New Insights into Mortality Risk

Incorporating Projections of Geroscience Advances into Risk Assessment

Andrew Coburn
Senior Vice President, RMS LifeRisks
Three things to keep an eye on in 2013

Sales of men’s health magazines

Twitter trending of “aspirin”

Laboratory ferrets

Daily dose of aspirin can cut cancer risk

New research shows that taking daily low-dose pills for just three years can reduce your risk of cancer by about a quarter.

Taking a low dose of aspirin each day may prevent cancer and stop it spreading, according to medical journals on Wednesday. However, some experts have voiced concerns over potential causes of stomach bleeding.

The new studies reinforce aspirin’s status as a weapon against cancer. They show that it can reduce your risk of cancer by about a quarter – 23% for men and 25% for women. The risk is 27% for those who take aspirin for longer than five years.

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Patterns of mortality are constantly changing

- Forecasts of future mortality patterns are essential to the financial planning and viability of life insurers and pension providers
- Projections of past patterns of mortality are not good guides to future mortality
- Understanding how mortality is changing and the drivers of change enables better projections of future mortality
- Geroscience is the study of aging, health, and mortality
- Changing patterns of mortality can be understood by incorporating geroscience into quantitative modeling
The Obesity Epidemic

Prevalence of adult obesity (BMI≥30), all US Population
Geographic Midriff Spread

% of population that are obese (*BMI = W/H^2 * ≥ 30)

Source: Centers for Disease Control
Obesity causes increased chances of:
- Type 2 diabetes
- Heart disease
- Cancers
  - Liver
  - pancreas
  - breast
  - others
- High blood pressure
- Osteoarthritis
- Dyslipidemia
- Dementia

Guess What - Obesity is Bad for You

Estimated Hazard Ratios for all-cause mortality among healthy subjects

Source: The New England Journal of Medicine

Body Mass Index

Increased Chance of Dying (Hazard Ratio)
Some people think so:

S. Jay Olshansky, Professor in the School of Public Health at the University of Illinois:
“From our analysis of the effect of obesity on longevity, we conclude that the steady rise in life expectancy during the past two centuries may soon come to an end.

Samuel Preston, Professor of sociology and demography at University of Pennsylvania:
“By 2040, obesity will reduce life expectancy by 0.733 percent for men, and 0.677 percent for women”

Chris Ruhm, Professor of public policy and economics at University of Virginia:
“High rates of obesity will provide a significant drag on life expectancy. The impact of severe or morbid obesity has been underestimated and, even in the baby boom generation, will be a much bigger problem”

Justin Denney, Assistant Professor of Sociology, Rice University:
“The 30 year gain in U.S. life expectancy from 1900 to the 2000 should not be projected throughout this one. The next 50 years will see a mere three-year increase.”
Future trends

% of Population Obese (BMI<30)

Mortality Improvement
(Annual rate of change, Difference to expected level)
Latest Snapshot of Obesity Trends

% of Age Group Obese

Obesity Survey October 2012

Gallup-Healthways Wellbeing Survey
Interviews with 579,210 American adults, Jan. 2-Sept. 30, 2012

No increase in Obesity for Males aged 23-28
Sales of men’s health magazines
Could it be the end of the beginning?

A recent report showed that obesity is also reducing in low-income young children in US cities

“After decades of alarming reports of Americans gaining weight, we’re seeing perhaps the beginning of the end of the obesity epidemic,” CDC Director Dr. Thomas Frieden

Body consciousness in young adults could signal the beginning of the end (or at least the end of the beginning) of the obesity epidemic

- Male health products and services is one of the fastest growing consumer sectors
- Sales of men’s health magazines are one of the very few growth sectors in publishing
- Men’s Health is the 36th best selling title in United States, with a circulation of 1.9 million
- U.S. Labor Department identifies jobs for fitness workers rising much faster than the average for all other occupations
- Other reports about obesity seem to suggest that young men may be leading a trend of the slowing down of the obesity epidemic
- May not be confined to US – obesity rates in young men in UK also seem to have plateaued

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Clients can analyze the potential increase in liabilities they would incur on their own portfolios from the ‘shock’ of an end to the obesity epidemic

Scenarios available in RMS LifeRisks to model liabilities for your portfolio include:

<table>
<thead>
<tr>
<th>ID</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20210001</td>
<td>Obesity Shock: Rapid Reversal of Obesity Epidemic</td>
<td>Obesity is shocked from its current trajectory to pre-WWII levels by 2030. All other variables as RMS reference view.</td>
</tr>
<tr>
<td>20210002</td>
<td>Obesity Shock: Declines Faster than Expected</td>
<td>Obesity prevalence plateaus and falls more quickly than expected. All other variables as RMS reference view.</td>
</tr>
<tr>
<td>20210003</td>
<td>Obesity Increases at Current Rate</td>
<td>Current obesity trajectories are maintained indefinitely. All other variables as RMS reference view.</td>
</tr>
<tr>
<td>20210004</td>
<td>Obesity Acceleration</td>
<td>Obesity becomes the norm in modern society. By 2050, nearly 80% of the population becomes obese. All other variables as RMS reference view.</td>
</tr>
</tbody>
</table>
There are large numbers of causes contributing to mortality change

