PPOs – Mortality recap

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Note

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• Although we have used our best efforts, no warranty is given about the accuracy of the information and no liability can be accepted for anybody relying on the accuracy of the information or following the recommendations in this presentation.

These slides were presented at GIRO 2016. They represent views from the perspective of insurers and reinsurers.

If you have any questions, please contact Sharon Cumberbach at the IFoA who will be able to put you in touch with the PPO Working Party members.
Agenda

• Mortality
  – Recap on the problem
  – Different modelling approaches
  – Sensitivity analysis
  – Synopsis of relevant mortality studies
What we wanted v What we have

- What we wanted – Analysis of THIN Dataset
  - To provide insight into mortality curve
- Thus far have struggled –
  - Funding initially
  - Now this
- Hope exists – IFoA Big data project
  - May be able to use this
- What we have -
  - Mortality – why important and compare studies
  - Market solutions – impact of correlations – structural options
Reserves as a Proportion of Outstanding

PPO Reserves as a Proportion of Outstanding Reserves

-2% | -1% | 0% | 1% | 2%
---|---|---|---|---
30% | 25% | 20% | 15% | 10%

Real Discount Rate Assumption

Known PPO Reserve Only

- Suggests that PPOs already in payment may currently make up somewhere between 10% and 28% of UK Motor case estimates, depending on the real discount rate assumed.

Reserves of PPOs in payment
Outstanding reserves from PRA returns

Caveat: All graphs are draft and subject to change

22 September 2016
Mortality
Recap of the problem
Summary of the issue

‘A PPO is a contingent, deferred, whole-life, wage-inflation-linked, guaranteed, impaired-life annuity, where the identity of the annuitant and the size of the annual payments are unknown at policy inception.’

Need to project mortality for young, severely injured claimants.

Limited data in order to model life expectancy of claimants, majority of mortality studies focussed on older, insured lives.
An ever developing area – a shock for the future?

Amphetamine Helped Brain Damaged Rats Regain Function

The animal model showed that the drug could stimulate healing after traumatic brain injury.

Stern cell therapy heals injured mouse brain

Animal study examines method for restoring brain cells killed by stroke or other neurological diseases.

Scientists and clinicians have long dreamed of helping the injured brain repair itself by creating new neurons, and an innovative NIH-funded study published today in Nature Medicine may bring this goal much closer to reality. A team of researchers has developed a therapeutic technique that dramatically increases the production of nerve cells in mice with stroke-induced brain damage.

The therapy relies on the combination of two methods that show promise as treatments for stroke-induced neurological injury. The first consists of surgically grafting human neural stem cells into the damaged area, where they are capable of quickly dividing and producing new cells. The second is to give the mice a compound known as 3K2A/ATP, which has been shown to promote the growth of new neurons.

Giving 3K2A/ATP to mice with stroke-induced brain damage dramatically increased the production of new neurons (labeled in red) from neural stem cells implanted next to the injured area. Eunice Hsiao, M.D., Ph.D., USC

Study says stem cell treatment can aid recovery of spinal injuries

Stem Cell treatment or the Human Embryonic Stem Cells (HESC) is effective in the replacement of damaged neurons, re-establishment of lost axonal connections, and providing of neuro-protective factors to allow the healing and recovery of spinal cord injury, revealed a study.

Agencies Aug 23, 2016 at 09:33 am
Important to accurately record injury classification, and share in a market consistent way so we can analyse as dataset grows.
Mortality

Different modelling approaches
What approaches are people taking?

- There are several ways to model the life expectancy of PPO claimants:
  - Annuity certain based on an experts judgement of life expectancy.
  - Or a probabilistic approach adjusting a standard lives table:
    - Multiplicative adjustment;
    - Additive adjustment
    - Age rating.

All those taking a probabilistic approach used the Ogden 7 tables or a more recently updated publication of the ONS table series which underlies Ogden 7.

