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PPOs – Mortality recap

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Presentation to GIRO 2016
22 September 2016

Note

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

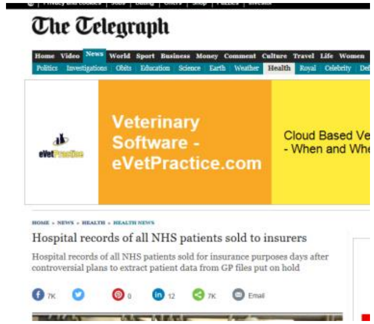
If you have any questions, please contact Sharon Cumberbach at the IFoA who will be able to put you in touch with the PPO Working Party members.

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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Hospital records of all NHS patients sold to insurers

Hospital records of all NHS patients sold for insurance purposes days after controversial plans to extract patient data from GP files put on hold

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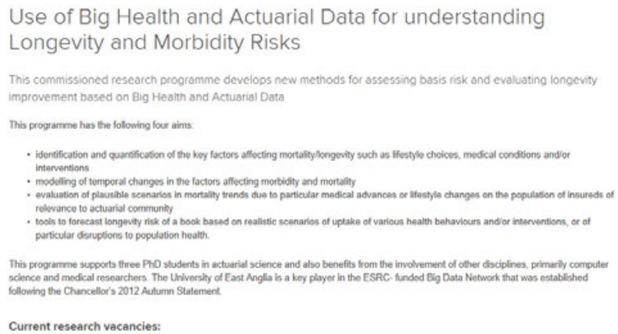
- Hope exists – IFoA Big data project
  - May be able to use this


Use of Big Health and Actuarial Data for understanding Longevity and Morbidity Risks

This commissioned research programme develops new methods for assessing basis risk and evaluating longevity improvement based on Big Health and Actuarial Data

This programme has the following four aims:

- identification and quantification of the key factors affecting mortality/longevity such as lifestyle choices, medical conditions and/or interventions
- modelling of temporal changes in the factors affecting morbidity and mortality
- evaluation of plausible scenarios in mortality trends due to particular medical advances or lifestyle changes on the population of insureds of relevance to actuarial community
- tools to forecast longevity risk of a book based on realistic scenarios of uptake of various health behaviours and/or interventions, or of particular disruptions to population health.

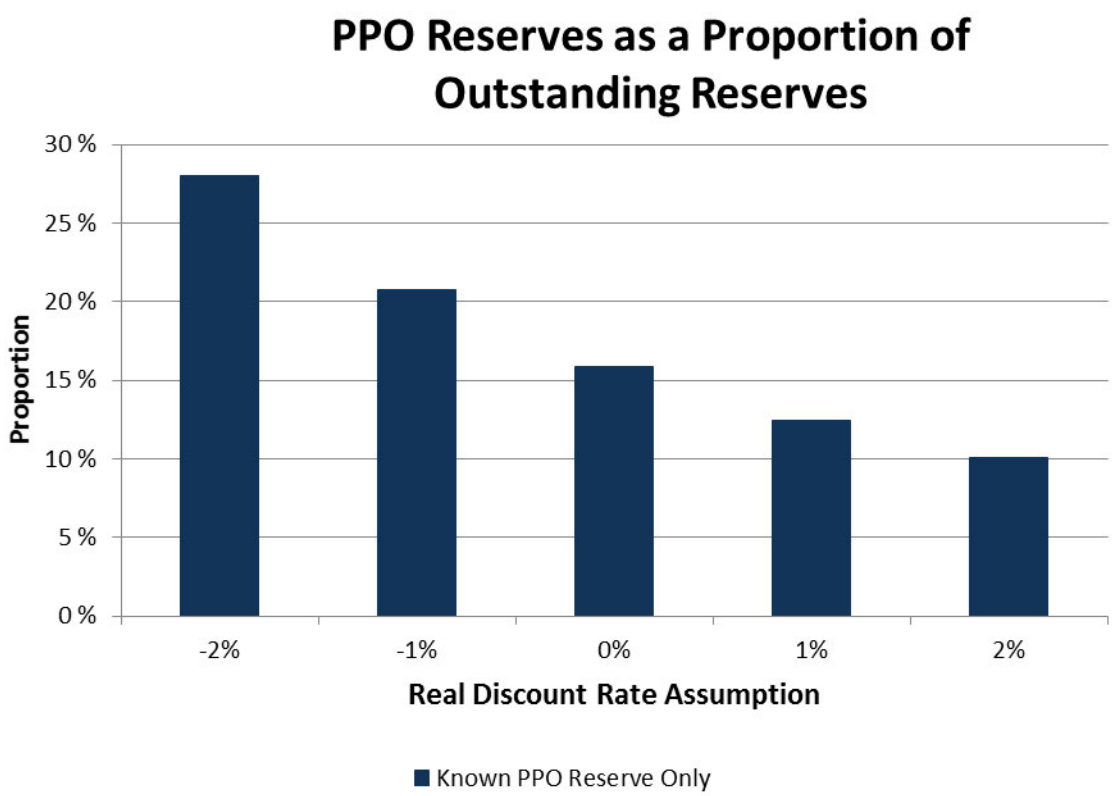
This programme supports three PhD students in actuarial science and also benefits from the involvement of other disciplines, primarily computer science and medical researchers. The University of East Anglia is a key player in the ESRC- funded Big Data Network that was established following the Chancellor's 2012 Autumn Statement.

