Report of the Genetic Testing Committee to the Medical Section
of the American Council of Life Insurance,
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The Potential Role of Genetic Testing in Risk Classification

Contents

Misconceptions about the differences between private and public insurance programs are common and many people have come to regard private health insurance and, to some extent, private life insurance, as entitlements. Such feelings may grow unless greater efforts are made to educate the public about the purpose and principles of private insurance. The public should also know the differences between life and health as well as individual and group insurance. The issues will vary depending on the product line.

Confidentiality, counseling and informed consent will be very important considerations. Fears may arise that an applicant's rights to self-determination and privacy could be violated if genetic tests are performed during the risk assessment process, or if the results of prior tests are used to classify risks. Historically, insurers have been very responsive to these concerns and they should continue to remain sensitive to them. Insurers will also need to reaffirm their position that counseling can best be provided through the applicant's attending physician.

The insurance business must be an active participant in future dialogues concerning the use of genetic tests to more accurately classify risks. It must assume a leading role to maintain its viability and to fulfill its social responsibilities. Recent experience with controversial issues such as unisex pricing and AIDS should serve as a reminder that compelling actuarial data do not necessarily guarantee the ability to use reasonable risk classification practices.

—Robert J. Pokorski, M.D.

Introduction

By the year 2000, genetic testing may be standard within the medical community. In much the same way that cholesterol and blood sugar tests are now part of routine examinations, genetic tests may be carried out to test for predispositions to such common diseases as cancer, heart disease and hypertension.

As genetic testing is perfected, society will be forced to confront important issues that have never before been of such widespread concern. Profound ethical questions will be posed concerning the practice of medicine, procreation, employment, privacy, individual versus societal rights, confidentiality, the "right to know" and the "right not to know." And among the most prominent issues that will be debated during these dialogues is the potential impact of genetic testing on future insurance applicants, current policyholders and the insurance business itself.

At some point, genetic testing may become standard practice within the medical community. Having a panel of genetic tests performed may be as routine as having a cholesterol or blood sugar done. If and when this occurs, insurers will be forced to consider ordering genetic tests themselves. Doing so could well enhance the risk selection process. But even more likely, ordering genetic tests could be considered a prudent business decision that responds to the considerable adverse selection that is certain to occur.

This report of the Genetic Testing Committee discusses four topics. These topics, and the issues each covers, are:

1. *Public and Government Relations Issues:* This section discusses the principles of insurance and risk classification; the two basic types of genetic tests; adverse selection and the use of genetic tests; differences between private and public insurance; group insurance; confidentiality, counseling and informed consent; the role of laboratories; and arguments supporting the use of genetic tests for risk classification.
2. *Genetic Testing: Analysis of Test Results:* This section discusses basic test theory as it relates to genetic testing; what a genetic test will do and what it will not be able to do; the relationships between genetic tests and different types of disorders; and a list of criteria that could be considered before using genetic tests to classify risks.
3. *Genetic Data: Impact on Underwriting:* This section discusses the potential impact of adverse selection; actuarial parallels between genetic disorders and other impairments or risk factors; the concept of "standard" insurance; and practical considerations for insurers contemplating genetic tests in underwriting.
4. *Genetic Overview:* This section reviews the subject of genetics; common genetic disorders; and the current status of genetic testing. It also provides a glossary of technical terms.

A. Introduction

We are entering an era in which the public has become so attuned to rapid developments in medicine and science that it will probably be willing to accept genetic explanations for the development of many diseases and complex human behaviors. Nevertheless, there will probably be resistance to the use of this type of information by insurers to better classify risks. Some of the reasons for this opposition, all of which are addressed in this section, follow:

- Beliefs that it is unfair to classify risks based on factors that people cannot control
- Concerns that insurers will use genetic tests to disqualify large numbers of people from affordable insurance coverage
- Skepticism or a lack of understanding of the accuracy and fairness of risk classification
- Concerns that insurers will be unable to deal with issues such as confidentiality, informed consent and counseling
- Beliefs that genetic tests will permit insurers to predict with certainty when and how policyholders will die or develop significant illnesses
- Ethical concerns that genetic tests for any reasons other than tightly restricted medical purposes will be used to restrict human rights
- Beliefs that people have a right to affordable private life and health insurance

Much of the concern about the possible use of genetic tests stems from a lack of knowledge of the basic tenets of private voluntary insurance. The annex at the end of this report describes the basic principles of insurance and risk classification.

B. Two Different Types of Genetic Tests

The designation "genetic disease" is usually used to describe two different types of diseases that have some genetic basis: (1) diseases with a genetic predisposition and (2) genetic diseases.

In diseases with a genetic predisposition (or a genetic component), the presence of a gene confers an increased tendency to develop the disease. The disease may develop depending on a variety of associated personal and environmental factors. These factors include geographic location, exercise, diet, obesity, tobacco use, heavy alcohol ingestion, exposure to harmful chemicals or toxins and so on. A genetic predisposition is often a factor in the development of some of the most common diseases. These include cancer, coronary heart disease, hypertension, diabetes mellitus and epilepsy.

Tests that can identify diseases with a genetic predisposition are of potential interest to insurers because they will indicate the likelihood of diseases that are responsible for the morbidity and/or mortality of the majority of people who contribute to the insurance pool. The results of prior tests performed by the applicant's attending physician would be important to insurers for accurate and fair risk classification. In some instances, insurers might consider ordering certain genetic tests of their own during underwriting.

In genetic diseases, the genetic component is so overwhelming that its effect is predictable. No environmental interaction is necessary, as is the case with diseases with a genetic predisposition, for the disease to develop. For example, an individual who inherits the gene for Huntington's disease, cystic fibrosis or Duchenne muscular dystrophy will eventually develop the disorder regardless of socioeconomic factors or preventive health measures. Individual genetic diseases are rare compared to diseases with a genetic predisposition. But, collectively, they are an important cause of morbidity and mortality. It may be a long time before insurers are interested in using genetic tests to identify even a small proportion of genetic diseases. The reason is prohibitive cost and the large number of diseases. Insurers would have to order whole batteries of expensive tests in order to identify disorders in a relatively small number of applicants.

C. Genetic Tests and Adverse Selection

Although the expense could be so great that insurers might prefer not to order genetic tests themselves, they could want access to prior genetic testing results. If test results were unavailable to insurers, applicants who already knew from tests performed by their own physician that they were predisposed to illness or early death could buy large amounts of insurance coverage. Moreover, they would be doing

policyholders and stockholders. They must generate a profit for those who have invested in the company. If insufficient premiums are collected in relation to the amount of benefits paid, a private insurance company will go out of business.

(b) *Public (Involuntary) Insurance.* The United States has used private means to fulfill certain general social welfare needs such as payment for health care. But private health insurance has never been a completely adequate or universal method of providing access to the health care system, nor has it been a perfect mechanism for covering all diseases. The poor, disabled, aged or seriously ill cannot always be covered by private means. For this reason, society has supplemented private insurance with publicly supported programs such as Social Security, Medicaid and Medicare.

Participation in a public insurance plan is usually not voluntary. Participants do not determine how much insurance protection they would like. Rather, participation is mandatory and benefit amounts or entitlements are determined by the law establishing the program.

