- Applies only to those employers covered under the Americans with Disabilities Act (ADA) and Title VII of the Civil Rights Act of 1964; therefore, it does not cover employers with fewer than 15 employees.

1.0.5 *Preemptive Law*

This last section will focus on what makes GINA such a special act. GINA is considered the first of its class, it is a preemptive act. Unlike the previous nondiscriminatory acts prior to GINA that look at previous discrimination cases to create laws to provide protection, GINA looks at the future. In a quote by President Johnson he explained “millions are being deprived of [the] blessings [of liberty]- not because of their own failures, but because of the color of their skin But it cannot continue” [39]. Although discrimination under GINA does not look at skin color it looks at traits that are not a matter of choice. Therefore when talking about anti-discrimination laws immutability refers to the “proposition that entities should not discriminate on the basis of traits that a person did not chose and cannot change or control without serious cost” [39]. Since the genetic makeup of an individual is determined at the moment of fertilization and before birth immutability protects individuals.

As a preemptive law, GINA found the greatest opposition. The opposition found
the lack of evidence as the greatest flaw of GINA. As mentioned before previous anti-discriminatory acts looked at cases to create a law. Since there were no know cases of genetic discrimination GINA supporters used the following cases as evidence to support their bill. The first case was *Norman-Bloodsaw v. Lawrence Berkeley Laboratory*, where the laboratories tested prospective employee’s urine and blood without their consent. The laboratory tested for sickle cell, syphilis, and pregnancies. Another example is Burlington Northern Santa Fe Corporation. The corporation tested the employees for a predisposition to carpal tunnel as they developed the syndrome from their everyday jobs. The last example involves Terry Sergeant, an insurance manager that lost her job after being diagnosed with a alpha-1 antitrypsin deficiency. The deficiency manifests in a progressive lung cancer condition. As a result she lost her disability, health, and life insurance. Where preemptive laws seemed unnecessary to the opposition, GINA had a great impact on the previous anti-discriminatory acts. Table 1.3 on the following page shows the effects GINA had on some existing laws.

After reviewing those cases, GINA supporters saw the necessity to protect individuals from future discrimination both by insurance companies and by employers. The next chapters will focused on the Ethical, Technological, and Economical aspects of GINA.
Table 1.3: Genetic Information Nondiscrimination Acts Effect on Existing Federal Laws

<table>
<thead>
<tr>
<th>LAW</th>
<th>CHANGE</th>
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<tbody>
<tr>
<td>Employee Retirement Income Security Act</td>
<td>Prohibits group health insurers from denying coverage or discrimination in price policy or premium change because of an individual's genetic information</td>
</tr>
<tr>
<td>Health Information Portability and Accountability Act</td>
<td>Genetic information should be treated as health information.</td>
</tr>
<tr>
<td>Internal Revenue Code of 1986 and Social Security Act of 1965</td>
<td>Prohibits use of genetic information in regard to Medicare and Medigap coverage</td>
</tr>
<tr>
<td>Public Health Service Act</td>
<td>Prohibits health insurers from offering individual coverage based on genetic information</td>
</tr>
</tbody>
</table>

Note. Based on information from Laurent et al., 2008.
Chapter 2

Ethics

Ethical and privacy issues surrounding one’s genetic information abound. This chapter discusses the ethical issues surrounding GINA, its protections, and its shortcomings.

2.1 Manifestation of Disease

2.1.1 Introduction

Over the years, the court system has found it difficult to define when a disease first manifests. Because of this, the courts’ approach has been separated into three categories: manifestation as apparent symptoms, manifestation as patient action, and manifestation as physician action. 

[38]
2.1.2 Manifestation as Apparent Symptoms

Manifestation as apparent symptoms describes a disease to manifest as soon as an individual notices symptoms of a disease instead of at the time of diagnosis \[38\].

In the case of *Cardamone v. Allstate Insurance Company* an individual went to see her doctor about her stomach pains one day before the effective date of her health insurance policy. The doctor discussed all possible sources of the pain, including gallstones, but needed to run further tests to determine the actual cause \[38\].