Current research vacancies:

- What we have -
  - Mortality – why important and compare studies
  - Market solutions – impact of correlations – structural options

GIRO

Reserves as a Proportion of Outstanding



$$\frac{\textit{Reserves of PPOs in payment}}{\textit{Outstanding reserves from PRA returns}}$$

- 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

Caveat: All graphs are draft and subject to change

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Recap of the problem

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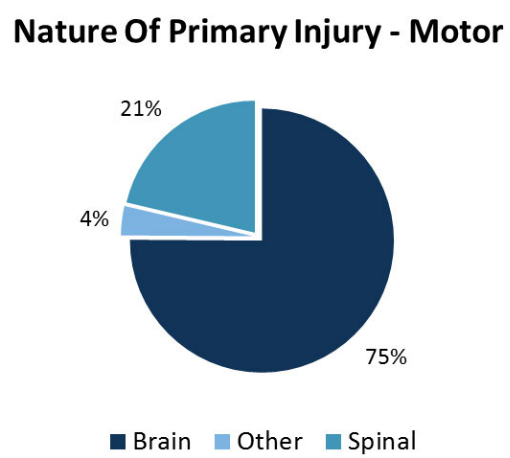
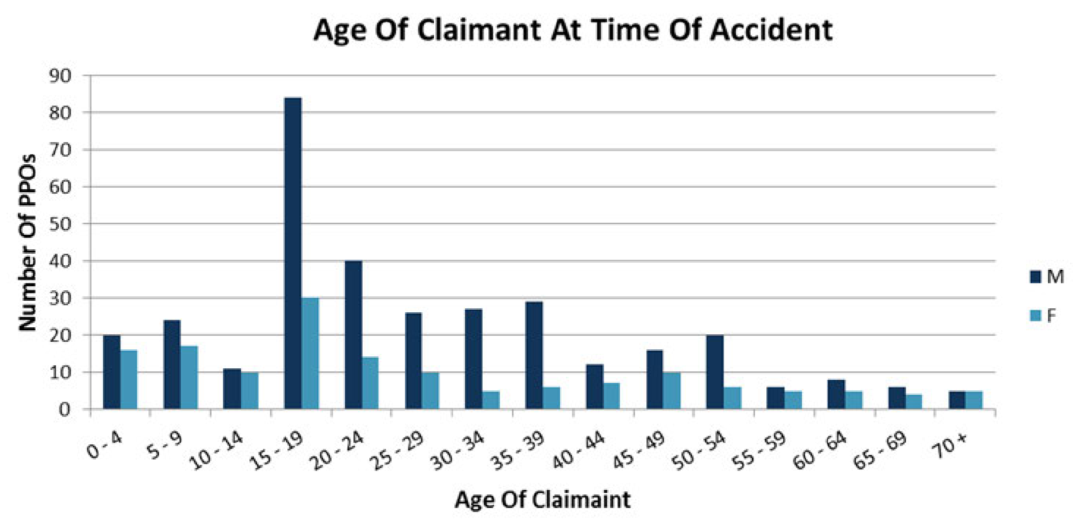
Summary of the issue

*'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.



Source: YE2015 Quantitative survey



Source: YE2015 Quantitative survey

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.

By Sophie Weiner Sep 18, 2016

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Scientists may have proven that amphetamines are effective in preventing long term effects

Monday, August 22, 2016

Stem cell therapy heals injured mouse brain

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

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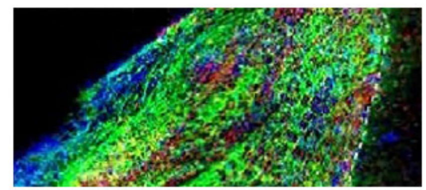
Scientists and clinicians have long dreamed of helping the injured brain repair itself by creating new neurons, and an innovative NIH-funded study published today in Nature Medicine may bring this goal much closer to reality. A team of researchers has developed a therapeutic technique that dramatically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



Giving 3K3A-APC 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. *Berislav Zlokovic, M.D., Ph.D., USC*

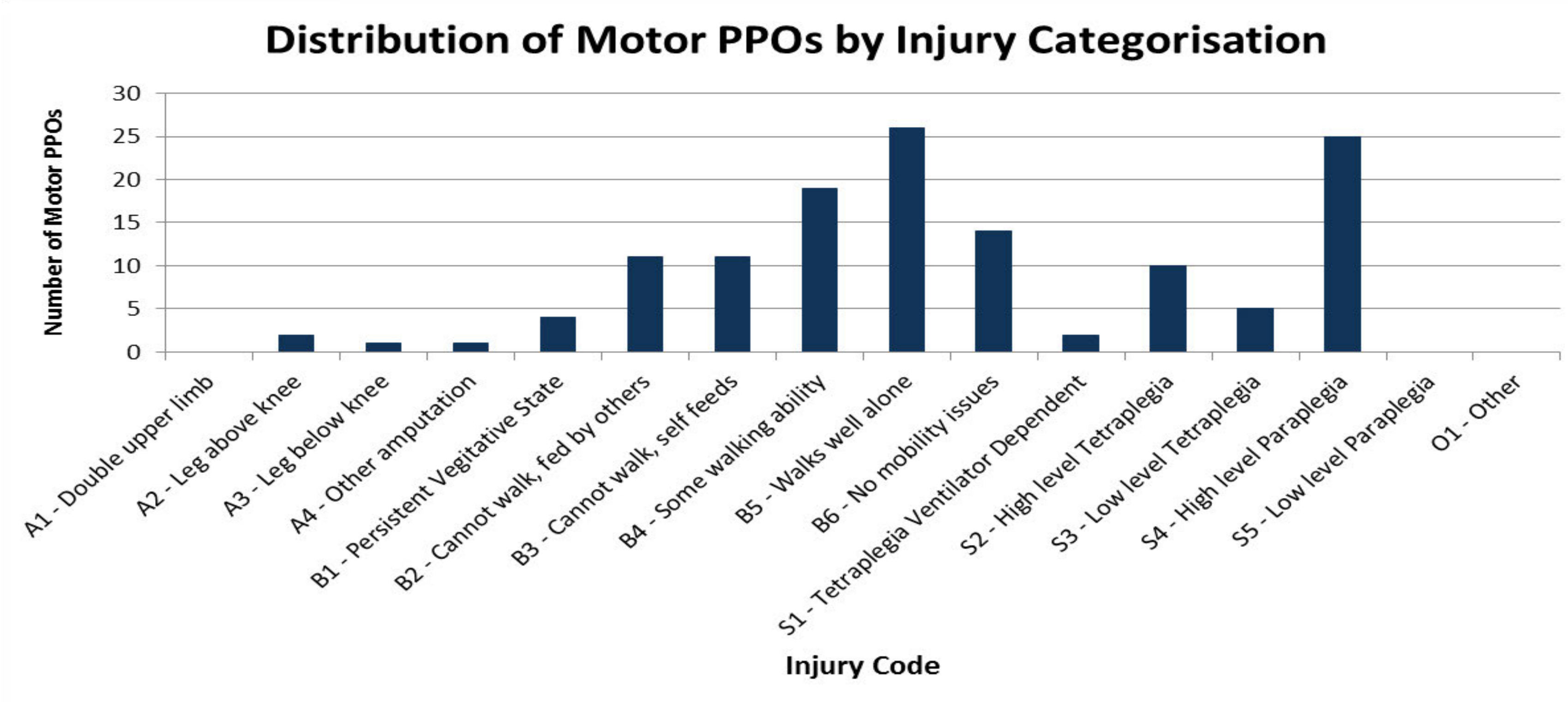
Home / News / Study says stem cell treatment can aid recovery of spinal injuries