Source 2015 YE qualitative survey
Three probabilistic methods

**Multiplier adjustment**
Using a multiplier to increase mortality has a larger effect in older years, where mortality is higher.

\[ q'_{x,t} = A \times q_{x,t} \]

**Age adjustment**
The reduction in life expectancy occurs because the PPO claimant experiences the same mortality as someone older than them.

\[ q'_{x,t} = q_{x+B,t} \]

**Additive adjustment**
This could be seen to capture the excess mortality more explicitly.

\[ q'_{x,t} = q_{x,t} + C \]
Using an annuity certain approach

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplest to apply</td>
<td>No benefit of pooling of risk</td>
</tr>
<tr>
<td>Specifically relates to claimant</td>
<td>No allowance for mortality shape</td>
</tr>
<tr>
<td></td>
<td>No allowance for future improvements</td>
</tr>
<tr>
<td></td>
<td>Potential for bias in estimates due to purpose of experts views</td>
</tr>
<tr>
<td></td>
<td>Cannot be used for volatility projections</td>
</tr>
<tr>
<td></td>
<td>Won’t accurately measure RI recovery</td>
</tr>
</tbody>
</table>

May want to adjust the life expectancy each year by the probability of survival in that year, i.e. LE / px
### Using an probabilistic approach: Multiplier Adjustment

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>• May offer improved allowance for</td>
<td>• Accident hump</td>
</tr>
<tr>
<td>mortality shape</td>
<td>issues at younger ages</td>
</tr>
<tr>
<td>• Simple to apply</td>
<td>• Very high mortality</td>
</tr>
<tr>
<td>• Main studies derive results in multiplier</td>
<td>allowance at higher ages</td>
</tr>
<tr>
<td>form</td>
<td></td>
</tr>
<tr>
<td>• Can be used explicitly allow for</td>
<td></td>
</tr>
<tr>
<td>future improvements</td>
<td></td>
</tr>
</tbody>
</table>

Appropriate for chronic and degenerate diseases, condition is expected to increase their risk of death increasingly throughout their lives. This may be the case for claimants with reduced mobility and fitness.

22 September 2016
### Using an probabilistic approach: Age rating

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Simple to apply</td>
<td>• Truncates mortality tables at very old ages</td>
</tr>
<tr>
<td>• Can be used explicitly allow for future</td>
<td>• Very little impact at younger ages</td>
</tr>
<tr>
<td>improvements</td>
<td>• Unlikely to capture shape issues correctly</td>
</tr>
<tr>
<td></td>
<td>• Medical research does not tend to express extra</td>
</tr>
<tr>
<td></td>
<td>mortality in this way</td>
</tr>
<tr>
<td></td>
<td>• No obvious link to any particular medical condition</td>
</tr>
</tbody>
</table>

An age adjustment on its own would be used if the mortality of an individual was expected to be equivalent to the mortality of an average person (with standard population mortality) who is x years older than the individual. Rarely used in the life insurance world.
Using an probabilistic approach: Additive adjustment

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Simple to apply</td>
<td>• Decreasing multiplicative effect over time</td>
</tr>
<tr>
<td>• Can be used explicitly allow for future improvements</td>
<td>• Large impact at younger ages depending on size of</td>
</tr>
<tr>
<td>• Independence of adjustment to age may be appropriate</td>
<td>adjustment</td>
</tr>
<tr>
<td></td>
<td>• Unlikely to capture shape issues correctly</td>
</tr>
</tbody>
</table>

An additive adjustment that does not vary by age would be used if the absolute impact of the injury on mortality was expected to be independent of age.
Mortality
Sensitivity analysis
Example PPO portfolio

• All cases preceding assume:
  – A lump sum amount of £1.7m
  – An annual starting amount of £78k
  – A settlement delay 7 years
  – A RI attachment point of £2m

Note: This is based on YE2014 Quantitative survey averages, and alternative assumptions would have different results.
## Base assumptions

For each example the adjustment for each method was fixed to give the same life expectancy.

<table>
<thead>
<tr>
<th>Claimant</th>
<th>Age at accident</th>
<th>Rated age at accident</th>
<th>Additive adjustment</th>
<th>Multiplicative adjustment</th>
<th>Life Expectancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>26 years</td>
<td>0.00802</td>
<td>4.00</td>
<td>53</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>38 years</td>
<td>0.01046</td>
<td>3.15</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>65</td>
<td>75 years</td>
<td>0.01816</td>
<td>2.48</td>
<td>8</td>
</tr>
</tbody>
</table>
## Base results