The next day the individual’s health insurance took effect as did she have X-rays taken. With X-rays in hand, the doctor diagnosed her with gallstones. The court suggested even though the patient’s diagnosis was not fully determined as gallstones on her first visit, that day was when the disease manifested due to clear and unmistakable symptoms. Therefore, since the disease manifested one day before the effective date of her insurance policy she was ineligible from compensation for her gallbladder surgery because of the pre-existing condition clause in the insurance policy \[38\].

2.1.3 Manifestation as Patient Action

Manifestation as patient action describes a disease to manifest as soon as an individual takes action upon treating symptoms of a disease instead of at the time of diagnosis \[38\].

In the case of *Doroshow v. Hartford Life and Accident Insurance Company*, an individual sued his insurance company because he was denied benefits by reason of a pre-existing condition. The individual showed symptoms of a motor neuron disease.
He was later diagnosed with amyotrophic lateral sclerosis (ALS) after the exclusionary period of his insurance ended [38].

During his exclusionary period, the individual visited his doctor but was misdiagnosed. The court concluded that the insurance company could deny benefits for all treatment due to the pre-existing condition exclusion. Since the individual pursued assistance specifically for a motor neuron disease and not general symptoms, the court determined the ALS manifested regardless of the misdiagnosis [38].

2.1.4 Manifestation as Physician Action

Manifestation as physician action describes a disease to manifest once an individual is diagnosed or could be diagnosed by a physician. It is the most common outline courts have used when defining if a disease has manifest [38].

In the case of Dowdall v. Commercial Travelers Mutual Accident Association of America, the insurance company declined to pay treatments for an individual with multiple sclerosis (MS) due to it being a pre-existing condition. The individual was not diagnosed with MS until after his health insurance policy became effective [38].

Due to the individual’s symptoms, the doctor believed the individual had MS previous to the effective date of his health insurance policy. Because of this, the court concluded the manifestation occurred before the health insurance policy. According to this, a disease can manifest without the knowledge of the individual or the doctor [38].
2.1.5 GINA’s Definition of Manifestation

According to GINA, a disease, whether a disorder or pathological condition, manifests once an individual has been or could be diagnosed by a health care professional with expertise within that field of medicine. If a diagnosis is based solely on genetic information, the disease is not manifested [30].

If an individual shows no signs or symptoms of a disease and has not yet been diagnosed but their genetic test results show a genetic variant related with a specific type of cancer and another variant which shows an increased risk in developing that type of cancer, the individual does not have a manifested disease [30].

2.2 Genetic Information

2.2.1 What is genetic information?

According to GINA, genetic information is information about an individual’s genetic test, a family member’s genetic test, or a family member’s disease or disorder [24].

2.2.2 What are the appropriate uses of genetic information?

The Combined DNA Index System, also known as CODIS, is a government administered DNA database cite Norrgard:2008b. This software allows the state, local and national law enforcement crime laboratories to share DNA profiles of convicted offenders, unsolved crime scene evidence and missing persons. Numerous matches have been connected linking cases together by genetic information alone [?]. As of
February of 2007, this software has created over 45,400 links which have aided in more than 46,300 different investigations [5].

CODIS uses two catalogs to which help produce leads in cases where biological evidence is found at the scene. The first catalog is of convicted offenders. It contains DNA profiles individuals who have committed misdemeanors to those who have committed sexual assaults and murder. For every individual who is convicted, each state requires a biological sample to be collected and submitted to the DNA database. The second catalog contains forensic information. DNA profiles from semen, saliva or blood are collected and processed through the database for a potential match [11].

2.3 Deficiencies of GINA

2.3.1 First Deficiency

The following insurances do not apply to GINA: life insurance, disability insurance, long-term care insurance, or any other probable uses of genetic information. This has caused individuals to doubt if they will even be protected from genetic testing [40].

2.3.2 Second Deficiency

GINA does not prohibit discrimination based on phenotype but only prohibits discrimination based on genotype. Therefore, GINA is only relevant to individuals who show no apparent symptoms of a disease. Individuals who are of high risk of developing a disease are protected from discrimination but are not protected if they develop the disease. It is not uncommon for health insurance companies in different
states to lawfully raise their rates or simply refuse renewing an individuals policy due to a change in the individuals health. 