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

PPOs by WP injury classification



Important to accurately record injury classification, and share in a market consistent way so we can analyse as dataset grows

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Different modelling approaches

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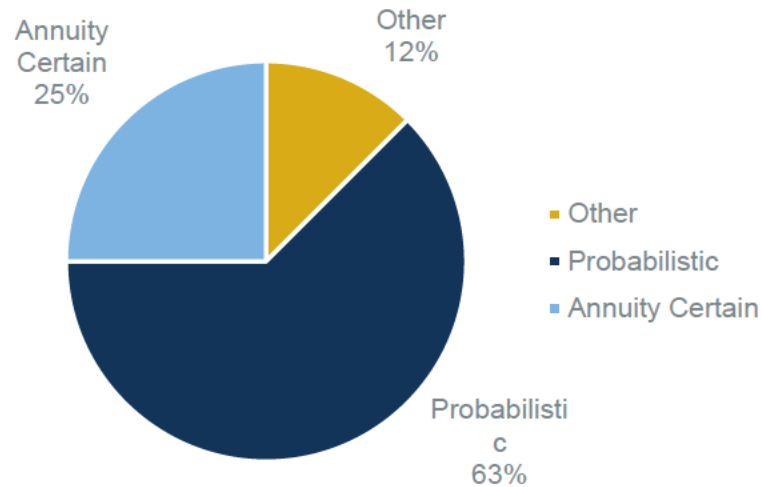
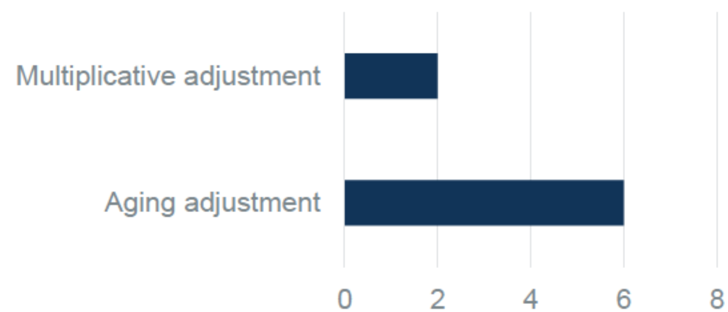
What approaches are people taking?

- 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.

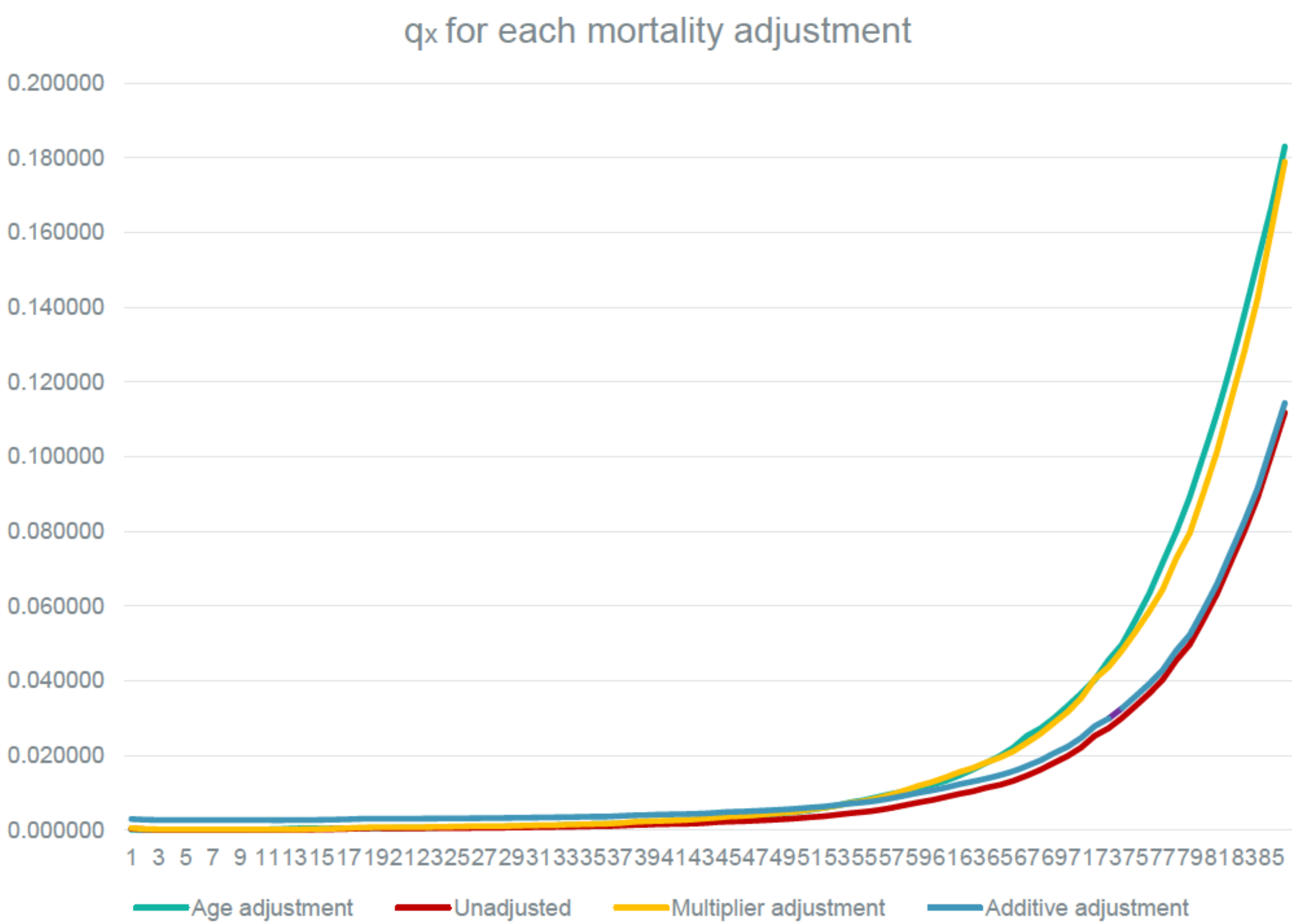


All those taking a probabilistic approach used the Ogden 7 tables or a more recently updated publication of the ONS table series which underlies Ogden 7.



