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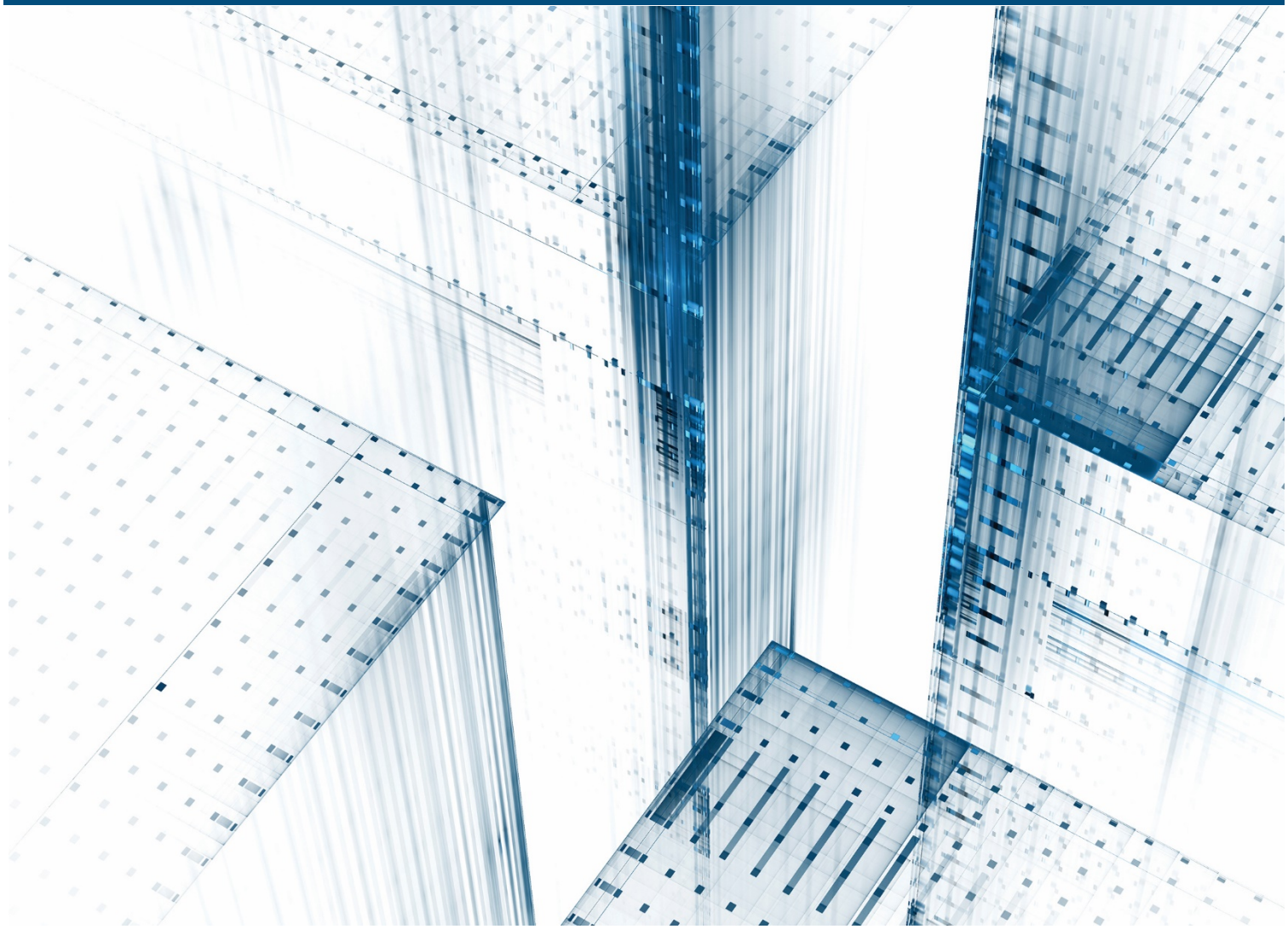
The Impact of Genetic Testing on Life Insurance Mortality



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The Impact of Genetic Testing on Life Insurance Mortality

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CONTENTS

Section 1: Executive Summary

In the U.S., federal and various state laws govern the use of genetic testing information for insurance purposes. Current federal legislation does not prohibit life insurers from utilizing genetic testing information in assessing life insurance applicants. However, some states do have laws that impact life insurers' ability to use genetic test information in underwriting and various countries around the world have passed or are considering legislative changes in the use of genetic testing information in underwriting insurance. In May 2017, federal laws were passed in Canada banning the use of all genetic information for business purposes. Recent news reports also suggest that the Australian parliament is considering similar legislation. This report examines the potential impact on U.S. life insurance industry claim costs should legislative changes occur in the U.S. on either the federal or state level that ban the use of genetic testing information in the new business life insurance process.

Two situations are explored:

1. Only the applicant knows the results of genetic testing, but both the applicant and the insurance company know the family history.
2. Only the applicant knows the results of genetic testing and family history; the insurance company knows neither.

This report also comments on how a ban on using genetic test results could affect the industry in other ways without specifically quantifying these impacts—for example, the likely creation of a lapse spiral in healthy lives in force, leading to mortality deterioration, or increasing cross-subsidies among individuals from different non-homogeneous risk classes.

Prior studies in other jurisdictions have tested the impact of a genetic testing ban on the life Insurance industry; results have varied widely with differences in methodology and underlying assumptions. For this report, a model was developed to analyze the topic from a U.S. life insurance perspective. This U.S. life insurance market model (the U.S. Model) has been adapted from a similar model described in the Canadian Institute of Actuaries' 2014 publication looking at the same topic for that country (Howard 2014). Industry-wide claim cash flows were the focus of this U.S. Model; other cash flows were intentionally ignored, as it would be unwieldy to include historic premiums from across the industry or to speculate on how an individual company would set future premiums in reaction to an increase in expected claims triggered by new legislation.

Model results summarized in Sections 5 and 6 illustrate that legislation prohibiting the use of genetic information during the underwriting process could have a material impact on the U.S. life Insurance industry:

- Where only the applicant knows the results of genetic testing but both the applicant and the insurance company know the family history at time of underwriting, future increases in expected new business claim cost range from 4% to 8% overall. When considering claims from the in-force block as well, industry-wide expected claim costs could rise by as much as 3%.

- Where only the applicant knows the result of genetic testing and family history, and the insurance company knows neither, future increases in expected new business claim cost range from 5% to 10% overall. When considering claims from the in-force block as well, industry-wide claim costs could rise by as much at 4%. Note that the relative impact of losing family history presented in this report is limited in that it only pertains to the 13 medical conditions modeled. Legislation limiting the use of family history in the underwriting process would affect the assessments of many medical impairments not considered specifically in this report; the true impact on claim cost will likely be greater.

- The U.S. Model suggested increases in industry-wide claims cost are expected to start slow but rise over time. Increases would at first be less than 1% of expected claim costs but would rise to upwards of 5% by year 30 of the cash flow projection.

- Splitting the U.S. Model results by sex suggests that females will experience higher claim cost increases across all scenarios.

The degree of the severity of the industry impact presented in this report is very sensitive to two assumptions:

1. the rate at which individuals in the general population get genetically tested and
2. the face amount purchased by individuals seeking insurance after finding they have genetic characteristics associated with an increased risk of developing a particular medical condition.

Both assumptions move the U.S. Model results proportionately, as shown in sensitivity tests 2 and 15 illustrated in Table 13 of Section 6. When we reduce both assumptions in combination,[1] the expected future claim increases are reduced by 75%.

Moving forward, the life insurance industry should seek and monitor reliable sources of information on genetic testing rates nationally and better understand individuals' attitude toward purchasing life insurance after taking a genetic test. Advances in the field of genomics also should be monitored, as medical diagnosis increasingly includes some genetic component. While other individual medical conditions not considered in the U.S. Model developed for this report have low prevalence in isolation, in aggregate they may present a nontrivial addition to expected future claim costs.

Section 2: Introduction

The steady march of medical progress continues, and announcements of advances in genetic testing and genomics are becoming commonplace. What is often linked to the public discussion about advancements in the field of genomics is the topic of genetic discrimination.

> Genetic discrimination occurs when people are treated differently by their employer or insurance company because they have a gene mutation that causes or increases the risk of an inherited disorder. (NIH 2017)

To limit genetic discrimination in the U.S., federal legislation and a variety of state legislation currently exist. While current U.S. federal legislation (the Genetic Information Nondiscrimination Act, or GINA) prohibits genetic discrimination in health insurance and in employment, it does not prohibit the use of genetic information in life insurance.

From a life insurer's perspective, "discrimination" is synonymous with the centuries-old and accepted practice of risk selection. Insurers will group individual risks into different homogeneous categories based on specific risk characteristics to better model their expected claim cost. These risk characteristics are sometimes within applicants' control (e.g., if they smoke or not, have multiple serious driving infractions or skydive), but some of the

[1] E.g., assuming 1 in 60 individuals in the population were genetically tested (instead of 1 in 30) annually and the face amounts purchased by those with genetic characteristics indicating the individual has a greater likelihood to contract a serious disease averaged $350,000 initially (instead of $700,000).

most common risk characteristics are outside the applicant's control (like their sex at birth or their age). Inherited genetic characteristics, while being outside the individual's control, can segment the population into higher-risk and lower-risk categories, especially when there is statistical evidence that those genetic characteristics indicate the individual has a greater likelihood to contract a serious disease in the future.

The purpose of this report is to illustrate the impact on the U.S. life insurance industry if legislation prohibits the use of genetic information during the underwriting process. The report will explore how life insurance claim costs could rise over time where there is asymmetric information between the insurance applicant and underwriter in two situations: (1) only the applicant knows the results of genetic testing, but both the applicant and the insurance company know the family history, and (2) the applicant knows the results of genetic testing and family history, but the insurance company knows neither. In both situations, the prospect of the applicant anti-selecting against the insurance company exists; the resulting increase in expected claims would eventually burden remaining policyholders with higher per unit insurance costs. The actuarial models built to analyze the claim impact for this report intentionally exclude any projected premium cash flows. Capturing past premiums for the entire U.S. market would make the U.S. Model unwieldy, and each individual company could react differently to changes in legislation and expected claim costs, given their unique situation and pricing practices.

This report is intended to serve as a resource for actuaries practicing in the U.S. and others who are investigating the potential impact of a genetic information ban on the life insurance market. In addition to this report, a spreadsheet tool has been developed and is available for download to illustrate many of the concepts described. The assumptions populated in the spreadsheet tool reproduce the U.S. Model results for one year of new business, and can be altered to explore how new business claim cash flows react to alternative assumptions.

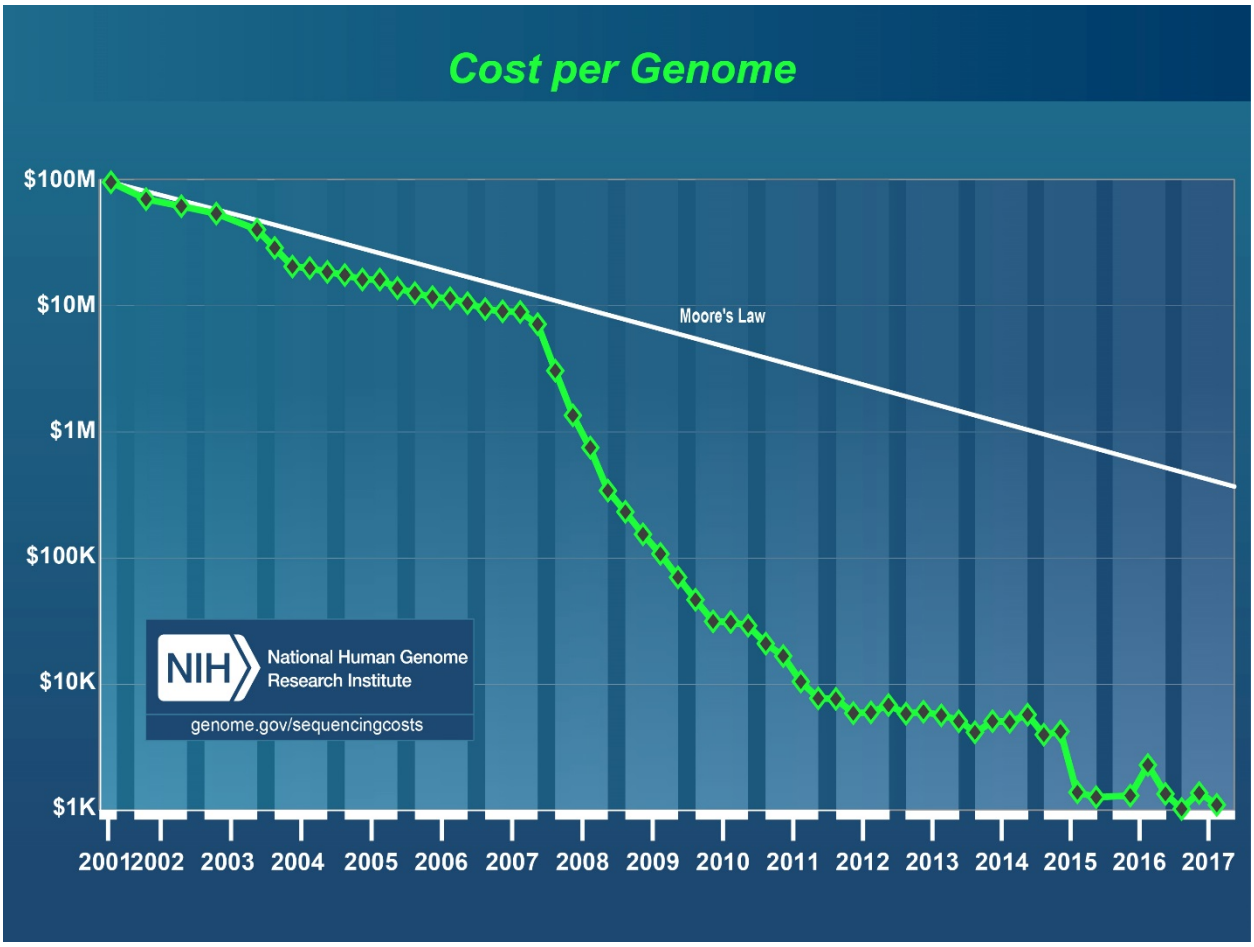
This paper is not intended to take one side or the other regarding the social debate as to whether genetic information or family history should be available during the underwriting process. However, by aiming to estimate the impact on future individual life insurance claims, the conclusions of this report could serve to inform that debate. A conscious effort has therefore been made to be unbiased when selecting modeling approaches and assumptions.

2.1 Genetic Testing Introduction and Terminology

> Genetic testing is a type of medical test that identifies changes in chromosomes, genes, or proteins. The results of a genetic test can confirm or rule out a suspected genetic condition or help determine a person's chance of developing or passing on a genetic disorder. More than 1,000 genetic tests are currently in use, and more are being developed. (NIH 2017)

Many test types would fall under the umbrella of "genetic testing," ranging from low-cost microarray testing used by some direct-to-consumer genetic services to high-cost whole-genome sequencing, where nearly all of the DNA material is tested. For whole-genome sequencing in particular, costs have rapidly declined and are nearing a point where a full genome can be sequenced for less than $1,000 (see Figure 1).

Figure 1
Cost per Genome: Cost of Sequencing a Human-Size Genome



Source: Wetterstrand KA. *DNA Sequencing Costs*: Data from the NHGRI Genome Sequencing Program (GSP) Available at *https://www.genome.gov/sequencingcostsdata/*. Accessed June 27, 2018.

The rapid pace of medical and technological advances leads to four defensible assumptions:

1. Genetic testing rates in the general population will continue to increase.
2. The cost to perform genetic tests will continue to decline.
3. The data storage and computing power required to analyze the vast amount of information produced with whole-genome sequencing will become cheaper and more accessible.
4. The ability to associate the likelihood of future disease with specific gene characteristics (either single-gene mutations or multiple genetic markers combined with environmental factors) will improve. Subsequently, the number of genes targeted for analysis will increase.

2.2 Potential Consequences for the Life Insurance Industry

2.2.1 Diagnostic and Predictive Genetic Tests

Diagnostic testing is used to identify or rule out a specific genetic or chromosomal condition. In many cases, genetic testing is used to confirm a diagnosis when a particular condition is suspected based on physical signs and symptoms. Diagnostic testing can be performed before birth or at any time during a

> person's life, but is not available for all genes or all genetic conditions. The results of a diagnostic test can influence a person's choices about health care and the management of the disorder. (NIH 2018)
>
> Predictive and presymptomatic types of testing are used to detect gene mutations associated with disorders that appear after birth, often later in life. These tests can be helpful to people who have a family member with a genetic disorder, but who have no features of the disorder themselves at the time of testing. Predictive testing can identify mutations that increase a person's risk of developing disorders with a genetic basis, such as certain types of cancer. . . . The results of predictive and presymptomatic testing can provide information about a person's risk of developing a specific disorder and help with making decisions about medical care. (NIH 2018)

Individuals taking a diagnostic genetic test are likely already symptomatic or experiencing medical difficulties that would be obvious through normal underwriting. Banning results from a diagnostic genetic test could be a disservice to an applicant whose symptoms are obvious, as the information from such a test may improve the underwriting outcome (e.g., receiving underwriting credits because a diagnostic test rules out the possibility of disease or knowing an applicant is receiving better, tailored treatment in the case of pharmacogenomics).

Where predictive genetic test information cannot be used by the insurance company, it is reasonable to assume individuals aware of personal genetic characteristics that indicate a higher probability of contracting a serious disease and perhaps dying earlier than average, will seek out insurance. They may purchase as much insurance as they can possibly afford in order to gain a windfall for their beneficiaries. The ability to take advantage of the insurance mechanism increases if family history is also unavailable at time of underwriting, as that information may partially substitute for information about an individual's genetic characteristics.

2.2.2 Asymmetric Information and Anti-selection

An environment where legislative changes restrict the underwriter's information about an applicant has two consequences for insurance companies. First, it increases the level of asymmetric information between the applicant and underwriter. Second, it creates the potential for anti-selection.

Asymmetric information is present when one party to a transaction or contract has more information than the counterparty. An insurance contract is a contract of utmost good faith, which means that all parties to the contract are under a strict duty to deal fully and frankly with each other. Customers must disclose all facts that are material (or relevant) to the risk for which they are seeking coverage. The underwriting process serves to reduce this difference in information between the two parties.

Adverse selection or anti-selection is the tendency of individuals knowing they are at higher risk to claim on an insurance policy to seek out or renew insurance more frequently and for higher amounts of coverage.

Legislation that increases knowledge gaps between the applicant and underwriter further limits the insurer's ability to appropriately assign risks into homogenous groups. Risk categories become broader, resulting in more cross-subsidization within a particular category; costs unfairly increase for individuals who are less risky, while individuals bringing more risk to the group benefit from lower proportional insurance rates than they would have otherwise. To the extent insurance companies underestimate the risk that certain applicants bring to a pool of insureds, eventually they must charge all policyholders within that pool higher premiums in order to cover the expected increase in claims.

2.2.3 Other Consequences

Regardless of rating or pricing laws, a more restrictive, general ban on insurance companies collecting or identifying individuals who have undergone genetic testing also impedes the company's ability to track experience by that dimension. This in turn makes it harder for the company to set actuarial assumptions based on this

policyholder trait (e.g., having received a genetic test prior to underwriting or not) or to understand whether they are being disproportionately targeted by individuals who have undergone genetic testing.

2.3 Current Legislation in the US and Comparison With Other Countries

2.3.1 The Genetic Information Nondiscrimination Act of 2008 (GINA)

> GINA has two parts: Title I makes it illegal for health insurance providers to use or require genetic information to make decisions about a person's insurance eligibility or coverage. Title II makes it illegal for employers to use a person's genetic information when making decisions about hiring, promotion, and several other terms of employment.
>
> GINA and other laws do not protect people from genetic discrimination in every circumstance. For example, GINA does not apply when an employer has fewer than 15 employees. It does not cover people in the U.S. military or those receiving health benefits through the Veterans Health Administration or Indian Health Service. GINA also does not protect against genetic discrimination in forms of insurance other than health insurance, such as life . . . insurance. (NIH 2017)

2.3.2 State-Specific Legislation Regarding Genetic Discrimination in Life Insurance

Laws governing the use of genetic tests for the purpose of life insurance underwriting are set at the state level. These laws vary widely from state to state; some make reference to specific genetic-related conditions, others require informed consent from the applicant before a genetic test can be requested for underwriting purposes, and still others have no specific laws in place.