2.3.3 Third Deficiency

GINA also bans employers from making it mandatory for individuals to undergo genetic testing as part of employment. Although it may seem as if GINA makes numerous changes to various provisions, GINA does not affect the main provisions of the Americans with Disabilities Act. This act states that an employer has the right to lawfully mandate an individual to disclose all of his or her health records to the employer. Because of this, it is most likely that with or without GINA, custodians of health records will still continue to send employers any and all health records they request as long as an authorization of the individual is provided.

2.4 Cases of Genetic Discrimination

2.4.1 Lawrence-Berkeley Laboratories

Lawrence-Berkeley Laboratories was a state and federal research institution. Throughout 1968-1993 pre-employment and annual medical examinations were given to all potential employees and current employees. They were told the examinations were cholesterol tests. Without the individuals consents, more tests such as tests for syphilis, sickle cell genetic markers and pregnancy were also ran. Instead of testing only women and African-Americans for specific traits, Lawrence-Berkeley tested all employees randomly. In 1998 the court stated the employer’s actions
disrupted the employees’ rights to privacy according to the U.S. Constitution [12].

### 2.4.2 Maori-New Zealand

In 2006, a study was conducted with the indigenous Maori people of New Zealand [16]. The indigenous Maori people make up 14.7% of New Zealand’s population. These individuals also commit the most acts of violence than any other ethnic group in the country [31]. The study claimed the violent crime statistics was due to the warrior gene these individuals possessed. Later, this study was proven scientifically false but by then the damage to the indigenous people had be done [16].

Dr. Nicola Poa, a leading New Zealand geneticist at the Christ Church School of Medicine said that it was “unheard to link a gene to race-based behavior” [2].

He later stated:

“It is pretty contentious to be tagging a gene, especially with that type of behavior, to an ethnic race. There are huge ethical behaviors behind it. I was appalled...you have to be very careful. It is quite a big leap to be able to connect it to a type of behavior. You really need input from psychologists or psychiatrists to do it at the molecular level. Genes are the basic building blocks. It’s a big leap to adapt it to someone’s behavior” [2]
2.4.3 Havasupai Tribe

The Havasupai Tribe is native to the Supai Village which is located at the bottom of the Grand Canyon in Arizona. In 1963, investigators helped the Havasupai Tribe address matters such as educational issues, community issues, as well as social and environmental issues [16].

Since diabetes was a prevalent disease found in the Havasupai Tribe, in 1989 a Havasupai Tribe member asked investigators to study the epidemic among members. Another investigator decided to take part in the diabetic study of the Havasupai Tribe as well. As another part of the project, he also decided to study genetic aspects of schizophrenia without receiving consent from the Havasupai Tribe members [16].

Overall, two hundred Havasupai Tribe members signed consent forms to give blood for the diabetes research. Researchers concluded that the rate of diabetes in the Havasupai Tribe was increasing too rapidly for it to be relevant to genetics [16].

Without the consent of the Havasupai Tribe members, research based on the given blood samples continued. Articles on evolutionary genetics, schizophrenia, inbreeding, and population migration were later published without any form of consent [16].

“The Havasupai Tribe claimed breach of fiduciary duty, lack of informed consent, fraud, misrepresentation, fraudulent concealment, intentional infliction of emotional distress, conversion, violation of civil rights, negligence, gross negligence. The claim eventually settled when the university where the investigators were employed issued a public apology, arranged the return of the blood samples, and agreed to collaborate with the Havasupai Tribe on matters such as health, education, and economic
development and to create a scholarship program” [16].