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.

$$q'_{x,t} = q_{x+B,t}$$

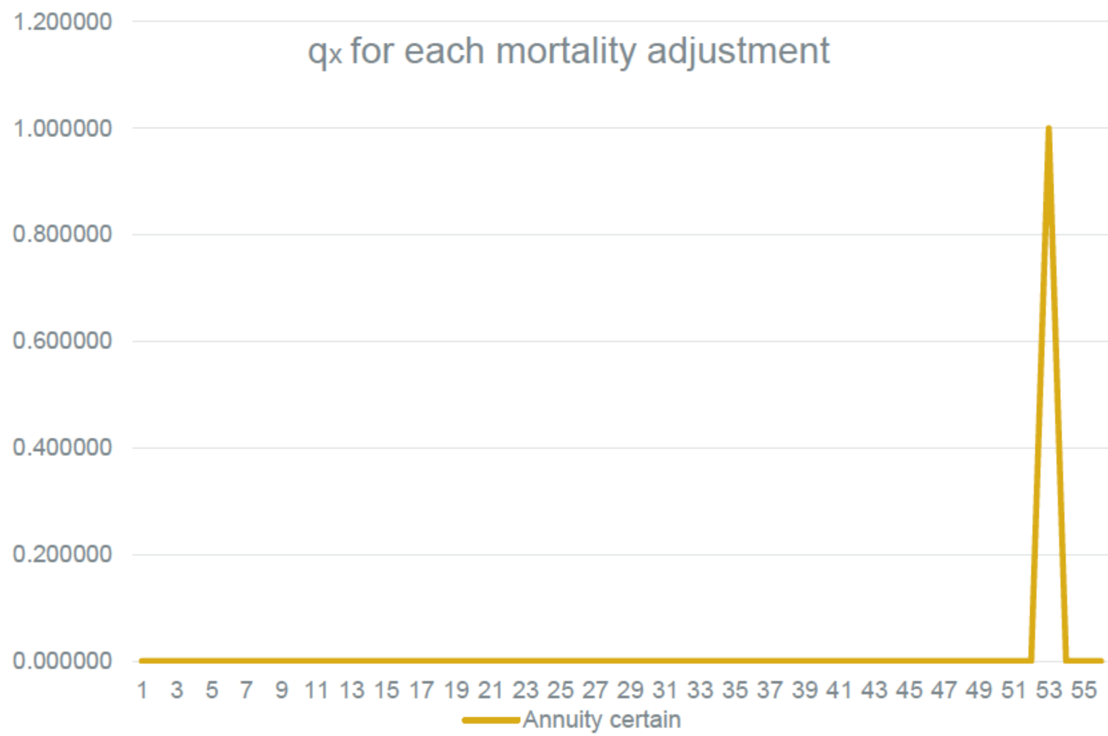
Additive adjustment

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

$$q'_{x,t} = q_{x,t} + C$$

Using an annuity certain approach

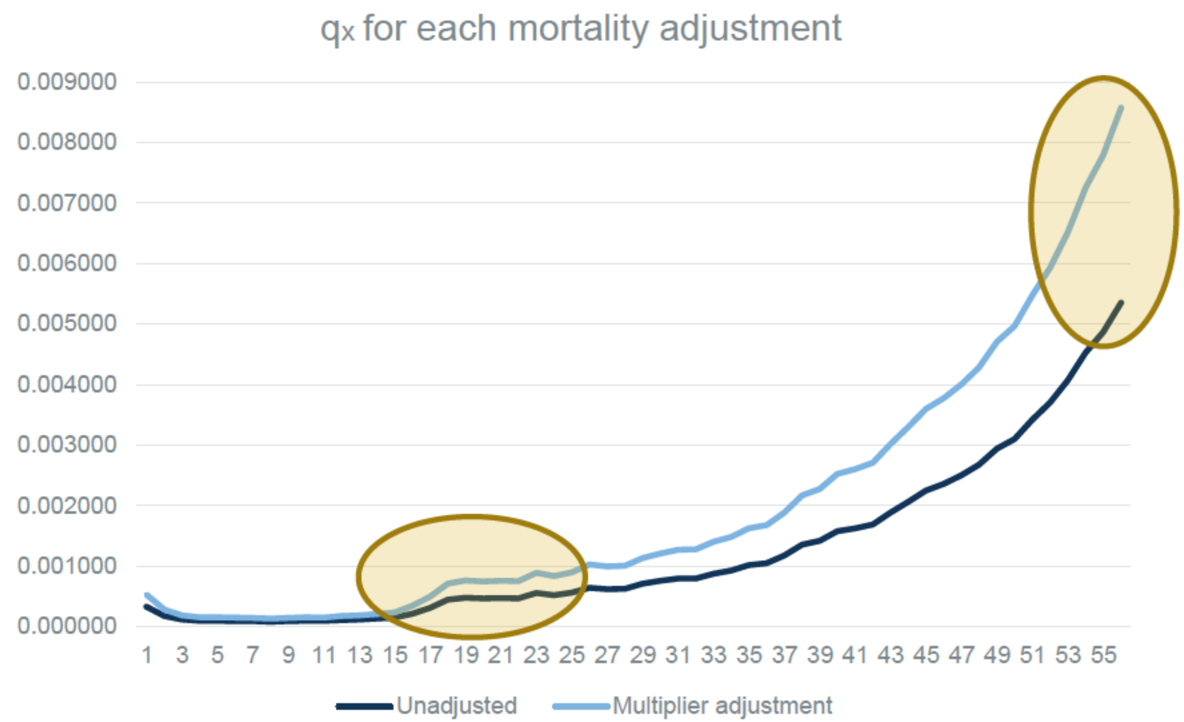
Pros	Cons
•Simplest to apply •Specifically relates to claimant	•No benefit of pooling of risk •No allowance for mortality shape •No allowance for future improvements •Potential for bias in estimates due to purpose of experts views •Cannot be used for volatility projections •Won't accurately measure RI recovery