**Lifestyle**
- Smoking
- Obesity
- Other lifestyle trends

**Medical Intervention**
Treatments for specific conditions:
- Cardiovascular Disease
- Cancer treatments
- Respiratory Disease
- Dementia
- Other key diseases
- Accident & Trauma

**Health Environment**
- Healthcare provision
- Sanitation, housing and other environmental factors

**Regenerative Medicine**
New classes of treatment for repairing damaged systems e.g.
- Stem cell therapy
- Nanomedicine
- Individualized gene therapy
- Improvements in transplantation

**Anti-Aging Processes**
Treatments to extend life through slowing natural processes of aging, e.g:
- Telomere Shortening
- IGF1
- Caloric restriction
We have nailed heart disease. Cancer’s next.

- The past 30 years of high mortality improvement has been driven by dramatic reductions in cardiovascular disease.
- Further reductions in CVD will continue to drive mortality improvement.
- But now cancer is a bigger killer for adults in United States and many western countries.
- Another big wave of mortality improvement could follow if we can reduce cancer mortality.
- But cancer has proven notoriously difficult to crack.
A medical breakthrough: it’s called aspirin

New medical studies show that taking aspirin reduces cancer risk

- Three new studies published in the Lancet in 2012 add to mounting evidence of aspirin’s anti-cancer effects
- Daily low dose (75mg) aspirin reduced all cancer mortality by 15-23%
- It is particularly effective against one particular sub-type called adenocarcinoma
  - Adenocarcinomas account for about a third of all cases of lung cancer
- Aspirin needs to be taken every day for 5 years to reduce mortality for colorectal, oesophageal, and lung cancers and up to 10 years for stomach cancer
- Study suggests that aspirin may selectively inhibit the development, growth and spread of very early cancers
Significant benefits

Impact of taking low-dose daily aspirin on a 65 year old life expectancy

<table>
<thead>
<tr>
<th></th>
<th>Period Life Expectancy Gain</th>
<th>Increase in probability of living to 80</th>
<th>Increase in probability of living to 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1 year</td>
<td>+6%</td>
<td>+42%</td>
</tr>
<tr>
<td>Female</td>
<td>6 months</td>
<td>+3%</td>
<td>+21%</td>
</tr>
</tbody>
</table>
From bench to bedside

- The science is now relatively clear and is being confirmed by further clinical trials.
- Potential side effects from taking aspirin could include stomach bleeding – about one in every two thousand people could suffer.
- Healthcare professionals are being cautious and are not yet ready to recommend that all middle aged people take daily aspirin.
- But it's cheap and easily available. People have started to take it anyway. Including some doctors.
- Higher risk groups, such as smokers, might benefit more.
- Over 10% of pensioners already take daily aspirin – how many more people might take it up?

How quickly might more people adopt the habit of taking daily aspirin and what impact would it have on pension liabilities?
Twitter trending of “Aspirin”
Gathering word of mouth

Monthly counts of tweets mentioning “aspirin” & “cancer”

Number of Tweets

Logarithmic Scale


7,000

25

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Cheap drug, costly impact

Aspirin could add $70 Billion to liabilities of US pensions

- RMS analysis suggests that a rapid and widespread take-up of daily low-dose aspirin could add **$70 Billion** to the $10 trillion liabilities of the US private sector pensions industry.

- The impact is of the same order as pensioners **giving up smoking** completely.

- As a proportion of total liabilities this is a relatively small increase.

- But aspirin is just one of many different vitagions that will contribute to the continuing wave of mortality improvement over the next few decades.

Scenarios available in RMS LifeRisks to model aspirin liabilities for your portfolio include:

<table>
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<tr>
<th>ID</th>
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</thead>
<tbody>
<tr>
<td>20220001</td>
<td>Rapid Aspirin Uptake with High Penetration</td>
</tr>
<tr>
<td>20220002</td>
<td>Moderate Aspirin Uptake with High Penetration</td>
</tr>
<tr>
<td>20220003</td>
<td>Moderate Aspirin Uptake with Moderate Penetration</td>
</tr>
</tbody>
</table>
Many different ways that mortality can change

- Natural Hazards
- Pandemic Influenza
- Terrorism
- Emerging Infectious Diseases
- Industrial Accidents & other causes
- Anti-Aging Processes
- Regenerative Medicine
- Health Environment
- Medical Intervention
- Lifestyle

