The search for new sources of mortality improvement - moving from remedial to curative medicine

Daniel Ryan, Head of R&D – Life & Health and Big Data, Swiss Re
IAA Mortality Working Group Seminar
9 June 2015
Future projections of longevity

Male life expectancy
CMI Working Paper 74

Attained age in calendar year

Total cohort life expectancy

- Start year 2014
- Start year 2019
- Start year 2024
- Start year 2029
- Start year 2034
- Start year 2039

Rapid rise in centenarians
Source: www.ons.gov.uk
Rapid pace of improvements in life expectancy

![Graph showing the increase in life expectancy over a decade](image)

Source: Global Burden of Disease 2010
Different views on which advances will have the greatest impact on future longevity

1. Stem cell therapy
2. Genetic testing
3. Vaccines
4. Monoclonal antibodies
5. Monitoring technology
6. Nanomedicine
Understanding the drivers to future longevity?

GENETICS

HEALTHCARE

BEHAVIOUR

ENVIRONMENT

INTERACTIONS
# Global Burden of Disease

Annual review of global impact of risk factors

## Ranking legend

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Global</th>
<th>High-income Asia Pacific</th>
<th>Western Europe</th>
<th>Australia</th>
<th>High-income North America</th>
<th>Central Europe</th>
<th>South America</th>
<th>Eastern Europe</th>
<th>East Asia</th>
<th>Tropical Latin America</th>
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<th>North Africa and Middle East</th>
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June 2014

IAA Morality Working Group Seminar | Daniel Ryan | 9 April 2015
Genomic sequencing
Increasing speed of developments

Sanger (capillary) sequencing

Next generation sequencing

Cancer Genomics

<table>
<thead>
<tr>
<th>Year</th>
<th>Technology</th>
<th>Cancer Type</th>
<th>Time</th>
<th>Cost</th>
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<tr>
<td>2000</td>
<td>Sanger</td>
<td>AML, Myeloma, CLL</td>
<td>~10 years</td>
<td>~$ 3.5 billion</td>
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<td>Illumina</td>
<td>Lung (NSCLC)</td>
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Genetic profiles for extreme longevity
New England Centenarian Study

http://www.plosone.org/article/info:doi/10.1371/journal.pone.0029848
Why remedial healthcare is unsustainable

<table>
<thead>
<tr>
<th>Remedial</th>
<th>Heart Attacks &amp; Strokes</th>
<th>Common Cancers</th>
<th>Diabetes</th>
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<tbody>
<tr>
<td>+70% reduced blood flow through artery</td>
<td>+80% of cancer life cycle complete before care</td>
<td>+90% insulin cells Destroyed - irreparable</td>
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## Current cost of pharmaceutical research

<table>
<thead>
<tr>
<th>Company</th>
<th>Ticker</th>
<th>Number of drugs approved</th>
<th>R&amp;D Spending Per Drug ($Mil)</th>
<th>Total R&amp;D Spending 1997-2011 ($Mil)</th>
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<td>GlaxoSmithKline</td>
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<td>Amgen Inc.</td>
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Sources: InnoThink Center For Research In Biomedical Innovation; Thomson Reuters Fundamentals via FactSet Research Systems
The rediscovery of regenerative medicine

Induced Pluripotent Stem Cell iPSC
Potential to make ‘all’ cell types

Nobel Prize October 2012
John Gurdon & Shinya Yamanaka
The contribution of robots to our future
New possibilities for healthcare delivery & support

Source: Cyberdyne & Tsukuba University

Source: Toyota
The contribution of robots to our future
Advances in surgical interventions

One of cancer therapy’s holy grails is the delivery of drugs directly to tumors, thereby killing diseased cells while sparing healthy ones. A promising solution may be to deploy armies of carefully engineered microbot-bacteria hybrids in the body. The submarine-like bots could power through fast currents in large blood vessels, transporting their drug-packing bacteria cargo to the network of tiny vessels that lead inside a tumor.
New horizons in curative healthcare

Remedial
- Control Symptoms
  - Caused by: Organ Dysfunction
  - Shown by: Blood tests and Imaging
- Aims: Avoid symptoms drugs, surgery, radiotherapy

Preventive
- Prevent Symptoms
  - Plus markers: eg: CA125
  - + genome = personal medicine
- Aims: Maintain Pre-disease Status

Curative & Prophylactic Cure
- Influence Cellular Networks at “pre-disease” level
- Target Cell Networks in nucleus & cytoplasm
- to influence structure & patterns of: genes, proteins & Cell Organelles (mitochondria, ribosome)
- Aims: Avoid symptoms drugs, surgery, radiotherapy
Futures of hypertension

Hypertension
Monitor & control by drugs
Investigate & removal of causes:
  Vascular
  Hormonal
  Tumours etc

After Heart Attack
Medical: drugs to help strengthen the heart
Surgical: stents for coronary arteries
Stem cells to preserve & restore heart muscle
Heart transplantation

After Stroke
Carotid bifurcation
Endarterectomy
Futures of hypertension

**Heart & Arteries**
Monitor blood pressure, sugar, lipids
Image coronary arteries for narrowing and Atheroma - CT scan measurement of cardiac calcification index - Venous MRI coronary angiography

**Brain**
Monitor blood pressure, sugar, lipids
Image carotid, vertebral & cerebral Arteries Doppler ultrasound

Medical & surgical treatments as required
Futures of hypertension

Vaccinate against hypertension
Modifying kidney and brain regulatory systems
Renin - Angiotensin - Aldosterone System

Modify heart & blood vessels
Modify elastic properties of vessels:
Remodel extracellular matrix
Modify blood vessel surfaces eroded by blood flow

“All of above in experimental stages”
Promoting healthy behaviour

Salience

Yellow tape was placed across a shopping cart indicating where fruit and vegetables should be placed. Result: 102% increase in sales of fruit and vegetables.

Norms

Google cafeteria hid unhealthy food out of sight and out of reach and placed healthy food more centrally. Result: fat consumption from chocolate decreased by 11%.

Incentives
Enhanced monitoring of our behaviours

Wearable sensors

Smart lenses

Internet of Things

Handheld medical scanner

Smart Pill

Source: www.proteus.com
Future potential of platforms - Healthkit


Swiss Re
IAA Morality Working Group Seminar | Daniel Ryan | 9 April 2015
GoogleX Baseline Project – a synthesis

Moonshot to deeper understanding of health OR Gateway to harmful obsession with early diagnosis
Concluding thoughts

• Significant uncertainty over future trajectory of population life expectancy – let alone individual longevity

• Further gains possible in life expectancy through systematic application of existing treatments and adoption of healthy behaviours – even before any breakthroughs

• Major concerns over the sustainability of current remedial healthcare and concentration of effort and resources

• Those who are about to retire are likely to benefit from early advances in curative healthcare

• Widespread use of sensors will provide individuals with direct and immediate feedback on impact of healthy and adverse behaviours – but then we have known the risks of smoking for decades
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