Everyone, including good risks, poor risks and even those suffering from a severe or terminal illness, is automatically insured. As a result, there are no options regarding the amount of benefits that will be paid, and adverse selection is not a concern. Premiums are charged in the form of income and Social Security taxes, or so-called "insurance premiums," but they are not and need not be proportionate to the risk assumed. Risk selection is not required and no profit motive exists.

These points are summarized in Table I below.

Two questions might arise as a result of the public's confusion over the fundamental differences between private commercial insurance and public insurance. First, couldn't legislators or regulators simply require that private insurers provide coverage at rates less than appropriate for the risk assumed for those individuals who have learned that a genetic test has identified a significant likelihood of premature death or illness? Such coverage would no doubt be at rates that are low in relation to the risks assumed. Second, couldn't private insurers be prohibited from ordering their own genetic tests or asking applicants and their physicians for the results of prior tests?

An affirmative answer to either of these questions would mean trouble for the private, voluntary insurance industry. Large-scale, mandated subsidization of poor risks by good risks —the inevitable result of such legislation— would be tantamount to an indirect tax levied solely against insurance policyholders and stockholders. The initial impact of such legislation might not appear significant. But its cumulative effects would be dramatic.

Under such legislation, many potential policyholders—primarily good risks—would be expected to subsidize poorer, underpriced risks. People with other health impairments (cancer and heart disease, for example) who pay a premium commensurate with their increased risk would soon realize that they are being overcharged or treated unfairly. As a result, people in this category would choose not to buy new or further coverage.

The increase in premiums would be relatively small at first. But, such a plan for mandated benefits would require a gradual but progres-

Table I: Comparisons Between Private and Public Insurance

	Private (Voluntary) Insurance	Public (Involuntary) Insurance
Examples	Private, commercial insurers	Medicare, Medicaid, Social Security
Participation	Voluntary	Mandatory
Amount of insurance	Optional	Controlled
Risk classification	Essential	Unnecessary
Potential for adverse selection	Yes	No
Profit required	Yes	No

Table II: Comparisons Between Individual and Group Insurance

	Individual	Group
Participation	Optional at discretion of the individual	Generally guaranteed as a benefit of employment and high participation common
Amount of insurance	Optional	Controlled
Individual risk classification	Essential	Generally not done
Potential for adverse selection	Significant	Minimal

The overall impact of genetic testing on group insurance coverage would probably be minimal. This is because about 90 percent of commercial group health insurance, and perhaps a similar percentage of group life insurance is sold to medium to large-sized groups on which there is no individual testing or underwriting. For small groups, the ramifications of possible genetic tests are less certain and might be similar to those described above for individual life and health insurance.

F. Confidentiality

During underwriting, information about serious health problems, mental disorders or other important matters may come to light. Insurers are experienced at dealing with this kind of sensitive and highly personal information. Maintaining confidentiality has always been a major concern.

Genetic data will, in principle, resemble other information that is currently reviewed by insurance companies or obtained from attending physicians during underwriting. This data could provide important prognostic information that would permit insurers to more accurately and equitably classify risks. But the ability to identify people who could develop a significant physical or mental impairment far in the future presents a new dimension in protecting confidentiality.

The emotional nature of this issue of confidentiality stems from the potential impact of this type of testing on individual "autonomy." Autonomy refers to the capacity of competent adults to formulate life plans and decisions freely. Autonomy depends on being able to act deliberately, based on one's own judgement about the consequences of certain behaviors and their value to oneself or others. Although individuals may have the right to be autonomous, they could nonetheless lose some elements necessary for autonomy with inappropriate disclosure of genetic test results. For instance, accidental disclosure of genetic data about an individual's predisposition to development of a disabling illness could change the way in which society treats that individual.[2]

Concerns about confidentiality will probably be proportionate to the potential adverse impact of improperly handled data. For example, genetic tests used to identify significant risks for physical disorders such as cancer or heart disease might be less controversial than tests for aptitude, personality, mental illness or other behavioral characteristics. As a result, some have already argued that genetic testing for certain disorders should be restricted because of the dire consequences of violated confidentiality. As an alternative, special guidelines for disclosure and/or protection of the most sensitive test data might be needed.

For instance, what is the proper course of action if a genetic test reveals unexpected information that would be of benefit, and/or potentially present serious harm to other family members? Should there be absolute confidentiality? Should test results be made available to relatives if there is a clear and present danger if they are not shared? Who has a legal right to such data?

Racial and ethnic issues may also surface since it is possible that genetic tests will identify characteristics or disorders that are highly associated with certain ethnic or racial groups. Concerns will be raised that the use of these tests may in some cases reinforce existing societal strictures or institutions that stereotype or stigmatize certain groups or otherwise reduce their freedoms and rights.[3]

[2] **Marc Lappe, Ph.D., "Long-Term Implications of Mapping & Sequencing the Human Genome: Ethical and Philosophical Implications," (Chicago: University of Illinois at Chicago, College of Medicine, prepared for the Congress of the United States, Office of Technology Assessment, 1987), p. 17–19.**

[3] **Lappe, p. 7–8.**

The scenario above reflects very real concerns. Technology may some day allow batteries of genetic tests to be performed inexpensively. In response to competitive pressures, more laboratories may offer to perform more tests for less money. These tests may be marketed to insurers as an adjunct to or substitute for traditional risk selection procedures—well before enough is known about the tests for decisions on their proper use.

How could an insurance company decide if a given genetic test would enhance the accuracy and fairness of risk classification? When a new test became available, insurers would need to examine current medical literature and study the ramifications on underwriting, pricing mortality and lapse assumptions, and government and public relations. Specific criteria would have to be created to ensure that a genetic test was used only after concerns about predictive value and equity were resolved. If the test satisfied all of these criteria, then it could be integrated with proven risk selection practices. If these concerns could not be resolved, then the best course might be to postpone use of the test.

Laboratories serving the insurance industry may play an important role in determining the use of genetic tests. Although attending physicians might begin to use these tests shortly after they became available, insurers and their laboratories would have to insist that genetic tests satisfy specific standards before use. Use of genetic tests, as noted earlier, extends well beyond the relatively straightforward concerns of test accuracy and the technical skill required of the insurance laboratories to perform the laboratory tests.

J. Arguments Supporting Use of Genetic Tests for Risk Classification

Insurers are just beginning to consider the impact of genetic testing on the private insurance industry. There are still far too many uncertainties to permit conclusions or projections. With this caveat in mind, some of the arguments favoring the use of genetic tests to help classify risks are discussed below.

Argument No. 1: Insurance applicants as a whole could benefit substantially from the use of genetic testing. Critics of using genetic tests to classify risks usually assume that the results would be unfavorable and that the affected applicants would be summarily declined. On the contrary, many tests would indicate a very low probability of premature death or illness from a particular genetic feature. This knowledge could allow insurance companies to lower the premiums for this very sizable group of good risks. At the same time, it could increase or at least maintain the same high proportion of people who are granted insurance at standard rates. Their risk would now have been more effectively determined.

