Swiss Re

Genetic testing anti-selection risk and implications for insurers

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Trends and prospects in genetic testing

What is Genetic Testing?

"Genetic testing looks for alterations in a person's genes or chromosomes to identify heritable or acquired mutations related to disease and health"

Diagnostic / confirmatory genetic testing

Identifies or confirms a specific genetic condition in a symptomatic individual

Pharmacogenomic testing

Guides individual drug dosage, selection and response

Direct-to-consumer (DTC) genetic testing

Genetic tests marketed directly to consumers without involving healthcare professionals

New-born screening

Identifies highly penetrant genetic disorders that can be treated early in life

Predictive and pre-symptomatic genetic testing

Estimates the risk of developing adult-onset disease or predicting future disease onset

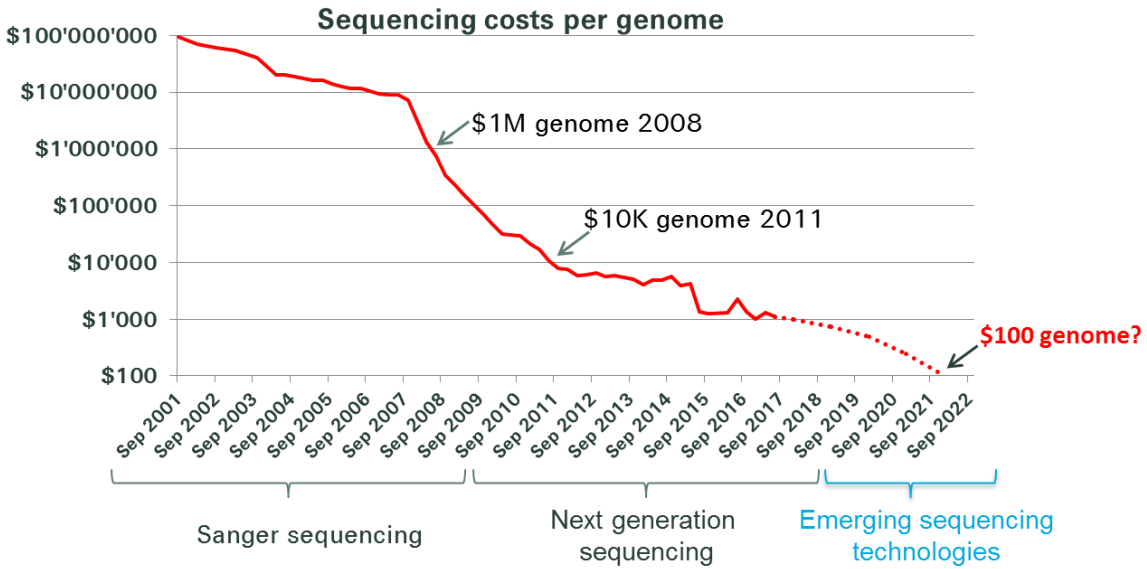
Nutrigenomic testing

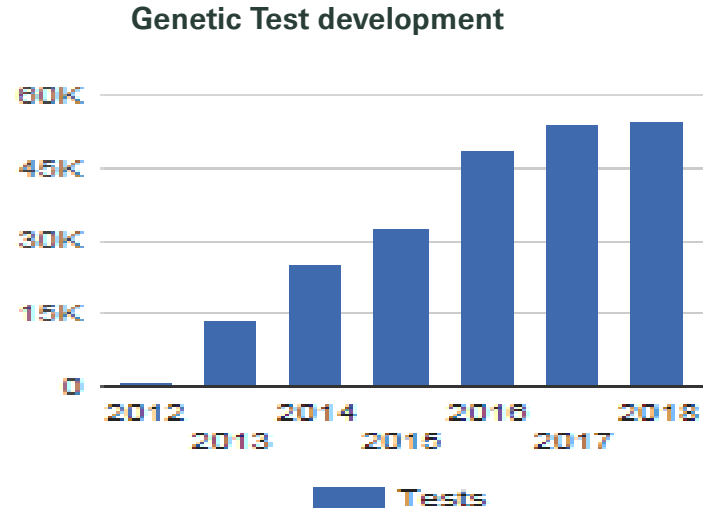
Studies the effect of genetic variations in relation to the interaction between diet/nutrition and health

Liquid biopsy testing

Detects molecular biomarkers in blood & other body fluids for diagnosis, prognosis and treatment

Declining sequencing costs and rapid growth of genetic tests





Plummeting genome sequencing costs and advances in human genetics increases the availability for different types of genetic testing

Genetic Testing Registry (GTR)