2.4.4 Pamela Fink

The first employment discrimination claim was filed by Pamela Fink in Connecticut [26]. In 2010, Ms. Fink claimed that she was fired due to genes she carried predisposing her to cancer [8]. In 2004, Ms. Fink had a genetic test which showed positive results for BRCA2 [26]. BRCA2 is a breast cancer type 2 susceptibility protein [10]. In January of 2006, she started a job at MXenergy as a public relations direction. In August of 2009, she received a good performance review and told her company that she would be having an upcoming surgery. In October of 2009, Ms. Fink took a 2 week medical leave for a double mastectomy. In January of 2010, she received a scathing negative review. By February of 2010 she was able to return to work after her surgery only be fired in March of 2010 [26]. Response from MXenergy CEO and President:

“I can assure [you] that there is far more to the story than has been reported. When all the facts are known, we are confident that this issue will be seen in a different light and our actions warranted, not criticized” [26].
2.5 Rights of Individuals

2.5.1 Are Family Members Required to Inform Children of Their Medical History?

To many, it may seem logical and ethical to inform a relative if they are carrying a dominant gene to a particular disease. However, this is not the case. Even though giving information to a family member might help save their life, it is not legally required to do so. In fact, requiring someone to disclose such information is considered to be ethically questionable [4].

2.5.2 Should Medical Professionals Communicate with Families Based on the Medical History of a Relative?

The diagnosis of a disease is dependent on how it is detected. There are many cancers that can be suggested through lab results, while others are confirmed indefinitely through tests. Once a medical professional is able to confirm the presence of a disease, the confidentiality of the patient may be at stake when preventive and reproductive options are presented. Some diseases may be considered to be very private and would violate the law and HIPAA if it were to be disclosed. The medical history of a patient is considered to be confidential and should not be shared with anyone. The ethical decision deals with sharing of this information if it can cause harm to another relative. In those cases, the patient is informed of the potential outcomes and is ushered to make a decision of what they want to do [4].
Unlike the United States, where an individual is in control of his or her health, in Japan, the informing of children depends on the hospital the individual is admitted to. There are a few hospitals in Japan that respect the individual’s decision to not tell their children about the cancer diagnosis, whereas other hospitals are more encouraging about discussing the individual’s diagnosis with relatives whom may have an increased risk of developing the same disease [15].

2.5.3 HIPAA

The U.S. Department of Health and Human Services (HHS) implemented the requirement of the Health Insurance Portability and Accountability Act of 1996 (HIPAA) to the Privacy Rule. The Privacy Rule considers the use and disclosure of an individual’s health information as protected health information [44]. The Privacy Rule is set in place to ensure that patient information remains confidential and does not fall into the wrong hands. However, some information may be beneficial to the advancements of science and the medical field. Due to this, the Privacy Rule is a bit flexible. The Privacy Rules allows the use of a patient’s medical information while still protecting personal information about the patient. Through this, the privacy of the patient remains intact and the information that researchers need is provided [44].
Chapter 3

Technology

From Charles Darwin’s groundbreaking publication in 1858, to the completion of the sequencing of the human genome in 2001, advances in the fields of biology and genetics have never been greater. This chapter explores the ramifications of these advances in technology on genetic privacy.

3.1 Background

3.1.1 DNA and Evolution

The road to being able to uniquely identify every person by their genetic “fingerprint” begins in 1869 as Friedrich Miescher was attempting to find the building blocks of life. In the process of analyzing leukocytes in pus, he discovered a substance he called ‘nuclein’, which had different characteristics than the protein he was accustomed to finding. Nuclein would later be called deoxyribonucleic acid.
Nearly concurrent to Miescher’s work, Charles Darwin had, in 1858, published his book, *On the Origin of Species by Means of Natural Selection*. Based on Darwin’s travels aboard the HMS Beagle and other research, the book suggests the means by which life evolves over time based on changing environmental conditions. Despite controversy at the time of the publication of the Origin, and scattered controversy since, no significant challenge has been made to the theory of evolution by natural selection, commonly called evolution [27].

Though common knowledge today, deoxyribonucleic acid (DNA) as the means of inheritance is a relatively recent discovery. Before 1944, the generally accepted means of heredity was believed to be protein. Work by Avery, MacLeod and McCarty in 1944 identified deoxyribonucleic acid as the mechanism of heredity, rather than protein [15].

