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Long Term Drivers of Future Mortality

Drivers and Cohorts – New Horizons in Mortality Research
An International Actuarial Association Mortality Working Group Webinar
March 21, 2017

Presented by:
Al Klein, FSA, MAAA
Principal and Consulting Actuary
Agenda

- Considerations for reviewing past drivers of mortality
- Discussion on future drivers of mortality
- Questions
Thought on studying mortality / longevity

- Start by looking back
  - What were the past drivers of mortality improvement?
  - Will they continue into the future?
  - If so, at the same or a different rate?
  - What are some of the considerations to answer this?
  - What new developments have taken place or will take place that will impact future drivers?
Two examples of past drivers of mortality

- Decreases in:
  - Infant mortality rates
  - Traffic fatality rates

- Question: Will these continue to be drivers of mortality improvement in the future?
Infant Mortality Rates – US (1990-2011)

Figure 5. Infant mortality rates: United States, 1990–2010 final and preliminary 2011

### Infant Mortality Rates – Select Countries (2007)

**FIGURE 1. Infant mortality rates, by race/ethnicity and year — United States, 1960–2011**

<table>
<thead>
<tr>
<th>Country</th>
<th>Rate per 1,000 Live Births</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luxembourg</td>
<td>1.8</td>
</tr>
<tr>
<td>Iceland</td>
<td>2.0</td>
</tr>
<tr>
<td>Sweden</td>
<td>2.5</td>
</tr>
<tr>
<td>Japan</td>
<td>2.6</td>
</tr>
<tr>
<td>Finland</td>
<td>2.7</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>3.1</td>
</tr>
<tr>
<td>Ireland</td>
<td>3.1</td>
</tr>
<tr>
<td>Norway</td>
<td>3.1</td>
</tr>
<tr>
<td>Portugal</td>
<td>3.4</td>
</tr>
<tr>
<td>Greece</td>
<td>3.6</td>
</tr>
<tr>
<td>Austria</td>
<td>3.7</td>
</tr>
<tr>
<td>Italy</td>
<td>3.7</td>
</tr>
<tr>
<td>Spain</td>
<td>3.7</td>
</tr>
<tr>
<td>Germany</td>
<td>3.9</td>
</tr>
<tr>
<td>Switzerland</td>
<td>3.9</td>
</tr>
<tr>
<td>Belgium</td>
<td>4.0</td>
</tr>
<tr>
<td>Denmark</td>
<td>4.0</td>
</tr>
<tr>
<td>Netherlands</td>
<td>4.1</td>
</tr>
<tr>
<td>Australia</td>
<td>4.2</td>
</tr>
<tr>
<td>New Zealand</td>
<td>4.8</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>4.8</td>
</tr>
<tr>
<td>Hungary</td>
<td>5.9</td>
</tr>
<tr>
<td>Poland</td>
<td>6.0</td>
</tr>
<tr>
<td>Slovak Republic</td>
<td>6.1</td>
</tr>
<tr>
<td>United States</td>
<td>6.8</td>
</tr>
<tr>
<td>Mexico</td>
<td>15.7</td>
</tr>
<tr>
<td>Turkey</td>
<td>20.7</td>
</tr>
</tbody>
</table>

*2007 data were not available for all Organization for Economic Co-operation and Development (OECD) countries.

Thoughts on Infant Mortality Rates

- According to a recent CDC report*, in 2010, the infant mortality rate in the US was 6.1 infant deaths per 1,000 babies.
  - This is the 4th highest rate among 29 of the world’s most developed countries.
  - It is more than double that of Finland and Japan (2.3) and Portugal and Sweden (2.5).
- Looks like there is still room for improvement.
- Has biggest impact on mortality improvement.
  - If more infants live, they may each add about 80 years to life expectancy.

* Source: Chicago Tribune, September 25, 2014

Source:
https://www.bing.com/images/search?q=graph+of+trends+in+motor+vehicle+deaths+in+us&view=detailv2&&id=E80C0D190C4AE3CC8E45D1A8D481A520924C0B07&selectedIndex=102&ccid=VPn7RnPm&simid=608037065357529007&thid=OIP.M5459fb4673e63be9989b2a643eae08doo&ajaxhist=0
Traffic Fatality Rates – Denmark, Canada (1990-2012)

![Graph 6. Source: IRTAD 2014 Annual Report, OECD/ITF 2014 (chart by author)]
Thoughts on Motor Vehicle Mortality