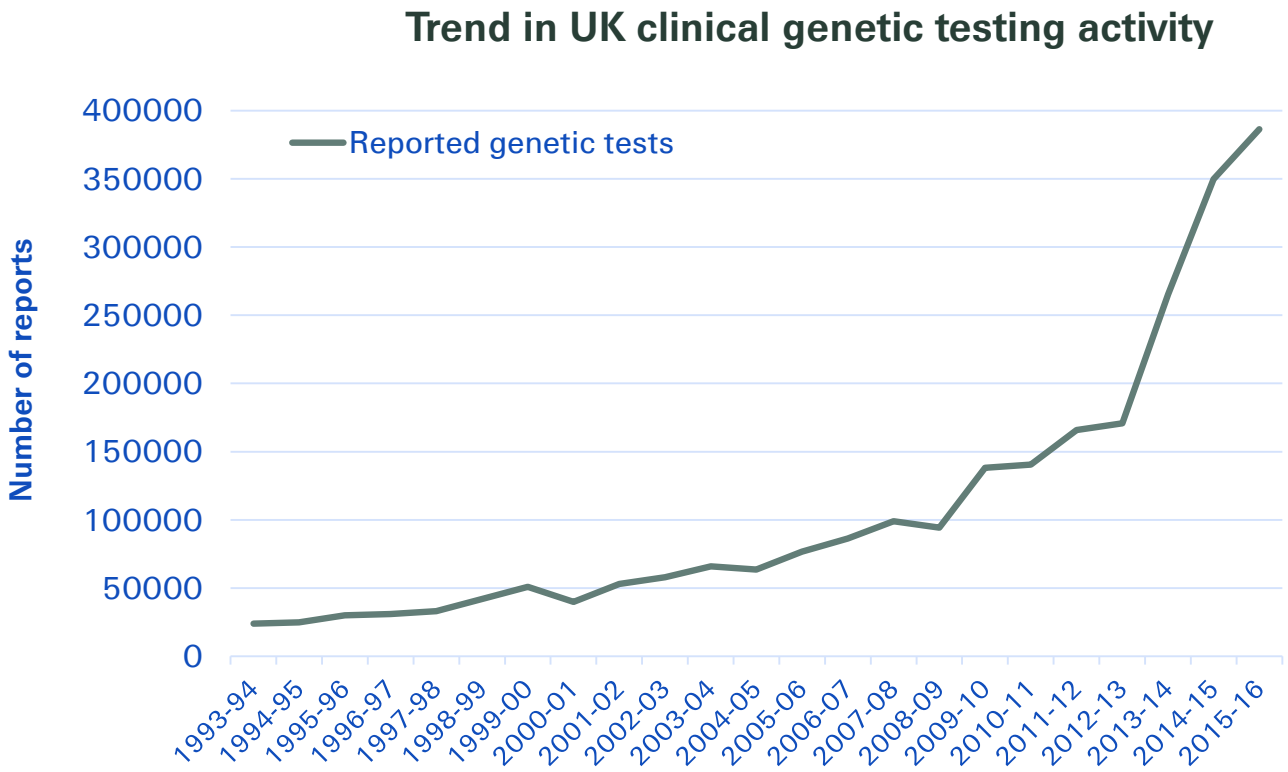
- 54,538 Tests
- 11,169 Disorders
- 16,415 Genes
- 506 Laboratories

May 24, 2018

Source: NIH National Human Genome Research Institute http://www.genome.gov/sequencingcosts/

Source: Genetic Testing Registry https://www.ncbi.nlm.nih.gov/gtr/

Genetic testing in the clinical practice has grown more than 20% annually in recent years



Source: ACGS audits

Advances in the understanding of human genetics increases the availability and uptake of genetic testing in the clinical practice

23and Me & Co: A booming Direct-To-Consumer market

Carrier Status**

If you are starting a family, find out if you are a carrier for certain inherited conditions.

40+ reports including:
- Polycystic Kidney Disease
- Cystic Fibrosis
- Hereditary Hearing Loss

Genetic Health Risks**

Learn how your genetics can influence your risk for certain diseases.

5 reports including:
- BRCA1/2 (selected variants) **NEW!**
- Late-Onset Alzheimer's
- Disease Parkinson's Disease

Ancestry

Discover where your DNA is from out of 31 populations worldwide - and more.

5 reports including:
- Ancestry Composition
- Your DNA Family
- DNA Relative Finder tool

Traits

Learn how your DNA influences your facial features, taste, smell and other traits.