2.3.3 Legislation in Other Countries

Canada

In Canada, the development of Bill S-201, Genetic Non-Discrimination Act, started in December 2015 was debated throughout 2016 and 2017 until it became law on May 4, 2017. Both the Canadian Life and Health Insurance Association (CLHIA) and the Canadian Institute of Actuaries (CIA) argued for exceptions in the law specifically for the life insurance industry. They tried to demonstrate how asymmetric information and anti-selection would increase life insurance rates for the insured population. Ultimately, the proposed exceptions were left out.

The resulting Canadian law is broad, and potential penalties for violating the law are severe, with individual fines up to $1 million and jail terms up to five years. The new law prohibits any person from requiring another individual to undergo a genetic test or disclose the results of a genetic test as a condition of providing goods or services to, entering into or continuing a contract or agreement with, or offering specific conditions in a contract or agreement with that individual.

United Kingdom

A compromise regarding the use of genetic testing information for underwriting purposes between the Government and Association of British Insurers (ABI) has been documented in the Concordat and Moratorium on Genetics and Insurance. The agreement, which is periodically reviewed,[2] generally restricts use of predictive genetic tests for the purpose of insurance underwriting but does not apply to diagnostic genetic tests. The

[2] Recently the Concordat and Moratorium on Genetics and Insurance was extended until 2019.

agreement also includes a mechanism to allow for the disclosure of certain predictive tests, including tests for Huntington's disease.

Currently, customers are not required to disclose the results of predictive genetic tests for life insurance face amounts up to £500,000. This clarification of predictive versus diagnostic tests and the limit on face amounts balance the needs of consumers and the industry. Specifically, consumers need significant amounts of coverage that could be purchased without fear of having to disclose results of prior predictive tests, while the industry needs to appropriately assess and price for the risk that individual customers bring to the insurance pool.

Australia

As in the U.S., Australia's current laws protect patients from genetic discrimination for health insurance. Recently, a parliamentary inquiry has begun to look into Australia's life insurance industry and its use of genetic information at the time of underwriting (*Insurance News* 2017).

2.4 Studies of Genetic Testing and Insurance: General Conclusions

Prior studies have looked at the topic of insurance costs when considering the loss of genetic information at the time of underwriting. Three studies in particular—one from the U.K. and two recent studies from Canada looking at both the life insurance and critical illness insurance markets in that country—were reviewed. While all focused on mono-genetic disorders, their conclusions regarding the impact on insurance costs varied considerably, in part due to differences in approach, number of genetic conditions considered and the level of anti-selection assumed.

2.4.1 Conclusions from the UK Study

The UK study (Macdonald 2011) concluded the cost to the market would be very small of the order of 0.1% of premium income. But this assumed that a) moderate adverse selection would occur because of the moratorium and b) family history underwriting was still allowed. If family history was assumed to also be excluded in the moratorium, the result would be a consolidation of underwriting classes and rise in premium increases in the 0.4% to 0.8% range. If adverse selection was assumed by at-risk individuals the study predicted small markets to be most impacted, but even in this scenario costs would only slightly exceed 2% of premium income.

2.4.2 Comments on the UK Study

Described in the UK study were multiple-state semi-Markov models used to illustrate the impact on premiums under various levels of genetic testing moratoria for both critical illness and life insurance. Conclusions for both markets were similar. Although the authors acknowledged that applicants could purchase larger face amounts, the results presented assume that "adverse selectors" purchased normal amounts of insurance.

Ultimately, the approach used by the U.K. study was decided against for this paper, as it was preferable to employ a less theoretical method, one that would project expected claim cash flows and could more easily be combined with cash flow projection models typically used in North America for pricing and valuation purposes.

2.4.3 Conclusions from the Canadian Life Study

The Canadian life study (Howard 2014) presented the impact of a genetic information ban in multiple ways. From the perspective of mortality experience, overall experience for males between attained ages 20—60 would go up by 36% and experience for females in that same age rage would increase by 58%. A second metric provided in the Canadian life study directly compares to results of this report; the present value of claim costs from those who tested positive in the year would be 12% of total claims.

2.4.4 Comments on the Canadian Studies

The model results from the two CIA studies (Howard 2014; 2016) were reproduced by this author for this report to understand the approaches employed, which were found to be both practical and intuitive. Although the model results were highly sensitive to the parameters and underwriting assumptions used, a fact acknowledged by the study author in the published reports, it was decided to adopt and adapt some of the model approaches outlined therein for this analysis. The modeling approach in this paper is more akin to the cost model approach from the Canadian study. The parameters and underwriting assumptions used the CIA studies were reviewed and where deemed appropriate altered for the U.S. Model. Those changes are described in the following sections and summarized in Appendix B.

Section 3: General Approach of the US Market Model

To illustrate the impact on the U.S. life insurance industry if legislation prohibited the use of genetic information for underwriting purposes, a market model projecting future claim cash flows was developed. This model was built in GGY's[3] AXIS actuarial software to easily accommodate multiple issue years of business and the projection of cash flows for 100 years. The U.S. Model's setup regarding policy issue dates, the timing of claims and timing of lapses was intentionally set so that any one issue year's projected claims could be easily reproduced in common spreadsheet software. All other cash flows (e.g., premium, surrender benefits and expenses) were intentionally ignored.

Model points for three separate blocks of business are included to represent the following categories of policies:

1. **Baseline In Force block:** individual life insurance policies from business written in the past that are in force at year-end 2015
2. **Baseline New Business block:** new individual life insurance policies for 20 years in the future assumed to have been written regardless of the genetic-testing legislation
3. **GT Positive New Business block:** additional new individual life insurance policies from lives seeking insurance after having received a positive genetic test result, which would have otherwise not bought insurance

Projected claim cash flows for these three blocks of business are combined and compared to illustrate how claims from the GT Positive New Business block will influence individual life insurance claims over time for the U.S. market.

For the two baseline blocks of business, no additional anti-selection was assumed, but a case could be made that genetic test results received after an insurance policy is purchased could affect an insured's propensity to lapse their policy. Policyholders who take genetic tests after purchasing insurance and find they are clear of all known genetic characteristics related to a higher likelihood of disease may lapse out of the insurance pool, resulting in worsened average mortality for the in-force block that remains. Subsequently, if premiums are increased on the in-force block, more "healthy" lives could be motivated to drop or replace their insurance coverage, creating a lapse spiral that further deteriorates the mortality of the remaining policies. For example, one of the two following scenarios assumes the Baseline In Force and New Business blocks are composed of Term 20 (T20) insurance plans with high levels of lapsation and mortality deterioration following the 20th policy year. This T20 scenario can serve

[3] GGY a Moody's Analytics Company (*https://www.ggy.com/*) is a software company located in Toronto, Canada.

to proxy a worsened case (not necessarily the worst case) where a lapse spiral in the baseline blocks exacerbates the mortality impact.

Section 4: Model Assumptions and Methods

4.1 The Baseline Blocks

4.1.1 Model Policies and Volume for the Baseline Blocks

In Force

Estimates of the number of policies and insurance volumes at year-end 2015 for the Baseline In Force block were based on life insurance purchases and life insurance in force figures presented in the American Council of Life Insurers (ACLI) *2016 Life Insurers Fact Book*. In Table 1, columns I, J and L are derived by estimating rough decrement rates each year (columns G and H) and applying them to life insurance purchases by year (columns A and B), bringing them forward to year-end 2015.

Table 1
Estimation of In-Force Model Volume at 2015 Year End (YE) by Issue Year

	Life Insurance Purchases by Year				Life Insurance in Force				In Force at YE 2015 by Issue Year			
	A	B	C = B/A	D = C_t/C_{t-1}	E	F	G = $E_t/(E_{t-1} + A_t)$	H = $F_t/(F_{t-1} + B_t)$	I = A_t $*\prod_t^{2015}(G)x$	J = B_t $*\prod_t^{2015}(H)x$	K = J_t/F_{2015}	L = J/I
Year	Policies[a] (million)	Face Amount (FA)[b] ($ million)	Average FA/Policy	Average FA Growth	Policies[c] (million)	Face Amount[d] ($ million)	Decrement Rate (Policies)	Decrement Rate (Face Amount)	Policies (million)	Face Amount ($ million)	% of 2015 In-Force Volume	Average FA/Policy ($)
1985					186	3,275,539						
1986 – 1990	78.416	5,007,851	63,863		177	5,391,053	92%	92%	1.815	44,068	0.4%	24,282
1991	13.583	1,041,706	76,692		170	5,700,252	89%	89%	1.881	46,756	0.4%	24,855
1992	13.452	1,048,357	77,933	1.02	168	5,962,783	92%	88%	2.089	53,101	0.4%	25,424
1993	13.664	1,101,476	80,612	1.02	169	6,448,885	93%	91%	2.317	63,145	0.5%	27,257
1994	13.835	1,057,233	76,417	1.03	169	6,448,758	92%	86%	2.521	66,392	0.5%	26,331
1995	12.595	1,039,258	82,514	0.95	166	6,890,386	91%	92%	2.483	75,964	0.6%	30,589
1996	12.022	1,089,268	90,606	1.08	166	7,425,746	93%	93%	2.593	86,525	0.7%	33,368
1997	11.734	1,203,681	102,581	1.10	162	7,872,561	91%	91%	2.714	102,745	0.8%	37,854
1998	11.559	1,324,671	114,601	1.13	160	8,523,258	92%	93%	2.933	123,943	1.0%	42,252
1999	11.673	1,399,848	119,922	1.12	162	9,172,397	94%	92%	3.213	141,334	1.1%	43,983
2000	11.820	1,593,907	134,848	1.05	163	9,376,370	94%	87%	3.448	174,098	1.4%	50,490
2001	14.059	1,600,471	113,840	1.12	166	9,345,723	94%	85%	4.374	200,730	1.6%	45,896
2002	14.692	1,752,941	119,313	0.84	169	9,311,729	94%	84%	4.875	258,223	2.1%	52,969
2003	13.821	1,772,673	128,259	1.05	176	9,654,731	96%	87%	4.903	311,241	2.5%	63,477
2004	12.581	1,846,384	146,760	1.07	168	9,717,377	89%	84%	4.636	372,188	3.0%	80,277
2005	11.407	1,796,384	157,481	1.14	166	9,969,899	93%	87%	4.719	428,579	3.5%	90,827
2006	10.908	1,813,100	166,218	1.07	161	10,056,501	91%	85%	4.877	499,551	4.0%	102,437
2007	10.826	1,890,989	174,671	1.06	158	10,231,765	92%	86%	5.318	610,458	4.9%	114,786
2008	10.207	1,869,554	183,164	1.05	156	10,254,379	93%	85%	5.453	704,744	5.7%	129,242
2009	10.139	1,744,357	172,044	1.05	153	10,324,455	92%	86%	5.840	775,983	6.3%	132,864
2010	10.123	1,673,216	165,289	0.94	152	10,483,516	93%	87%	6.332	865,042	7.0%	136,615
2011	10.309	1,672,514	162,238	0.96	151	10,993,501	93%	90%	6.920	989,566	8.0%	142,997
2012	10.306	1,679,314	162,945	0.98	146	11,215,136	91%	88%	7.436	1,098,658	8.9%	147,742
2013	9.929	1,640,202	165,193	1.00	144	11,365,441	92%	88%	7.915	1,212,541	9.8%	153,188
2014	9.440	1,590,181	168,451	1.01	143	11,825,927	93%	91%	8.149	1,329,667	10.8%	163,170
2015	10.305	1,647,292	159,854	1.02	142	12,342,152	93%	92%	9.545	1,509,003	12.2%	158,092
Total	**373.405**	**42,896,828**							**119.301**	**12,144,247**	**98.4%**	
Average				**1.03**								

[a] Policies from Table 7.8, "Life Insurance Purchases, by Year—Individual."
[b] Face Amounts from Table 7.8, "Life Insurance Purchases, by Year—Individual."
[c] Policies from Table 7.9, "Life Insurance in Force in the United States, by Year—Individual."
[d] Face Amounts from Table 7.9, "Life Insurance in Force in the United States, by Year—Individual."
Source: American Council of Life Insurers (2016); individual life insurance purchases and life insurance in force by year.

Based on the data shown in Table 1, the Baseline In Force block comprises the accumulated polices issued from years 1990 through 2015, assumed to be in force at year-end 2015. In total, 119.3 million policies with total face amount $12.1 trillion are represented.

There is insufficient data available to distinguish the in-force policies by type of product. For the purpose of this exercise, two scenarios were run: one where all in-force policies are assumed to be whole life (WL) plans, and the other where all in-force policies are T20 plans. The two scenarios will be used as the boundaries of the range of possible outcomes, as it is our expectation that actual results would fall somewhere between them.

New Business

The Baseline New Business block comprises 20 years of newly written policies for issue years 2016 to 2035. For each year, it is assumed 10 million new individual life insurance policies are issued,[4] with average face amounts starting at $165,000 in 2016, increasing by 3% each year up to $289,000 in 2035 (see Table 2).

Table 2
Baseline New Business Assumed, by Issue Year

	Life Insurance Purchases by Year			
	A	B	C = B/A	D = C_t/C_{t-1}
Year	Policies (million)	Face Amount (FA) ($ million)	Average FA/Policy ($)	Average FA Growth (%)
2016	10	1,646,493	164,649	
2017	10	1,695,888	169,589	1.03
2018	10	1,746,764	174,676	1.03
2019	10	1,799,167	179,917	1.03
2020	10	1,853,142	185,314	1.03
2021	10	1,908,736	190,874	1.03
2022	10	1,965,998	196,600	1.03
2023	10	2,024,978	202,498	1.03
2024	10	2,085,728	208,573	1.03
2025	10	2,148,300	214,830	1.03
2026	10	2,212,749	221,275	1.03
2027	10	2,279,131	227,913	1.03
2028	10	2,347,505	234,751	1.03
2029	10	2,417,930	241,793	1.03
2030	10	2,490,468	249,047	1.03
2031	10	2,565,182	256,518	1.03
2032	10	2,642,137	264,214	1.03
2033	10	2,721,402	272,140	1.03
2034	10	2,803,044	280,304	1.03
2035	10	2,887,135	288,714	1.03
Total	200	44,241,876		

[4] 10 million new business policies are assumed based on the 5-year average from 2011 to 2015 life insurance purchases illustrated in column A of Table 1.

Similar to the Baseline In Force block for the two scenarios, the first assumes all new business policies are whole life, and the second assumes all are T20.

4.1.2 Assumptions for the Baseline Blocks

Product Assumptions

Our initial scenario assumes both the Baseline In Force and Baseline New Business blocks are WL coverage that runs to attained age 100. This simplifies the U.S. Model and influences the pattern of projected claims for the two baseline blocks, giving a low estimate for the expected impact from the GT Positive New Business block's additional claims.

A second scenario assumes the two baseline blocks are comprised of renewable T20 plans only. This gives a high estimate for the expected impact from the GT Positive New Business block's additional claims.

The mix of actual business in force and sold in the future will contain many plans, some WL and others term plans of various lengths. It is assumed the impact of the GT Positive New Business block on overall life insurance claims will fall between the low and high estimates provided.

Mortality and Improvement

The mortality rates assumed for the Baseline In Force and Baseline New Business blocks are the 25 years select then ultimate, sex-distinct 2015 Valuation Basic Table RR100 non-smoker tables on the age-last basis.[5]

For the Baseline New Business, these mortality rates were used without adjustment. For the Baseline In Force, a mortality adjustment factor was applied to calibrate projected claims in 2016 to approximately $58 billion. This claim amount chosen to calibrate the Baseline In Force mortality assumption was derived from the payment to beneficiaries for individual life business in 2015 illustrated in ACLI (2016),[6] trended up for one year by 12% to 2016. The following mortality adjustments were used to calibrate claims:

- WL scenario: males 250%, females 200%
- T20 scenario: males 230%, females 230%

To account for mortality deterioration after the initial 20-year coverage period in the T20 scenario, the following adjustments for both baseline blocks are applied on top of the underlying mortality assumptions (see Table 3).[7]

[5] An "age last" basis was used because the GT Positive block was derived from population data assumed to capture individuals' current age, not their closest or nearest age.
[6] Individual payments to beneficiaries from ACLI (2016), Table 5.2, "Payments from Life Insurance Policies."
[7] Mortality deterioration adjustments for durations 21+ were set considering mortality experience presented by issue age and duration for the T15 business in Kueker et al. (2014).

Table 3

T20 Scenario Mortality Deterioration Adjustments (%)

Duration	Issue Ages				
	0–29	30–39	40–49	50–59	60+
1–20	100	100	100	100	100
21	100	315	350	450	385
22	100	215	240	315	260
23	100	160	175	230	190
24	100	150	165	215	180
25	100	143	155	199	169
26	100	136	145	182	157
27	100	129	135	166	146
28	100	121	125	149	134
29	100	114	115	133	123
30	100	107	105	116	111
31+	100	100	100	100	100

For both in-force and new business model points, future mortality improvement is assumed for each projected year starting in 2016. The SOA's 2016 recommended sex-distinct attained-age mortality improvement rates for AG-38 for year-end 2016 have been used.[8]

Lapses

In the WL scenario, lapse rates for both baseline blocks are assumed to be 6.3% each year. This assumption is based on the average combined termination rates for individual business from 2005 to 2015 outlined in ACLI (2016).[9]

In the T20 scenario, lapse rates for both the baseline blocks are outlined in Table 4.[10]

Table 4

T20 Scenario Lapse Rates for the Baseline Blocks (%)

Duration	Issue Ages				
	0–19	20–29	30–39	40–49	50+
1–19	6.3	6.3	6.3	6.3	6.3
20	15	45	60	75	85
21	5	15	30	40	45
22+	5	5	8	10	10

Sex and Age Distribution

Model volumes were distributed by sex and issue age for both baseline blocks, as seen in Table 5. Assumed model splits are based on the SOA's 2008–09 Individual Life Experience Report exposures for durations 1–25 (Society of Actuaries 2013).[11]

[8] Society of Actuaries, "Mortality Improvement Rates for AG-38 for Year-End 2016," *https://www.soa.org/experience-studies/2016/research-mortality-improvement-2016/*.

[9] From Table 7.4 Voluntary Termination Rates for Life Insurance Policies, Calculated by Face Amount (percent) in ACLI (2016).

[10] Lapse rates for durations 20+ were set considering lapse experience presented by issue age for the T15 business in Kueker et al. (2014).

[11] Appendix A p. 1 % Exposure by amount found in SOA (2013)

Table 5
Sex and Issue Age Model Splits by Volume

Model Split	Assumed Distribution (by Volume)
Sex	
Male	67%
Female	33%
Issue Age Group	
0	1.1%
1–4	1.2%
5–9	0.9%
10–17	1.3%
18–24	3.5%
25–29	9.8%
30–34	18.5%
35–39	20.8%
40–49	27.8%
50–59	11.3%
60–69	2.8%
70–79	0.9%
80+	0.2%

4.2 The GT Positive New Business Block

4.2.1 Model Policies and Volume for GT Positive New Business Block

The GT Positive New Business block also comprises 20 years of newly written policies for issue years 2016 to 2035. For each year, assuming family history (FHx) is included in the underwriting process, 19,319 additional policies are added to the U.S. Model representing individuals who fulfill all three of the following conditions:

1. Have taken a predictive genetic test and learned they have genetic characteristics that suggest a higher risk to contract one of the genetic conditions considered
2. Seek out higher-than-average amounts of coverage with the understanding that legislation does not allow for life insurance companies to request or access the results of that predictive genetic test
3. Are able to pass through underwriting without their higher risk factor being detected

The number of additional policies included in the U.S. Model each year increases to 25,502 when FHx is assumed to also be excluded from the underwriting process.

The procedures to determine the number of policies written and their related assumptions, from each genetic condition contributing to the 19,319 new business policies (25,502 when FHx is excluded), are described in section 4.2.2 and 4.2.3. In reviewing and reproducing the results of the Canadian Institute of Actuaries (CIA) 2014 life study (Howard 2014), the methods described therein were considered reasonable and practicable and have been for the most part adopted for this work. Alterations to the CIA study's methods and underwriting assumptions are outlined in the various subsections of 4.2.2 and 4.2.3 below and illustrated in Appendix B.