<table>
<thead>
<tr>
<th></th>
<th>Claimant 1</th>
<th>Claimant 2</th>
<th>Claimant 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gross cost</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All approaches*</td>
<td>4.472m</td>
<td>3.725m</td>
<td>1.809m</td>
</tr>
<tr>
<td><strong>RI recovery – traditional cover</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age rating</td>
<td>1.757m</td>
<td>1.235m</td>
<td>0.064m</td>
</tr>
<tr>
<td>Additive adjustment</td>
<td>1.794m</td>
<td>1.262m</td>
<td>0.081m</td>
</tr>
<tr>
<td>Multiplicative adjustment</td>
<td>1.761m</td>
<td>1.237m</td>
<td>0.063m</td>
</tr>
<tr>
<td><strong>RI recovery – IUA clause</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All approaches**</td>
<td>1.497m</td>
<td>1.126m</td>
<td>-</td>
</tr>
<tr>
<td><strong>RI recovery – Delayed 20</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age rating</td>
<td>2.021m</td>
<td>1.574m</td>
<td>0.096m</td>
</tr>
<tr>
<td>Additive adjustment</td>
<td>1.834m</td>
<td>1.405m</td>
<td>0.104m</td>
</tr>
<tr>
<td>Multiplicative adjustment</td>
<td>2.010m</td>
<td>1.559m</td>
<td>0.095m</td>
</tr>
</tbody>
</table>

*Note simplification as real discount rate 0%, gross would be different if not

** IUA fixed basis as per contract
Age rating approach

A rated age of 5 yrs younger which results in a life expectancy 5.4 yrs longer

A rated age of 5 yrs younger which results in a life expectancy 5.2 yrs longer

A rated age of 5 yrs older which results in a life expectancy 5.3 yrs less

A rated age of 5 yrs older which results in a life expectancy 5.1 yrs less

Claimant 1 (10 yrs at accident)  Claimant 2 (25 yrs at accident)

- Gross  - RI recs (traditional cover)  - Delayed 20
Age rating approach

A rated age of 5 yrs younger which results in a life expectancy 5.4 yrs longer

A rated age of 5 yrs younger which results in a life expectancy 5.2 yrs longer

A rated age of 5 yrs older which results in a life expectancy 5.3 yrs less

A rated age of 5 yrs older which results in a life expectancy 5.1 yrs less

A rated age of 5 yrs older which results in a life expectancy 2.8 yrs less

Claimant 1 (10 yrs at accident)  Claimant 2 (25 yrs at accident)  Claimant 3 (65 yrs at accident)

Gross  RI recs (traditional cover)  Delayed 20

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Multiplier approach

A reduction in multiplier of 1.4 also results in a life expectancy 5.4 yrs longer.

A reduction in multiplier of 1.1 also results in a life expectancy 5.2 yrs longer.

An increase in multiplier of 2.0 also results in a life expectancy 5.3 yrs less.

A increase in multiplier of 1.7 also results in a life expectancy 5.1 yrs less.

Claimant 1 (10 yrs at accident)
Claimant 2 (25 yrs at accident)

Gross  RI recs (traditional cover)  Delayed 20
Multiplier approach

A reduction in multiplier of 1.4 also results in a life expectancy 5.4 yrs longer

A reduction in multiplier of 1.1 also results in a life expectancy 5.2 yrs longer

A reduction in multiplier of 2.0 also results in a life expectancy 3.2 yrs longer

An increase in multiplier of 2.0 also results in a life expectancy 5.3 yrs less

A increase in multiplier of 1.7 also results in a life expectancy 5.1 yrs less

A increase in multiplier of 1.3 also results in a life expectancy 2.8 yrs less

Claimant 1 (10 yrs at accident)
Claimant 2 (25 yrs at accident)
Claimant 3 (65 yrs at accident)

Gross  RI recs (traditional cover)  Delayed 20
Additive approach

A reduction in additive adjustment of 0.0028 also results in a life expectancy 5.4 yrs longer.

A reduction in additive adjustment of 0.0060 also results in a life expectancy 5.2 yrs longer.

An increase in additive adjustment of 0.0032 also results in a life expectancy 5.3 yrs less.

An increase in additive adjustment of 0.0053 also results in a life expectancy 5.1 yrs less.

Claimant 1 (10 yrs at accident)
Claimant 2 (25 yrs at accident)

Gross  | RI recs (traditional cover)  | Delayed 20
Additive approach

A reduction in additive adjustment of 0.0028 also results in a life expectancy 5.4 yrs longer.

A reduction in additive adjustment of 0.0060 also results in a life expectancy 5.2 yrs longer.

An increase in additive adjustment of 0.0032 also results in a life expectancy 5.3 yrs less.

An increase in additive adjustment of 0.0053 also results in a life expectancy 5.1 yrs less.