It is true that tests for genetic diseases (as opposed to diseases with a genetic predisposition) will be able to identify some people who will probably become ill or die prematurely. Knowledge of such test results could lead to adverse underwriting decisions by insurers, such as higher premium payments or declinations. But these tests would offer significant benefits to others who are also at risk. For example, consider applicants with a family history of Huntington's disease who have no manifestations themselves. Without genetic testing, no one would know whether these people have inherited the disease. They would be considered risks that would be very difficult to insure at reasonably low rates. But if a genetic test indicated that they were not carrying the Huntington's disease gene, then insurance coverage could be offered at favorable rates.

Argument No. 2: Insurers try to maintain a broad market. Insurers are acutely aware of the problems that might arise if the results of genetic tests were used to prevent significant numbers of applicants from getting insurance at affordable rates. Such a situation would result in acute public and government relations problems. But financial factors would exert an even greater influence.

Private insurance companies are in business to sell, rather than deny, insurance. Since insurance is very competitive, insurers have no incentive to use new tests unless, by doing so, they can operate more efficiently or offer a lower cost product to the "typical" consumer. Even with the advent of genetic testing, the economic need to generate new sales would ensure that the market for insurance products was kept as large as possible.

Because people do not understand how private insurance companies function, it is important to emphasize the need for public education in the next decade. Studies continue to show that a significant number of people think that risk classification is unfair.[12] Unless public awareness of the need for risk classification is raised, these perceptions could worsen if genetic tests were ever used to classify risks. And the opposition to the use of these tests for insurance purposes might be much greater than it would have been otherwise.

Argument No. 5: Risk classification is a sound business practice. The current levels of affordability and availability of insurance are as good as they are because of risk classification and the principle of equity: Policyholders are charged equal premiums for equal risks. If insurers were unable to use the results of genetic tests during the underwriting process because "risks should only be classified on the basis of factors that people can control," then *equity* would give way to *equality* (equal premiums regardless of risk) and private insurance as it is known today might well cease to exist.

Risk classification is not just a matter of fairness. It is also a sound business practice that enables insurers to offer insurance products at attractive, affordable prices. Most people do not wish to pay more for insurance than what they perceive to be their fair share.

And where would the line be drawn? If two people of different ages purchased insurance coverage at the same time, would the younger person be expected to contribute the same amount to the pool as the older person? Would a healthy person be asked to pay the same premium as a person who is already ill as a result of a disease that is beyond his or her control? And, if two people had genetic tests performed, and one test was favorable, and the other unfavorable, would they both be forced to make the same premium payments into a common insurance pool, even though the likelihood of an early claim was markedly different? The answer is a resounding "No!" In a voluntary insurance market where people can freely choose the timing, seller and amounts of their insurance purchases, the need for risk classification is more than a matter of fairness. It is an economic necessity.

K. Concluding Remarks

The dilemmas created by the few genetic tests that have already been introduced in the medical community foreshadow the issues that are likely to arise as new genetic tests are developed and used for diagnosis. As these tests are introduced, complex social questions will arise relating to topics such as ethics, law, medicine, public health, employment and finances.

Attending physicians may begin to use a wide variety of genetic tests within the next decade. Insurers probably will not be interested in ordering these tests themselves. Most of these tests would not be appropriate for screening large numbers of individuals for relatively uncommon diseases. However, insurers will be interested in reviewing the results of prior tests. These test results would be important to control adverse selection.

As technology is perfected and/or genetic testing within the general population becomes common, insurers may eventually consider ordering genetic tests. Doing so would enhance their ability to classify risks and would provide some protection against the adverse selection that will occur with the widespread use of these tests within the medical community. It is important to remember that testing by insurers would carry with it the responsibility to anticipate consequences of the testing. In particular, any decision to initiate genetic testing would have to be part of a deliberate, coordinated effort by a company's medical director(s), underwriters, actuaries, attorneys and government relations personnel.

We are well on the way to one of humanity's greatest scientific achievements: a complete understanding of the human genome. As society enters this uncharted area, the insurance business must participate in dialogues about the use of genetic tests. The industry must assume a role of leadership in order to maintain the viability of private insurance and to fulfill its social responsibilities. Rather than waiting until the issue is fully upon them, insurers must start today to discuss and understand the issues surrounding genetic testing. Recent experience with controversial issues such as unisex pricing and AIDS should serve as a reminder that compelling actuarial data does not necessarily guarantee the ability to use reasonable risk classification practices.

[9] **Joseph Martin, M.D., et al., "Predictive Testing For Huntington's Disease With Use of a Linked DNA Marker," (Waltham, Mass.: *New England Journal of Medicine*, March 3, 1988), Vol. 318, No. 9, p. 535–42.**

[10] **Peter Gorner, "A New Genetic Test Can Foretell Agonizing Death: Would You Take It?" (Chicago: *Chicago Tribune*, August 4, 1988).**

[11] **Amy Virshup, "The Promise and the Peril of Genetic Testing: Perfect People," (New York: *New York*, July 27, 1987), p. 26–34.**

[12] **"The MAP Survey: 20 Years of Charting Public Opinion," (Washington, D.C.: The American Council of Life Insurance, *Council Review*, December, 1988, Vol. 13, No. 7), p. 3–4.**

A. The Functions of Tests

Many people think that if a test is positive, a particular disease is present. Conversely, they believe that if a test is negative, a particular disease is absent. Few test results are so accurate.

A test can help a diagnostician decide whether it is likely that a patient has a particular disease. The diagnostician determines the pre-test probability before the test is performed. Then, he or she calculates the post-test probability by examining the test's sensitivity and specificity and the prevalence of the disease. The diagnostician uses these factors to determine the probability of the disease. Note that most clinical tests are used to determine a patient's probability of *current* presence of disease.

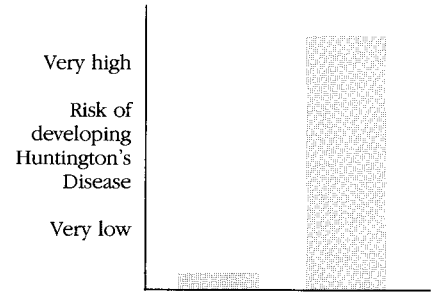
In contrast, some tests may be used to predict the likelihood of *future* presence of disease. The degree of patient risk for the disease can be *discrete* or *continuous*. A test that presents discrete risk gives a "yes-or-no" answer; the patient either does or does not have the predisposition. Take the genetic test for Huntington's disease. This test segments a heterogeneous population of family members at high risk for developing Huntington's disease into two homogeneous categories, those who will develop the disease and those who will not (Figure 1).

A test for continuous risk gives a result that may fall anywhere along a line (Figure 2), and does not separate the population into groups of those who are at risk and those who are not. Serum cholesterol is an example of a continuous risk. As cholesterol level increases, so does the risk of coronary disease.

Of course, there are mixtures of the two (Figure 3). Discrete and continuous risk factors are present in the portion of the population that has a family history of coronary disease. In one sense, testing can segment this population into sub-populations that have discontinuous risks: extensive lipoprotein testing can identify the five percent of this population that is at very high risk. (This five percent accounts for half of all cases of coronary disease occurring before the age of 55.)[1] However, for the remaining 95 percent of the population, a family history of coronary disease is still somewhat of a continuous risk.