For individuals knowing they are at increased risk to develop a genetic condition and choosing to seek out life insurance, the face amount of coverage assumed starts at $700,000 in 2016 and increases by 3% each year to

approximately $1.2 million in 2035. This face amount is more than four times higher than the average new business life insurance policy, as seen in column C of Table 2. It was chosen subjectively to represent a material increase from the average face amount that would not seem unreasonable to an underwriter or require more stringent age and amount requirements. As in the CIA's 2014 life study (Howard 2014), it is assumed these individuals purchase term insurance with rights to convert to whole life coverage up to age 65. This assumption was deemed reasonable, as term premium rates would be more affordable at the higher face amounts assumed and as it gives these individuals the option to continue coverage after age 65 should they survive but find their health has deteriorated.

Table 6
Genetically Tested New Business Assumed by Issue Year

	Life Insurance Purchases, by Year with FHx Included[a]				Life Insurance Purchases, by Year with FHx Excluded[b]			
	A	B	C = B/A	D = C_t/C_{t-1}	A‘	B‘	C‘ = B‘/A‘	D‘ = $C‘_t/C‘_{t-1}$
Year	Policies	Face Amount ($ million)	Average FA/Pol ($)	Average FA Growth (%)	Policies	Face Amount ($ million)	Average FA/Pol ($)	Average FA Growth (%)
2016	19,319	13,523	700,000		25,502	17,851	700,000	
2017	19,319	13,929	721,000	1.03	25,502	18,387	721,000	1.03
2018	19,319	14,347	742,630	1.03	25,502	18,939	742,630	1.03
2019	19,319	14,777	764,909	1.03	25,502	19,507	764,909	1.03
2020	19,319	15,221	787,856	1.03	25,502	20,092	787,856	1.03
2021	19,319	15,677	811,492	1.03	25,502	20,695	811,492	1.03
2022	19,319	16,148	835,837	1.03	25,502	21,316	835,837	1.03
2023	19,319	16,632	860,912	1.03	25,502	21,955	860,912	1.03
2024	19,319	17,131	886,739	1.03	25,502	22,614	886,739	1.03
2025	19,319	17,645	913,341	1.03	25,502	23,292	913,341	1.03
2026	19,319	18,174	940,741	1.03	25,502	23,991	940,741	1.03
2027	19,319	18,719	968,964	1.03	25,502	24,711	968,964	1.03
2028	19,319	19,281	998,033	1.03	25,502	25,452	998,033	1.03
2029	19,319	19,859	1,027,974	1.03	25,502	26,215	1,027,974	1.03
2030	19,319	20,455	1,058,813	1.03	25,502	27,002	1,058,813	1.03
2031	19,319	21,069	1,090,577	1.03	25,502	27,812	1,090,577	1.03
2032	19,319	21,701	1,123,295	1.03	25,502	28,646	1,123,295	1.03
2033	19,319	22,352	1,156,993	1.03	25,502	29,506	1,156,993	1.03
2034	19,319	23,023	1,191,703	1.03	25,502	30,391	1,191,703	1.03
2035	19,319	23,713	1,227,454	1.03	25,502	31,303	1,227,454	1.03
Total	**386,380**	**363,376**			**510,040**	**479,674**		

[a]Scenario and associated model assumption where family history information is available at time of underwriting.
[b]Scenario and associated model assumption where family history information is not available at time of underwriting.

4.2.2 Genetic-Condition-Specific Assumptions for the GT Positive New Business Block

The assumptions related to the genetic markers outlined in the CIA's 2014 life study (Howard 2014) were reviewed by two senior medical directors volunteering on this project's oversight group. Some alterations were recommended and have been included in the U.S. Model. One member of the original committee of medical doctors and chief underwriters that developed the original assumption set used in the CIA's 2014 life study was consulted to understand their development and intended purpose. I am not qualified to make these assumptions myself, and I have relied on but do not take responsibility for the assumptions set out in Table 7. (This is a disclosure in accordance with Section 4.3 of Actuarial Standard of Practice No. 41. It does not imply any objection to the assumptions.) From my discussions with the two medical directors from this oversight group and with the medical doctor from the original committee that set the CIA's 2014 life study's assumptions, and based on my knowledge of their expertise, I am comfortable using their work.

Conditions Included

The 13 conditions included in the U.S. Model are the same as those used by the CIA's 2014 life study (Howard 2014). There are, however, many genetic-related conditions that could affect insurance claims and be worthy of inclusion in the U.S. Model over time, especially considering improvements in testing technology and the future potential to relate multi-genic characteristics to increased risk of disease. While other conditions were considered and seven were proposed for inclusion in the U.S. Model by the project oversight group, it was decided those seven should be left out, as the documented prevalence rates found in the U.S. population were low and their impact on the results was expected to be negligible.[12]

The following 13 conditions were included in the U.S. Model:

1. Breast cancer (BRCA1 or 2)
2. Hypertrophic cardiomyopathy (HTCM)
3. Dilated cardiomyopathy (DCM)
4. Arrhythmogenic right ventricular cardiomyopathy (ARVCM)
5. Long QT syndrome (Long QT)
6. Brugada syndrome (Brugada)
7. Huntington's disease (Huntington)
8. Polycystic kidney disease (PKD)
9. Myotonic dystrophy (MDyst 1 or 2)
10. Alzheimer's disease early onset—autosomal dominance (ADEO)
11. Hereditary nonpolyposis colorectal cancer (HNPCC)
12. Marfan's syndrome (Marfan)
13. Catecholaminergic polymorphic ventricular tachycardia (CPVT)

Table 7 provides details about each condition, using the abbreviation given for each.

Table 7
Conditions Included and Associated Assumptions for the U.S. Model

Condition	Prevalence (*n*)	Penetrance	Rating	Predicted With FHx Included	Predicted With FHx Excluded	Male	Standard[a]	Grading[b]
BRCA 1 or 2	900	75%	350%	25%	25%	0%	0	5
HTCM	500	69%	10/k	25%	25%	50%	5	15
DCM	2,700	75%	40/k	0%	0%	50%	Varies[c]	Varies[d]
ARVCM	2,500	75%	23/k	0%	0%	50%	0	0
Long QT	2,000	25%	500%	25%	25%	50%	0	0
Brugada	2,000	75%	15/k	25%	25%	50%	0	0
Huntington	20,000	95%	1,000%	50%	0%	50%	5	10
PKD	1,000	100%	500%	50%	0%	50%	20	15
MDyst 1 or 2	8,000	75%	500%	50%	0%	50%	15	10
ADEO	19,000	100%	1,000%	50%	0%	50%	15	10
HNPCC	500	50%	300%	50%	0%	50%	0	15
Marfan	5,000	50%	500%	50%	0%	50%	0	0
CPVT	10,000	75%	1,000%	25%	0%	50%	0	5

[a]Standard patterns assumed are illustrated in Appendix C.
[b]Grading patterns assumed are illustrated in Appendix C.
[c]DCM uses an age-specific standard assumption in which standard mortality applies until attained age 30.
[d]DCM uses an age-specific grading assumption in which substandard mortality begins at attained age 30 and grades linearly to attained age 60 or for a minimum of 10 years for issue ages greater than 50.

[12] Additional conditions considered (related prevalence): Li-Fraumeni syndrome (20,000), pancreatic cancer (9,000), cystic fibrosis (3,200), Von-Hippel-Lindau and pheochromocytomas (36,000), multiple endocrine neoplasia type 2 (35,000), Peutz-Jegher (Range), familial adenomatous polposis (30,000).

Prevalence

The prevalence of the genetic marker in the U.S. population is expressed as 1 individual per *n* individuals.

Penetrance

Penetrance is defined as the probability that those with a particular genetic characteristic will ultimately develop the related disease. Penetrance is expressed as a percentage of those who have the genetic marker. For the purpose of the U.S. Model, this percentage is used to determine how many of the resulting policies issued will experience substandard mortality. The complement of penetrance is assumed to have standard mortality.

Rating

Those with the disease classified as substandard lives will exhibit higher mortality expressed either as a percentage of standard or as a number of additional deaths per year (expressed in Table 7 as a flat extra per thousand, denoted "/k"). The rating is assumed to continue for life, with one exception: Long QT is assumed to have excess mortality only until age 40 and be standard thereafter.

Predicted With FHx Included and With FHx Excluded

Even in an environment where genetic test results are unavailable to the insurer, some of those with the genetic characteristics will still be identified for being an increased risk by the underwriting process. This assumes either their family history or other underwriting criteria inform the underwriter of the increased mortality risk. The probability the underwriter catches the specific condition in lieu of the genetic test information is expressed as a percentage chosen in 25% intervals. For example, if "predicted" is shown as 25%, it assumes that 25% of those who test positive will have their increased risk identified by the underwriter and will ultimately be rated appropriately or declined. The remaining 75% of those who test positive are included in the U.S. Model as they would obtain insurance at standard rates.

To reflect the U.S. market and common underwriting evidence collected, two senior medical directors volunteering on the project oversight group reviewed and made recommendations to alter the predicted percentages from the CIA's 2014 life study (Howard 2014). (These percentages are illustrated in the Predicted With FHx Included column of Table 7). They also opined on what the predicted percentages would change to if insurers were unable to gather information about an applicant's family history (FHx) in addition to not having access to the genetic test results (the Predicted With FHx Excluded column of Table 7). The predicted percentages were dropped to 0% for seven of the 13 conditions in this scenario.

Male

This is the proportion of new policies that are assumed to be for males. Breast cancer is assumed to apply to females only. All other conditions are equally distributed by sex.

Standard

For model lives assumed to eventually contract the related condition, the standard assumption reflects the number of years following policy issue that those lives will exhibit average new business mortality. Some conditions have this assumption set as 0, indicating that higher mortality related to the condition is applied immediately from policy issue.

Dilated cardiomyopathy is assumed to have an age-specific standard period, where standard mortality is assumed for attained ages under 30.

Grading

This is the number of years over which mortality is assumed to increase from average new business mortality to the full rating applicable for that condition. Grading is assumed to start mid-year and is linear over this period. For

example, if grading is 5, then mortality in the first year of the grading is assumed to be 10% of the rating, 30% in the second, 50% in the third, 70% in the fourth, 90% in the fifth and 100% thereafter.

Dilated cardiomyopathy is assumed to have a grading pattern that varies by issue age:

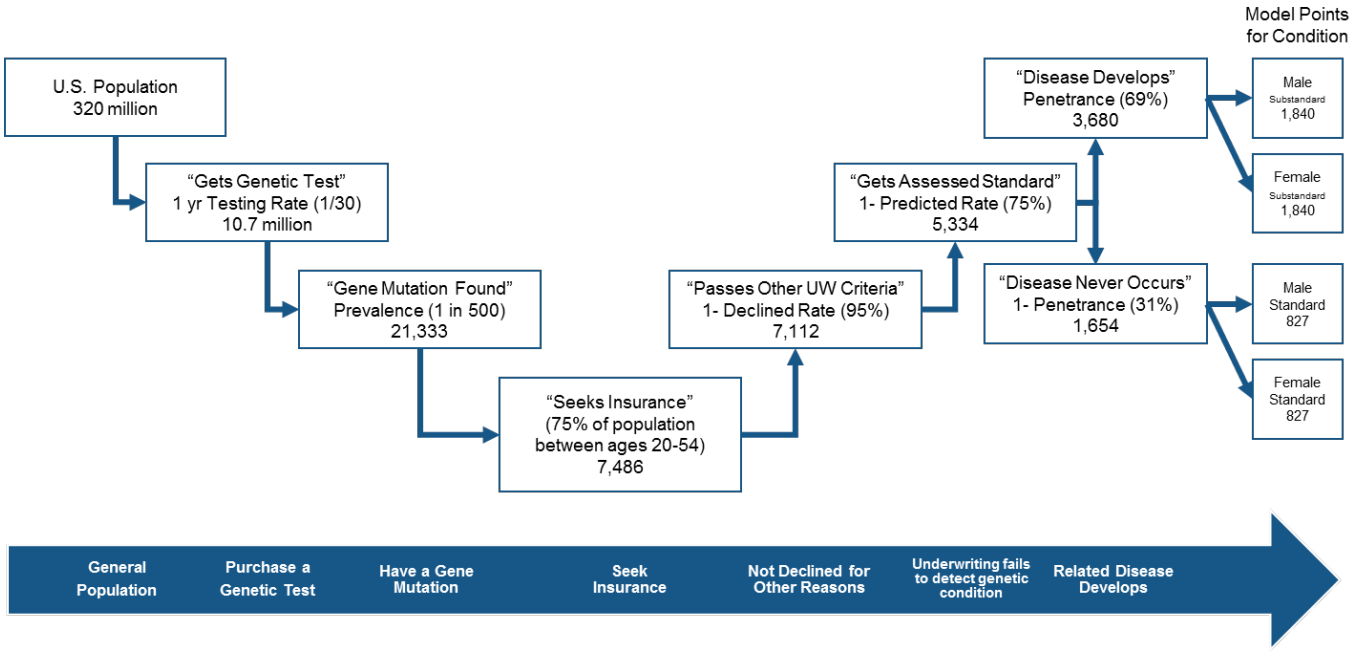
- For issue ages less than or equal to 30, the grading begins at attained age 30 and runs for 30 years to reach 100% at 60.
- For issue ages between 31 and 50, the grading period is adjusted to assume 100% substandard mortality by age 60.
- For issue ages greater than 50, the grading period runs for 10 years.

4.2.3 Non-Condition-Specific Assumptions for the GT Positive New Business Block and Resulting New Business Model Points

The creation of model points for any one of the genetic conditions is a multiplicative exercise, starting with the U.S. population and ending with new business policy counts for four model points distinguished by their sex and classification into substandard and standard lives.

Figure 2 illustrates how the number of policies for hypertrophic cardiomyopathy's (HTCM) four model points is derived.

Figure 2
Model Point Creation for Hypertrophic Cardiomyopathy Example With FHx Included



The total of 19,319 (25,502 when FHx is excluded) GT Positive New Business block policies for each new business year (see Table 6) is a result of following the same process for each of the 13 conditions. The resulting policy counts for each model point by condition are shown in Table 8.

Table 8

Policy Counts by Model Point for 1 New Business Year, by Condition

Condition	Policy Counts by Model Point With FHx Included				Total With FHx Included	Total With FHx Excluded[a]
	Male Substandard	Male Standard	Female Substandard	Female Standard		
BRCA 1 or 2	—	—	2,222	741	2,963	2,963
HTCM	1,840	827	1,840	827	5,334	5,334
DCM	494	165	494	165	1,317	1,317
ARVCM	533	178	533	178	1,422	1,422
Long QT	74	221	74	221	588	588
Brugada	500	167	500	167	1,333	1,333
Huntington	42	2	42	2	89	178
PKD	889	—	889	—	1,778	3,556
MDyst 1 or 2	83	28	83	28	222	444
ADEO	47	—	47	—	94	187
HNPCC	889	889	889	889	3,556	7,112
Marfan	89	89	89	89	356	712
CPVT	100	33	100	33	267	356
Total	**5,580**	**2,599**	**7,802**	**3,340**	**19,319**	**25,502**

[a]Policy counts by model point when FHx is excluded have been left out of this table, as they are distributed between sex and substandard classes in the same proportions as when FHx is included.

Within each model point, the resulting new business face amount volumes are distributed across each issue age between 20 and 54 (see Table 9).

Table 9

Model Point Age Distribution, by Sex

Age Group	Male	Female
20–24	15.3%	14.6%
25–29	14.9%	14.6%
30–34	14.5%	14.3%
35–39	13.7%	13.7%
40–44	13.4%	13.7%
45–49	13.7%	13.9%
50–54	14.5%	15.2%

US Population

The population is assumed to be 320 million and remain stable for years 2016 to 2035. Distributions by sex and age, based on U.S. census estimates,[13] were considered when determining how many individuals would seek out insurance and in setting sex and age distinct model points for the GT Positive New Business block.

[13] Estimates from U.S. Census Bureau, American FactFinder, 2015 American Community Survey 1-Year Estimates, *https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_1YR_S0101&prodType=table*.

Table 10
US Population Distributions from 2015, by Sex and Age Group

	Male	Female
	49.2%	50.8%
Age Group by Sex		
0–19	26.6%	24.7%
20–24	7.3%	6.7%
25–29	7.1%	6.7%
30–34	6.9%	6.6%
35–39	6.5%	6.3%
40–44	6.4%	6.3%
45–49	6.5%	6.4%
50–54	6.9%	7.0%
55+	25.7%	29.4%

Testing Rate

It is assumed one in 30 individuals from the general population will be tested in each new business year. This is an assumption adopted from the CIA's 2014 life study (Howard 2014). Attempts were made to find historical rates of genetic testing to validate this assumption, but nothing suitable was found. It should be noted that applying this testing rate to the U.S. population results in an expectation that 10.7 million individuals are genetically tested each year. While this may seem like a stretch for testing levels today, it may not be unreasonable as an average assumption over the next 20 years as testing costs decline, direct-to-consumer genetic tests advance, and genetic tests are more commonly called for in routine medical examinations. As this is a key model assumption, genetic testing rates should be monitored closely in the future.

Seeking Insurance

It is assumed 75% of individuals in the population that (a) are between the ages of 20 and 54, (b) took a genetic test and (c) test positive for genetic characteristic that increases their risk for one of the conditions considered will seek out insurance. For Long QT those seeking insurance are assumed to be between the ages of 20 and 34, as Long QT syndrome is assumed to apply only before age 40.

The added restriction that those seeking insurance would come from the 20-to-54 age range is a key difference between this model and the CIA's 2014 life study (Howard 2014). The rationale for reducing the likely insured population is that individuals over the age of 54 would likely not be asymptomatic for the 13 genetic conditions considered, and individuals under the age of 20 would likely not meet the financial conditions necessary to qualify for purchasing the insurance amounts assumed. Of the U.S. population in 2015, 47% are estimated to be between 20 and 54 years of age.[14]

Declined Rate

It is assumed that 5% of applicants are declined for reasons unrelated to the 13 conditions considered. This is an assumption adopted from the CIA's 2014 life study (Howard 2014).

[14] 2015 estimates from U.S. Census Bureau, American FactFinder, 2015 American Community Survey 1-Year Estimates by Age and Sex, https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_1YR_S0101&prodType=table.

4.2.4 Other Assumptions for the GT Positive New Business Block

Mortality and Improvement

Standard Mortality. The standard mortality rates assumed for the GT Positive New Business block are the 25 years select then ultimate, sex-distinct 2015 Valuation Basic Table RR100 nonsmoker tables on the age-last basis (2015 VBT Qx), used without adjustment.

Multiple Extra Ratings. The extra mortality for those model points classified as substandard lives, when the rating is expressed as a multiple rating, is determined by multiplying the ultimate mortality rate from 2015 VBT Qx at the appropriate attained age by (rating – 100%) adjusted by the standard and grading adjustments. As was done in the CIA's 2014 life study (Howard 2014), the ultimate mortality rates are used because the extra mortality concerns a condition that is not caught in underwriting and because the data for extra mortality are based on population studies rather than insured lives.

Flat Extra Mortality per 1,000. The extra mortality for those model points classified as substandard lives, when the rating is expressed as a flat extra per 1,000 rating, is taken as a flat addition to standard mortality in all years adjusted by the standard and grading adjustments.

Mortality Improvement. Future mortality improvement is assumed for each projected year starting in 2016, using the SOA's 2016 recommended sex-distinct attained-age Mortality Improvement Rates for AG-38 for Year-End 2016.[15]

Lapses and Conversion

The underlying lapse rate assumed for all years is 0.5% for policies issued at standard with substandard mortality experience due to suppressed genetic information. The lapse rate for lives with projected standard mortality experience is 6.3%.

Additional lapses are applied at the end of attained age 64 to reflect the policyholder's decision at age 65 to either abandon the policy or continue the coverage by converting to a whole life plan. This is an assumption adopted from the CIA's 2014 life study (Howard 2014). For Alzheimer cases, it is assumed 100% of substandard lives will continue their policy and 50% of the standard lives will continue their policy past age 64 (see Table 11). For all other conditions, it is assumed that 75% of substandard lives will continue their policy and 0% of standard lives will continue their policy past age 64.

Table 11
Additional Lapses Applied At End of Attained Age 64

Condition	Standard Lives	Substandard Lives
Alzheimer's	50%	0%
All others	100%	25%

As Long QT syndrome is assumed to apply only before age 40, all policies modeled for this condition are expected to lapse at age 40.

[15] Society of Actuaries, Mortality Improvement Rates for AG-38 for Year-End 2016, *https://www.soa.org/experience-studies/2016/research-mortality-improvement-2016/*.