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

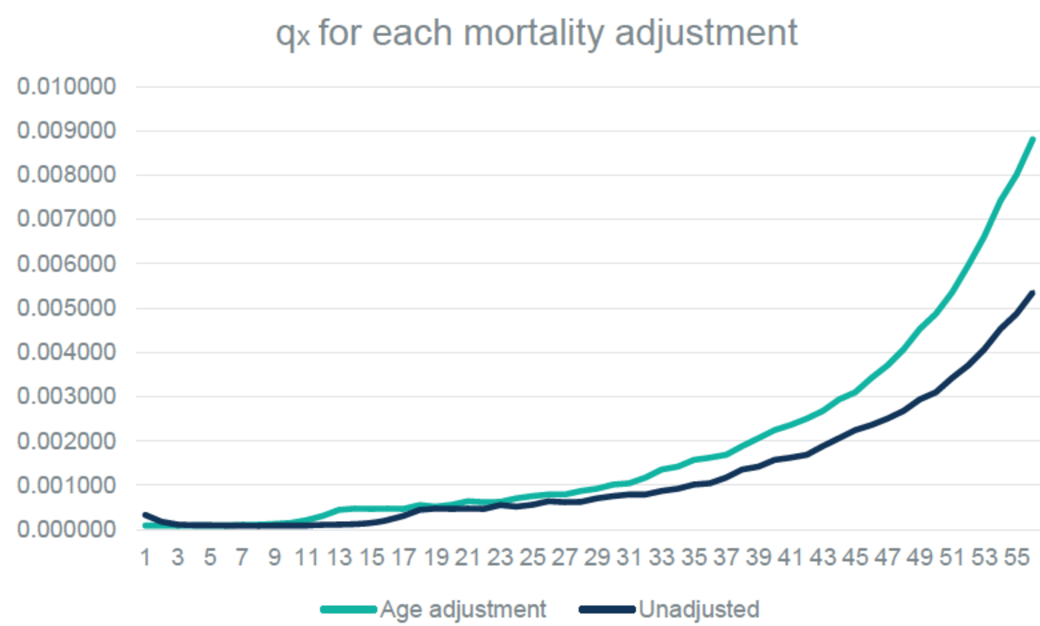
Pros	Cons
• May offer improved allowance for mortality shape • Simple to apply •Main studies derive results in multiplier form •Can be used explicitly allow for future improvements	•Accident hump issues at younger ages •Very high mortality allowance at higher ages



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.

Using an probabilistic approach: Age rating

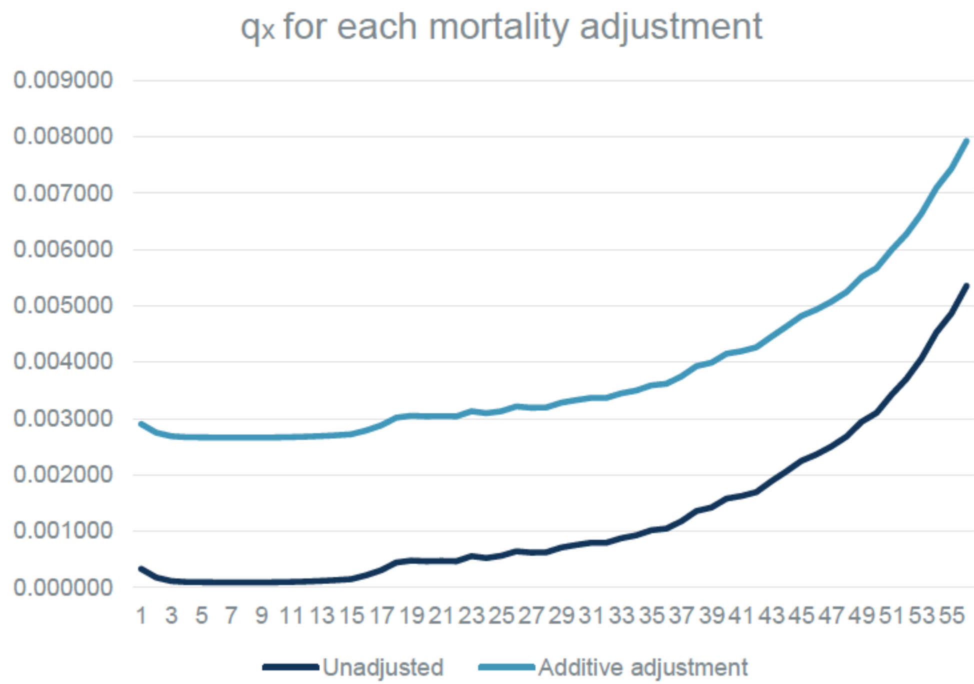
Pros	Cons
•Simple to apply •Can be used explicitly allow for future improvements	•Truncates mortality tables at very old ages •Very little impact at younger ages •Unlikely to capture shape issues correctly •Medical research does not tend to express extra mortality in this way •No obvious link to any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



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

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



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.

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Sensitivity analysis

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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.

	Age at accident	Rated age at accident	Additive adjustment	Multiplicative adjustment	Life Expectancy
Claimant 1	10	26 years	0.00802	4.00	53
Claimant 2	25	38 years	0.01046	3.15	40
Claimant 3	65	75 years	0.01816	2.48	8