DNA can be thought of as serial data encoded with a quaternary numbering system. Each protein in the body is represented by a base-4 string of ”numbers” with the digits A, T, G and C. The digits are represented by the amino acids adenine, thymine, guanine and cytosine, respectively. DNA data also has built-in error correction mechanisms based on a complementary string of data wherein an adenine binds to a thymine and a guanine binds to a cytosine, and vice-versa. Since the coding strand from which proteins are made and the non-coding strand are complementary but identical, the error checking machinery of the cell can usually correct any mutations in the strands. However the mechanism sometimes fails to work.

Darwin’s theory described change over long (evolutionary) periods of time. The same mechanism of small random mutations in genetic information, as well as
reassortment of maternal and paternal DNA during meiosis also contribute to the mechanism by which DNA can change over human generational time, while still maintaining similarity to parental DNA.

By 1972, Fier, et al. had developed the ability to ascertain the sequence of DNA nucleotides in a bacteriophage [33]. This paved the way to improved sequencing methods developed by Sanger and Coulson in 1975 [41].

The International Human Genome Mapping Consortium began sequencing the human genome in 1998. By the end of 1999, all data had been gathered from sequencing and assembly work had begun. In February 2001 the announcement was published that the human genome had been sequenced [32].

As with most new technology, the cost of sequencing a human genome is declining. The cost to sequence the first human genome was $100 M. As shown in Figure 3.1 on the next page, the cost to sequence a human genome has fallen to less than $10000 as of 2013. Further reductions in costs will yield easier access to sequencing.

While the ability to sequence the whole human genome was being developed, other scientists were at work using some of the same technologies to find the genes associated with various genetic diseases. As of this writing, there are over 6000 genes associated with diseases [12].

3.1.2 Familial DNA

Meanwhile, the ability to uniquely identify individuals using DNA was being developed by Alec J. Jeffreys. This technology takes advantage of the fact that each individual has areas of unexplored (sometimes called “junk”) DNA that contain sections of
Figure 3.1: Declining cost to sequence a human genome from 2001 to 2013 [7].

DNA nucleotides that are copies of repeating sequences. These sections are called microsatellites or more commonly Short Tandem Repeats (STR). The sequence being repeated is between two and five base pairs long. The sequence, for instance, could be:

ATGC ATGC ATGC ATGC ATGC ATGC ATGC

One individual could have this sequence repeated 20 times at a particular locus (location on the DNA), while another person might have the sequence repeated 10 times at the same locus. Each individual has two alleles per locus, which may have different STR counts. While an individual might have the same number of STRs at a locus as another individual, the probability of two people having the same number of
STRs at two locations is smaller. As the number of loci being analyzed are increased, the probability of non-monozygotic twins (who have the same DNA and are essentially clones of one another) having identical repeat counts is very small. Currently 13 loci are used for STR analysis. This yields a possibility of two non-monozygotic twin individuals having the same STR count at all loci of 1 in 10 billion [22].

As previously mentioned, each loci has two alleles. After fertilization and during meiosis, the chromosomes from the mother’s egg and the father’s sperm undergo a process called *crossing over* that results in the combining of DNA from each parent. Thus certain loci can have STR counts identical to the mother, and some can be the same as the father. This genetic record leads to traceability of STR counts to either parent. Further, a parent’s STR counts can lead to traceability to the parent’s parent, and so forth [22].

Thus, given an individual’s STR counts, their DNA fingerprint, and a database of other individuals’ DNA fingerprints, a family tree can be constructed. Individuals interested in doing so recreationally can use online resources such as ySearch[13], which maintains a database of user contributed DNA fingerprints. This allows previously unknown persons to locate relatives.

### 3.1.3 Degree of Relatedness

Based on the previous sections of the Background section (See 3.1 on page 23), it can be intuited that biotechnology has given us the means to determine the predisposition to disease, as well as familial lineage. Since some diseases are inherited, it stands to reason that an inference can be made from the genetic information obtained from an
individual’s ancestors as to the individuals alleged propensity to disease. GINA seeks to limit such inferences by limiting the use of DNA information obtained from family members of the “fourth degree” or less [7].