Section 5: Model Results

The impact on the life insurance industry, if a ban on genetic testing information is in place for underwriting, is expressed as the percent increase in the present value (PV) of projected model claims from adding the GT Positive New Business block to the baseline blocks. The following subsections present results of two modeled scenarios to give a low and high estimate of this impact. The first assumes all policies in the baseline blocks are whole life (WL) plans; the second assumes all policies in the baseline blocks are T20 plans. In addition, the GT Positive New Business block was run under two assumption sets—the first where family history (FHx) was assumed to be included at the time of underwriting, and the second where family history was excluded.[16] A summary of these model results is presented in Table 12.

Table 12
Claim Impact Estimates of Genetic Information Ban on U.S. Life Insurance Market

Claim Impact Estimate of Genetic Information Ban on Life Insurance Market	GT Positive New Business/Baseline Blocks % Increase in PV of Claims @ 4%, All Projected Years			
	FHx Included in Underwriting		FHx Excluded in Underwriting	
	Low	High	Low	High
Total market claims, overall	1.8%	3.0%	2.4%	3.9%
Total market claims, male	1.1%	1.9%	1.5%	2.5%
Total market claims, female	3.8%	6.0%	4.7%	7.5%
New business claims, overall	4.4%	7.4%	5.7%	9.5%
New business claims, male	2.7%	4.5%	3.7%	6.1%
New business claims, female	8.6%	14.6%	10.7%	18.2%

5.1 Comparison With Total Baseline Blocks

Figures 3 and 4 graph the projected claim cash flows aggregated from the three modeled blocks of business (In Force Baseline, New Business Baseline and GT Positive New Business). On the secondary axis, the GT Positive New Business block claims relative to the aggregated claims of the two baseline blocks is measured as a percentage in each projection year illustrating the increase in claims to be expected from the introduction of the genetically tested policies into the market and their influence on total claims over time.

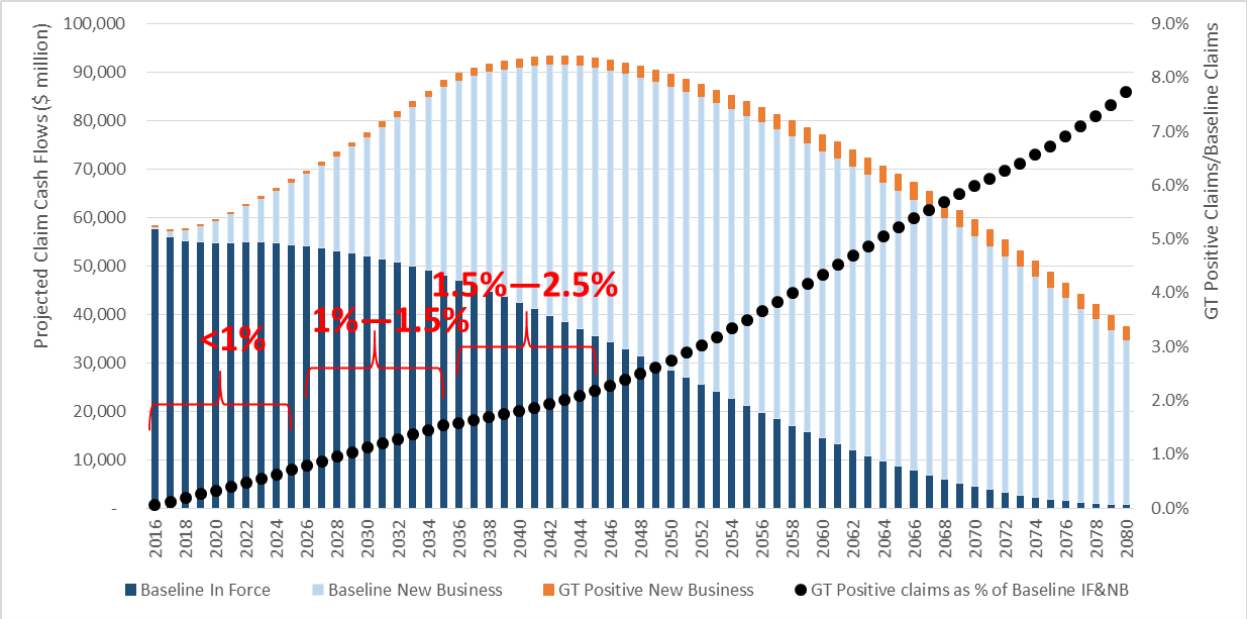
In both Figures 3 and 4, the percentages in the first 30 projection years highlight how little the claims from the GT Positive New Business block affect market claims over the first 10 years, but that percentage steadily increases over time as the baseline blocks run off (mainly because of a higher assumed lapse rate). The U.S. Model results in Figure 4 suggest that over 30 years, claims from the GT Positive New Business block could constitute upwards of 5% of all market claims. This is interesting, given the extremely low number of policies modeled from the GT Positive New Business block compared with the policy counts from the baseline blocks.

Looking at the U.S. Model results split by sex, we see higher-impact estimates in general for females. This occurs because they represent less of the baseline blocks' model weight and their standard mortality is lower.

The graphs in Figures 3 and 4 present the U.S. Model results where FHx is still included in the underwriting process. Illustrations of the claim cash flows from the modeled scenarios where FHx is excluded from the underwriting process would result in very similar graphs but with more GT Positive New Business claims.

[16] Impact of losing family history pertains only to the 13 medical conditions modeled.

Figure 3
Projected Model Claim Cash Flows and GT Positive New Business Claims as a % of Aggregated Baseline Claims, Assuming WL Policies

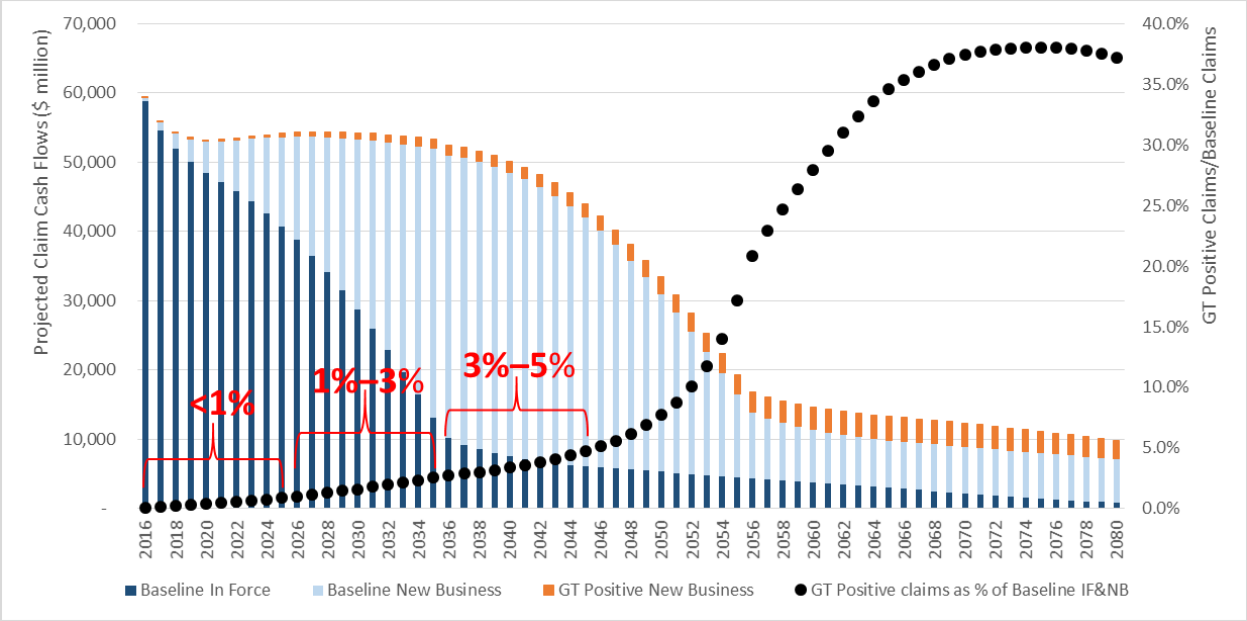


FHx Included		Present Value of Claims @ 4% ($ millions)				% Incr. GT Positive/Baseline			
Modeled Block		All Years	2016–2025	2026–2035	2036–2045	All Years	2016–2025	2026–2035	2036–2045
Overall	GT Positive Claims	31,108	1,753	7,208	13,462	1.8%	0.4%	1.2%	1.8%
	Baseline IF & NB Claims	1,689,579	492,223	626,104	734,761				
Male	GT Positive Claims	13,637	831	3,308	6,065	1.1%	0.2%	0.7%	1.2%
	Baseline IF & NB Claims	1,224,981	370,876	458,401	525,726				
Female	GT Positive Claims	17,471	922	3,901	7,397	3.8%	0.8%	2.3%	3.5%
	Baseline IF & NB Claims	464,598	121,347	167,704	209,035				

FHx Excluded		Present Value of Claims @ 4% ($ millions)				% Incr. GT Positive/Baseline			
Modeled Block		All Years	2016–2025	2026–2035	2036–2045	All Years	2016–2025	2026–2035	2036–2045
Overall	GT Positive Claims	40,157	1,907	8,132	16,230	2.4%	0.4%	1.3%	2.2%
	Baseline IF & NB Claims	1,689,579	492,223	626,104	734,761				
Male	GT Positive Claims	18,369	920	3,830	7,615	1.5%	0.2%	0.8%	1.4%
	Baseline IF & NB Claims	1,224,981	370,876	458,401	525,726				
Female	GT Positive Claims	21,788	987	4,302	8,615	4.7%	0.8%	2.6%	4.1%
	Baseline IF & NB Claims	464,598	121,347	167,704	209,035				

Figure 4

Projected Model Claim Cash Flows and GT Positive New Business Claims as a % of Aggregated Baseline Claims, Assuming T20 Policies



FHx Included		Present Value of Claims @ 4% ($ millions)				% Incr. GT Positive/Baseline			
Modeled Block		All Years	2016–2025	2026–2035	2036–2045	All Years	2016–2025	2026–2035	2036–2045
Overall	GT Positive Claims	31,108	1,753	7,208	13,462	3.0%	0.4%	1.7%	3.5%
	Baseline IF & NB Claims	1,024,001	441,447	431,422	387,738				
Male	GT Positive Claims	13,637	831	3,308	6,065	1.9%	0.3%	1.1%	2.2%
	Baseline IF & NB Claims	733,419	318,066	309,023	276,541				
Female	GT Positive Claims	17,471	922	3,901	7,397	6.0%	0.7%	3.2%	6.7%
	Baseline IF & NB Claims	290,583	123,382	122,400	111,198				

FHx Excluded		Present Value of Claims @ 4% ($ millions)				% Incr. GT Positive/Baseline			
Modeled Block		All Years	2016–2025	2026–2035	2036–2045	All Years	2016–2025	2026–2035	2036–2045
Overall	GT Positive Claims	40,157	1,907	8,132	16,230	3.9%	0.4%	1.9%	4.2%
	Baseline IF & NB Claims	1,024,001	441,447	431,422	387,738				
Male	GT Positive Claims	18,369	920	3,830	7,615	2.5%	0.3%	1.2%	2.8%
	Baseline IF & NB Claims	733,419	318,066	309,023	276,541				
Female	GT Positive Claims	21,788	987	4,302	8,615	7.5%	0.8%	3.5%	7.7%
	Baseline IF & NB Claims	290,583	123,382	122,400	111,198				

5.2 Comparison With New Business Baseline Block

Figures 5 and 6 graph the projected claim cash flows aggregated from the New Business blocks only. On the secondary axis, the GT Positive New Business block claims relative to the Baseline New Business block claims are measured as a percentage in each projection year. This illustrates the percentage increase in new business claims to be expected from the introduction of the genetically tested policies into the market and their influence on total new business claims over time if a ban on genetic information for underwriting were in place.

Compared with Figures 3 and 4, the impact of claims from the GT Positive New Business block is more pronounced when looking only at new business claims. In both Figures 5 and 6, the percentages in the first 30 projection years highlight an increase in new business claims of approximately 3.5% to 4% when FHx is included in underwriting. From a pricing actuary's perspective, this may materially eat into any current expected profit margins. In the specific scenario where the Baseline New Business is assumed to be T20 with high lapses at the end of the level term period (Figure 6), the impact on the present value of claims over the first 30 years is again approximately 4%. But over the entire projection period, it reaches a level of 7.4%, and 9.5% if FHx is excluded from underwriting as well. However, the relative impact of losing family history presented is limited in that it pertains only to the 13 medical conditions modeled. Legislation limiting the use of family history in the underwriting process would affect the assessments of many medical impairments not considered specifically in this report; the resulting impact on claim cost will likely be greater than the relative impact without family history illustrated throughout the report.

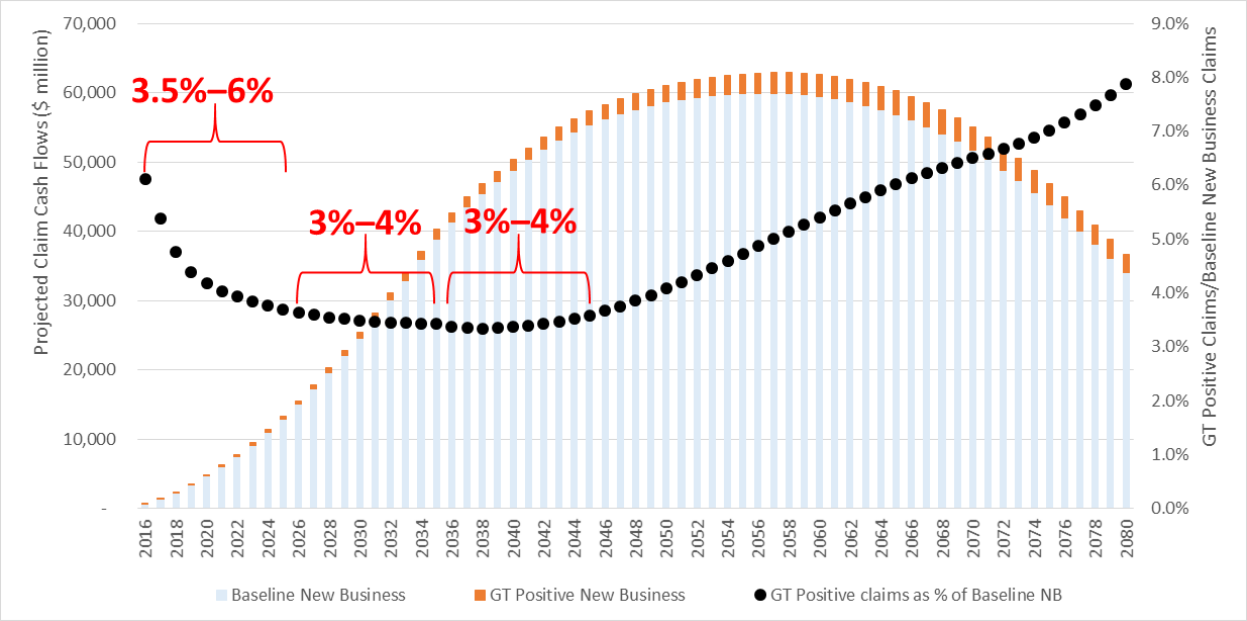
Looking at the U.S. Model results for new business split by sex, we see higher-impact estimates for females. The reason is that they represent less than 30% of the claims from the Baseline New Business block but over 50% of the claims from the GT Positive New Business block.[17]

The graphs in Figures 5 and 6 present the U.S. Model results where FHx is still included in the underwriting process. Illustrations of the claim cash flows from the modeled scenarios where FHx is excluded from the underwriting process would result in very similar graphs but with more GT Positive New Business claims.

[17] This is partly because breast cancer is assumed to apply only to female model points, while the remaining 13 conditions are split evenly amongst males and females.

Figure 5

Projected Model New Business Claim Cash Flows and GT Positive New Business Claims as a % of Baseline New Business Claims, Assuming WL Policies

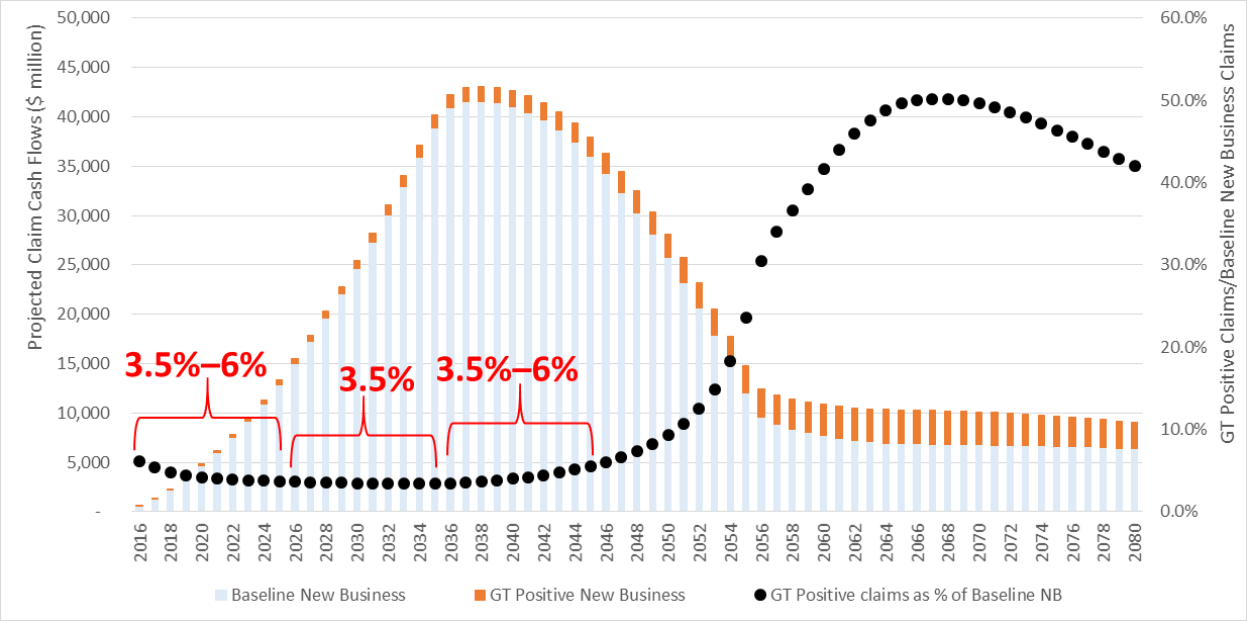


FHx Included		Present Value of Claims @ 4% ($ millions)				% Incr. GT Positive/Baseline			
Modeled Block		All Years	2016–2025	2026–2035	2036–2045	All Years	2016–2025	2026–2035	2036–2045
Overall	GT Positive Claims	31,108	1,753	7,208	13,462	4.4%	4.0%	3.5%	3.4%
	Baseline NB Claims	701,602	43,823	206,706	394,124				
Male	GT Positive Claims	13,637	831	3,308	6,065	2.7%	2.6%	2.2%	2.2%
	Baseline NB Claims	498,046	31,982	148,739	281,531				
Female	GT Positive Claims	17,471	922	3,901	7,397	8.6%	7.8%	6.7%	6.6%
	Baseline NB Claims	203,556	11,841	57,968	112,593				

FHx Excluded		Present Value of Claims @ 4% ($ millions)				% Incr. GT Positive/Baseline			
Modeled Block		All Years	2016–2025	2026–2035	2036–2045	All Years	2016–2025	2026–2035	2036–2045
Overall	GT Positive Claims	40,157	1,907	8,132	16,230	5.7%	4.4%	3.9%	4.1%
	Baseline NB Claims	701,602	43,823	206,706	394,124				
Male	GT Positive Claims	18,369	920	3,830	7,615	3.7%	2.9%	2.6%	2.7%
	Baseline NB Claims	498,046	31,982	148,739	281,531				
Female	GT Positive Claims	21,788	987	4,302	8,615	10.7%	8.3%	7.4%	7.7%
	Baseline NB Claims	203,556	11,841	57,968	112,593				

Figure 6

Projected Model New Business Claim Cash Flows and GT Positive New Business Claims as a % of Baseline New Business Claims, Assuming T20 Policies