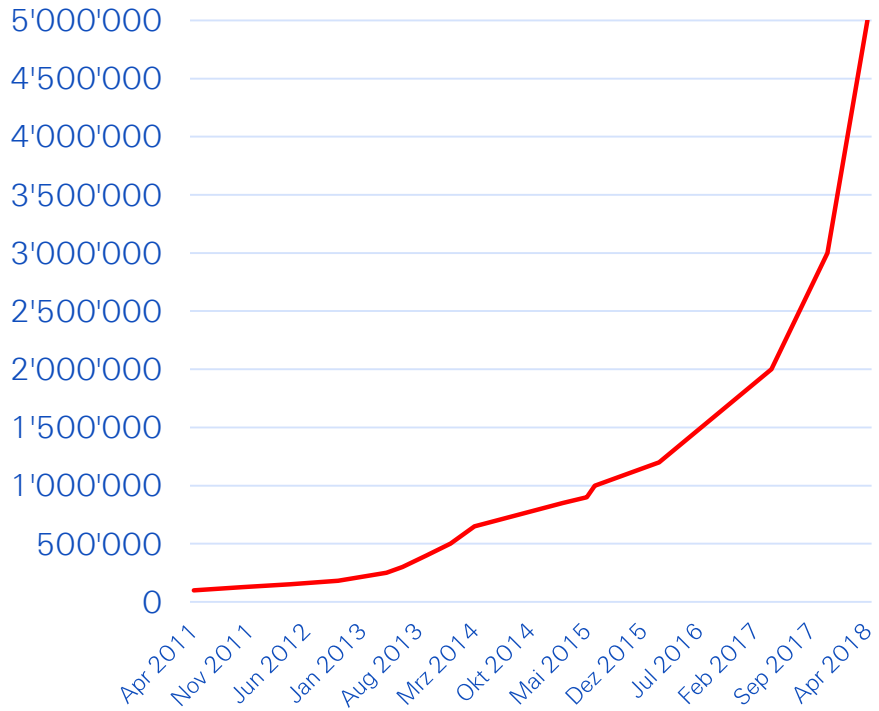
5 reports including:
- Hair loss
- Sweet vs. salty
- Unibrow, freckles…

Wellness

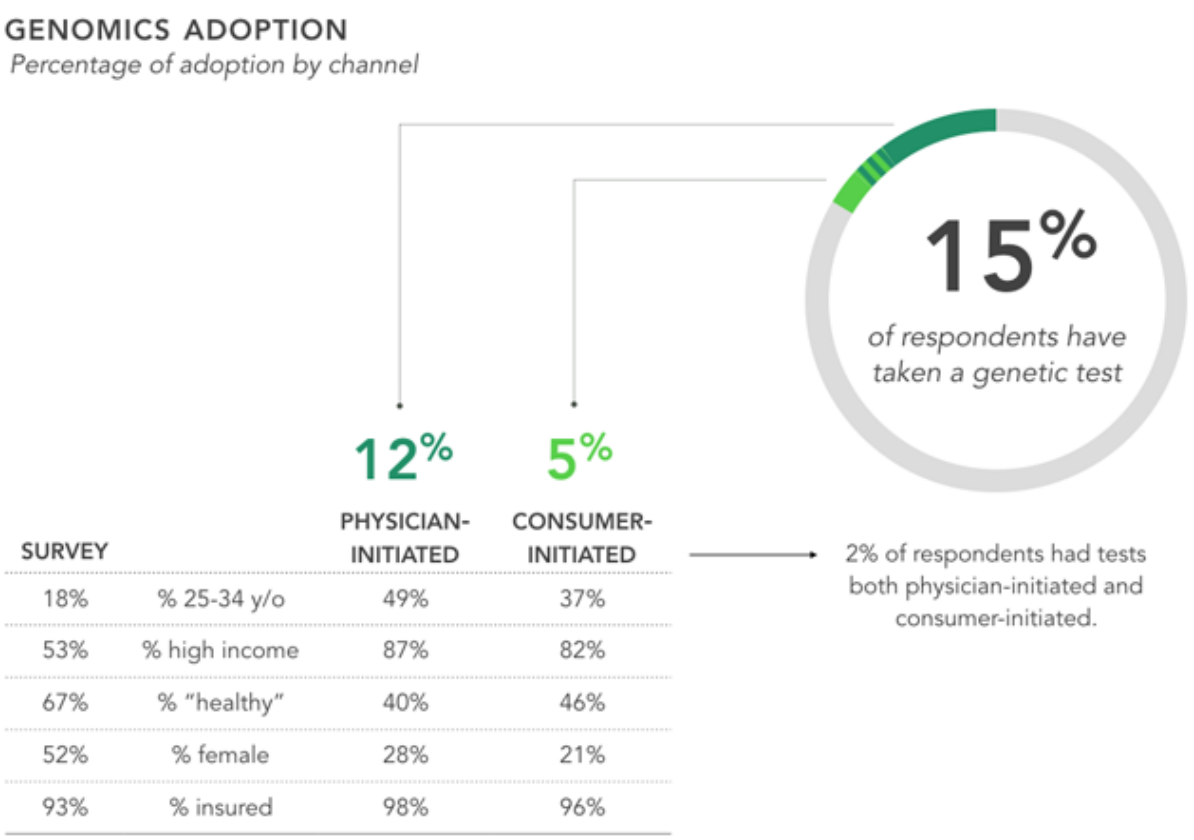
Learn how your genes play a role in your well-being and lifestyle choices.