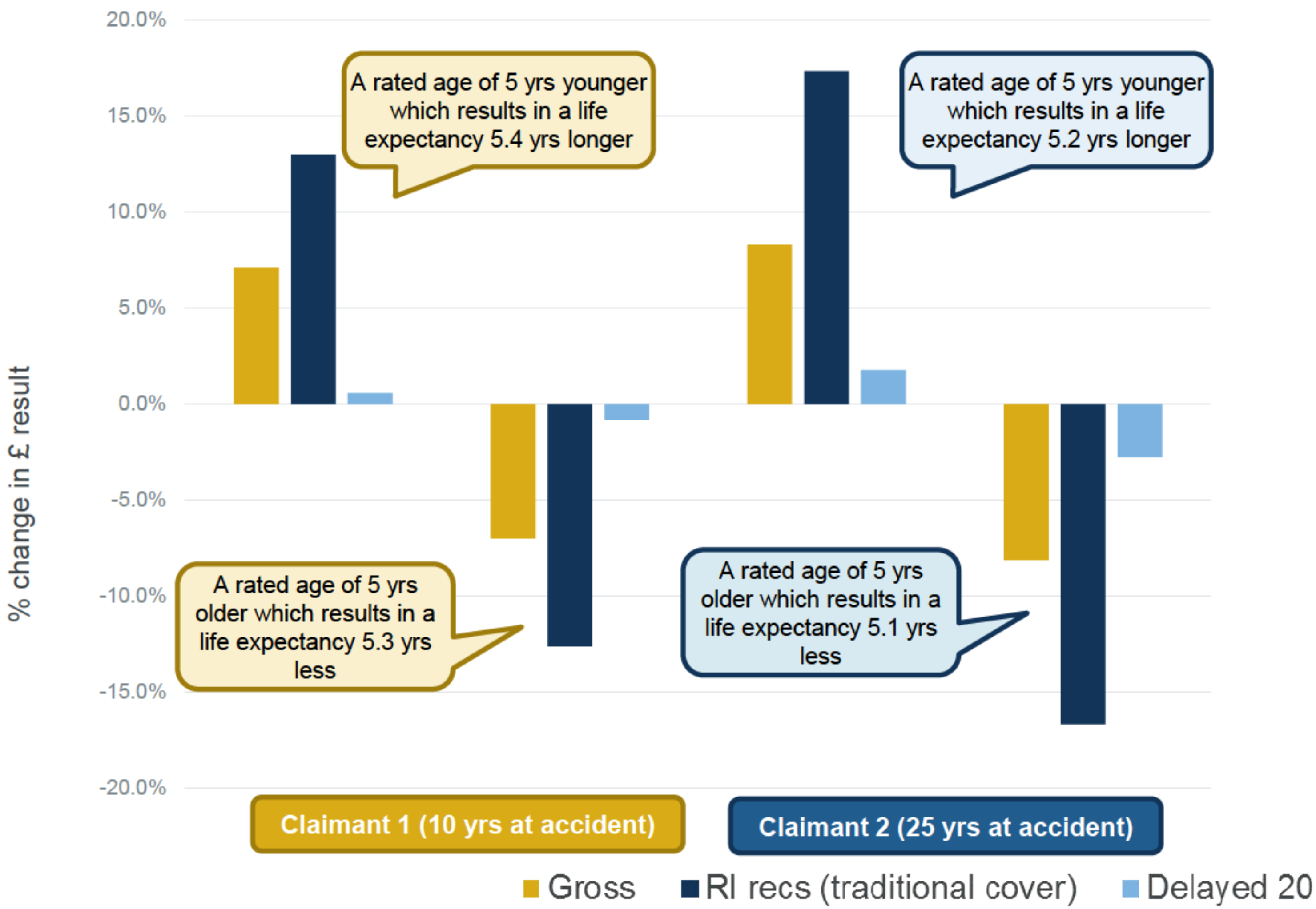
Base results

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

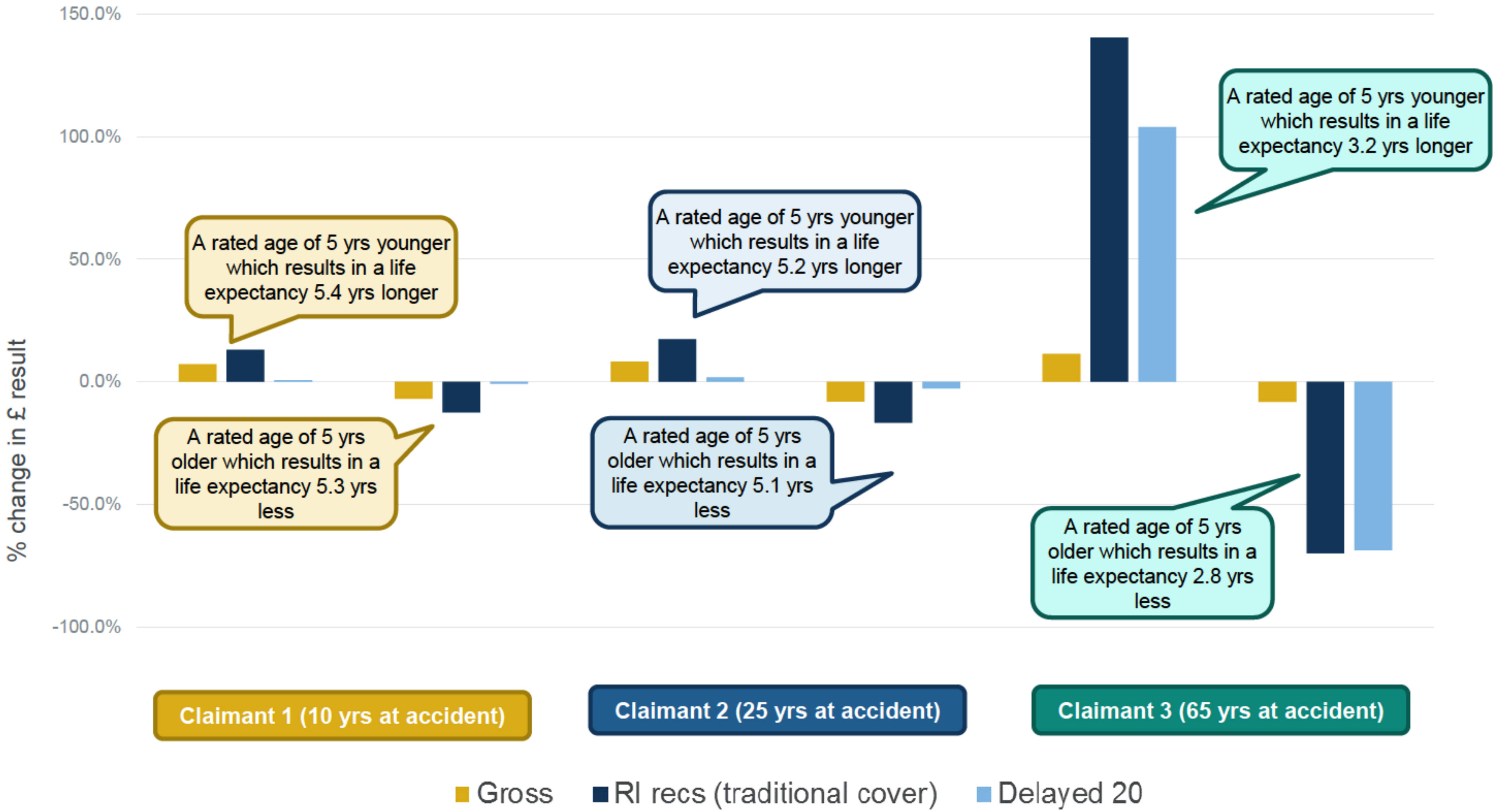
*Note simplification as real discount rate 0%, gross would be different if not