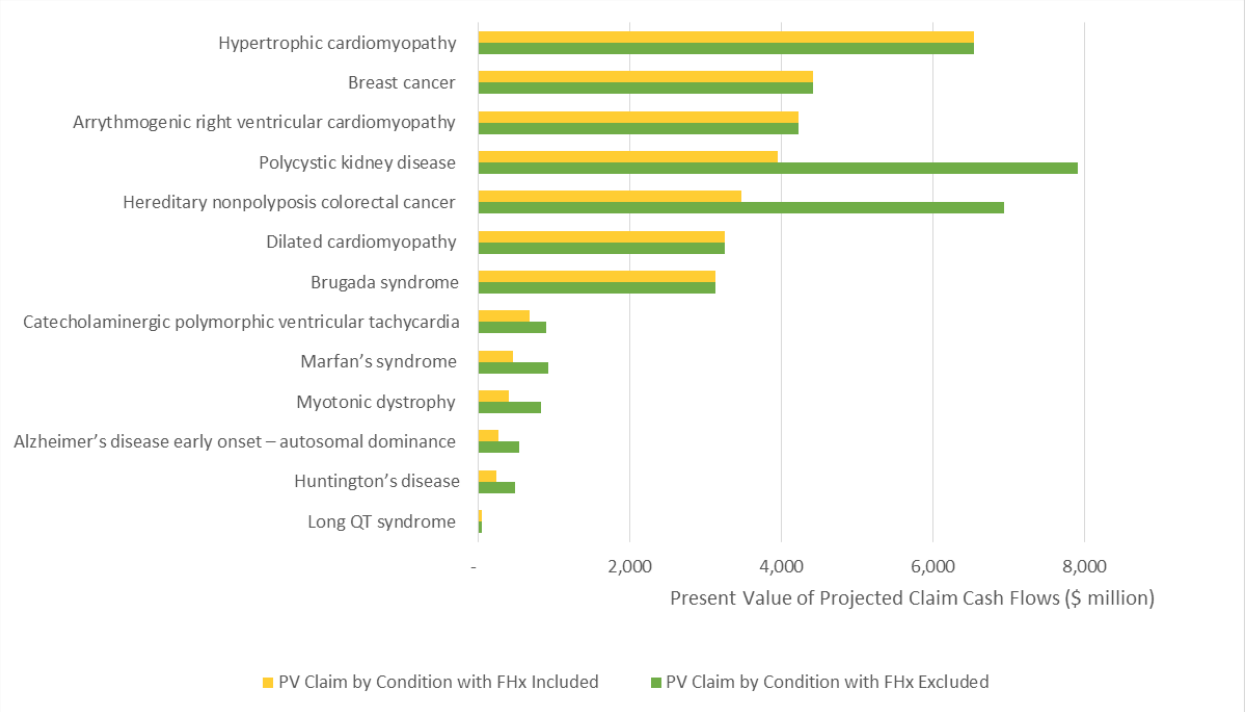
FHx Included		Present Value of Claims @ 4% ($ millions)				% Incr. GT Positive/Baseline			
Modeled Block		All Years	2016–2025	2026–2035	2036–2045	All Years	2016–2025	2026–2035	2036–2045
Overall	GT Positive Claims	31,108	1,753	7,208	13,462	7.4%	4.0%	3.5%	4.1%
	Baseline NB Claims	422,961	43,823	206,706	324,766				
Male	GT Positive Claims	13,637	831	3,308	6,065	4.5%	2.6%	2.2%	2.6%
	Baseline NB Claims	303,049	31,982	148,739	231,923				
Female	GT Positive Claims	17,471	922	3,901	7,397	14.6%	7.8%	6.7%	8.0%
	Baseline NB Claims	119,911	11,841	57,968	92,843				

FHx Excluded		Present Value of Claims @ 4% ($ millions)				% Incr. GT Positive/Baseline			
Modeled Block		All Years	2016–2025	2026–2035	2036–2045	All Years	2016–2025	2026–2035	2036–2045
Overall	GT Positive Claims	40,157	1,907	8,132	16,230	9.5%	4.4%	3.9%	5.0%
	Baseline NB Claims	422,961	43,823	206,706	324,766				
Male	GT Positive Claims	18,369	920	3,830	7,615	6.1%	2.9%	2.6%	3.3%
	Baseline NB Claims	303,049	31,982	148,739	231,923				
Female	GT Positive Claims	21,788	987	4,302	8,615	18.2%	8.3%	7.4%	9.3%
	Baseline NB Claims	119,911	11,841	57,968	92,843				

5.3 Excess Claims Cost for GT Positive New Business Block

Figure 7 shows the present value of the projected claims for the GT Positive New Business block claims, by condition.

Figure 7
Present Value (PV) of GT Positive New Business Block Claims, by Condition



Four of the five top conditions contributing to the GT Positive New Business claims have the highest prevalence rates assumed.[18] The only standout in the top five is arrhythmogenic right ventricular cardiomyopathy, which has a lower prevalence at 1 in 2,500 but is assumed to have a high flat extra rating, which is applied immediately at policy issue; a high rate of penetrance for the disease; and a zero probability that other underwriting information will otherwise inform the underwriter of the condition.

Figure 7 also shows that when FHx is excluded and the predicted rates are assumed to be lower, claims expected from polycystic kidney disease and hereditary nonpolyposis colorectal cancer double, making them the two leading contributors to the GT Positive New Business claims.

[18] The four are hypertrophic cardiomyopathy, breast cancer, polycystic kidney disease and hereditary nonpolyposis colorectal cancer.

Section 6: Sensitivity Tests

Table 13 summarizes the overall low and high impact estimates of adding the GT Positive New Business claims to baseline block claims. The subsections that follow describe in more detail the sensitivity tests performed.

Table 13
Sensitivity Test Summary

Claim Impact Estimate of Genetic Information Ban on Life Insurance Market		GT Positive New Business/Baseline Blocks % Increase in PV of Claims @ 4%, All Projected Years			
		Total Market Claims		New Business Claims	
Sensitivity Test	Description	Low	High	Low	High
Base	FHx included	1.8%	3.0%	4.4%	7.4%
1	FHx excluded	2.4%	3.9%	5.7%	9.5%
2	Testing rate at 1 in 60 (from 1 in 30)	0.9%	1.5%	2.2%	3.7%
3	Testing rate at 1 in 15 (from 1 in 30)	3.7%	6.1%	8.9%	14.7%
4	Testing rate grades from 1 in 60 to 1 in 15 over 20 years	2.2%	3.7%	5.4%	8.9%
5	Seeking insurance at 100% (from 75%)	2.5%	4.1%	5.9%	9.8%
6	Seeking insurance at 50% (from 75%)	1.2%	2.0%	3.0%	4.9%
7	Increase prevalence by 20%	2.2%	3.6%	5.3%	8.8%
8	Reduce prevalence by 20%	1.5%	2.4%	3.5%	5.9%
9	Increase penetrance by 20% (capped at 100%)	2.1%	3.5%	5.2%	8.5%
10	Decrease penetrance by 20%	1.5%	2.5%	3.6%	6.0%
11	Increase penetrance to 100%	2.5%	4.2%	6.1%	10.1%
12	Change all predicted % to 0	2.7%	4.4%	6.4%	10.6%
13	Decrease all predicted % by half	2.2%	3.7%	5.4%	9.0%
14	Turn substandard lapse to 0% from 0.5%	2.1%	3.5%	5.1%	8.4%
15	Change face amount to $350,000 (from $700,000)	0.9%	1.5%	2.2%	3.7%

6.1 Testing Rate

Sensitivity tests 2 and 3 adjust the proportion of individuals in the U.S. population who receive a genetic test in any given year down to 1 in 60 and up to 1 in 15, respectively.

Sensitivity test 4 assumes the testing rate starts lower at 1 in 60 individuals in 2016 and increases over the 20 years new business is added to the U.S. Model, reaching 1 in 15 individuals by 2036. This is likely the most realistic situation capturing an increase in testing rates over time.

The U.S. Model results move linearly in relation to the testing rate assumption, as it affects all model points (by sex and substandard classification) proportionally.

6.2 Seeking Insurance

Sensitivity tests 5 and 6 adjust the percentage up and down by 25%, respectively, of individuals who would seek out insurance coverage after discovering they have tested positive for a genetic characteristic related to one of the

13 conditions included in the U.S. Model. As with the testing rate sensitivities, the U.S. Model results move linearly in relation to this assumption.

6.3 Prevalence

Sensitivity tests 7 and 8 adjust the prevalence rates for all 13 conditions by 20% up and down. The U.S. Model results move linearly in relation to this assumption, as it affects all model points (by sex and substandard classification) proportionally.

6.4 Penetrance

Sensitivity tests 9 and 10 adjust the penetrance rates for all 13 conditions up by 20% (capped at 100%) and down by 20%, respectively. The U.S. Model results move linearly in relation to this assumption (upwards to the point of being capped) as the GT Positive New Business model volume is shifted from the standard to substandard model points.

Sensitivity test 11 provides a worst-case scenario where each of the 13 conditions has 100% penetrance, resulting in no model volume in the standard model points.

6.5 Predicted Rate

Sensitivity test 12 illustrates a worst-case where remaining underwriting criteria have zero ability to detect the higher probability of mortality related to the genetic condition. The U.S. Model results move linearly in relation to this assumption, as it affects all model points (by sex and substandard classification) proportionally.

Sensitivity test 13 is similar to test 12 but only reduces the predicted rate in half.

6.6 Substandard Lapse

Sensitivity test 14 assumes the substandard model points have a lapse rate of 0%. This illustrates the impact should genetically tested policyholders who develop the related condition never lapse their policy.

6.7 Face Amount

Sensitivity test 15 halves the face amount assumed for individuals seeking out insurance following a positive genetic test, reducing it to $350,000 in 2016. The face amount in all subsequent new business years increases by 3%, as in the base scenario. As expected, the claim is exactly halved in this test.

Section 7: General Conclusions

Based on the assumptions described in Section 4 of this report, the U.S. Model developed illustrates that legislation prohibiting the use of genetic information and family history during the underwriting process has the potential to materially affect U.S. life insurance industry claims.

If only the applicant knows the result of genetic testing but both the applicant and the insurance company know the family history at time of underwriting, the present value of new business claim costs modeled increase by 4% to 8% overall. The impact is dampened partially when considering claims from the Baseline In Force block; the U.S. Model indicates that industry-wide claim costs could rise by as much at 3% on a present value basis.

If the applicant alone knows the result of genetic testing and family history and the insurance company knows neither, the present value of new business claim costs modeled increases by 5% to 10% overall. The impact is dampened partially when considering claims from the Baseline In Force block; the U.S. Model indicates that industry-wide claim costs could rise by as much at 4% on a present value basis.

In general, estimated increases in industry-wide claims cost are low at first and increase over time. In the first 10 years, projected modeled claims increase by less than 1%. The cost increase rises quickly over the next 20 years to upwards of 5% of projected claims, as the Baseline In Force and New Business policies run off.

Splitting the results by sex suggests higher claim increases for females under all scenarios. Females proportionally represent less than 30% of baseline claims but over 50% of the claim costs from genetically tested business.

With only 13 medical conditions included in the analysis, it is reasonable to assume claim impacts will be higher, considering the cumulative effect from all other conditions known to be associated with identifiable genetic characteristics. It is also reasonable to assume that the number of these conditions will grow over time as the field of genomics advances. Similarly, the relative impact of losing family history is limited in that it pertains only to the 13 medical conditions modeled. Legislation limiting the use of family history in the underwriting process would affect the assessments of many medical impairments not considered specifically in this report; the resulting impact on claim cost will likely be greater than the relative impact without family history illustrated.

Section 8: Industry Next Steps

The U.S. Model results produced and presented in this report are very sensitive to the testing rate and face amount assumptions. They are highly subjective and move the U.S. Model results proportionately. Although it is reasonable to assume genetic testing rates in the U.S. will increase over time, and that some individuals with particular genetic characteristics will seek out higher-than-average insurance amounts, it is at present difficult to validate these two assumptions. Pricing actuaries in particular should familiarize themselves with these assumptions and test ranges to gain comfort with and understand the impact of genetic testing developments. Generally, the insurance industry should be encouraged to seek out reliable sources of information on genetic testing rates nationally and on individuals' attitude toward purchasing insurance after taking a genetic test.

The life insurance industry should continue to monitor advances in the field of genomics, as medical diagnosis increasingly includes some genetic component. While other individual medical conditions may have low prevalence in isolation, they may present a nontrivial addition to the claim cost model when considered in aggregate.

Appendix A: Model Distributions, Projected Policy Counts and Coverage Amounts

A.1 Model Distributions by Coverage Amount

The **Baseline In Force block** models $12.1 trillion of life insurance coverage in force at year-end 2015 (as illustrated in column J of Table 1). Table 14 shows the percent distribution of this model volume by sex, issue year and issue age.

Table 14

Baseline In Force Block: Model Point Distribution

Sex, Issue Year	Age Band													Total
	0	1–4	5–9	10–17	18–24	25–29	30–34	35–39	40–49	50–59	60–69	70–79	80+	
M, 1990	0.0028	0.0028	0.0021	0.0031	0.0084	0.0238	0.0450	0.0507	0.0676	0.0274	0.0069	0.0022	0.0005	0.2431
M, 1991	0.0029	0.0030	0.0022	0.0033	0.0090	0.0252	0.0477	0.0537	0.0717	0.0290	0.0073	0.0024	0.0005	0.2580
M, 1992	0.0033	0.0034	0.0025	0.0037	0.0102	0.0287	0.0542	0.0610	0.0814	0.0330	0.0083	0.0027	0.0006	0.2930
M, 1993	0.0040	0.0041	0.0030	0.0044	0.0121	0.0341	0.0644	0.0726	0.0968	0.0392	0.0099	0.0032	0.0007	0.3484
M, 1994	0.0042	0.0043	0.0032	0.0046	0.0127	0.0358	0.0677	0.0763	0.1018	0.0412	0.0104	0.0034	0.0007	0.3663
M, 1995	0.0048	0.0049	0.0036	0.0053	0.0146	0.0410	0.0775	0.0873	0.1165	0.0472	0.0119	0.0039	0.0008	0.4191
M, 1996	0.0054	0.0056	0.0041	0.0060	0.0166	0.0467	0.0883	0.0995	0.1327	0.0537	0.0135	0.0044	0.0009	0.4774
M, 1997	0.0064	0.0066	0.0049	0.0071	0.0197	0.0555	0.1048	0.1181	0.1575	0.0638	0.0161	0.0052	0.0011	0.5668
M, 1998	0.0078	0.0080	0.0059	0.0086	0.0238	0.0669	0.1264	0.1425	0.1900	0.0770	0.0194	0.0063	0.0013	0.6838
M, 1999	0.0089	0.0091	0.0067	0.0098	0.0271	0.0763	0.1442	0.1624	0.2167	0.0878	0.0221	0.0072	0.0015	0.7797
M, 2000	0.0109	0.0113	0.0083	0.0121	0.0334	0.0940	0.1776	0.2001	0.2669	0.1081	0.0272	0.0089	0.0018	0.9605
M, 2001	0.0126	0.0130	0.0095	0.0140	0.0385	0.1083	0.2048	0.2307	0.3077	0.1246	0.0314	0.0102	0.0021	1.1074
M, 2002	0.0162	0.0167	0.0123	0.0180	0.0495	0.1394	0.2634	0.2968	0.3959	0.1603	0.0404	0.0132	0.0027	1.4246
M, 2003	0.0195	0.0201	0.0148	0.0216	0.0596	0.1680	0.3175	0.3577	0.4772	0.1933	0.0487	0.0159	0.0032	1.7171
M, 2004	0.0233	0.0241	0.0177	0.0259	0.0713	0.2009	0.3797	0.4278	0.5706	0.2311	0.0582	0.0190	0.0039	2.0534
M, 2005	0.0268	0.0277	0.0204	0.0298	0.0821	0.2313	0.4372	0.4926	0.6571	0.2661	0.0670	0.0219	0.0045	2.3645
M, 2006	0.0313	0.0323	0.0238	0.0347	0.0957	0.2696	0.5096	0.5742	0.7659	0.3102	0.0781	0.0255	0.0052	2.7560
M, 2007	0.0382	0.0395	0.0290	0.0424	0.1170	0.3295	0.6227	0.7017	0.9359	0.3790	0.0955	0.0311	0.0064	3.3679
M, 2008	0.0441	0.0455	0.0335	0.0490	0.1351	0.3804	0.7189	0.8100	1.0804	0.4376	0.1102	0.0359	0.0073	3.8881
M, 2009	0.0486	0.0502	0.0369	0.0539	0.1487	0.4189	0.7916	0.8919	1.1897	0.4818	0.1214	0.0396	0.0081	4.2811
M, 2010	0.0542	0.0559	0.0411	0.0601	0.1658	0.4669	0.8824	0.9943	1.3262	0.5371	0.1353	0.0441	0.0090	4.7725
M, 2011	0.0620	0.0640	0.0471	0.0688	0.1896	0.5341	1.0094	1.1374	1.5171	0.6144	0.1548	0.0505	0.0103	5.4595
M, 2012	0.0688	0.0710	0.0522	0.0764	0.2106	0.5930	1.1207	1.2628	1.6843	0.6822	0.1718	0.0560	0.0114	6.0613
M, 2013	0.0759	0.0784	0.0577	0.0843	0.2324	0.6545	1.2369	1.3937	1.8589	0.7529	0.1897	0.0618	0.0126	6.6896
M, 2014	0.0833	0.0859	0.0632	0.0924	0.2548	0.7177	1.3563	1.5283	2.0385	0.8256	0.2080	0.0678	0.0138	7.3358
M, 2015	0.0945	0.0975	0.0718	0.1049	0.2892	0.8145	1.5393	1.7344	2.3134	0.9370	0.2360	0.0770	0.0157	8.3252
F, 1990	0.0014	0.0014	0.0010	0.0015	0.0042	0.0117	0.0221	0.0249	0.0333	0.0135	0.0034	0.0011	0.0002	0.1197
F, 1991	0.0014	0.0015	0.0011	0.0016	0.0044	0.0124	0.0235	0.0265	0.0353	0.0143	0.0036	0.0012	0.0002	0.1271
F, 1992	0.0016	0.0017	0.0012	0.0018	0.0050	0.0141	0.0267	0.0301	0.0401	0.0162	0.0041	0.0013	0.0003	0.1443
F, 1993	0.0019	0.0020	0.0015	0.0022	0.0060	0.0168	0.0317	0.0357	0.0477	0.0193	0.0049	0.0016	0.0003	0.1716
F, 1994	0.0020	0.0021	0.0016	0.0023	0.0063	0.0177	0.0334	0.0376	0.0501	0.0203	0.0051	0.0017	0.0003	0.1804
F, 1995	0.0023	0.0024	0.0018	0.0026	0.0072	0.0202	0.0382	0.0430	0.0574	0.0232	0.0059	0.0019	0.0004	0.2064
F, 1996	0.0027	0.0028	0.0020	0.0030	0.0082	0.0230	0.0435	0.0490	0.0653	0.0265	0.0067	0.0022	0.0004	0.2351
F, 1997	0.0032	0.0033	0.0024	0.0035	0.0097	0.0273	0.0516	0.0582	0.0776	0.0314	0.0079	0.0026	0.0005	0.2792
F, 1998	0.0038	0.0039	0.0029	0.0042	0.0117	0.0330	0.0623	0.0702	0.0936	0.0379	0.0095	0.0031	0.0006	0.3368
F, 1999	0.0044	0.0045	0.0033	0.0048	0.0133	0.0376	0.0710	0.0800	0.1067	0.0432	0.0109	0.0036	0.0007	0.3841
F, 2000	0.0054	0.0055	0.0041	0.0060	0.0164	0.0463	0.0875	0.0986	0.1315	0.0532	0.0134	0.0044	0.0009	0.4731
F, 2001	0.0062	0.0064	0.0047	0.0069	0.0189	0.0534	0.1009	0.1136	0.1516	0.0614	0.0155	0.0050	0.0010	0.5455
F, 2002	0.0080	0.0082	0.0060	0.0088	0.0244	0.0687	0.1297	0.1462	0.1950	0.0790	0.0199	0.0065	0.0013	0.7017
F, 2003	0.0096	0.0099	0.0073	0.0107	0.0294	0.0827	0.1564	0.1762	0.2350	0.0952	0.0240	0.0078	0.0016	0.8457
F, 2004	0.0115	0.0118	0.0087	0.0127	0.0351	0.0989	0.1870	0.2107	0.2810	0.1138	0.0287	0.0094	0.0019	1.0114
F, 2005	0.0132	0.0136	0.0100	0.0147	0.0405	0.1139	0.2153	0.2426	0.3236	0.1311	0.0330	0.0108	0.0022	1.1646
F, 2006	0.0154	0.0159	0.0117	0.0171	0.0472	0.1328	0.2510	0.2828	0.3772	0.1528	0.0385	0.0126	0.0026	1.3574
F, 2007	0.0188	0.0194	0.0143	0.0209	0.0576	0.1623	0.3067	0.3456	0.4610	0.1867	0.0470	0.0153	0.0031	1.6588
F, 2008	0.0217	0.0224	0.0165	0.0241	0.0665	0.1874	0.3541	0.3990	0.5322	0.2155	0.0543	0.0177	0.0036	1.9150
F, 2009	0.0239	0.0247	0.0182	0.0266	0.0732	0.2063	0.3899	0.4393	0.5860	0.2373	0.0598	0.0195	0.0040	2.1086
F, 2010	0.0267	0.0275	0.0203	0.0296	0.0817	0.2300	0.4346	0.4897	0.6532	0.2645	0.0666	0.0217	0.0044	2.3506
F, 2011	0.0305	0.0315	0.0232	0.0339	0.0934	0.2631	0.4972	0.5602	0.7472	0.3026	0.0762	0.0249	0.0051	2.6890
F, 2012	0.0339	0.0350	0.0257	0.0376	0.1037	0.2921	0.5520	0.6220	0.8296	0.3360	0.0846	0.0276	0.0056	2.9854
F, 2013	0.0374	0.0386	0.0284	0.0415	0.1145	0.3224	0.6092	0.6864	0.9156	0.3708	0.0934	0.0305	0.0062	3.2949
F, 2014	0.0410	0.0423	0.0311	0.0455	0.1255	0.3535	0.6681	0.7527	1.0040	0.4066	0.1024	0.0334	0.0068	3.6132
F, 2015	0.0465	0.0480	0.0353	0.0517	0.1424	0.4012	0.7582	0.8543	1.1395	0.4615	0.1163	0.0379	0.0077	4.1005
Total	**1.1351**	**1.1715**	**0.8619**	**1.2600**	**3.4737**	**9.7837**	**18.4894**	**20.8334**	**27.7885**	**11.2545**	**2.8351**	**0.9245**	**0.1886**	**100.0000**

The **Baseline New Business block** models $44.2 trillion of life insurance coverage issued between 2016 and 2035 (as illustrated in column B of Table 2). Table 15 shows the percent distribution of this model volume by sex, issue year and issue age.