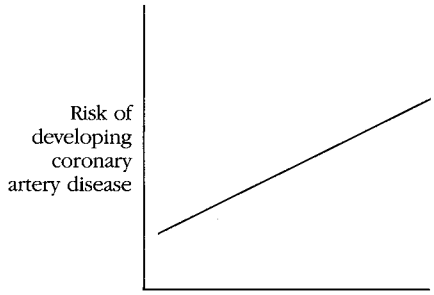
Predisposition tests for discrete risks are more accurate than those for continuous risks. For example, many people see the test for Huntington's disease as a way of detecting a "ticking time bomb." For this particular disease, the metaphor probably fits. However, it

Figure 1
Example of a Discrete Risk Factor



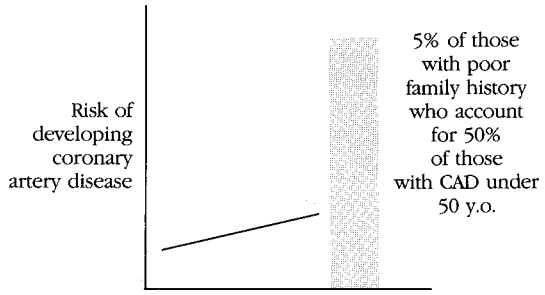
Diagnostic marker for Huntington's Disease

Figure 2
Example of a Continuous Risk Factor



Serum cholesterol levels

Figure 3
Example of Blend of Discrete and Continuous Risk Factors



Increasingly poor family history of heart disease

[1] **R. R. Williams, "Nature, Nurture, and Family Predisposition," (Waltham, Mass.: *New England Journal of Medicine*, March 24, 1988), Vol. 318, No. 12, p. 769–71.**

(b) No current disease, but predisposition to disease in the future. Predisposition can be either discrete or continuous. A discrete risk factor is either present or absent. For example, the presence of the HIV antibody indicates almost certain development of a disease in the future.

A continuous risk factor is not simply present or absent. The risk varies. Most risk factors currently used are of this variable type. For example, the risk for hypertension varies with the blood pressure level. The higher the level, the higher the risk. Obesity and cholesterol are other examples. Smoking is often considered a discrete factor. But this risk is also continuous: the more cigarettes used, the higher the risk.

The first extensive use of genetic tests may be to predict predisposition to disease, as discussed above, rather than to diagnose disease.

Sometimes, the risk selection process must use information that is not complete, as in the case of suspected disease. For example, someone with a history of chest pain might be considered at risk for coronary disease. The clinician asks the patient to have further studies, but the patient refuses. If that patient applies for insurance, the insurance company might evaluate his or her risk. To cover the risk that the chest pain *is* coronary artery disease, an insurer may ask for additional payment to cover that risk.

When a disease is caused by a single gene, genetic tests could enable greater diagnostic precision. However, most clinical diagnostic tests would still be important.

Most people recognize known diseases as an insurance risk. Examples are personal histories of heart disease or cancer. In this category, genetic tests might or might not have widespread underwriting implications. In many cases, insurers would already know that a disease is present and would take action accordingly. It would not matter if the diagnosis were made through genetic testing or other means.

D. Criteria for Tests Used for Screening Purposes

There are specific criteria that should be developed to evaluate the use of genetic tests in the risk selection process. Some of these criteria were outlined earlier by Dr. Pokorski in the *Journal of Insurance Medicine* and are presented briefly below.[6]

(a) Test Criteria:

- Sensitivity—Whether the test has high sensitivity. Is the test highly effective in identifying applicants in whom the impairment will eventually develop?
- Specificity—Whether the test has high specificity. Is the test highly effective in identifying applicants in whom the impairment will never develop?
- Predictive value—Whether the test will produce only a small percentage of false positive or false negative results.
- Affordability, safety, convenience—Whether the test is cost-effective, safe and convenient for screening large numbers of insurance applicants.
- Status in the medical community—Whether the test is understood and accepted.
- Ease of performance—Whether the test can be done readily and reliably by the reference laboratories used by insurers.

(b) Impairment Criteria:

- Severity—Whether the test deals with an impairment that has significant implications for morbidity and/or mortality.
- Prevalence—Whether the impairment occurs frequently enough among insurance buyers to justify broad screening.

(c) Underwriting and Consumer Criteria:

- Equity—Whether the test improves the equity of the underwriting process by more accurate assignment of individuals to appropriate risk classes.
- Affordability and availability—Whether the test enhances consumer value by keeping insurance costs low, and product availability high, for the great majority of insurance applicants.

These criteria for genetic testing by insurers are considerably more stringent than those that would apply to an attending physician using virtually the same genetic tests to screen patients for undiagnosed genetic disorders. This is because insurers must deal with more complex issues than relatively straightforward questions about accuracy and technical ability.

[6] **R. J. Pokorski, "The Genetic Testing Debate," (Los Angeles: *Journal of Insurance Medicine*, 1988), Vol. 20, No. 4, p. 57–61.**

A. Prior Knowledge of Genetic Condition

As genetic tests become increasingly available, more and more applicants will know of their genetic predisposition to disease or of an existing disease when they apply for insurance. While one can only guess at the number of applicants who will know about their genetic makeup, the number could be large. For example, one authority cites 76 incidents of genetic disease per 1,000 live births.[1] This number includes chromosomal disorders, like Down's Syndrome; so-called single gene disorders, like hemophilia and adult polycystic kidney disease; and multi-factorial genetic diseases like cleft palate, some types of congenital heart disease and diabetes. A significant percentage of those 76 per 1,000 could have delayed, adult-onset manifestations. The extra risk associated with the presence or high likelihood of developing one of these disorders would not necessarily require extra premiums in all cases. But the insurer would consider adverse action in some cases, depending on the facts of the application.

B. Adverse Selection

Those who know that they are at no risk or are at low risk for a particular genetic problem could have heightened expectations of continued health and longevity. As a result, they might be inclined to seek less insurance than might otherwise be the case. Obviously, if an individual underwent extensive genetic testing and all the results were negative, that individual would perhaps be ever less inclined to seek insurance, particularly health coverage. The disincentive among those who might believe themselves to be at low risk of early morbidity or mortality would be hard to estimate. The disincentive might be significant, or it might in fact be minimal and have very little impact on purchasing decisions. Some, at least, would wish to buy coverage for accidental death only. These deaths account for more potential years of life lost in the United States than any illness.[2] Conversely, those who test positive or who are told that they have a high risk of developing a particular genetic condition could be highly motivated to seek additional insurance. Depending on the scope of genetic testing, this group could range from less than one in 1,000 applicants to as many as 50 or more per 1,000 applicants.

Moreover, regardless of the extent to which insurers may gather genetic data on applicants, the industry must examine major actuarial considerations. Some of these issues are outlined below.

C. Actuarial Issues: Potential Impact of Adverse Selection

One can assess the possible extent of adverse selection by applicants who know their genetic status and the actual effects of such selection. Assume that a life insurer has an average mortality experience of one per 1,000 per year in typical age ranges, and a cumulative mortality rate of 10 deaths per 1,000 in the first 10 policy years. Adverse selection at even 10 policies per 1,000 issued could have a serious impact on insurers. This would be true even if only half of those who made an adverse selection died prematurely or developed early morbidity. For example, if five of those 10 per 1,000 died within the first 10 years, deaths per 1,000 would rise from 10 to 15 overall. This would be a significant, although not necessarily catastrophic, increase.