** IUA fixed basis as per contract

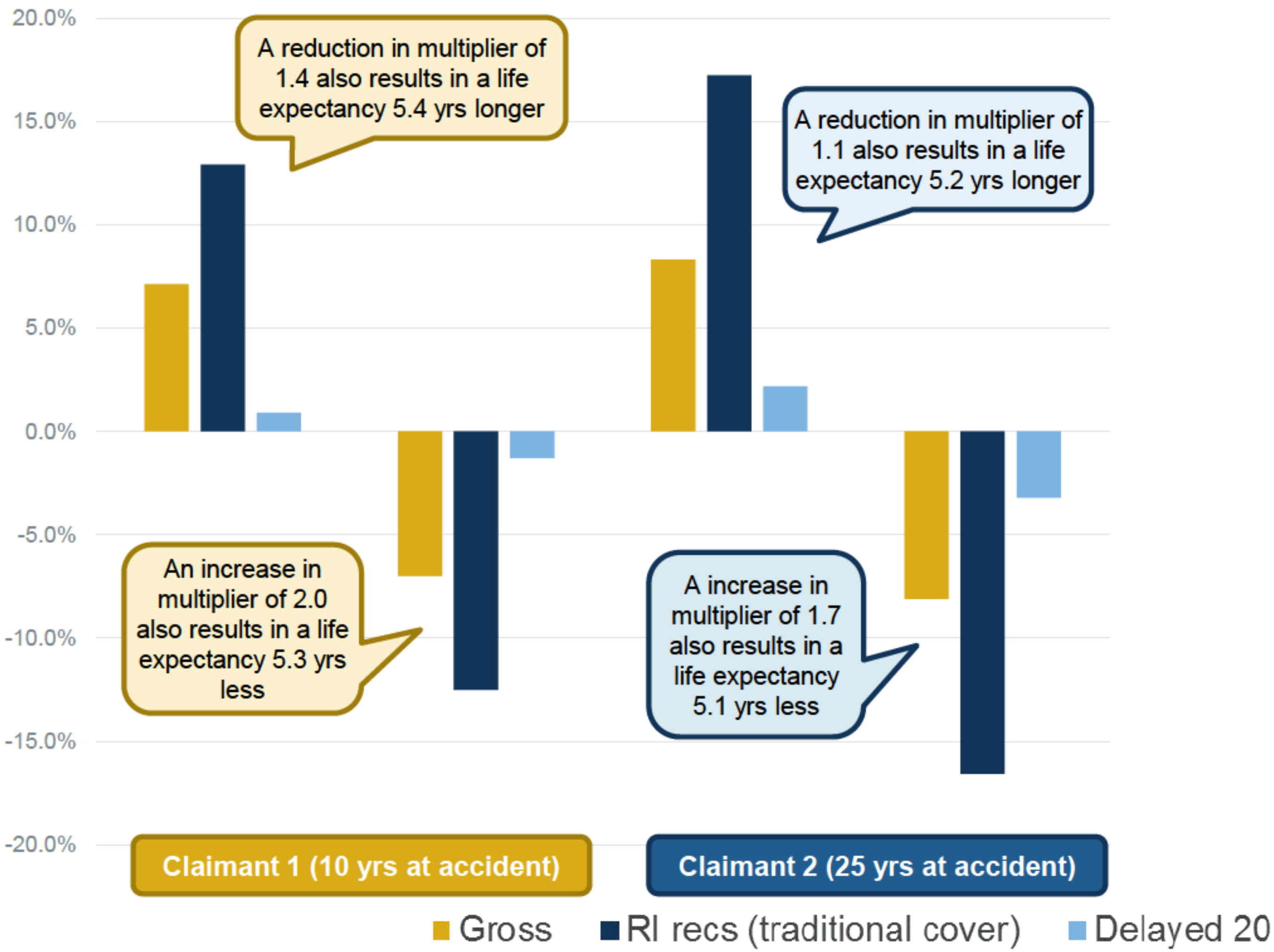
Age rating approach