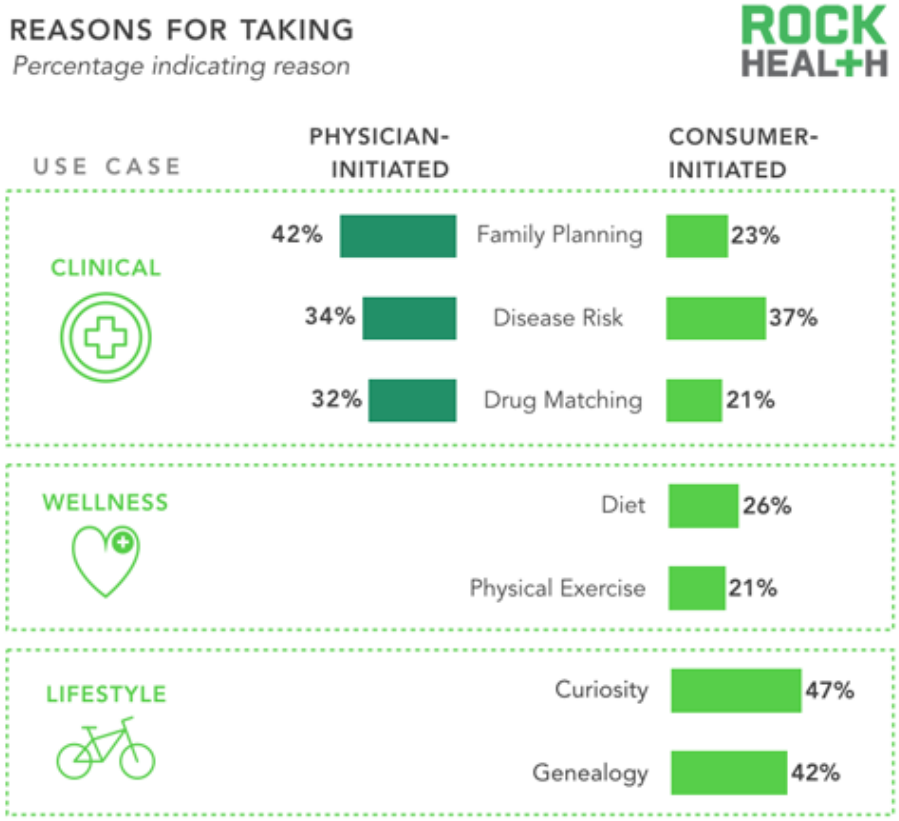
21 reports including:
- Deep sleep
- Lactose intolerance
- Genetic weight

23andMe customer development



Genetic testing frequency: US genetic testing consumer adaption rates





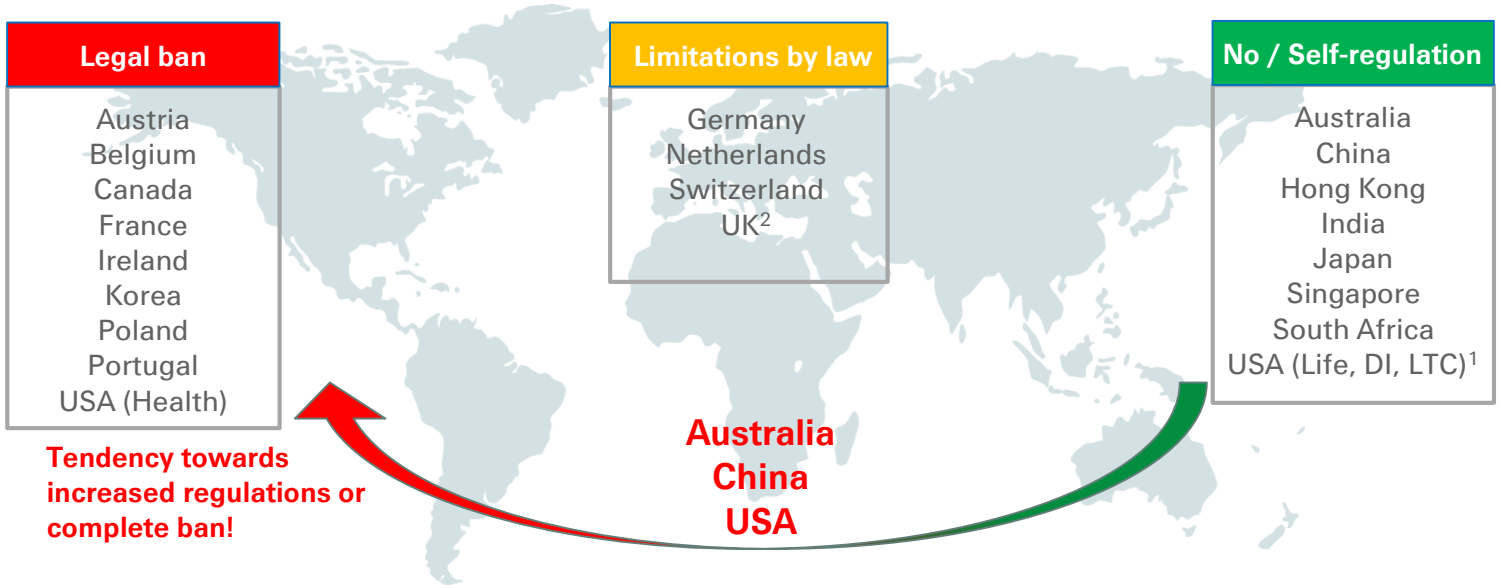
Source: https://rockhealth.com/reports/the-genomics-inflection-point-implications-for-healthcare/#consumer-sentiments, 2016, n=1060

At least half of consumers open to taking a genetic test in the future as prices drop; most to satisfy personal curiosity but half wants to know more about potential disease risk!