Table 15
Baseline New Business Block: Model Point Distribution

Sex, Issue Year	Age Band													Total
	0	1–4	5–9	10–17	18–24	25–29	30–34	35–39	40–49	50–59	60–69	70–79	80+	
M, 2016	0.0283	0.0292	0.0215	0.0314	0.0866	0.2440	0.4610	0.5195	0.6929	0.2806	0.0707	0.0231	0.0047	2.4935
M, 2017	0.0292	0.0301	0.0221	0.0324	0.0892	0.2513	0.4749	0.5351	0.7137	0.2890	0.0728	0.0237	0.0048	2.5683
M, 2018	0.0300	0.0310	0.0228	0.0333	0.0919	0.2588	0.4891	0.5511	0.7351	0.2977	0.0750	0.0245	0.0050	2.6453
M, 2019	0.0309	0.0319	0.0235	0.0343	0.0946	0.2666	0.5038	0.5676	0.7571	0.3066	0.0772	0.0252	0.0051	2.7247
M, 2020	0.0319	0.0329	0.0242	0.0354	0.0975	0.2746	0.5189	0.5847	0.7799	0.3158	0.0796	0.0259	0.0053	2.8064
M, 2021	0.0328	0.0339	0.0249	0.0364	0.1004	0.2828	0.5345	0.6022	0.8033	0.3253	0.0820	0.0267	0.0055	2.8906
M, 2022	0.0338	0.0349	0.0257	0.0375	0.1034	0.2913	0.5505	0.6203	0.8274	0.3351	0.0844	0.0275	0.0056	2.9773
M, 2023	0.0348	0.0359	0.0264	0.0386	0.1065	0.3000	0.5670	0.6389	0.8522	0.3451	0.0869	0.0284	0.0058	3.0666
M, 2024	0.0359	0.0370	0.0272	0.0398	0.1097	0.3090	0.5840	0.6581	0.8777	0.3555	0.0896	0.0292	0.0060	3.1586
M, 2025	0.0369	0.0381	0.0280	0.0410	0.1130	0.3183	0.6015	0.6778	0.9041	0.3662	0.0922	0.0301	0.0061	3.2534
M, 2026	0.0380	0.0393	0.0289	0.0422	0.1164	0.3279	0.6196	0.6981	0.9312	0.3771	0.0950	0.0310	0.0063	3.3510
M, 2027	0.0392	0.0404	0.0297	0.0435	0.1199	0.3377	0.6382	0.7191	0.9591	0.3885	0.0979	0.0319	0.0065	3.4515
M, 2028	0.0404	0.0416	0.0306	0.0448	0.1235	0.3478	0.6573	0.7406	0.9879	0.4001	0.1008	0.0329	0.0067	3.5551
M, 2029	0.0416	0.0429	0.0316	0.0461	0.1272	0.3583	0.6770	0.7629	1.0175	0.4121	0.1038	0.0339	0.0069	3.6617
M, 2030	0.0428	0.0442	0.0325	0.0475	0.1310	0.3690	0.6973	0.7857	1.0481	0.4245	0.1069	0.0349	0.0071	3.7716
M, 2031	0.0441	0.0455	0.0335	0.0489	0.1349	0.3801	0.7183	0.8093	1.0795	0.4372	0.1101	0.0359	0.0073	3.8847
M, 2032	0.0454	0.0469	0.0345	0.0504	0.1390	0.3915	0.7398	0.8336	1.1119	0.4503	0.1134	0.0370	0.0075	4.0013
M, 2033	0.0468	0.0483	0.0355	0.0519	0.1432	0.4032	0.7620	0.8586	1.1452	0.4638	0.1168	0.0381	0.0078	4.1213
M, 2034	0.0482	0.0497	0.0366	0.0535	0.1475	0.4153	0.7849	0.8844	1.1796	0.4777	0.1203	0.0392	0.0080	4.2449
M, 2035	0.0496	0.0512	0.0377	0.0551	0.1519	0.4278	0.8084	0.9109	1.2150	0.4921	0.1240	0.0404	0.0082	4.3723
F, 2016	0.0139	0.0144	0.0106	0.0155	0.0427	0.1202	0.2271	0.2559	0.3413	0.1382	0.0348	0.0114	0.0023	1.2281
F, 2017	0.0144	0.0148	0.0109	0.0159	0.0439	0.1238	0.2339	0.2635	0.3515	0.1424	0.0359	0.0117	0.0024	1.2650
F, 2018	0.0148	0.0153	0.0112	0.0164	0.0453	0.1275	0.2409	0.2714	0.3621	0.1466	0.0369	0.0120	0.0025	1.3029
F, 2019	0.0152	0.0157	0.0116	0.0169	0.0466	0.1313	0.2481	0.2796	0.3729	0.1510	0.0380	0.0124	0.0025	1.3420
F, 2020	0.0157	0.0162	0.0119	0.0174	0.0480	0.1352	0.2556	0.2880	0.3841	0.1556	0.0392	0.0128	0.0026	1.3823
F, 2021	0.0162	0.0167	0.0123	0.0179	0.0495	0.1393	0.2632	0.2966	0.3956	0.1602	0.0404	0.0132	0.0027	1.4237
F, 2022	0.0166	0.0172	0.0126	0.0185	0.0509	0.1435	0.2711	0.3055	0.4075	0.1650	0.0416	0.0136	0.0028	1.4664
F, 2023	0.0171	0.0177	0.0130	0.0190	0.0525	0.1478	0.2793	0.3147	0.4197	0.1700	0.0428	0.0140	0.0028	1.5104
F, 2024	0.0177	0.0182	0.0134	0.0196	0.0540	0.1522	0.2876	0.3241	0.4323	0.1751	0.0441	0.0144	0.0029	1.5557
F, 2025	0.0182	0.0188	0.0138	0.0202	0.0557	0.1568	0.2963	0.3338	0.4453	0.1803	0.0454	0.0148	0.0030	1.6024
F, 2026	0.0187	0.0193	0.0142	0.0208	0.0573	0.1615	0.3052	0.3439	0.4586	0.1858	0.0468	0.0153	0.0031	1.6505
F, 2027	0.0193	0.0199	0.0147	0.0214	0.0591	0.1663	0.3143	0.3542	0.4724	0.1913	0.0482	0.0157	0.0032	1.7000
F, 2028	0.0199	0.0205	0.0151	0.0221	0.0608	0.1713	0.3238	0.3648	0.4866	0.1971	0.0496	0.0162	0.0033	1.7510
F, 2029	0.0205	0.0211	0.0155	0.0227	0.0626	0.1765	0.3335	0.3757	0.5012	0.2030	0.0511	0.0167	0.0034	1.8035
F, 2030	0.0211	0.0218	0.0160	0.0234	0.0645	0.1817	0.3435	0.3870	0.5162	0.2091	0.0527	0.0172	0.0035	1.8576
F, 2031	0.0217	0.0224	0.0165	0.0241	0.0665	0.1872	0.3538	0.3986	0.5317	0.2153	0.0542	0.0177	0.0036	1.9134
F, 2032	0.0224	0.0231	0.0170	0.0248	0.0685	0.1928	0.3644	0.4106	0.5476	0.2218	0.0559	0.0182	0.0037	1.9708
F, 2033	0.0230	0.0238	0.0175	0.0256	0.0705	0.1986	0.3753	0.4229	0.5641	0.2285	0.0575	0.0188	0.0038	2.0299
F, 2034	0.0237	0.0245	0.0180	0.0263	0.0726	0.2046	0.3866	0.4356	0.5810	0.2353	0.0593	0.0193	0.0039	2.0908
F, 2035	0.0244	0.0252	0.0186	0.0271	0.0748	0.2107	0.3982	0.4487	0.5984	0.2424	0.0611	0.0199	0.0041	2.1535
Total	**1.1351**	**1.1715**	**0.8619**	**1.2600**	**3.4737**	**9.7837**	**18.4894**	**20.8334**	**27.7885**	**11.2545**	**2.8351**	**0.9245**	**0.1886**	**100.0000**

The **GT Positive New Business block** models $363.4 billion of life insurance coverage issued between 2016 and 2035 when family history is available at the time of underwriting (as illustrated in column B of Table 6) and models $479.7 billion of life insurance coverage issued between 2016 and 2035 when family history is not available at the time of underwriting (as illustrated in column B' of Table 6). Table 16 shows the percent distribution of this model volume by condition, sex and standard/substandard assignment under these two scenarios. Table 17 shows the percent distribution of model points by sex, issue year and issue age applicable to both scenarios when family history is and is not available at underwriting.

Table 16

GT Positive New Business Block: Model Point Distribution by Condition, Sex and Standard/Substandard Assignment

Condition	Sex and Standard/Substandard Assignment: FHx Included				Total	Sex and Standard/Substandard Assignment: FHx Excluded				Total
	Male Substandard	Male Standard	Female Substandard	Female Standard		Male Substandard	Male Standard	Female Substandard	Female Standard	
BRCA 1 or 2	—	—	11.5039	3.8346	15.3385	—	—	8.7147	2.9049	11.6196
HTCM	9.5252	4.2794	9.5252	4.2794	27.6093	7.2158	3.2419	7.2158	3.2419	20.9154
DCM	2.5564	0.8521	2.5564	0.8521	6.8171	1.9366	0.6455	1.9366	0.6455	5.1643
ARVCM	2.7609	0.9203	2.7609	0.9203	7.3625	2.0915	0.6972	2.0915	0.6972	5.5774
Long QT	0.3806	1.1418	0.3806	1.1418	3.0449	0.2883	0.8650	0.2883	0.8650	2.3066
Brugada	2.5884	0.8628	2.5884	0.8628	6.9023	1.9608	0.6536	1.9608	0.6536	5.2288
Huntington	0.2186	0.0115	0.2186	0.0115	0.4602	0.3312	0.0174	0.3312	0.0174	0.6972
PKD	4.6016	—	4.6016	—	9.2031	6.9718	—	6.9718	—	13.9436
MDyst 1 or 2	0.4314	0.1438	0.4314	0.1438	1.1504	0.6536	0.2179	0.6536	0.2179	1.7429
ADEO	0.2422	—	0.2422	—	0.4844	0.3669	—	0.3669	—	0.7339
HNPCC	4.6016	4.6016	4.6016	4.6016	18.4062	6.9718	6.9718	6.9718	6.9718	27.8871
Marfan	0.4602	0.4602	0.4602	0.4602	1.8406	0.6972	0.6972	0.6972	0.6972	2.7887
CPVT	0.5177	0.1726	0.5177	0.1726	1.3805	0.5229	0.1743	0.5229	0.1743	1.3944
Total	**28.8847**	**13.4461**	**40.3885**	**17.2807**	**100.0000**	**30.0084**	**14.1818**	**38.7232**	**17.0867**	**100.0000**

Table 17

GT Positive New Business Block: Model Point Distribution by Sex, Issue Year and Issue Age

Sex, Issue Year	Age Band: All Conditions Except Long QT							Total	Age Band: Long QT Only			Total
	20–24	25–29	30–34	35–39	40–44	45–49	50–54		20–24	25–29	30–34	
M, 2016	0.5707	0.5551	0.5394	0.5081	0.5003	0.5081	0.5394	3.7212	1.2753	1.2404	1.2055	3.7212
M, 2017	0.5878	0.5717	0.5556	0.5234	0.5153	0.5234	0.5556	3.8328	1.3136	1.2776	1.2416	3.8328
M, 2018	0.6055	0.5889	0.5723	0.5391	0.5309	0.5391	0.5723	3.9482	1.3531	1.3161	1.2790	3.9482
M, 2019	0.6238	0.6067	0.5896	0.5554	0.5469	0.5554	0.5896	4.0673	1.3940	1.3558	1.3176	4.0673
M, 2020	0.6426	0.6250	0.6074	0.5722	0.5634	0.5722	0.6074	4.1901	1.4360	1.3967	1.3573	4.1901
M, 2021	0.6614	0.6433	0.6252	0.5889	0.5799	0.5889	0.6252	4.3129	1.4781	1.4376	1.3971	4.3129
M, 2022	0.6814	0.6627	0.6441	0.6067	0.5974	0.6067	0.6441	4.4431	1.5228	1.4810	1.4393	4.4431
M, 2023	0.7019	0.6827	0.6635	0.6250	0.6154	0.6250	0.6635	4.5771	1.5687	1.5257	1.4827	4.5771
M, 2024	0.7231	0.7033	0.6834	0.6438	0.6339	0.6438	0.6834	4.7148	1.6159	1.5716	1.5273	4.7148
M, 2025	0.7447	0.7243	0.7039	0.6631	0.6529	0.6631	0.7039	4.8562	1.6643	1.6187	1.5731	4.8562
M, 2026	0.7670	0.7460	0.7250	0.6830	0.6724	0.6830	0.7250	5.0013	1.7141	1.6671	1.6201	5.0013
M, 2027	0.7898	0.7682	0.7466	0.7033	0.6925	0.7033	0.7466	5.1502	1.7651	1.7167	1.6684	5.1502
M, 2028	0.8138	0.7915	0.7692	0.7246	0.7135	0.7246	0.7692	5.3064	1.8186	1.7688	1.7190	5.3064
M, 2029	0.8383	0.8154	0.7924	0.7465	0.7350	0.7465	0.7924	5.4665	1.8735	1.8222	1.7708	5.4665
M, 2030	0.8635	0.8398	0.8161	0.7688	0.7570	0.7688	0.8161	5.6302	1.9296	1.8767	1.8239	5.6302
M, 2031	0.8891	0.8648	0.8404	0.7917	0.7795	0.7917	0.8404	5.7976	1.9870	1.9325	1.8781	5.7976
M, 2032	0.9160	0.8909	0.8658	0.8156	0.8030	0.8156	0.8658	5.9725	2.0469	1.9908	1.9348	5.9725
M, 2033	0.9433	0.9175	0.8917	0.8400	0.8270	0.8400	0.8917	6.1512	2.1081	2.0504	1.9926	6.1512
M, 2034	0.9713	0.9447	0.9181	0.8649	0.8516	0.8649	0.9181	6.3335	2.1706	2.1112	2.0517	6.3335
M, 2035	1.0010	0.9736	0.9461	0.8913	0.8776	0.8913	0.9461	6.5270	2.2370	2.1757	2.1144	6.5270
M Total	**15.3361**	**14.9160**	**14.4958**	**13.6555**	**13.4454**	**13.6555**	**14.4958**	**100.0000**	**34.2723**	**33.3333**	**32.3944**	**100.0000**
F, 2016	0.5420	0.5420	0.5339	0.5096	0.5096	0.5177	0.5663	3.7212	1.2466	1.2466	1.2280	3.7212
F, 2017	0.5583	0.5583	0.5499	0.5249	0.5249	0.5333	0.5833	3.8328	1.2840	1.2840	1.2648	3.8328
F, 2018	0.5751	0.5751	0.5665	0.5407	0.5407	0.5493	0.6008	3.9482	1.3226	1.3226	1.3029	3.9482
F, 2019	0.5924	0.5924	0.5836	0.5570	0.5570	0.5659	0.6189	4.0673	1.3625	1.3625	1.3422	4.0673
F, 2020	0.6103	0.6103	0.6012	0.5739	0.5739	0.5830	0.6376	4.1901	1.4037	1.4037	1.3827	4.1901
F, 2021	0.6282	0.6282	0.6188	0.5907	0.5907	0.6001	0.6563	4.3129	1.4448	1.4448	1.4233	4.3129
F, 2022	0.6472	0.6472	0.6375	0.6085	0.6085	0.6182	0.6761	4.4431	1.4884	1.4884	1.4662	4.4431
F, 2023	0.6667	0.6667	0.6567	0.6269	0.6269	0.6368	0.6965	4.5771	1.5333	1.5333	1.5104	4.5771
F, 2024	0.6867	0.6867	0.6765	0.6457	0.6457	0.6560	0.7175	4.7148	1.5794	1.5794	1.5559	4.7148
F, 2025	0.7073	0.7073	0.6968	0.6651	0.6651	0.6756	0.7390	4.8562	1.6268	1.6268	1.6025	4.8562
F, 2026	0.7285	0.7285	0.7176	0.6850	0.6850	0.6958	0.7611	5.0013	1.6754	1.6754	1.6504	5.0013
F, 2027	0.7501	0.7501	0.7389	0.7053	0.7053	0.7165	0.7837	5.1502	1.7253	1.7253	1.6995	5.1502
F, 2028	0.7729	0.7729	0.7614	0.7268	0.7268	0.7383	0.8075	5.3064	1.7777	1.7777	1.7511	5.3064
F, 2029	0.7962	0.7962	0.7843	0.7487	0.7487	0.7606	0.8319	5.4665	1.8313	1.8313	1.8039	5.4665
F, 2030	0.8200	0.8200	0.8078	0.7711	0.7711	0.7833	0.8568	5.6302	1.8861	1.8861	1.8580	5.6302
F, 2031	0.8444	0.8444	0.8318	0.7940	0.7940	0.8066	0.8822	5.7976	1.9422	1.9422	1.9132	5.7976
F, 2032	0.8699	0.8699	0.8569	0.8180	0.8180	0.8310	0.9089	5.9725	2.0008	2.0008	1.9709	5.9725
F, 2033	0.8959	0.8959	0.8826	0.8424	0.8424	0.8558	0.9360	6.1512	2.0606	2.0606	2.0299	6.1512
F, 2034	0.9225	0.9225	0.9087	0.8674	0.8674	0.8812	0.9638	6.3335	2.1217	2.1217	2.0901	6.3335
F, 2035	0.9507	0.9507	0.9365	0.8939	0.8939	0.9081	0.9932	6.5270	2.1865	2.1865	2.1539	6.5270
F Total	**14.5652**	**14.5652**	**14.3478**	**13.6957**	**13.6957**	**13.9130**	**15.2174**	**100.0000**	**33.5000**	**33.5000**	**33.0000**	**100.0000**

A.2 Projected Policy Counts and Coverage Amounts

Table 18 presents the projected coverage amounts and policy counts from the three modeled blocks of business. For the Baseline In Force and Base Line New Business blocks, the scenarios assume whole life plans where lapses are set at 6.3% flat. For the GT Positive New Business block, the scenario assumes family history is available at the time of underwriting.