Calculation of the degree of relatedness of two individuals is much simpler than Wright’s method of calculating the Coefficient of Relatedness [46], and can be accomplished by constructing a table of consanguinity as shown in Figure 3.2 on the next page. A simplified version in the form of a family tree is shown in Figure 3.3 on the facing page. Beginning with the first individual (“Fred” in this case), the count is incremented by one for each connection traversed. In the example, the count increments as follows: 1=Mom, 2=Big Memaw, 3=Aunt Jane, 4=Louise, 5=Paolo. Thus for the purposes of GINA, genetic information collected from Paolo can be used to assess Fred’s eligibility for employment, insurance, and other services since he is not considered a family member. When viewed in a family tree or table of consanguinity, it appears that a degree of relatedness of five might still allow the inference of genetic propensity to disease. However, Congress believes limiting family to the fourth degree or less is acceptable, and is greater than current medical practice which considers individuals of the third degree or less to be related [7].

It is notable that Congress specifically includes adopted individuals to prevent discrimination against their adoptive parents in matters of employment or health insurance. The purpose of GINA is to prevent discrimination based on genetic information of family members, adoptive or otherwise [7].
Figure 3.2: Table of Consanguinity used to calculate relatedness.

Figure 3.3: Sample calculation of degree of relatedness from "Fred" to "Paolo". The count is determined by beginning at an individual with a designated count of 0, and incrementing for each person in the connecting path to the destination person.
3.2 Possible Confounds

3.2.1 Paternal Mitochondrial DNA Leakage

Since females have two X-chromosomes and do not have a Y-chromosome, matrilineal inheritance can be traced using mitochondrial DNA. The technique used to characterize mitochondrial DNA differs from the STR loci counting previously elucidated and involves sequencing of hypervariable regions in the mitochondrial DNA.

One potential problem with determining maternity is a recently discovered phenomenon known as paternal mitochondrial DNA leakage. Normally, paternal mitochondria in the sperm are ubiquitinated and targeted for degradation within minutes of fertilization of the egg \[43\]. The paternal mitochondrial DNA is also vastly (100:1) outnumbered by the mitochondrial DNA in the egg. This usually results in the expected inheritance of maternal mitochondrial DNA.

However, there have been cases in which paternal mitochondrial DNA has “leaked” into the mitochondrial DNA \[17\]. This paternal mitochondrial DNA leakage could result in misattribution of maternity, since the child’s mitochondrial DNA might not match the mother’s DNA.

3.2.2 Polygenic Diseases

While some diseases are monogenic, that is, caused by a single defect in a single gene, other common diseases cannot be attributed to a single defect in a single gene. These diseases are termed polygenic and have been described as a “web” of genes. This web of genes can be large and intricate, requiring a genomic study of large populations of
3.2.3 Combined Genetic and Idiopathic Casuation

Other factors complicate the attribution of susceptibility to disease to one or a multitude of genes. Among these factors are environmental triggers and physiological conditions. Therefore the presence or absence of a genetic signature for a disease may not be a reliable indicator for susceptibility.

An example of one such disease is Parkinson’s Disease (PD). Mutations in SNCA, PARK2, PINK1, PARK7 and LRRK2 have been determined to be the cause of primary PD in some cases. However a correlation between pesticide exposure and manifestation of PD onset has been documented, as well as a causative link between a toxin (1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine) found in a drug of abuse and manifestation of PD. Examples such as this highlight the need for GINA, as an individual’s family member may have been exposed to pesticides while working in fields. Though the individual has no genetic or increased idiopathic propensity to PD, the onset of PD in a family member could be construed as susceptibility and affect the individual’s employment or healthcare.

3.3 Impact on Research

3.3.1 Research Volunteers

Fear of the disclosure of genetic information is impacting the number of individuals who volunteer for research studies, despite the fact that genetic information is considered
protected information. Research based on genetics is important to discovering
treatments and cures for diseases with genetic indicators. The Department of Health
and Human Services is required by GINA to clarify that genetic information is
protected, private information [18].