Use of genetic testing information in L&H insurance underwriting

Key markets under regulatory pressure from banning genetic testing information for insurance underwriting

Current regulatory approaches to insurers' access and use of genetic data fall into **3 major categories**:



Regulatory restrictions typically apply to:

- **Predictive genetic tests**
  - The use of diagnostic genetic information to confirm the presence of a disease is generally allowed for underwriting purposes as long as actuarially justifiable;
- **Life insurance/disability income/long-term care** as most developed countries offer public healthcare or mandate the purchase of health insurance

[1] Legislation varies at state level. Approx. 1/3 of states have regulation restricting the use of genetic information in life insurance

2 Only for list of approved tests. Currently only Huntington's disease for life insurance

Predictive value of genetic tests and risk assessment

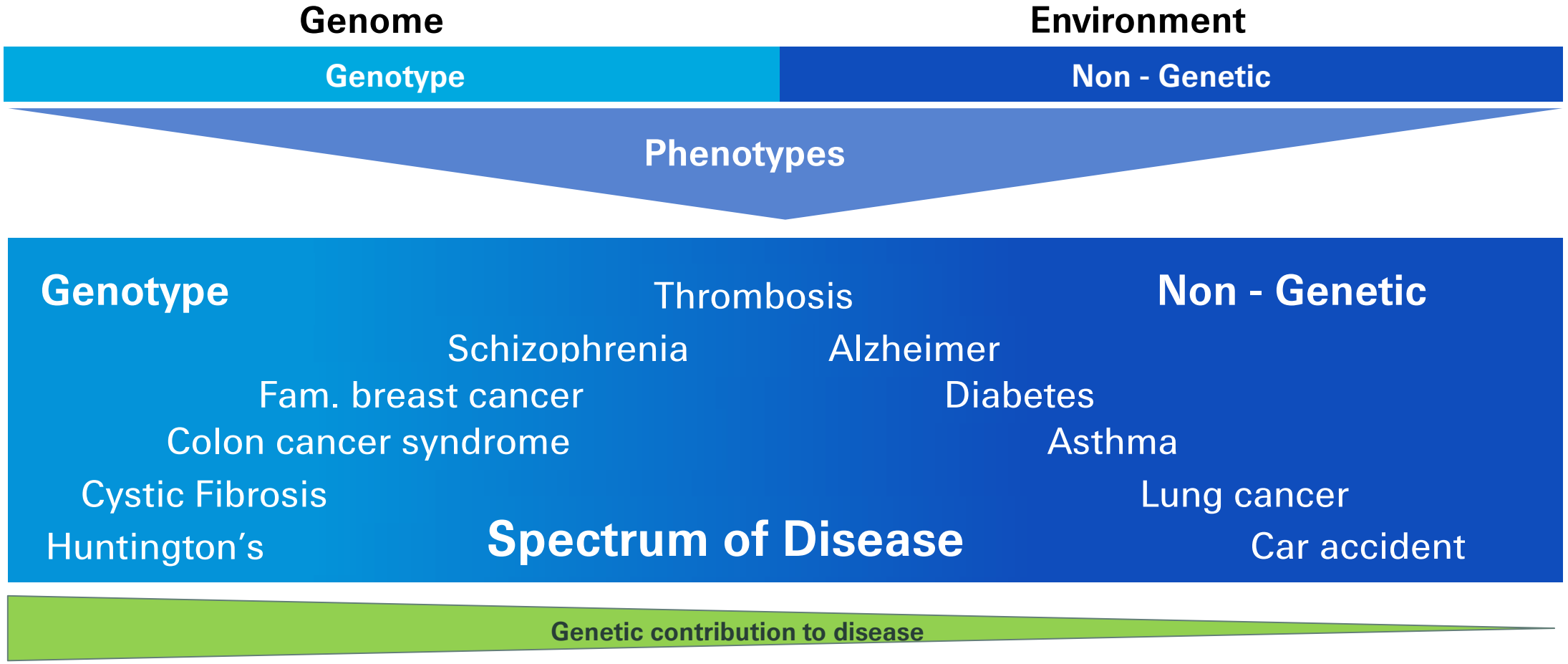
Insurance underwriting and risk classification