Table 18
Projected Model Coverage Amount and Policy Count, by Block of Business

Model Projection Year	Baseline In Force				Baseline New Business				GT Positive New Business (FHx Included)			
	Coverage Amount ($)		Policy Count		Coverage Amount ($)		Policy Count		Coverage Amount ($)		Policy Count	
	New Business (billion)	In Force (billion)	New Business (million)	In Force (million)	New Business (billion)	In Force (billion)	New Business (million)	In Force (million)	New Business (billion)	In Force (billion)	New Business	In Force
31 Dec 2015	—	12,142.9	—	119.2	—	—	—	—	—	—	—	—
2016	—	11,319.8	—	110.7	1,646.5	1,646.0	10.0	10.0	13.5	13.5	19,319	19,273
2017	—	10,550.6	—	102.9	1,695.9	3,236.9	10.0	19.4	13.9	27.0	19,319	38,056
2018	—	9,830.6	—	95.5	1,746.8	4,777.5	10.0	28.1	14.3	40.7	19,319	56,370
2019	—	9,156.4	—	88.7	1,799.2	6,272.3	10.0	36.3	14.8	54.4	19,319	74,235
2020	—	8,524.7	—	82.3	1,853.1	7,725.7	10.0	44.0	15.2	68.2	19,319	91,670
2021	—	7,932.8	—	76.3	1,908.7	9,141.7	10.0	51.2	15.7	82.2	19,319	108,692
2022	—	7,378.1	—	70.8	1,966.0	10,524.3	10.0	57.9	16.1	96.3	19,319	125,288
2023	—	6,858.4	—	65.6	2,025.0	11,877.1	10.0	64.2	16.6	110.5	19,319	141,473
2024	—	6,371.6	—	60.7	2,085.7	13,203.6	10.0	70.1	17.1	124.9	19,319	157,264
2025	—	5,915.8	—	56.1	2,148.3	14,507.2	10.0	75.6	17.6	139.4	19,319	172,674
2026	—	5,489.0	—	51.9	2,212.7	15,791.0	10.0	80.8	18.2	154.1	19,319	187,716
2027	—	5,089.6	—	47.9	2,279.1	17,058.1	10.0	85.6	18.7	168.9	19,319	202,254
2028	—	4,715.8	—	44.2	2,347.5	18,311.3	10.0	90.1	19.3	183.9	19,319	216,311
2029	—	4,366.0	—	40.8	2,417.9	19,553.6	10.0	94.3	19.9	198.9	19,319	229,911
2030	—	4,038.8	—	37.6	2,490.5	20,787.6	10.0	98.3	20.5	214.1	19,319	243,072
2031	—	3,732.8	—	34.6	2,565.2	22,015.9	10.0	101.9	21.1	229.4	19,319	255,815
2032	—	3,446.9	—	31.8	2,642.1	23,241.0	10.0	105.4	21.7	245.0	19,319	268,164
2033	—	3,179.8	—	29.2	2,721.4	24,465.3	10.0	108.6	22.4	260.7	19,319	280,135
2034	—	2,930.5	—	26.8	2,803.0	25,691.2	10.0	111.5	23.0	276.7	19,319	291,742
2035	—	2,697.7	—	24.5	2,887.1	26,920.9	10.0	114.3	23.7	292.9	19,319	302,996
Total					**44,241.9**		**200.0**		**363.4**		**386,374**	
2040	—	1,751.8	—	15.5	—	19,243.2	—	81.6	—	254.6	—	262,671
2045	—	1,096.7	—	9.4	—	13,663.1	—	57.9	—	218.8	—	225,370
2050	—	654.6	—	5.4	—	9,612.5	—	40.6	—	185.9	—	191,130
2055	—	367.3	—	2.9	—	6,677.1	—	28.1	—	156.3	—	159,897
2060	—	190.7	—	1.5	—	4,555.6	—	19.1	—	128.3	—	130,203
2070	—	38.9	—	0.3	—	1,944.1	—	8.0	—	77.3	—	77,164
2075	—	16.1	—	0.1	—	1,188.2	—	4.9	—	56.4	—	55,887
2080	—	7.0	—	0.1	—	681.1	—	2.7	—	39.4	—	38,635
2085	—	3.3	—	0.0	—	359.7	—	1.4	—	26.0	—	25,053
2090	—	1.6	—	0.0	—	172.3	—	0.7	—	15.5	—	14,584
2095	—	0.7	—	0.0	—	74.6	—	0.3	—	8.0	—	7,303
2100	—	0.2	—	0.0	—	30.2	—	0.1	—	3.3	—	2,950
2105	—	0.1	—	0.0	—	12.8	—	0.1	—	1.0	—	876
2110	—	0.0	—	0.0	—	6.0	—	0.0	—	0.2	—	147
2115	—	—	—	—	—	2.9	—	0.0	—	—	—	—

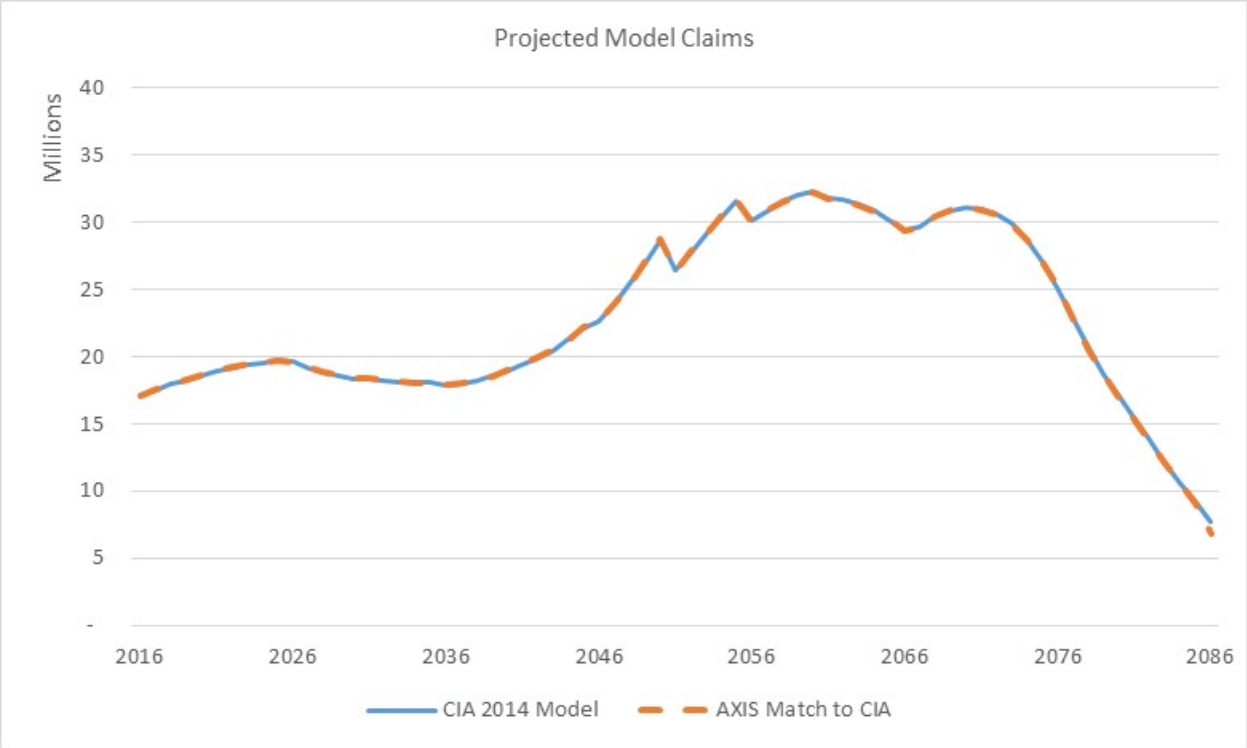
Appendix B: Model Walk From the CIA Model to the US Model

This study began by reproducing the model results from the two Canadian Institute of Actuaries (CIA) studies (Howard 2014; 2016) to understand the approaches employed. These were found to be both practical and intuitive. The approach outlined in the CIA's 2014 life study (Howard 2014) to model the 13 genetic conditions was adapted in this study for the determination of the GT Positive New Business block model points and their resulting mortality assumptions. This appendix illustrates the sequence of major adaptations and their impact on the projected claims for the 13 genetic conditions.

B.1 Step 0: Matching CIA Model Claims

Projected claims underlying the CIA's 2014 life study (Howard 2014) for the 13 genetic conditions were first replicated using GGY's[19] AXIS actuarial modeling software. Claims illustrated in Figure 8 are from one year of new business assumed to be written in 2016.

Figure 8
Claims Matching the CIA's 2014 Life Study Versus Projected AXIS Model Claims for One Year of New Business

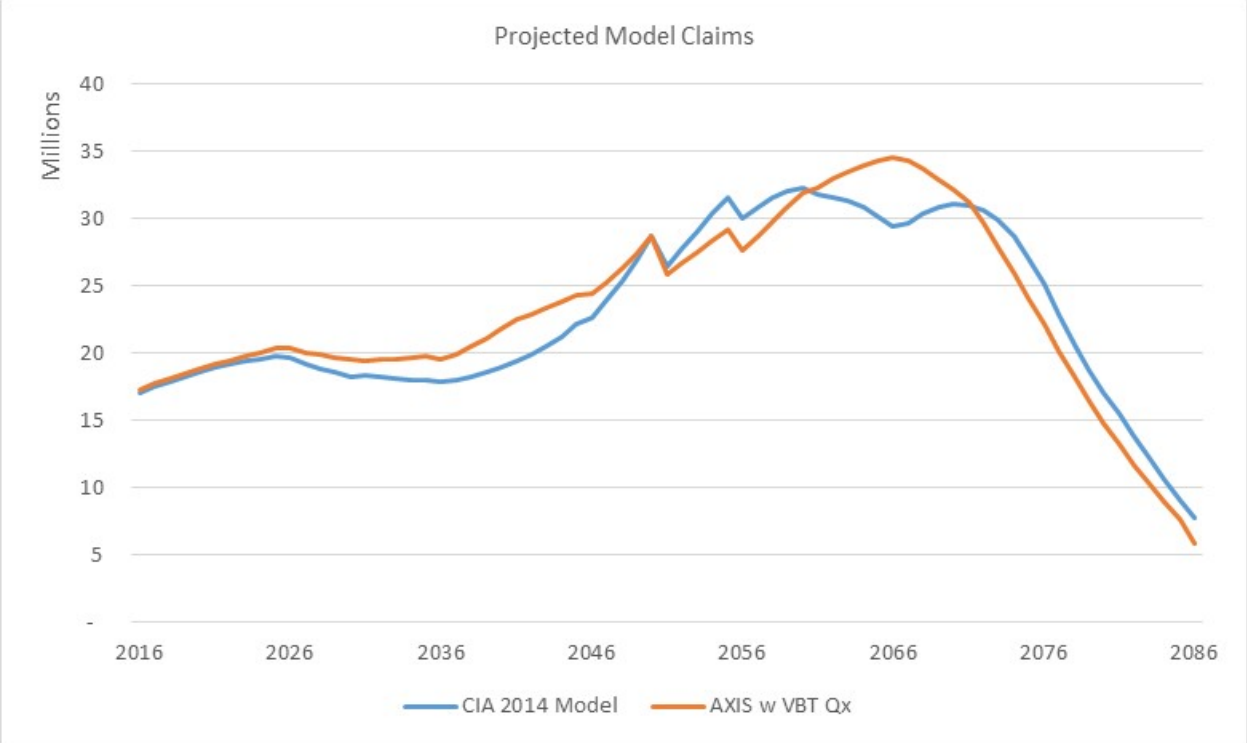


[19] GGY a Moody's Analytics Company (*https://www.ggy.com/*) is a software company located in Toronto, Canada.

B.2 Step 1: Replacing Mortality Table

Next, the underlying mortality table (and adjustments) used in the CIA 2014 life study (Howard 2014) was replaced by 100% of the 2015 Valuation Basic Table RR100 nonsmoker tables, to reflect U.S. life insurance mortality experience. Changing the underlying mortality tables increased the present value of claims (discounted at 4% flat) by 3.3%, as shown in Figure 9.

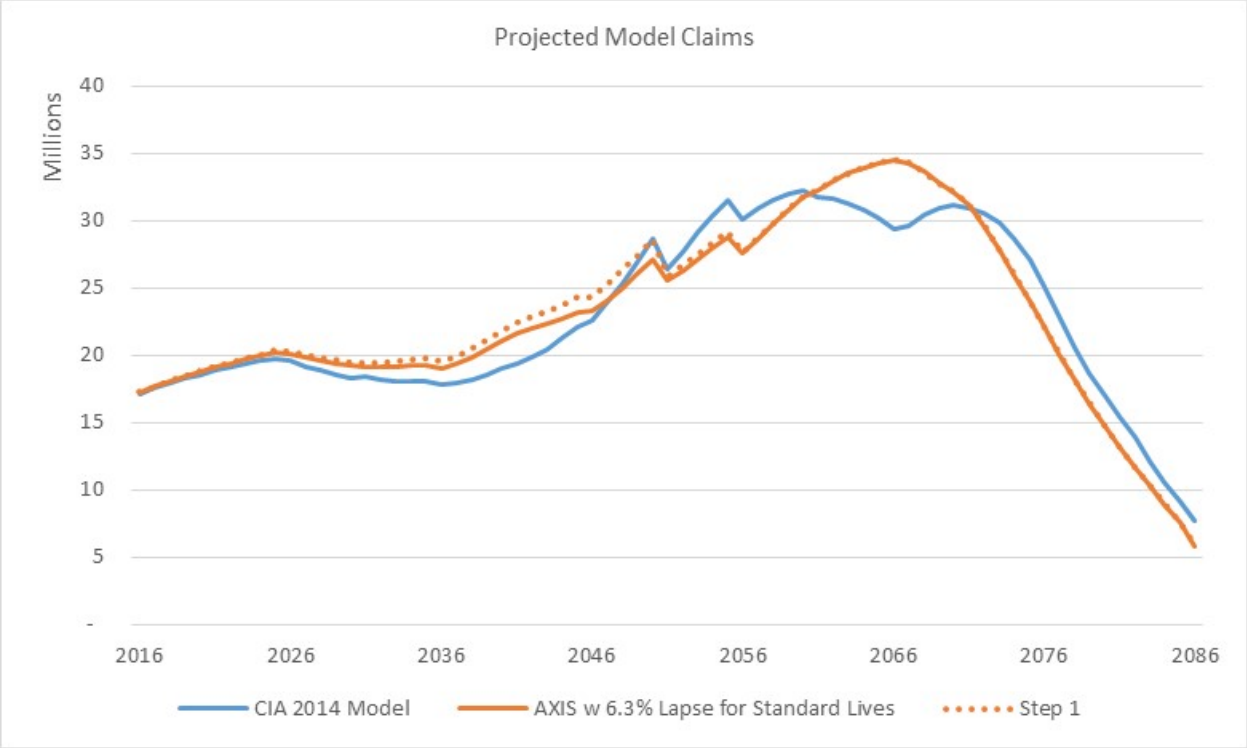
Figure 9
Claims Matching the CIA's 2014 Life Study Versus Projected AXIS Model Claims for One Year of New Business Using: (a) 2015 VBT RR100 Nonsmoker Mortality



B.3 Step 2: Setting Lapses for Standard Lives to 6.3%

For model points assumed to have standard mortality based on the genetic condition's penetrance rate, the lapse rate was set to 6.3% (up from 3% in the CIA 2014 life study), to reflect average historic lapses in the U.S. Changing the lapse rate reduced claims, most noticeably in earlier durations (see Figure 10).

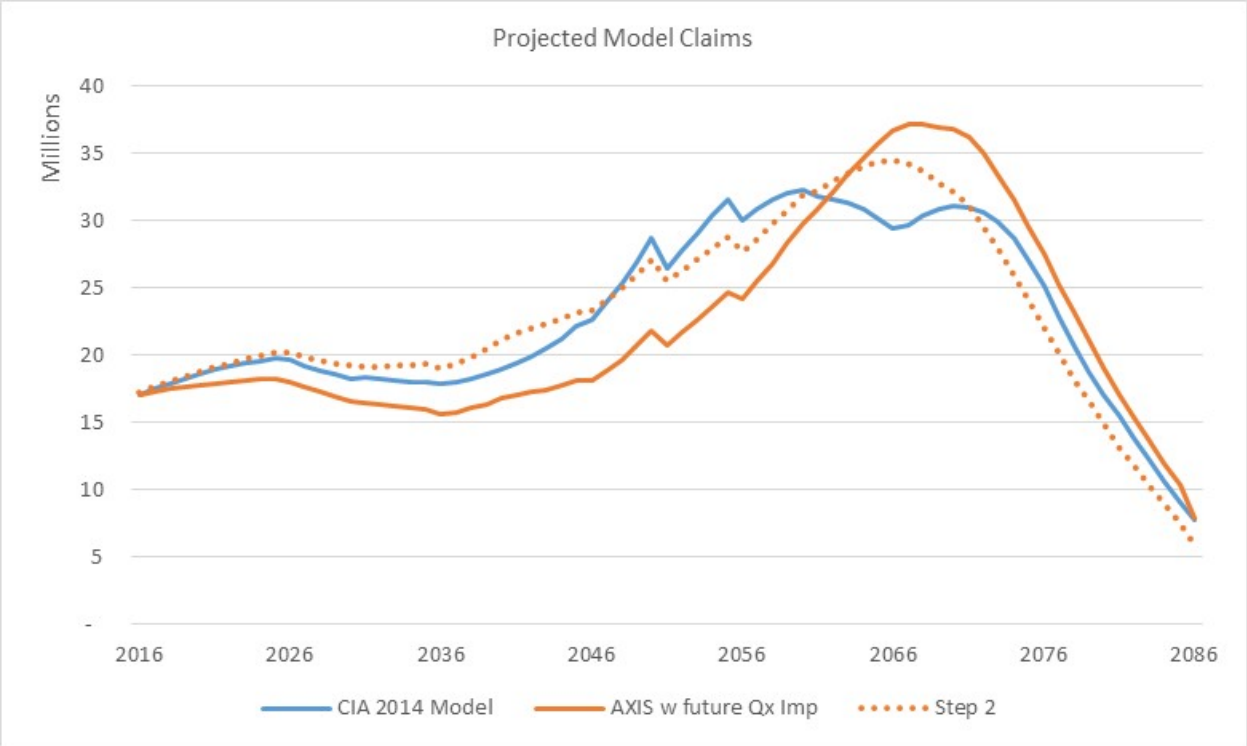
Figure 10
Claims Matching the CIA's 2014 Life Study Versus Projected AXIS Model Claims for One Year of New Business Using: (a) 2015 VBT RR100 Nonsmoker Mortality and (b) 6.3% Lapse for Standard Model Points



B.4 Step 3: Assuming Future Mortality Improvement

The next change was to assume mortality improvement projected forward past the valuation date. Doing so reduced claims considerably, pushing claims lower in earlier projection years and increasing claims in later projection years. The cumulate effect of the first three steps is that the present value of projected claims is 7.3% lower than the CIA's model claims (see Figure 11).