3.4 Exception

3.4.1 Law Enforcement and Human Remains Identification

One interesting exception to the coverage of GINA is for employers whose employees
conduct analysis of DNA samples for law enforcement and human remains identifica-
tion purposes. In the course of handling these samples, there is the possibility that
the sample will become contaminated with the employee’s DNA. A sample of the
employee’s DNA is thus required to rule out the possibility of contamination. In this
narrowly defined case, employers may require employees to submit their DNA for
analysis to ascertain whether samples from crime scenes or remains become contami-
nated with the employee’s DNA. Restrictions included in the law stipulate the DNA
can only be analyzed and used for identification purposes - that is, genomic testing
for disease susceptibility is not to be performed. The employee’s DNA fingerprint
data also may not be entered into law enforcement or national databases, unlike
innocent suspects who are arrested and released without being charged [7].
Chapter 4

Economics

The costs of any piece of legislation must be carefully considered before a decision is made to vote it into law. Seemingly small costs can potentially be multiplied millions of times across the populace of a country. This chapter considers some of the costs associated with GINA.

4.1 Cost to Insurers

4.1.1 Individual Health Insurance

The costs of implementing GINA has been estimated by the Department of Health and Human Services and is expected to be higher in the individual health care market due to the necessity of each company reviewing their policies and procedures for compliance. Additional expense will be incurred in the training of underwriters to comply with GINA’s guidelines for the use of genetic information. The cost estimate
for the ≈490 insurers is 100 h of additional training at an estimated hourly rate of $116 for a total of $5.6 M \[6\].

Individual health insurance underwriters will pass along the costs of increased fees from medical record providers to the purchasers of insurance. Individual insurers request records from medical record providers for approximately 20% of applicants. The information received from the providers routinely contains family history information, which is considered genetic information under GINA. Thus the burden of redacting medical records of genetic information will fall to the providers. This redaction of some 3 M medical records per year is expected to require 1/2h each at a rate of $26/h, for a total impact of $41 M. One interesting caveat about the acquisition of genetic information in medical records from providers is that if the providers fail to redact the information, it is considered an “incidental collection” and is not considered a violation of GINA. The only requirement of the insurer is that the genetic information not be used \[6\].

### 4.1.2 Adverse Selection

Of concern to individual providers is the phenomenon known as adverse selection. Adverse selection is the term given to the tendency of the sick (or potentially sick) to seek insurance coverage at a higher rate than the general population. This can lead to increased burden on insurers and loss of profitability. The falling price of genetic testing will enable individuals to have themselves or family members tested for genetic predisposition to certain diseases. If the results indicate susceptibility, the individuals will be more likely to seek medical insurance coverage. Under the laws
of GINA, the results of the genetic test will not be available to the insurer. Thus the costs incurred could be disproportionately higher than providing coverage to a median cohort of applicants.

4.1.3 Prophylactic Surgery

Many women with a family history of breast cancer seek testing for mutations in the breast cancer predictive loci \textit{BRCA1} (which expresses a DNA repair enzyme) and \textit{BRCA2} (which expresses a tumor supressor). The results of testing can be used to determine if an elective prophylactic mastectomy is warranted \cite{37}. Under the protection of GINA, the results of the genetic testing cannot be revealed. Thus, women whose testing revealed a mutation in either or both genes, and who do not elect to have surgery, will not be discriminated against if the disease does not manifest. Their family members will also not be discriminated against based on the results of the test. The protections of GINA in this case should lead to more at-risk women seeking testing and thus increase positive outcomes. Prophylactic surgery can result in reduced healthcare costs. This is indicated by the 25\%–44\% of private plans that cover the surgery \cite{35}.

4.2 Cost to Business

4.2.1 Small Business Exemption

GINA specifically excludes employers with fewer than 15 employees, therefore the economic impact to those employers should be negligible \cite{7}. The effect of GINA as a
disincentive to growth of a business remains to be explored.

4.2.2 Human Resources Training

GINA training is estimated to require three hours of time from human resources (HR) personnel. The training can be conducted by attendance of an EEOC class, or by studying the materials provided on a government website. The estimated cost per HR employee, using national average wages would therefore be from $139 to $696 [7].

4.2.3 Unfunded Mandates Reform Act of 1995

The total estimated impact on the public and private sectors has been estimated to be less than $100 M per year. Therefore the Act is exempt from the Unfunded Mandates Reform Act of 1995 (UMRA). Under the UMRA, mandates imposed by the government onto state, local and tribal governments are limited [9].