Many factors that influence the risks of ill health or death may be used in insurance underwriting, based on statistical evidence. Such risk factors may include:

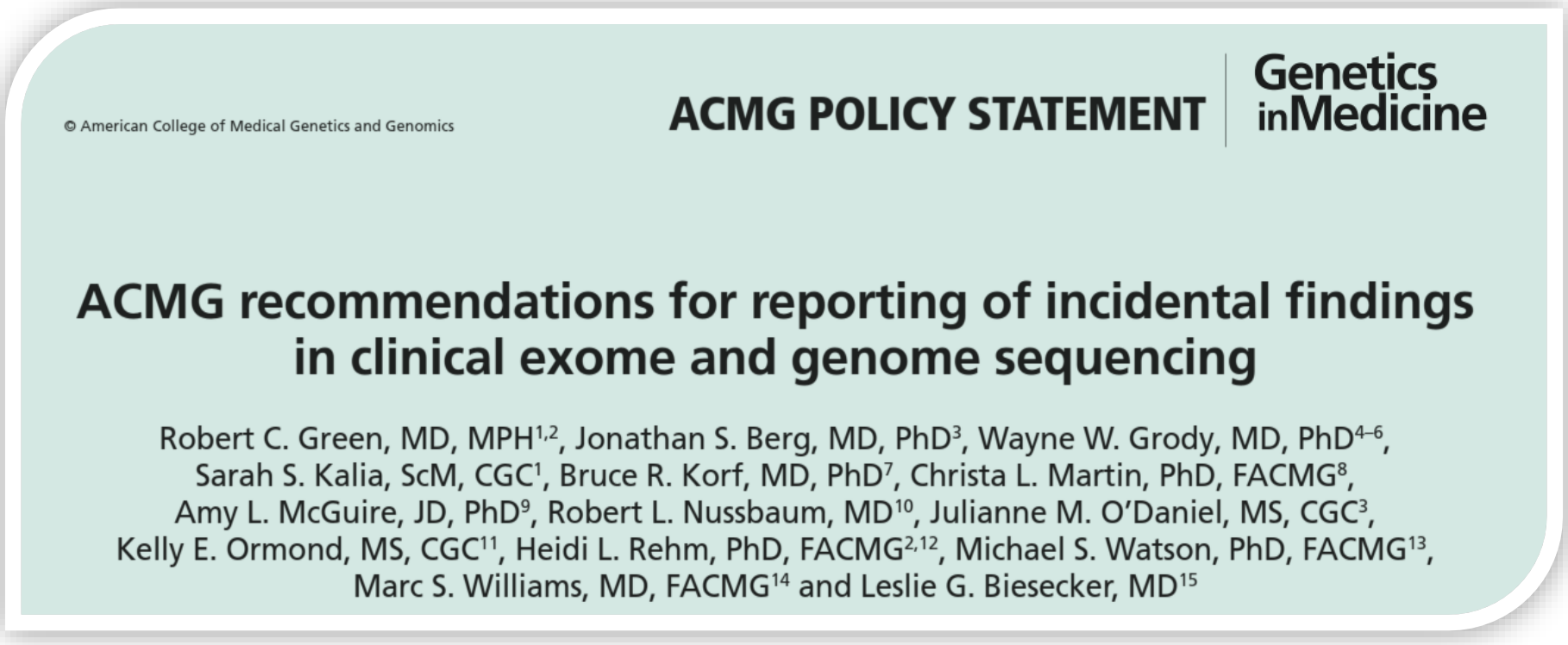
- **Non-medical factors:**
  - Financials: occupation, income, sum assured, ...
  - Habits: sport, travelling, alcohol, drugs, ...

- **Medical factors:**
  - age, (gender), medical records, family history, smoking status, blood pressure, lipid levels, ...
  - **Genotype** as a valid risk factor candidate in insurance pricing?

The risk for disease is multi-factorial and depends on genetic and environmental components