- Internationally, US may always have more cars on the road
- Positives
  - Many new safety features: air bags, lane departure warnings, blind spot indicators, reverse backup sensors, automatic braking, cameras, radar
  - Increased awareness not to drink and drive
  - Increased seatbelt use
  - In most US states, requirement for more time behind the wheel for new drivers before they are allowed their driver’s license
- Negatives
  - Cell phone usage while driving
  - Increasing speed limits
Long Term Drivers of Future Mortality

- This discussion will be based on preliminary work done by the International Actuarial Association (IAA) Mortality Working Group (MWG)
  - In process of writing a paper
  - Expect to finish later this year
# Authors of Paper

<table>
<thead>
<tr>
<th>Authors (10)</th>
<th>Countries (7)</th>
</tr>
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<tbody>
<tr>
<td>Assia Billig</td>
<td>Canada</td>
</tr>
<tr>
<td>Simon Brimblecombe</td>
<td>UK</td>
</tr>
<tr>
<td>Mathew Edwards</td>
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<td>Michael Eves</td>
<td>Switzerland</td>
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<td>Sam Gutterman</td>
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<td>Al Klein, Chair</td>
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<td>Mika Mäkinen</td>
<td>Finland</td>
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<td>Darko Medved</td>
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<td>Lars Pralle</td>
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<td>Marianne Purushotham</td>
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## Long Term Drivers of Future Mortality

<table>
<thead>
<tr>
<th>11 Key Broad Drivers</th>
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<tbody>
<tr>
<td>Aging</td>
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<tr>
<td>Catastrophes</td>
</tr>
<tr>
<td>Diseases</td>
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<tr>
<td>Environmental</td>
</tr>
<tr>
<td>Healthcare/medical care</td>
</tr>
<tr>
<td>Inequality</td>
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</tbody>
</table>

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Features of Paper

- History of drivers
- Current situation
- Discussion on how drivers impact both developed and developing countries
- Considerations on how to quantify and apply drivers
Caveats on the Long Term Drivers

- These are *my* high level *thoughts* on the various topics
- There is *overlap* between the drivers
- Many of the drivers have both a *positive and negative* aspect, and these will be covered in the paper
- Paper will provide more detail and may vary from this as the thoughts of others are incorporated
- Our hope is to make this *paper* one of the most *comprehensive* discussions on this topic
Aging

- Ability to travel
- Mental, physical, and social activities
- Outlook
- Parabiosis
Aging – Other Potential Topics

- Activities of daily living
- Diet
- Drugs
- Frailty
- Living arrangements
- Overall health
- Support network
Catastrophes

- Electric Magnetic Pulse (EMP)
Catastrophes - Other Potential Topics

- Draught
- Earthquakes, volcanic eruptions
- Epidemics, pandemics
- Fire, floods
- Floods

- Hurricanes, tornados, typhoons
- Nuclear
- Sandstorms
- Terrorism
- Tsunamis
- War
Diseases

- Cure
- Drug/antibiotic-resistant infections
### Drug-Resistant Infections in the US - 2013

<table>
<thead>
<tr>
<th>Drug-Resistant Infections in US (Top 6 and Overall)</th>
<th>Annual Number of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Infections</td>
</tr>
<tr>
<td>Overall</td>
<td>2,000,000</td>
</tr>
<tr>
<td>Clostridium Difficile</td>
<td>CDIFF</td>
</tr>
<tr>
<td>Carbapenem-Resistant Enterobacteriacease</td>
<td>CRE</td>
</tr>
<tr>
<td>Extended Spectrum Enterobacteriacease</td>
<td>ESBL</td>
</tr>
<tr>
<td>Methicillin-Resistant Staphylococcus Aureus</td>
<td>MRSA</td>
</tr>
<tr>
<td>Streptococcus pneumonia</td>
<td>Strep</td>
</tr>
<tr>
<td>Vancomycin-Resistant Enterococci</td>
<td>VRE</td>
</tr>
</tbody>
</table>

Diseases - Other Potential Topics

- Communicable / Non-communicable
- Containment / Control
- Incubation period
- Infection rate
- Research

- Severity
- Spread of disease
- Susceptibility
- Treatment
- Vaccination
Environmental

- Chemicals and hormones
- Pesticides
- Pollution
Environmental – Other Potential Topics

- Availability of outdoor activities
- Crime rate
- Green space
- Water quality
Healthcare/medical care

- Quality
Healthcare/medical care – Other Potential Topics

- Access
- Availability
- Usage
Inequality

- Socioeconomic differences (within countries)
London Tube Map
Life expectancy at birth and child poverty. Map by James Cheshire, University College London, June 2012.