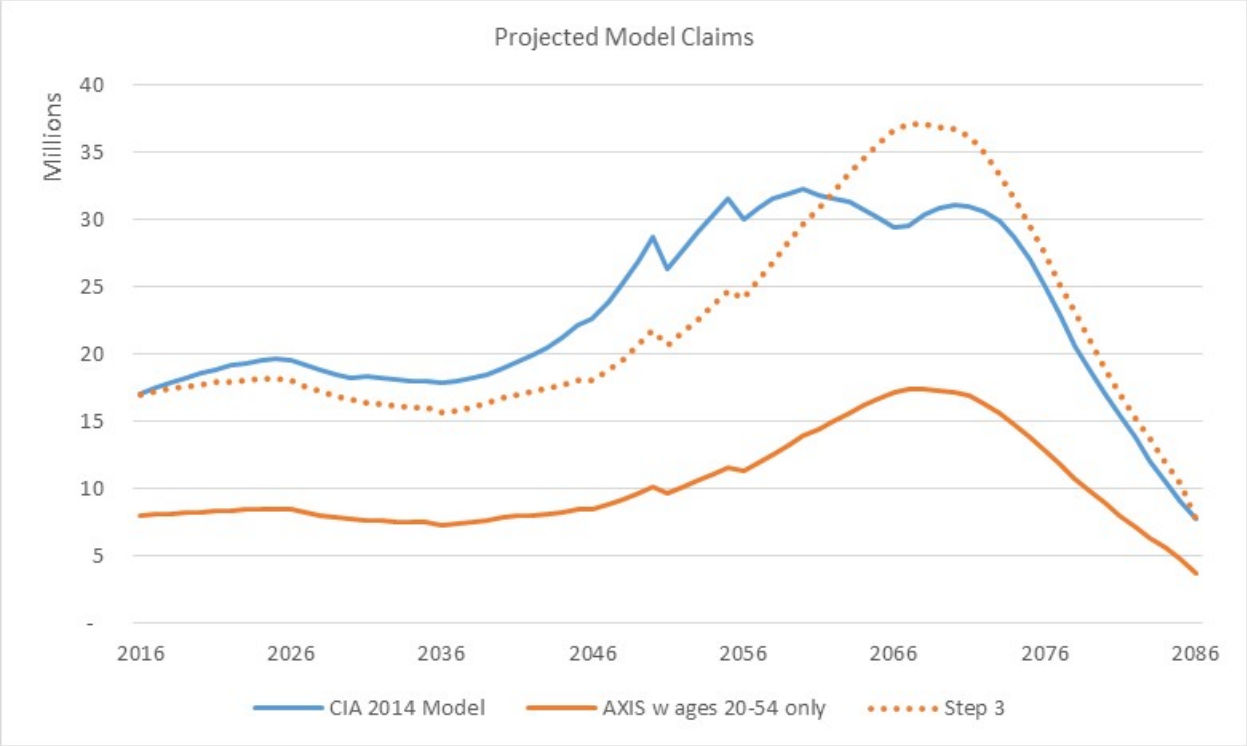
Figure 11
Claims Matching the CIA's 2014 Life Study Versus Projected AXIS Model Claims for One Year of New Business Using: (a) 2015 VBT RR100 Nonsmoker Mortality, (b) 6.3% Lapse for Standard Model Points and (c) Mortality Improvement Projected Forward Past the Valuation Date



B.5 Step 4: Assuming Only Ages 20–54 in the General Population Will Seek Insurance

The biggest change from the CIA's 2014 life study came from assuming that the only individuals in the general population to seek out insurance would be those between the ages of 20 and 54 with a positive genetic test result. The cumulative effect of the first four steps is that the present value of projected claims is 56.6% lower than the CIA's model claims (see Figure 12).

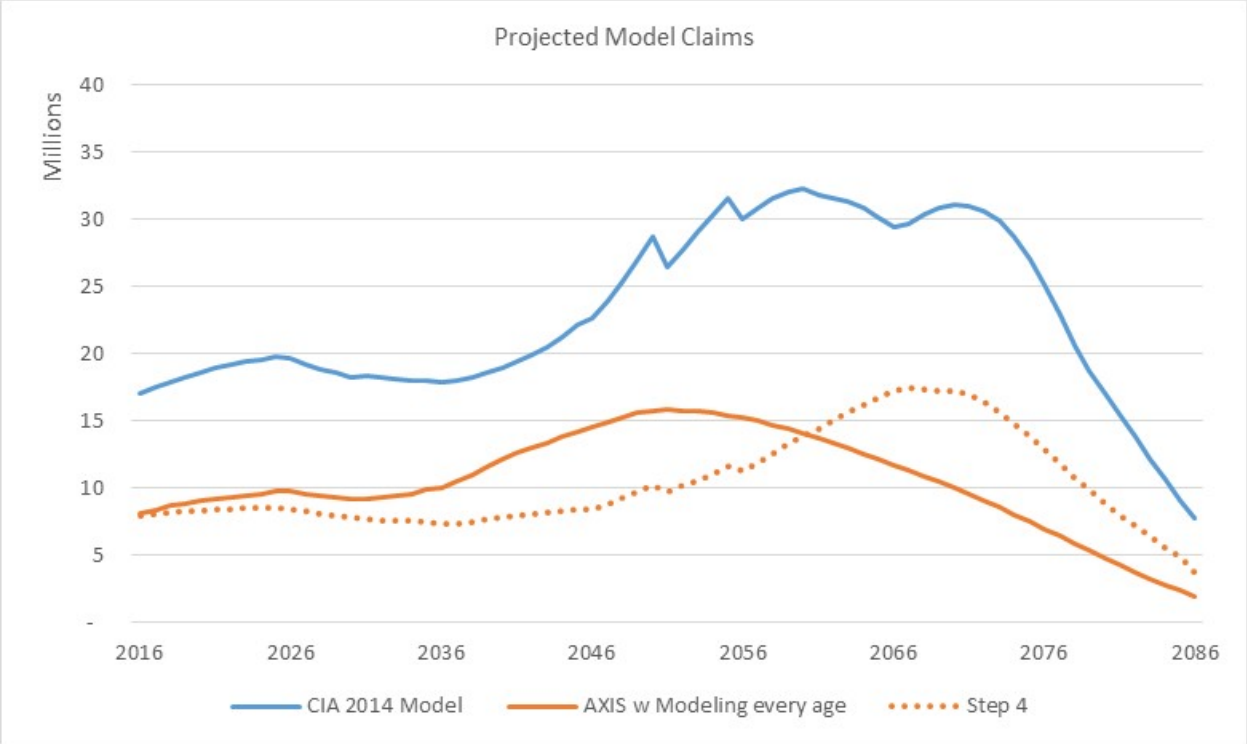
Figure 12
Claims Matching the CIA's 2014 Life Study Versus Projected AXIS Model Claims for One Year of New Business Using: (a) 2015 VBT RR100 Nonsmoker Mortality, (b) 6.3% Lapse for Standard Model Points, (c) Mortality Improvement Projected Forward Past the Valuation Date and (d) Those Seeking Insurance Only Between Ages 20 and 54



B.6 Step 5: Modeling Every Age Instead of a Central Age

The CIA's 2014 life study modeled claims from each genetic condition based on an average age per condition; the average age at testing assumed by the CIA model never exceeded 35. Modeling every age between 20 and 54 pulls the claims forward in the projection, as there are more model points at older ages, increasing early duration mortality. The cumulative effect of the first five steps is that the present value of projected claims is 50% lower than the CIA's model claims (see Figure 13).

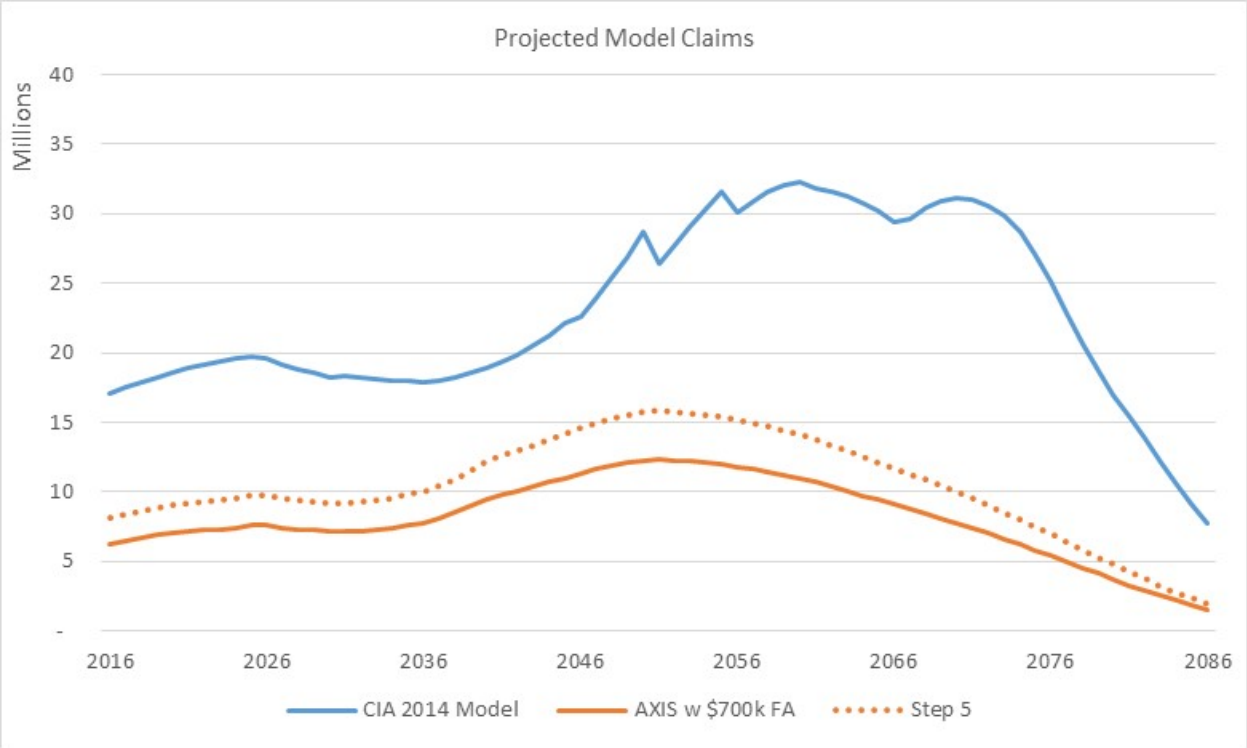
Figure 13
Claims Matching the CIA's 2014 Life Study Versus Projected AXIS Model Claims for One Year of New Business Using: (a) 2015 VBT RR100 Nonsmoker Mortality, (b) 6.3% Lapse for Standard Model Points, (c) Mortality Improvement Projected Forward Past the Valuation Date, (d) Those Seeking Insurance Only Between Ages 20 – 54 and (e) Distinct Model Point Ages



B.7 Step 6: Assuming Coverage Amounts of $700,000

The CIA's study assumed that individuals with a positive genetic test result would purchase a coverage amount of $900,000. This study further reduced projected claims by assuming a $700,000 coverage amount purchased in 2016 (see Figure 14).

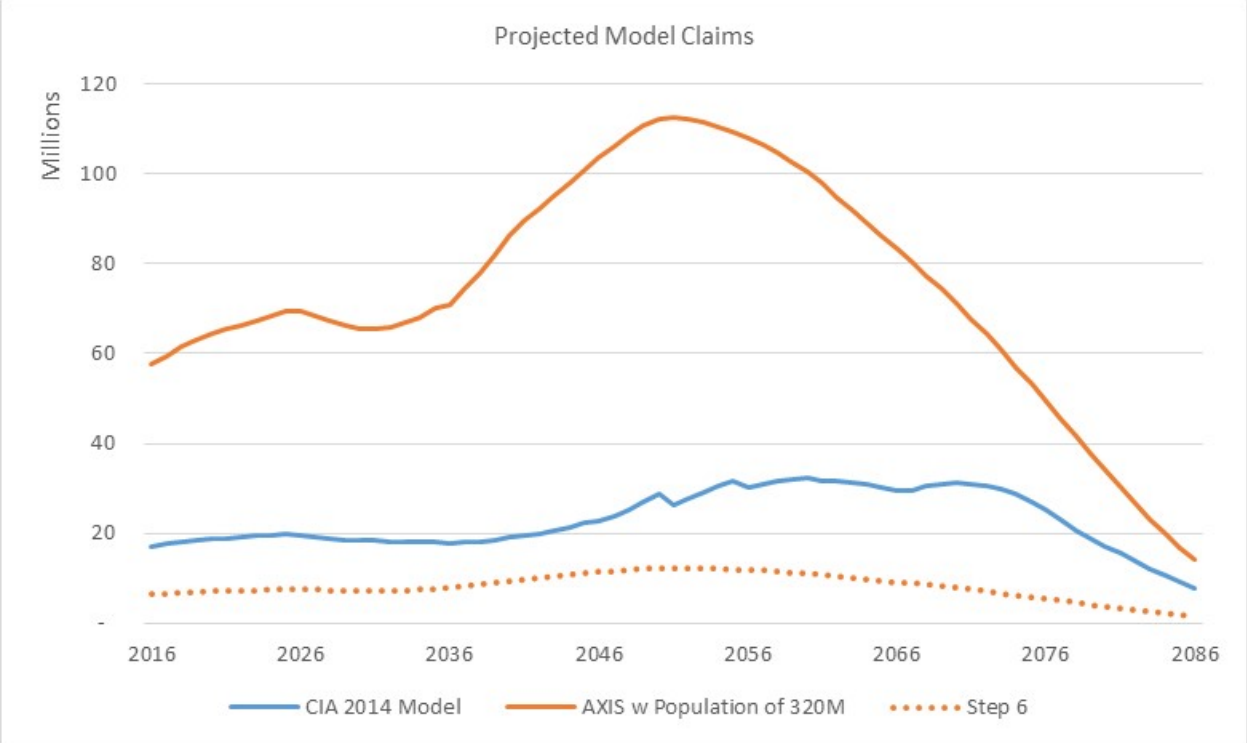
Figure 14
Claims Matching the CIA's 2014 Life Study Versus Projected AXIS Model Claims for One Year of New Business Using: (a) 2015 VBT RR100 Nonsmoker Mortality, (b) 6.3% Lapse for Standard Model Points, (c) Mortality Improvement Projected Forward Past the Valuation Date, (d) Those Seeking Insurance Only Between Ages 20 – 54, (e) Distinct Model Point Ages and (f) $700,000 Coverage Amounts



B.8 Step 7: Adjusting for US Population Size

The final stepwise change was to adjust the model claims for the population of the U.S. As shown in Figure 15, the study used a population of 320 million in 2016, instead of the Canadian population of 35 million.

Figure 15
Claims Matching the CIA's 2014 Life Study Versus Projected AXIS Model Claims for One Year of New Business Using: (a) 2015 VBT RR100 Nonsmoker Mortality, (b) 6.3% Lapse for Standard Model Points, (c) Mortality Improvement Projected Forward Past the Valuation Date, (d) Those Seeking Insurance Only Between Ages 20 – 54, (e) Distinct Model Point Ages, (f) $700,000 Coverage Amounts and (g) U.S. Population of 320 Million



The projected claims illustrated in these seven steps use the underlying assumptions by condition outlined in the CIA's 2014 life study, not those ultimately used for this report, documented in Table 7 of section 4.2.2.

Appendix C: Standard and Grading Assumptions

The combinations of Standard and Grading assumptions outlined in Table 7 created adjustment patterns that vary by duration and are applied to substandard mortality extras assumed for each condition. Table 19 shows the various multiplicative percentages for each condition except dilated cardiomyopathy (DCM), and Table 20 shows the multiplicative percentages for sample DCM issue ages.

Table 19

Multiplicative Factors Applied to the Substandard Ratings by Standard/Grading Combination, Excluding DCM

Duration	Standard/Grading Combination						
	0/0	0/5	0/15	5/10	5/15	15/10	20/15
1	100.00	10.00	3.33	—	—	—	—
2	100.00	30.00	10.00	—	—	—	—
3	100.00	50.00	16.67	—	—	—	—
4	100.00	70.00	23.33	—	—	—	—
5	100.00	90.00	30.00	—	—	—	—
6	100.00	100.00	36.67	5.00	3.33	—	—
7	100.00	100.00	43.33	15.00	10.00	—	—
8	100.00	100.00	50.00	25.00	16.67	—	—
9	100.00	100.00	56.67	35.00	23.33	—	—
10	100.00	100.00	63.33	45.00	30.00	—	—
11	100.00	100.00	70.00	55.00	36.67	—	—
12	100.00	100.00	76.67	65.00	43.33	—	—
13	100.00	100.00	83.33	75.00	50.00	—	—
14	100.00	100.00	90.00	85.00	56.67	—	—
15	100.00	100.00	96.67	95.00	63.33	—	—
16	100.00	100.00	100.00	100.00	70.00	5.00	—
17	100.00	100.00	100.00	100.00	76.67	15.00	—
18	100.00	100.00	100.00	100.00	83.33	25.00	—
19	100.00	100.00	100.00	100.00	90.00	35.00	—
20	100.00	100.00	100.00	100.00	96.67	45.00	—
21	100.00	100.00	100.00	100.00	100.00	55.00	3.33
22	100.00	100.00	100.00	100.00	100.00	65.00	10.00
23	100.00	100.00	100.00	100.00	100.00	75.00	16.67
24	100.00	100.00	100.00	100.00	100.00	85.00	23.33
25	100.00	100.00	100.00	100.00	100.00	95.00	30.00
26	100.00	100.00	100.00	100.00	100.00	100.00	36.67
27	100.00	100.00	100.00	100.00	100.00	100.00	43.33
28	100.00	100.00	100.00	100.00	100.00	100.00	50.00
29	100.00	100.00	100.00	100.00	100.00	100.00	56.67
30	100.00	100.00	100.00	100.00	100.00	100.00	63.33
31	100.00	100.00	100.00	100.00	100.00	100.00	70.00
32	100.00	100.00	100.00	100.00	100.00	100.00	76.67
33	100.00	100.00	100.00	100.00	100.00	100.00	83.33
34	100.00	100.00	100.00	100.00	100.00	100.00	90.00
35	100.00	100.00	100.00	100.00	100.00	100.00	96.67
36	100.00	100.00	100.00	100.00	100.00	100.00	100.00
37	100.00	100.00	100.00	100.00	100.00	100.00	100.00
38	100.00	100.00	100.00	100.00	100.00	100.00	100.00
39	100.00	100.00	100.00	100.00	100.00	100.00	100.00
40	100.00	100.00	100.00	100.00	100.00	100.00	100.00
41+	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 20

Multiplicative Factors Applied to the Substandard Ratings for DCM Model Points: Select Issue Ages

Duration	Issue Age						
	20	25	30	35	40	45	50+
1	—	—	1.67	2.22	2.78	3.33	5.00
2	—	—	5.00	6.20	7.75	10.00	15.00
3	—	—	8.33	10.18	12.72	16.67	25.00
4	—	—	11.67	14.17	17.69	23.33	35.00
5	—	—	15.00	18.15	22.66	30.00	45.00
6	—	1.67	18.33	22.13	27.63	36.67	55.00
7	—	5.00	21.67	26.11	32.60	43.33	65.00
8	—	8.33	25.00	30.09	37.57	50.00	75.00
9	—	11.67	28.33	34.07	42.54	56.67	85.00
10	—	15.00	31.67	38.06	47.51	63.33	95.00
11	1.67	18.33	35.00	42.04	52.49	70.00	100.00
12	5.00	21.67	38.33	46.02	57.46	76.67	100.00
13	8.33	25.00	41.67	50.00	62.43	83.33	100.00
14	11.67	28.33	45.00	53.98	67.40	90.00	100.00
15	15.00	31.67	48.33	57.96	72.37	96.67	100.00
16	18.33	35.00	51.67	61.94	77.34	100.00	100.00
17	21.67	38.33	55.00	65.93	82.31	100.00	100.00
18	25.00	41.67	58.33	69.91	87.28	100.00	100.00
19	28.33	45.00	61.67	73.89	92.25	100.00	100.00
20	31.67	48.33	65.00	77.87	97.22	100.00	100.00
21	35.00	51.67	68.33	81.85	100.00	100.00	100.00
22	38.33	55.00	71.67	85.83	100.00	100.00	100.00
23	41.67	58.33	75.00	89.82	100.00	100.00	100.00
24	45.00	61.67	78.33	93.80	100.00	100.00	100.00
25	48.33	65.00	81.67	97.78	100.00	100.00	100.00
26	51.67	68.33	85.00	100.00	100.00	100.00	100.00
27	55.00	71.67	88.33	100.00	100.00	100.00	100.00
28	58.33	75.00	91.67	100.00	100.00	100.00	100.00
29	61.67	78.33	95.00	100.00	100.00	100.00	100.00
30	65.00	81.67	98.33	100.00	100.00	100.00	100.00
31	68.33	85.00	100.00	100.00	100.00	100.00	100.00
32	71.67	88.33	100.00	100.00	100.00	100.00	100.00
33	75.00	91.67	100.00	100.00	100.00	100.00	100.00
34	78.33	95.00	100.00	100.00	100.00	100.00	100.00
35	81.67	98.33	100.00	100.00	100.00	100.00	100.00
36	85.00	100.00	100.00	100.00	100.00	100.00	100.00
37	88.33	100.00	100.00	100.00	100.00	100.00	100.00
38	91.67	100.00	100.00	100.00	100.00	100.00	100.00
39	95.00	100.00	100.00	100.00	100.00	100.00	100.00
40	98.33	100.00	100.00	100.00	100.00	100.00	100.00
41	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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