ACMG reporting of “secondary” findings fromgenome/exome-sequencing



ACMG POLICY STATEMENT | Genetics inMedicine

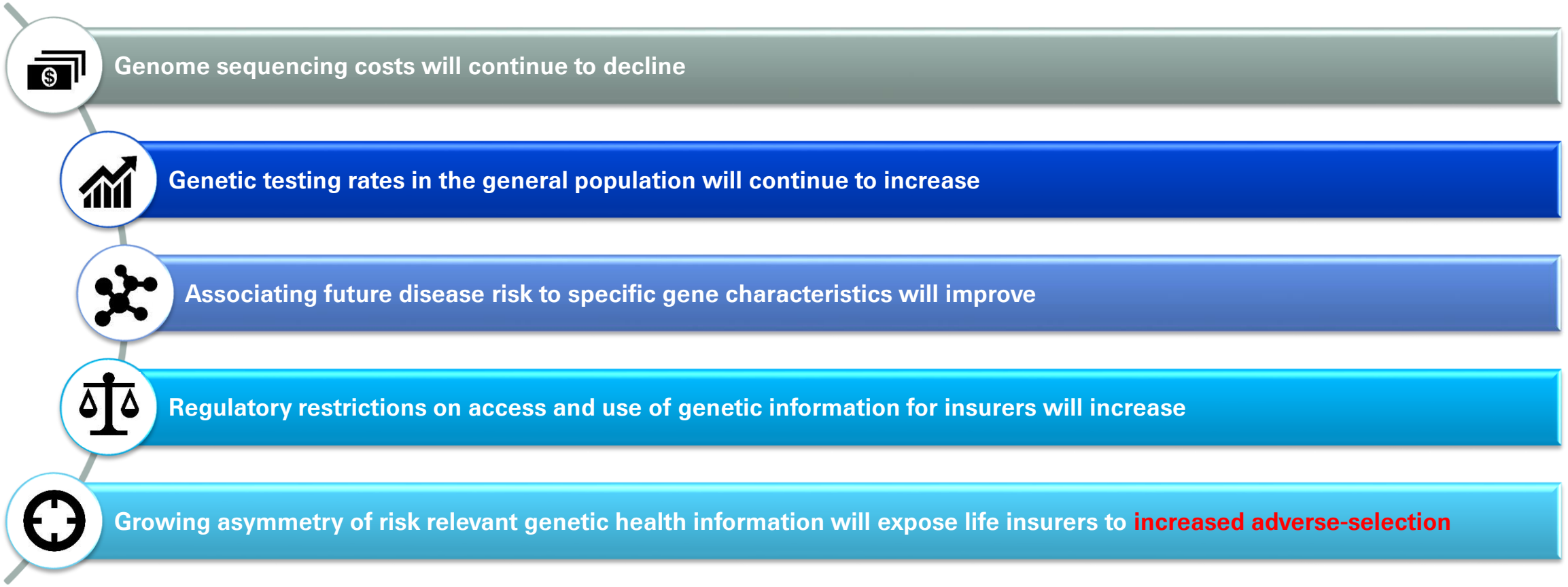
ACMG recommendations for reporting of incidental findings in clinical exome and genome sequencing

Robert C. Green, MD, MPH[1,2], Jonathan S. Berg, MD, PhD[3], Wayne W. Grody, MD, PhD[4–6], Sarah S. Kalia, ScM, CGC[1], Bruce R. Korf, MD, PhD[7], Christa L. Martin, PhD, FACMG[8], Amy L. McGuire, JD, PhD[9], Robert L. Nussbaum, MD[10], Julianne M. O’Daniel, MS, CGC[3], Kelly E. Ormond, MS, CGC[11], Heidi L. Rehm, PhD, FACMG[2,12], Michael S. Watson, PhD, FACMG[13], Marc S. Williams, MD, FACMG[14] and Leslie G. Biesecker, MD[15]

- Minimum list of **59 genes** and variants for **27 conditions** to be returned whenever clinical exome sequencing is performed for any medical reason.
- Medically **"actionable"** pathogenic variants with strong evidence for clinical validity and utility.

Genetic testing and anti-selection risk for insurers

Future trends in genetic testing and insurance risk considerations

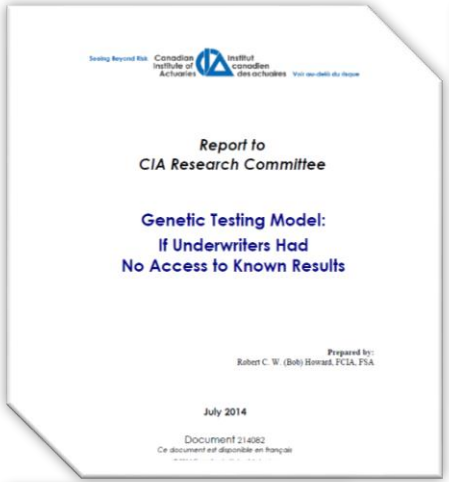


Studies on genetic testing and its impact on insurance purchasing behaviour

Genetic disease (Gene)	Insurance product	Odds ratio of over - insuring after positive test	Study
Breast cancer (BRCA1/2)	Life	5.1x more likely to increase coverage	Armstrong et al.; 2003 (USA)
Alzheimer's disease (APOE4)	LTC	5.7x more likely to change coverage	Taylor et al.; 2005 (USA)
Alzheimer's disease (APOE4)	LTC	2.3x more likely to increase coverage	Zick et al.; 2010 (USA)
Alzheimer's disease (APOE4)	LTC	4x more likely to change coverage	Christensen et al.; 2015 (USA)
Huntington's disease (HD)	LTC	5x more likely to purchase insurance	Oster et al.; 2010 (USA & Canada)
Colorectal cancer (HNPCC)	Life	1.3x more likely to purchase insurance	Aktan-Collan et al.; 2001 (Finland)

Understanding of consumers behaviour is key to investigate the potential impact on insurance purchasing behaviour and level of adverse selection against insurers