Geographical differences in mortality in the US

Source:
https://www.bing.com/images/search?q=graph+of+geographical+differences+in+mortality+in+the+us&view=detailv2&id=C62345BEF128A1AFE5357BCC35C777D6ECE9D13&selectedIndex=82&ccid=86XVIs2E&simid=608006588272544162&thid=OIP.Mf3a5d522ed843b370dfab681ed0ac65a00&ajaxhist=0
Poverty Levels in the US

Poverty in Rural America, 2008

Percent in Poverty
(White areas are urban counties.)

Highest
Ziebach County, SD
54.4%

National Average
13.2%

Lowest
Los Alamos County, NM
3.1%

54.4% to 25%
25% to 20%
20% to 14.3%
14.2% to 12.2%
12.1% to 10%
10% to 3.1%
Education Levels in the US
Violent Crime Rates in the US

Source: https://www.bing.com/images/search?q=Crime+Rate+Map+of+Us&view=detailv2&id=7789A5CE1F3F83EF5F151F4863EB09F1DBF98C38&selectedIndex=14&ccid=%2bve0A2cq&simid=608032040256145242&thid=OIP.Mfaf7b403672ad1cb65b9096ac7d727adH0&ajaxhist=0
Inequality – Other Potential Topics

- Access to care
- Between countries
- Education
- Income
- Living conditions
- Safety
Lifestyle

- Diet/nutrition
- Exercise / Physical activity
- Obesity
- Stress
Lifestyle - Other Potential Topics

- Addictions
- Alcohol
- Avocations
- Behaviors
- Drugs
- Education
- Occupation
- Smoking
- Support structure
- Travel
Medical advances

- 3-D organ printing
- CRISPR
- Genetics
- Growing human organs
- Immunotherapy
Medical Advances - Other Potential Topics

- Anti-aging
- Bioelectronics
- Biomarkers
- Cancer
- Cardiovascular
- Cures
- Drug interactions
- Implantations
- Immunizations
- Inflammation
- Medical errors and problems
- Precision medicine
- Regenerative medicine
- Smart pills
- Statins
- Stem cells
- Telomeres
- Tissue engineering
Political

- Regulations
- Resources
Political – Other Potential Topics

- Availability of healthcare
- Limits to birth rates
- Nuclear aspirations
- Spending
- Stability of leadership
Technological advances

- Ingestible sensors
- Internet and Internet of things
Technological Advances - Other Potential Topics

- Artificial intelligence
- Cell phones
- Electronic health/medical records
- GMOs
- Global connectivity
- Nano-technology
- Robotics
- Self-driving cars
- Smart meters
- Social media
- Virtual reality
- Wearables
What we don’t know today

- New technologies
What else don’t we know today?

- Disasters
- Ongoing research
- Travel
- Knowledge
- Nanoparticles
- Outer space
- Work environment
Bio – Al Klein

- Al is a principal and consulting actuary with Milliman’s Buffalo Grove / Chicago office. He joined the firm in 2009.

- Al’s primary responsibilities include industry experience studies and helping clients with mortality, longevity, and underwriting related issues. Al’s expertise on mortality and underwriting includes traditional products, simplified issue, final expense, older age, and preferred.

- Prior to joining Milliman, Al worked for a large stock life insurance company where he was responsible for experience studies across all lines of business. He has also worked for other life insurance companies, a reinsurer and consultant, where he has been responsible for strategic planning, product development and traditional reinsurance.

- Al is a frequent speaker and currently involved with a number of industry activities, including:
  - Society of Actuaries (SOA) representative and Co-Vice Chair for the Mortality Working Group (MWG) of the International Actuarial Association
  - MWG Chair of projects on: Underwriting Around the World, Future Drivers of Mortality, Older Age Mortality
  - SOA Longevity Advisory Group
  - Chair of SOA Underwriting Issues and Innovation Seminar Planning Committee
  - SOA Mortality and Underwriting Survey Committee, Chair of survey on Predictive Analytics and Accelerated and Enhanced Underwriting
  - SOA Project Oversight Groups: US Population Mortality (and paper on the top 15 causes of death by region), 1900 Birth Year Cohort Project, Human Mortality Database Project, IFoA (Institute and Faculty of Actuaries, UK) Mortality Modeling Review
  - Joint American Academy of Actuaries (AAA) / SOA Preferred Mortality Oversight Group
  - 2015 SOA Valuation Basic Table Development Team
  - Longer Life Foundation Advisory Board

- Al received a Bachelor of Science degree in Actuarial Science and Finance from the U. of Illinois, Urbana

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