[1] **J. Connor and M. A. Ferguson-Smith, M.A., *Essential Medicine Genetics*, Second Edition (St. Louis: Blackball Scientific Publications, 1987).**

[2] ***CA—A Cancer Journal for Clinicians*, (New York: American Cancer Society, January–February 1989), Vol. 39, No. 1, p. 34.**

D. Actuarial Parallels

Current actuarial literature on the potential impact of genetic testing on the insurance industry is lean. When and if genetic testing is used, actuaries will need to draw from their experience with clinical studies, just as they did in the 1960s with the smoker/non-smoker issue and in the mid 1980s with the risk for AIDS. Good insurance industry data on the mortality and morbidity risks of smoking among insured groups have become available only recently. Thus, the industry can anticipate a significant lag before good insurance data describing the impact of genetic testing are available. Moreover, unlike the nearly binary, "yes/no" nature of the risk factor in the smoker/non-smoker studies, the nature and extent of data obtained from genetic tests are likely to vary greatly among insurers. The penetration of genetic screening in clinical medicine will itself be irregular. And adoption of genetic testing technology by insurers would be even more irregular. For budgetary, legal and administrative reasons, any such adoption probably would not keep pace with developments in clinical medicine.

It is also interesting to look at parallels and distinctions between the actuarial models used to project the impact of HIV testing and models that could be used to project the impact of genetic testing. Again, there are major differences. One important difference is the heterogeneity of genetic data enhancing risk classification compared with the relatively simple and definitive "test/no-test" approach to HIV evaluation in most jurisdictions. Too, the HIV model is based on a general acceptance that a positive test translates into an unusually high morbidity and mortality risk. A positive result from some genetic tests would carry a similar message. But the predictive value of many other genetic tests is either not well established or would not suggest a large increase in the risk for morbidity or mortality.

For all these reasons, then, it will probably be a long time before we have meaningful insurance industry experience data describing the impact of using more genetic data in underwriting.

Actuaries may have just as difficult a time assessing the scope and impact of adverse selection among individuals insured during the next 15 years but underwritten without the benefit of genetic data. The heterogeneity of the technology's clinical use and the large number of other factors that affect future morbidity and mortality will combine to present actuaries with a major challenge.

E. Redefining "Standard"

The impact of incorporating genetic test results into underwriting would vary greatly with the nature and extent of the testing used. In fact, the impact would not be known until the results of ongoing clinical studies and insurance industry experience become available. Clearly, adverse underwriting decisions would be made in the interim. While some of these decisions would be declinations, many of them would probably result in substandard offers. On the other hand, at least some applicants whose family history or other medical data would previously have generated a declination would become insurable. Furthermore, the increased accuracy of risk classification would tend to produce better experience in the standard class than would otherwise be the case.[3]

The life insurer using genetic test results might issue a slightly smaller percentage of all policies standard. Obviously, the specific impact would depend on the validity and scope of the use of tests, the percentage of applicants tested, and other factors. Sooner or later, though, market pressures could lead to a redefinition of "standard" to include many who are marginally substandard at present.

[3] **H. Woodman, "Are All Substandard Risks Still Substandard?" (*On The Risk*, 1988), Vol. 5, No. 1.**

Insurers will have a large amount of genetic data from which to choose. One would expect the greatest yield by testing for prevalent conditions with a high risk of premature mortality or morbidity. An important determinant in selecting a particular test will be that test's protective value. That is, the value of testing would be determined by its ability to discourage adverse selection and identify applicants with a substandard or declinable condition. Would use of that test save the insurer more in future benefit costs than the technical, market and potential legal costs of testing? A recent *Best's Review* article describes a methodology life insurers can use to evaluate HIV testing limits, and presumably, other testing limits as well.[5]

As any specific set of genetic data might be more predictive of morbidity than mortality, or vice versa, insurers will need to set the threshold for testing by business line. Moreover, even within the health/disability lines, the data might more accurately predict morbidity related to health care costs than to functional/work capacity—or vice versa.

I. Selecting Genetic Data

As stated earlier, insurers already obtain relevant genetic data by requesting some family history on applicants. Other family history comes from other sources. Sometimes this data, such as a family history of Huntington's disease, triggers an adverse action. But because genetic testing is still far from routine, few if any insurers ask questions about a large number of specific hereditary disorders. In other words, even though insurers obtain some genetic data via a family history, the industry basically is selecting from the least intrusive end of the list of data available through family histories. In doing so, they are obtaining the least specific, least meaningful responses in most cases.

From a broader perspective, there will be an expanding spectrum of genetic data available on applicants. These data will come not just from family histories but from specific testing and counseling, whether obtained directly or indirectly.

Attending physicians could obtain genetic data directly in many clinical contexts, including the following:

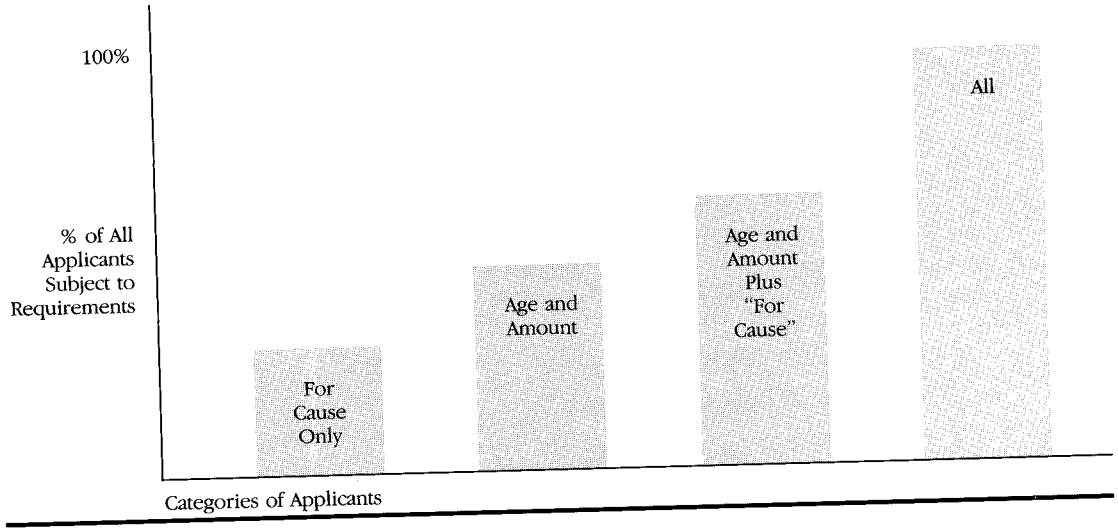
- Individual with family history of genetic condition, including chromosome abnormality
- Parents of offspring with known chromosome or other genetic abnormality
- Infertility
- Recurrent miscarriage
- Evaluation of intersex states
- Sperm donors
- Paternity testing
- Diagnostic work-up of various clinical presentations
- DNA banking

In fact, there are four categories of genetic data that might enhance risk classification:

- Detailed family history relative to a checklist of the most common genetic conditions likely to be missed otherwise, and that are associated with high premature morbidity and mortality risks
- Detailed "systems review" for footprints of genetic conditions
- History and details of genetic testing and/or counseling of applicant
- Actual genetic testing of applicant, either for a specific condition or a battery of tests on a screening basis

[5] **D. A. Super, "When is HIV Testing Cost-Effective?" (Oldie's, N.J.: *Best's Review, L/H*, December 1988), p. 14–19.**

Figure 3: Categories of Applicants Subject to Genetic Testing Requirements



K. Four Categories of Applicants

An insurer might obtain genetic data for one of four different categories of applicants. The first category is for cause only. The second is applicants within an age and amount guideline. The third option would be to obtain data on an age and amount and for-cause basis. The fourth option would be obtaining data routinely on a mixed age-and-amount and for-cause basis. Figure 3 illustrates these categories.