4.2.4 Bribes for Genetic Information

Employers are prohibited from offering monetary incentives for employees to provide their genetic information or family medical history. However, in the context of a wellness program, incentives may be offered to the employee to complete a survey that includes indications of their genetic predisposition to disease, such as family medical history. Employers may also offer incentives for the employee to improve their health and reduce the risk of manifestation of disease [7].
4.3 Future of GINA

4.3.1 GINA Opens Door to DNA Age in Medicine

GINA helps scientists and companies discover new ways to give individuals diagnostic tests based on their genetic information without the fear of discrimination. Individuals who have previously paid with cash to avoid insurance claims will not have to worry about being discriminated against because there is a wider health plan coverage of genetic tests. New genetic tests help doctors prescribe more effective drugs to their patients. This will help reduce the monopoly in the drug industry and overall, provide patients with a positive outcome [20].

A company called Genentech used this approach with Herceptin, a breast cancer drug. In return, the company was successful with financial reward. A biomarker is a protein or chemical which can be found in the bloodstream. It acts as an indicator to specific diseases or disorders. Individuals who were tested for specific biomarkers showed they were likely to benefit from the use of Herceptin. Genentech now plans to use biomarker tests to assist prescribing individuals to future medication research [20].

The FDA informed physicians to use genetic screening tests before prescribing HIV/AIDS medication to their patients. The FDA believes screening tests will protect individuals from allergic reactions to medications [20]. According to Dave Bromund, health insurers should benefit from GINA and personalized medicine. Mr. Bromund believes if a genetic test can determine whether a new and expensive form of treatment against cancer will be responsive, that treatment should be tailored
to those individuals of similar genetic makeup and only to those who would benefit. Individuals who will not benefit from the treatment can avoid all expenses and risks [20].
Chapter 5

Summary

As a consequence of rapid advances in biology and genetics, in 2008 the United States Government passed preemptive legislation to help prevent the use of genetic information as a means of discrimination in the issuance of health insurance or obtaining and retaining employment.

Known as the Genetic Information Nondiscrimination Act, the legislation provides restrictions on the gathering and use of genetic information. The hope being that individuals will not be held responsible for, or penalized for, anomalies in their genome that may or may not manifest later as disease. While the Act covers health insurers and employers, it does not cover insurers of life, long-term care or disability. It also does not apply to employers with fewer than 15 employees.

The Act is expected to have minimal financial impact on the United States economy. The total impact of the Act is expected to be less than $100M/year, a large portion of which will be due to retraining costs of administrative personnel.
By protecting an individual’s genetic privacy the Act is expected to encourage participation in disease research that may have a genetic component. This participation is crucial to advancing the field of medicine and the coming age of personalized medicine.
Appendix A

Group Opinion

After reviewing the Genetic Information Nondiscriminatory Act of 2008 we came to the conclusion that this is a good bill. As a new type of law we agree that trying to protect the general public from future discrimination on the basis of genetic information is sound and reasonable. Although the law still has some loopholes through which insurance providers and employers can jump, the protection provided under GINA satisfies many of the public’s concerns. We believe that under such regulations more individuals will be encouraged to undergo genetic testing. The participation of individuals in such genetic testing will provide much more information about diseases and treatment that will prove beneficial. Not only will those individuals participating receive benefits, but they will also receive better treatment and prevention from genetic disorders as a result of continuing findings in the area of genetics.

In the area of insurance coverage provision we believe that companies should have some say in the premiums charged for some individuals. We believe people should
not be discriminated against on the basis of genetic makeup. Individuals are not responsible for the genetic information that is passed down to them from their parents. We strongly support a law that supports and protects the right of an individual’s immutability. We believe the cost of health insurance and premiums should not be decided by asymptomatic conditions. We believe that individuals should not pay more for matters that are out of their control as in inherited traits. On the other hand, we support the increase of individual premiums due to unhealthy behaviors such as smoking, excessive alcohol and the use of drugs, amongst others, that may lead to acquired genetic conditions.

To conclude we believe genetic information is personal and it is the individual’s decision to allow other parties to have knowledge of any personal or family history.
Bibliography