Expected Mortality

Mortality Shocks

Trend Risks
Capital reserving for mortality shocks

Tail risk assessment for excess mortality

- Many life insurance companies are more explicitly modeling tail risk in mortality
- In Europe, Solvency II requires life insurers to model their 1-in-200 mortality shock
- Pandemic risk is difficult to quantify using statistical analysis of historical experience
- Increasing uptake of epidemiological models to manage excess mortality risk from infectious disease outbreaks
- As with all risks, this risk can change with new events…
How to model pandemic risk

- Infectiousness
- Virulence

Social spread and community immunity patterns

- Age & Gender Infection Response

Government response measures

- Non-Pharmaceutical Measures
- Pharmaceutical Treatments
- Vaccine Speed and Effectiveness

Basis Risk Adjustment

- Insured Lives Mortality Differences
Avian flu
Your worst nightmare

H5N1 - the deadliest strain of influenza

- In 2005 and 2006 a new form of influenza emerged, A(H5N1), which **kills 60%** of people who catch it
- It could only be caught from close contact with birds – mostly domestic poultry
- It particularly hit **young adults** and economically productive people – similar to the age profile of life insurance policy-holders
- It caused a public health scare, massive eradication of poultry stocks, and major contingency planning by government agencies and the World Health Organization
- Fortunately it was **not infectious** – humans couldn’t spread it to each other
Laboratory Ferrets
Transmissible H5N1 made in the lab

- Two teams of scientists have now artificially created mutations of H5N1 to enable airborne transmission in ferrets
- The intention of this research is to improve surveillance for similar mutations in nature, and to create vaccines
- The versions created are probably fairly mild – but they want to continue and develop more virulent strains. This is known as H5N1 ‘gain-of-function’ research
- The danger is that viruses could escape from the labs and trigger a virulent pandemic
- The controversy triggered by the announcement led to a moratorium of further research until the safety implications had been fully debated
- On January 23, the research community decided to resume their research
- Researchers decided it was OK to continue research in level 3 biosecurity labs, rather than confine it to maximum security biosecurity level 4
The ferret’s long tail

There’s a new worst-case scenario for excess mortality

Assessing the extreme tail of the excess mortality risk distribution means inclusion of a high-virulence pandemic from the escape of a virus from a research laboratory.

Laboratory escape likelihoods are small, but they do happen:

- 42 laboratories are currently working with potential pandemic pathogens (PPPs)
- Over 5000 recorded cases of Laboratory-Acquired Infections in researchers since 1930
- A virus flushed down the drains from the Pirbright BSL-4 research laboratory caused an outbreak of foot-and-mouth disease in cattle in England in 2007
- Malicious releases of deadly pathogens from research labs include 2001 anthrax letters
- One critic of the research has estimated that there is an 80% chance within 13 years of an escape of a virus from ‘gain-of-function’ H5N1 research
RMS Analysis

If a high virulence version of an H5N1 virus escaped from a research lab, 50 million people could die prematurely

- RMS white paper and descriptions of scenarios available from RMS website
- Insurance clients are urged to incorporate extreme events into their risk management

Scenarios available in RMS LifeRisks to model XSM losses for your portfolio, resulting from a potential man-made pandemic:

<table>
<thead>
<tr>
<th>RMS IDM Event ID</th>
<th>Transmissibility ($R_0$)</th>
<th>Virulence (Case Fatality Rate)</th>
<th>Vaccination achieved in yr 1</th>
<th>Total Deaths Worldwide</th>
<th>Global Death Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>10996</td>
<td>2.0</td>
<td>0.3</td>
<td>~30%</td>
<td>50 million</td>
<td>7 per 1,000 population</td>
</tr>
<tr>
<td>11218</td>
<td>2.25</td>
<td>0.025</td>
<td>~50%</td>
<td>18 million</td>
<td>2.5 per 1,000 population</td>
</tr>
</tbody>
</table>
RMS Longevity Risk Model is the first model to estimate the future progress of geroscience

- Simulates future trajectories of causes of mortality change
- Incorporates a meta-model of medical progress in treating the major causes of death in older populations
- Recognizes the key characteristic of random chance in enabling future medical breakthroughs
- Bases all mortality modeling on evidence-based medical science
- Provides timeline constraints as a key variable for change
- Introduces the concept of limits to mortality reduction potential for a cause
In conclusion

Mortality risk is changing

- Risk management strategies depend on a solid understanding of the risk
- New developments can quickly change the landscape of risk
- RMS is committed to keeping clients fully informed about changes and our views
- RMS models enable clients to assess their exposure to these changing risks

So keep an eye on…

- Men’s Health sales
- Trending “aspirin”
- Lab ferrets