L. Summary

The rapid growth of genetic technology will clearly have an impact on insurers regardless of whether they incorporate genetic testing into underwriting. If insurers do not proceed with genetic testing, adverse selection will become a significant issue. If insurers do proceed, there will be a menu of genetic tests from which to choose. Decisions as to which categories of applicants would require testing, the scope of data that would have to be requested, and assurances that the genetic data obtained would enhance risk classification will be major issues. The applicability and methods of using genetic testing deserve careful, deliberate and thorough evaluation by each insurer's underwriting decision-makers.

A. Summary

Genetic disorders include diseases caused directly by a gene defect (cystic fibrosis, for example) and diseases where a genetic predisposition may be important (heart disease). Those not overtly affected by an abnormal gene still may carry the trait and pass it on to future generations via the parental chromosomes. What are inherited in the chromosomes are segments of DNA, called genes, that code for the production of specific proteins. It is the presence, absence, or abnormality of these protein products that determines normalcy or aberration in the person who inherits the gene.

Genetic disorders can be classified into three broad categories: Chromosomal abnormalities that are visible under the microscope (Trisomy 21 or Down's Syndrome), microgenetic mutations of single genes (sickle cell anemia) that often require molecular genetic techniques to delineate, and the multi-factorial disorders (diabetes mellitus) that most likely result from a combination of environmental influences acting on a susceptible DNA substrate.

Most single gene disorders are relatively rare and in the past, pedigree analysis has been able to demonstrate specific inheritance patterns: autosomal recessive, dominant and codominant, and X-linked recessive. Multifactorial disorders comprise the bulk of adult disease (e.g., heart disease, diabetes mellitus, some cancers, and mental disorders, such as manic-depression) and display variable patterns of inheritance not easily characterized up to the present other than by vague terms, such as "familial tendencies" towards disease.

Today, new genetic engineering techniques are allowing for the more accurate diagnosis and study of all types of genetic disorders. Some of these important techniques are: DNA cloning, which is a method of producing multiple copies of a piece of DNA, RNA or its protein product; the use of restriction fragment length polymorphisms (RFLPs) that break DNA into specific patterns that can then be linked to the presence or absence of an abnormal gene; and the manufacture of DNA probes, which are artificially constructed pieces of DNA (or RNA) that attempt to match homologous segments of DNA from tissue samples of an individual who presents for testing.

The next step for the medical scientist will be the treatment of heritable disorders by direct manipulation of the genetic DNA.

B. Genetics Overview

There may be as many as 3,500 human disorders with a genetic component. Some are genetic diseases and, in fact, are directly attributable to a specific chromosomal abnormality or a specific gene defect; others are better classified as disorders with some evidence of a genetic predisposition or tendency. Individually, diseases caused by a single gene defect are rare, but combined with the disorders of genetic predisposition, they represent a wide panorama of human illness with some hereditary component and affect over half the U.S. population. To this list of persons "affected" by heritable disorders, add the carriers of a genetic trait who may or may not suffer consequences themselves, but who are at risk of propagating the aberrant gene and thus continuing the travails of disease into distant genera-

these proteins that determines the expression of human genetic characteristics (the phenotype) that the DNA segment (the genotype) preordained for human health or disease.

Chromosomal DNA is composed of two chains twisted about one another in a double helix form, with opposite units, the nucleotide bases, paired together. The set of human chromosomes contains 3 billion of these base pairs (the DNA codes), the average single gene containing about 2,000 base pairs. There are estimates that up to 100,000 different human genes exist, but even this number would encompass only 6% of the total chromosomal DNA. The vast majority of human DNA is therefore repetitive in nature, involved in regulatory functions, or has no known function.

The discussion of the genetic basis of human disease must include a number of different types of abnormalities. First of all, the chromosome itself may be visibly aberrant under the microscope. Chromosomes were first observed in 1877; first observed to carry genes in 1903. In 1944, nucleic acid was shown to carry hereditary information. Sex chromosomes were isolated in 1949, but not until the landmark work of Watson & Crick in 1953 was the DNA structure established and not until 1956 was the actual number of human chromosomes finally fixed at 46. In 1959, the first chromosomal disease in man, trisomy 21 (Down's Syndrome) was delineated. Since then, hundreds of abnormalities have been described. Translocations (transfers) of chromosomal material among chromosomes, additions or deletions of entire chromosomes and deletions of parts of chromosomes have all been documented, along with the clinical disorders that develop from them.

Besides the visible chromosomal disorders, there are many so-called "single gene" disorders caused by micro-abnormalities at the chromosomal level. Prior to the development of the newer DNA techniques, the genetic contribution of an individual could only be inferred indirectly from his clinical appearance and a genetic disorder inferred also only indirectly from inheritance patterns as seen in family tree or pedigree studies. DNA studies now allow for direct genotypic determinations of micro-genetic or single gene disorders.

The 22 homologous pairs of non-sex chromosomes (the autosomes) carry genes occupying a very specific location or locus on the chromosome; the pair of genes at that locus are composed of one of paternal origin, and one of maternal origin. Alternate forms of a gene are called alleles. Alleles arise by mutation of the normal or common allele and this mutation may or may not cause a disorder in the function of the gene. If both members of a gene pair on a pair of chromosomes are identical (have the same DNA code or sequence), then the individual is homozygous for that locus; if members of the gene pair are different, the individual is heterozygous for that locus.

*Table V: Twin Concordance (Monozygotic) for Some Traits**

Trait	Concordance	Trait	Concordance
Cleft lip	40%	Schizophrenia	60%
Spina bifida	6%	Manic-depression	70%
Pyloric stenosis	15%	Mental retardation IQ less than 50	60%
Congenital dislocation of the hip	41%	Multiple Sclerosis	20%
Talipes equinovarus	23%	Tuberculosis	51%
Neural tube defect	6%	Atopic disease	50%
Hypertension	30%	Hyperthyroidism	47%
Diabetes mellitus (Type I)	50%	Psoriasis	61%
Diabetes (Type II)	100%	Gallstones	27%
Cancer	17%	Sarcoidosis	50%
Epilepsy	37%		

*Modified after Connor, Ferguson-Smith, *Essential Medical Genetics* (1987)

*Table VI: Discontinuous Human Multi-factorial Traits**

Congenital Malformations	Common Adult Diseases
Cleft lip and palate	Rheumatoid arthritis
Congenital heart disease	Epilepsy
Neural tube defect	Peptic ulcer
Pyloric stenosis	Schizophrenia
	Manic-depression

*Modified after Connor, Ferguson-Smith, *Essential Medical Genetics* (1987)

In addition to the visible chromosome aberrations and micro-genetic or *single* gene disorders described above, many traits are multi-factorial, that is their expression depends on one or more pairs of genes, each having a small additive effect. Their expression also depends on factors in the environment that interact with this genetic substrate. Table V gives some examples of disorders of multi-factorial significance and the concordance of the disorder for monozygotic twins (twins developed from the same fertilized ovum). If a single gene produces a disorder, "concordance" would be 100 percent for monozygotic twins since they share all the same genes. If a disorder is purely environmental, concordance is near 0 percent. Percentages in between describe multi-factorial inheritance.