Modelling around the world - Attempt in quantifying the anti-selection impact


Canadian Institute of Actuaries / Institut canadien des actuaires

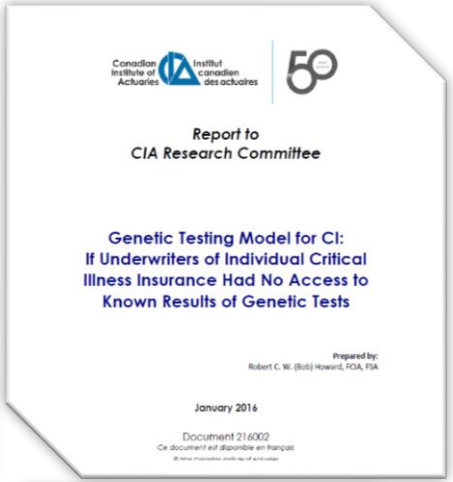
Report to
CIA Research Committee

Genetic Testing Model:
If Underwriters Had
No Access to Known Results

Prepared by:
Robert C. W. (Bob) Howard, FCIA, FSA

July 2014

Document 214082


Canadian Institute of Actuaries / Institut canadien des actuaires

Report to
CIA Research Committee

Genetic Testing Model for CI:
If Underwriters of Individual Critical
Illness Insurance Had No Access to
Known Results of Genetic Tests

Prepared by:
Robert C. W. (Bob) Howard, FCIA, FSA

January 2016

Document 216002


SOCIETY OF ACTUARIES

SOA commissioned report

The SOA has commissioned a report to illustrate the potential impact on the U.S. life insurance industry if legislation existed prohibiting the use of and/or disclosure of genetic information during the underwriting process.


Actuaries Summit
Think Differently
21-23 May 2017
Grand Hyatt Melbourne
Actuaries Institute

Thinking about life insurance through a genetic lens

Prepared by Dr Damjan Vukcevic & Jessica Chen

Presented to the Actuaries Institute
Actuaries Summit
21 – 23 May 2017
Melbourne

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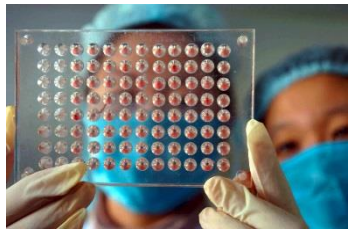
Important model assumptions

- Proportion of population at risk for genetic conditions under study
- Proportion of population taking a genetic test each year
- Proportion of new applications if known to have higher genetic risk
- Proportion of policies that may lapse if known to have lower genetic risk
- Effectiveness of UW (e.g. family history)
- **Anti-selection: How much higher face amount is bought, relative to the average person?**

Sources:
(1) Genetic Testing Model: If Underwriters Had No Access to Known Results, Canadian Institute of Actuaries, Robert C. W. (Bob) Howard, July 2014
(2) Genetic Testing Model for CI: If Underwriters of Individual Critical Illness Insurance Had No Access to Known Results of Genetic Tests, Canadian Institute of Actuaries, Robert C. W. (Bob) Howard, January 2016
(3) Thinking about life insurance through a genetic lens, Damjan Vukcevic & Jessica Chen, May 2017
(4) Genetic Testing & the Threat of Anti-selection, Mark Lombardo, ACLI Symposium on Genetics & Insurance, April 2018

Additional risk considerations for insurers

Disease incidence & over-diagnosis



Genetic tests used for **screening** (e.g. liquid biopsy) may lead to **increase in disease incidence** & **over-diagnosis**.

Over-diagnosis: Identification of "disease" that may never have caused symptoms or premature death

Adverse-selection

Consumer's **knowledge** of their genetic information and future health

Insurance **non-disclosure** and/or **access restrictions** to risk-relevant genetic information

Adverse selection through selective purchase or lapse

$ $ $ Health-care costs

Increased medical treatment costs: additional screening, medical counselling, preventive or therapeutic interventions

Reimbursement cost of genetic testing

Legal risk

Request & use of genetic information in underwriting is **highly regulated** in an increasing number of markets

Insurers' **medical risk selection process** is further limited

Reputational risk

Debate on **potential discrimination** in employment, insurance and privacy & security of personal genetic information

Insurers **voluntarily limit the use of genetic testing data** for risk selection

Reflections

- Scientific advances
  - clinical and over-the-counter genetic testing will continue its rapid growth
- Regulations
  - increasing regulatory pressure restricting request and use of genetic tests and family history for insurance UW
- Anti-selection
  - growing availability of predictive health information from genetic testing leads to increased exposure to anti-selection
- Additional risks
  - enhanced screening leading to early disease detection/over-diagnosis of indolent disease and increased medical treatment costs

Further information and client material on genetic testing

- Publications:
  - Seeing the future? How genetic testing will impact life insurance
  - Genomic Medicine
  - Personalised genetic testing and its impact to insurance

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