An increase in additive adjustment of 0.0535 also results in a life expectancy 2.8 yrs less.

Claimant 1 (10 yrs at accident)

Claimant 2 (25 yrs at accident)

Claimant 3 (65 yrs at accident)

Gross  RI recs (traditional cover)  Delayed 20
## Summary of results

<table>
<thead>
<tr>
<th></th>
<th>Claimant 1 (10yrs old at accident)</th>
<th>Claimant 2 (25yrs old at accident)</th>
<th>Claimant 3 (65yrs old at accident)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Exp.</td>
<td>58/53/47</td>
<td>45/40/35</td>
<td>11/8/5</td>
</tr>
<tr>
<td><strong>Age rating</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated age</td>
<td>21/26/31</td>
<td>33/38/43</td>
<td>70/75/80</td>
</tr>
<tr>
<td>Gross cost</td>
<td>4.79m/4.47m/4.16m</td>
<td>4.03m/3.73m/3.42m</td>
<td>2.01m/1.81m/1.66m</td>
</tr>
<tr>
<td>Trad. RI rec</td>
<td>1.99m/1.76m/1.54m</td>
<td>1.45m/1.23m/1.03m</td>
<td>0.15m/0.06m/0.02m</td>
</tr>
<tr>
<td>D20 rec</td>
<td>2.03m/2.02m/2.01m</td>
<td>1.60m/1.57m/1.53m</td>
<td>0.20m/0.10m/0.03m</td>
</tr>
<tr>
<td><strong>Additive adj</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additive adj</td>
<td>0.0052/0.0080/0.0112</td>
<td>0.0060/0.0105/0.0158</td>
<td>0.0298/0.0717/0.1253</td>
</tr>
<tr>
<td>Gross cost</td>
<td>4.79m/4.47m/4.16m</td>
<td>4.03m/3.73m/3.42m</td>
<td>2.01m/1.81m/1.66m</td>
</tr>
<tr>
<td>Trad. RI rec</td>
<td>2.01m/1.80m/1.58m</td>
<td>1.47m/1.26m/1.06m</td>
<td>0.17m/0.08m/0.03m</td>
</tr>
<tr>
<td>D20 rec</td>
<td>1.91m/1.83m/1.75m</td>
<td>1.50m/1.40m/1.30m</td>
<td>0.19m/0.10m/0.05m</td>
</tr>
<tr>
<td><strong>Multiplier adj</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiplier</td>
<td>2.62/4.00/6.00</td>
<td>2.03/3.15/4.83</td>
<td>1.72/3.01/5.00</td>
</tr>
<tr>
<td>Gross cost</td>
<td>4.79m/4.47m/4.16m</td>
<td>4.03m/3.73m/3.42m</td>
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<td>1.99m/1.76m/1.54m</td>
<td>1.45m/1.24m/1.03m</td>
<td>0.15m/0.06m/0.02m</td>
</tr>
<tr>
<td>D20 rec</td>
<td>2.03m/2.01m/1.98m</td>
<td>1.59m/1.56m/1.51m</td>
<td>0.20m/0.10m/0.03m</td>
</tr>
</tbody>
</table>
Mortality

Synopsis of relevant studies
What studies have been done?

- NZ study
  - Cohort analysed: All bodily injury accident claims in NZ - Motor only included in our study, exposure 1999 onwards
  - Key findings: Spinal injuries have higher mortality than brain, severity of injury significant. Multipliers vary by age.
  - Link: https://www.actuaries.org.uk/documents/update-periodical-payment-orders-working-party-0
- Australia study
  - Cohort analysed: Transport accidents directly caused by the driving of a car, motorcycle, bus, train or tram, exposure 2008 onwards
  - Key findings: Spinal injuries have higher mortality than brain, severity of injury significant. Multipliers vary by age. Spinal higher than NZ spinal, brain lower than NZ brain.
- Swedish study
  - Cohort analysed: Traffic accident annuitants
  - Key findings: Appears to show mortality tends to the general population at older ages (over 55) and they have derived their own curve.
  - Link: http://www.svenskforsakring.se/Global/Rapporter/Livsl%c3%a4ngdsantagande%20i%20trafikskadelivr%c3%a4ntor%202016-03-31.pdf?epslanguage=sv
- US Spinal Injury improvements
  - Cohort analysed: Spinal injury patients (non violent causes)
  - Key findings: Suggests little improvement in mortality over time, for spinal injury patients after two years from accident despite
general population improvements