Most normal human characteristics are determined as continuous multi-factorial traits, i.e., they have a continuously graded distribution and follow a Gaussian (bell-shaped) distribution curve in the general population (such as height, weight and intelligence). Discontinuous multi-factorial traits have a threshold which, when exceeded, leads to malformation or disease. The further the threshold is exceeded, the greater is the extent of the disorder. Table VI gives some examples of such diseases.

For congenital malformations, the threshold was exceeded in utero; for other diseases, some environmental factor or factors in life tipped the balance of the genetically primed individual towards disease; thus the term that someone has a heritable "propensity" to develop a certain disorder.

After cleavage, a particular human DNA sequence can be purified and then copied in large numbers (amplification) by cloning techniques. The isolated DNA sequence to be "cloned" is inserted into the DNA structure of the cloning vector (usually a lambda virus or a bacterial plasmid). The vector, now containing a recombinant DNA sequence, replicates autonomously in a host bacterial cell (usually the bacterium E. Coli). Broths of E. Coli reproduce the recombinant DNA in large quantities in synchrony with its own bacterial DNA. The human DNA, now available in large amounts, can be re-isolated from the recombinant DNA by purification and electrophoretic techniques. Similar cloning procedures have already allowed for the commercial production of useful medical products such as insulin, growth hormone, somatostatin, Factor IX, interferon and some vaccines.

Cloning techniques can be used to produce genomic DNA libraries where large quantities of human DNA can be stored in preparation for research or diagnostic endeavors.

Genomic DNA cloning can be further simplified by first fractionating the chromosomes (i.e., separating and isolating the individual chromosomes) to obtain one chromosome carrying the gene of some specific interest. Thus chromosome-specific libraries can also be produced. If a particular gene is mapped to a specific chromosome, then it is easier to work with that particular chromosome's DNA, than with all the DNA in the total human genome.

Furthermore, if a particular protein has been sequenced (the amino acid structure of that protein is known), then it may be possible to work in reverse, that is to reconstruct the DNA or RNA sequence—actually assemble artificially part of a gene, duplicate this artificial piece of DNA with cloning techniques, and then develop a library or bank of *gene-specific members*.

*Table VII: Gene Probes**

Globin gene clusters	a1 Antitrypsin
Growth hormone	Albumin
Chorionic somatomammotrophin	Glucose-6-phosphate dehydrogenase
Chorionic gonadotrophin	Pre-parathyroid hormone
Prolactin	B Microglobulin
Insulin	a-Tubulin
Interferons	Clotting factors VII, VIII and IX
Collagen, types I, II and III	von Willebrand factor
HLA-DR (many)	Antithrombin III
Histone (several)	Several components of complement pathway
Immunoglobulin (heavy chain and light chains)	Somatostatin
Gastrin	a-Fetoprotein
Ribosomal RNA	Myosins, heavy chain
Melanocyte stimulating hormone	Phosphoglycerate kinase
Corticotrophin	Hypoxathine phosphoribosyltransferase
B Lipoprotein	Several apolipoproteins; LDL receptor
B Endorphin	Erythropoietin
Actin	Several proto-oncogenes

*Modified after Weatherall, *The New Genetics and Clinical Practice* (1985)

With the use of restriction endonucleases and DNA hybridization techniques, it is currently possible to diagnose cystic fibrosis, Duchenne muscular dystrophy, many hemoglobinopathies, hemophilia A and B and other genetic disorders. Any gene worth studying will eventually have a probe made to find it. Table VII lists some gene probes of medical interest already available.

DNA probes are also essential tools in the continuing effort to map the entire human genome. Addendum 1 gives some of the known current gene map; it includes important genes and the chromosomes to which they have been assigned.

Addendum 2 is a glossary of terms used in genetic science.

Resources:

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M. M. Krabbe and L. J. Shapers (editors), "Frontiers in Genetic Medicine," (Columbus: Ross Laboratories, the 92nd Ross Conference on Pediatric Research, Columbus, 1987).

B. Levin, *Genes*, 3rd edition (New York: John Wieldy & Sons, Inc., 1987).

Victor McKusick, *Mendelian Inheritance in Man*, 8th edition (Baltimore: The Johns Hopkins University Press, 1988).

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D. J. Weatherall, *The New Genetics and Clinical Practice*, 2nd edition (Oxford: Oxford University Press, 1986).

Addendum 1 (continued)*

Gene	Chromosome
Kirsten rat sarcoma protooncogene-I	6
Kirsten rat sarcoma protooncogene-2	12
Unique sequence DNA probe	X
Leucyl-tRNA synthetase	5
Lactate dehydrogenase A	11
Lactate dehydrogenase B	12
Lewis blood group	19
Langer-Giedion syndrome	8
Lutheran blood group	19
Lysosomal alpha D-mannosidase	19
Malate dehydrogenase, soluble	2
Malate dehydrogenase, mitochondrial	7
Malic enzyme	6
Multiple endocrine neoplasia, type II (Sipple syndrome)	20
Surface marker recognised by monoclonal antibody 12E7	7
MN blood group	4
Onc gene: Moloney murine sarcoma virus	8
Mannosephosphate isomerase	15
Onc gene: avina myelobastosis virus	6
Onc gene: myelocytomatosis virus	8
Myosin heavy chain	17
N-acetyl-alpha-D-galactos-aminidase	22
Nucleoside phosphorylase	14
Nail-patella syndrome	9
Oncogene NRAS	1
Ornithine transcarbamylase	X
Phenylalanine hydroxylase/ phenlyketonuria	12
Porphobilinogen deaminase	11
Peptidase A	18
Peptidase B	12
Peptidase C	1
Peptidase D	19
Poliovirus sensitivity	19
Fibrinogen, alpha chain	4
Onc gene: feline sarcoma virus	15
Phosphofructokinase, liver	21
Phosphofructokinase, platelet	10
6-Phosphogluconate dehydrogenase	1
Phosphoribosylglycinamide formyltransferase	14
Phosphoglycerate kinase	X
Phosphoglucomutase-1	1
Phosphoglucomutase-2	4
Phosphoglucomutase-3	6
Phosphoglycolate phosphatase	16
Alpha-1-antitrypsin	14
Inorganic pyrophosphatase	10
Prader-Willi syndrome	15
Oncogene RAF1	3
Retinoblastoma	13
Unique sequence DNA probe	X
Rhesus blood group	1
$_5$S RNA gene(s)	1
Ribosomal RNA	13–15, 21, 22
Secretor	19
Superoxide dismutase, soluble	21
Superoxide dismutase, mitochondrial	6
Oncogene SRC (Rous sarcoma)	20
Somatostatin	3
Steroid sulfatase	X
Testis determining factor	Y
Testicular feminization syndrome	X
Transferrin receptor	3
Thymidine kinase, solule	17
Triosephosphate isomerase	12
Uridine monophosphate kinase	1
Wilms tumor/aniridia/ gonadoblastoma/ retardation	11
Xg blood group	X
Spherocytosis	8
Adult polycystic kidney disease	16

*Modified after Connor, Ferguson-Smith, *Essential Medical Genetics* (1987)

LAMBDA VIRUS—virus typically used as the cloning vector to insert a foreign DNA segment into another organism's DNA

LINKAGE—describes the tendency of genes to be inherited together as a result of their location on the same chromosome

LOCUS—place on a chromosome occupied by a gene

MAPPING—determination of location of genes on particular chromosomes

MULTIFACTORIAL TRAIT—characteristic determined by polygenetic influences or a combination of genetic and non-genetic factors

MONOZYGOTIC TWINS—twins originating from one fertilized ovum (as opposed to fraternal twins that begin as two separate fertilized ova)

NUCLEOTIDE—nucleic acid product composed of one nitrogenous base, one sugar, and a phosphate group; sequences of which compose the DNA code

ONCOGENE—genes whose products have the ability to transform cells into a tumorous growth. Probably of viral origin (if carried by a retrovirus, given the form V-onc)

PEDIGREE STUDY—study of the family of an individual to determine inheritance pattern of a trait

PHENOTYPE—the appearance or other characteristics of an organism, resulting from its genetic (genotype) constitution

POLYMERASE CHAIN REACTION (PCR)—a rapid method of gene-amplification, or duplicating segments of DNA

PROTO-ONCOGENE—the normal counterparts in the human (or animal) genome to the oncogenes carried by some retroviruses (given the form C-onc)

RECESSIVE TRAIT—a trait requiring identical paired alleles for expression

RECOGNITION SITE—site on a chromosome at which restriction endonucleases will cleave the DNA

RECOMBINANT DNA—combination of DNA from two separate sources into one DNA sequence

RESTRICTION ENDONUCLEASE—enzyme that cleaves DNA into a specific sequence

RESTRICTION FRAGMENT LENGTH POLYMORPHISM (RFLP)—variations in the pattern of DNA fragments that are obtained when DNA of different individuals is cleaved by restriction enzymes

RIBONUCLEIC ACID (RNA)—type of nucleic acid that is found in chromosomes intracellularly; messenger RNA carries the coded information from DNA to the cellular cytoplasm and there determines the order of amino acid production for protein synthesis; also the genetic material of some viruses, including retroviruses

SEX-LINKED INHERITANCE—traits determined by genes found on the X or Y chromosome

SINGLE GENE DISORDER—disorder caused by a "point" mutation of one gene

TRAIT—a characteristic determined by a gene, combination of genes, or combination of gene and environmental influences

TRANSFORMATION—conversion of normal cells to a state of unrestrained growth (tumor)

TRANSLATION—the synthesis of amino acids on the RNA template

TRANSLOCATION—the transfer of part of a chromosome to another chromosome

TRANSCRIPTION—the synthesis of RNA from the DNA codes

TRISOMY 21—the disease Down's syndrome; an extra chromosome 21 is found

Insurance is intended to provide financial protection against unexpected or untimely events. Life and health insurance are purchased because death or serious illness can come at any time. People buy life insurance to protect heirs or business associates from financial distress that can accompany an unexpected death. Health insurance is meant to provide protection in the event that a significant financial loss results from an unanticipated illness.

How does insurance work? Basically, policyholders pay a relatively small, affordable amount into a common "pool." The benefits of that pool are distributed to the beneficiaries of those who die (life insurance) and to those who become disabled (disability insurance) or develop a serious illness (health insurance). In this way, financial losses that can accompany these events can be mitigated, even though the events themselves cannot be prevented.

But not all people are alike. The likelihood and magnitude of loss will vary. Some people will apply for large amounts of insurance and others for small amounts. Some will be young and others old. Occupations and avocations will modify the likelihood of unexpected death or illness, as will health-enhancing activities such as exercise, proper diet and non-smoking. And some applicants will already be in poor health or at known significant risk of developing poor health in the future.

These different factors are evaluated to the extent feasible by the insurance company through a process known as "risk selection and classification." The more common term for this is "underwriting." By means of this process, the insurance company determines the appropriate contribution to the pool by an individual policyholder.

The fundamental underlying goal of the underwriting process is equity: policyholders with the same or similar expected risk of loss are charged the same. The higher the risk, the higher the premium; the lower the risk, the lower the premium. Note the distinction between equity and equality. With equity, premiums vary with risk; with equality, everyone —young/old, healthy/ill, and with or without associated factors that significantly increase the likelihood of early claims—would pay the same price.

During underwriting, risk classifications are created that recognize the many differences that exist among individuals in order to place applicants into groups with comparable expectations of longevity and health. The risk presented by any single individual cannot be determined with absolute precision. But if people are assigned to groups with reasonable accuracy and the total number of insured people is large, then the estimate of the risk of the entire group of insured people is likely to be accurate.

Until now, characteristics of importance for risk classification have included factors such as age, gender, health history, general physical condition, occupation, the use of alcohol and tobacco, family history and lately, serum cholesterol. These factors serve to identify individuals who have a greater or lesser likelihood of premature death or illness. Because of this process, costs are held down for the great majority of insurance applicants since premiums more closely match the risk taken on by the insurance company.

Risks are usually classified into three general groups:

(a) Standard—The risk presented does not differ significantly from that of most people who apply for insurance. Standard mortality, for purposes of comparing with other groups, is said to be 100 percent. Approximately 92 percent of applications for individual life insurance are accepted on a standard basis. For health insurance, about 75 percent of applications individually underwritten are sold at standard rates without limitations and/or restrictions.

(b) Substandard—The risk presented is greater than the risks of those individuals accepted on a standard basis. Substandard mortality is generally considered to be an anticipated mortality greater than the 100 percent mortality expected in the standard risk group.

What would happen if the insurance company was unaware of important, unfavorable information that was known to applicants? The answer is that there would be serious errors in risk classification. Some people would get their insurance at unreasonably low cost. More claims would be filed than were expected by the insurer. And if the insurer made a significant number of risk classification errors, the financial status of the entire insurance pool would be significantly affected.

Could premiums simply be increased "across-the-board" to cover the payment of these unanticipated benefits? Where permitted, an insurer could increase premiums to reflect expectations. But this would encourage potential insurance applicants who are at low risk to either buy from a different seller or to leave the insurance market altogether. And with the exodus of the low risk insureds who would have subsidized the individuals who had knowledge of their unfavorable risk status (individuals who had adversely selected against the insurance pool), a further increase in premiums would become necessary. More potential applicants would then decide not to apply.

Eventually a point would be reached where the desired coverage would become unavailable on any reasonable premium basis, or the insurer would become financially unsound. This "assessment spiral" phenomenon is not a theoretical possibility. It actually occurred in some companies during the 1880s and early 1900s because of poor risk classification practices.