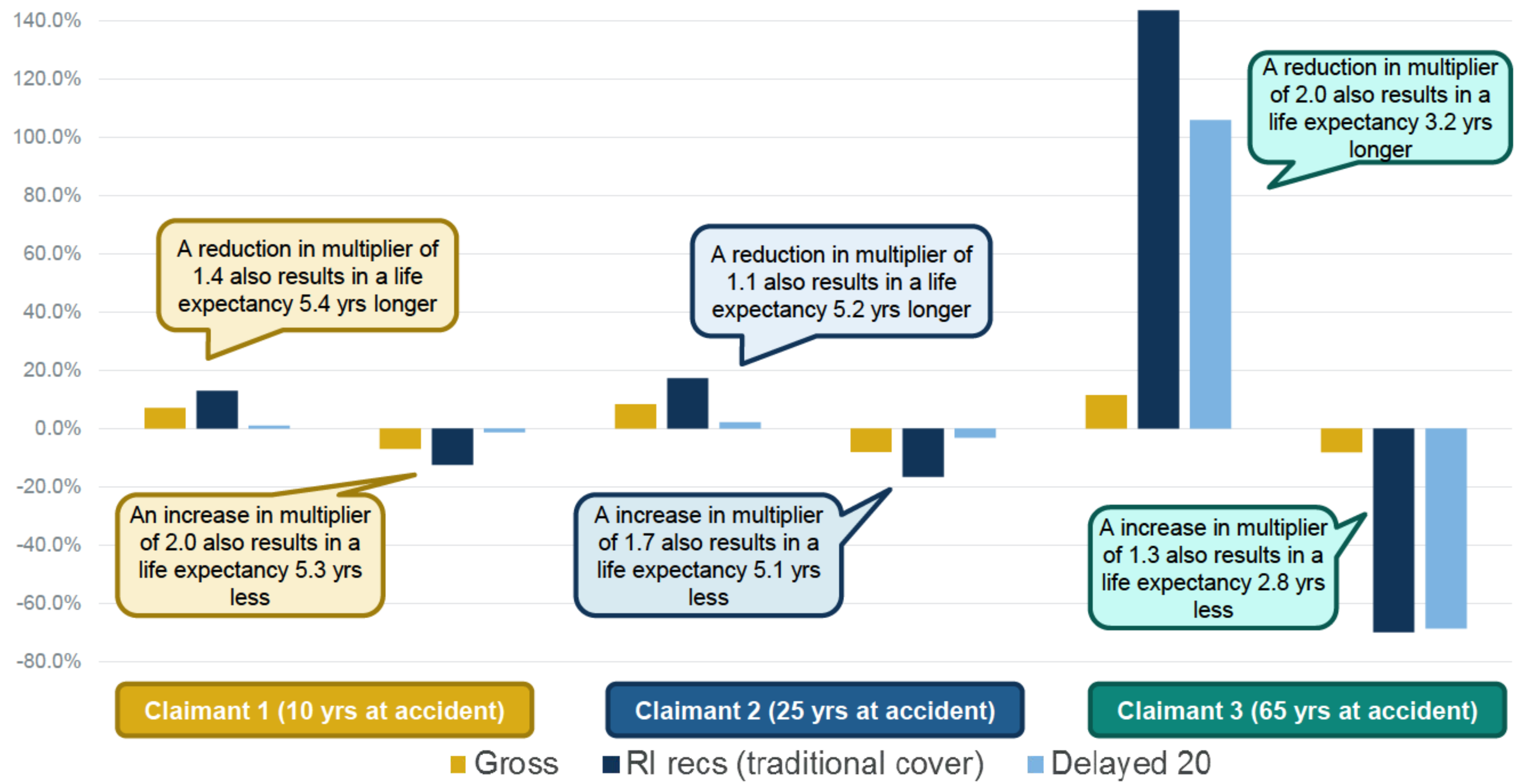
Age rating approach



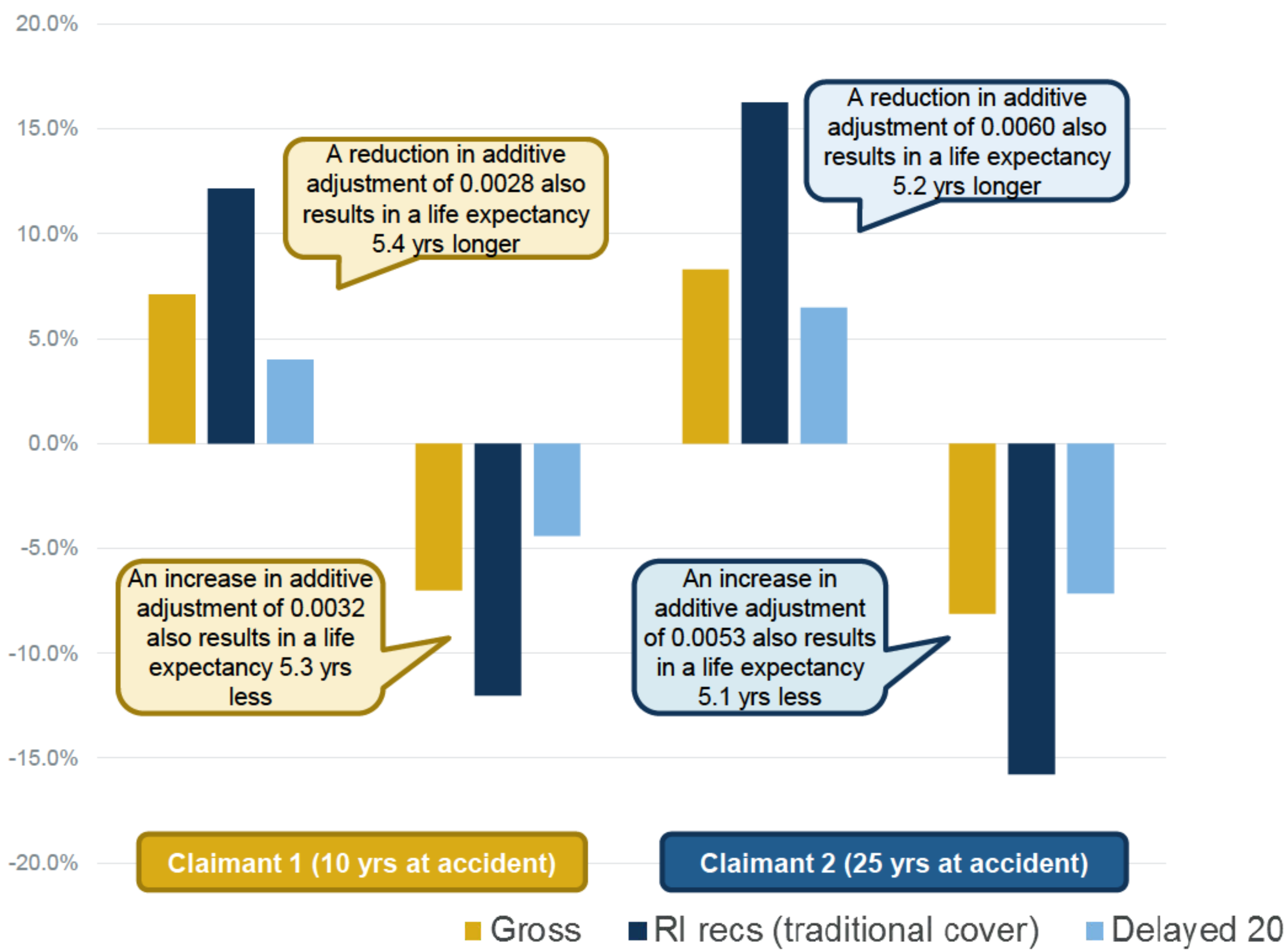
Multiplier approach



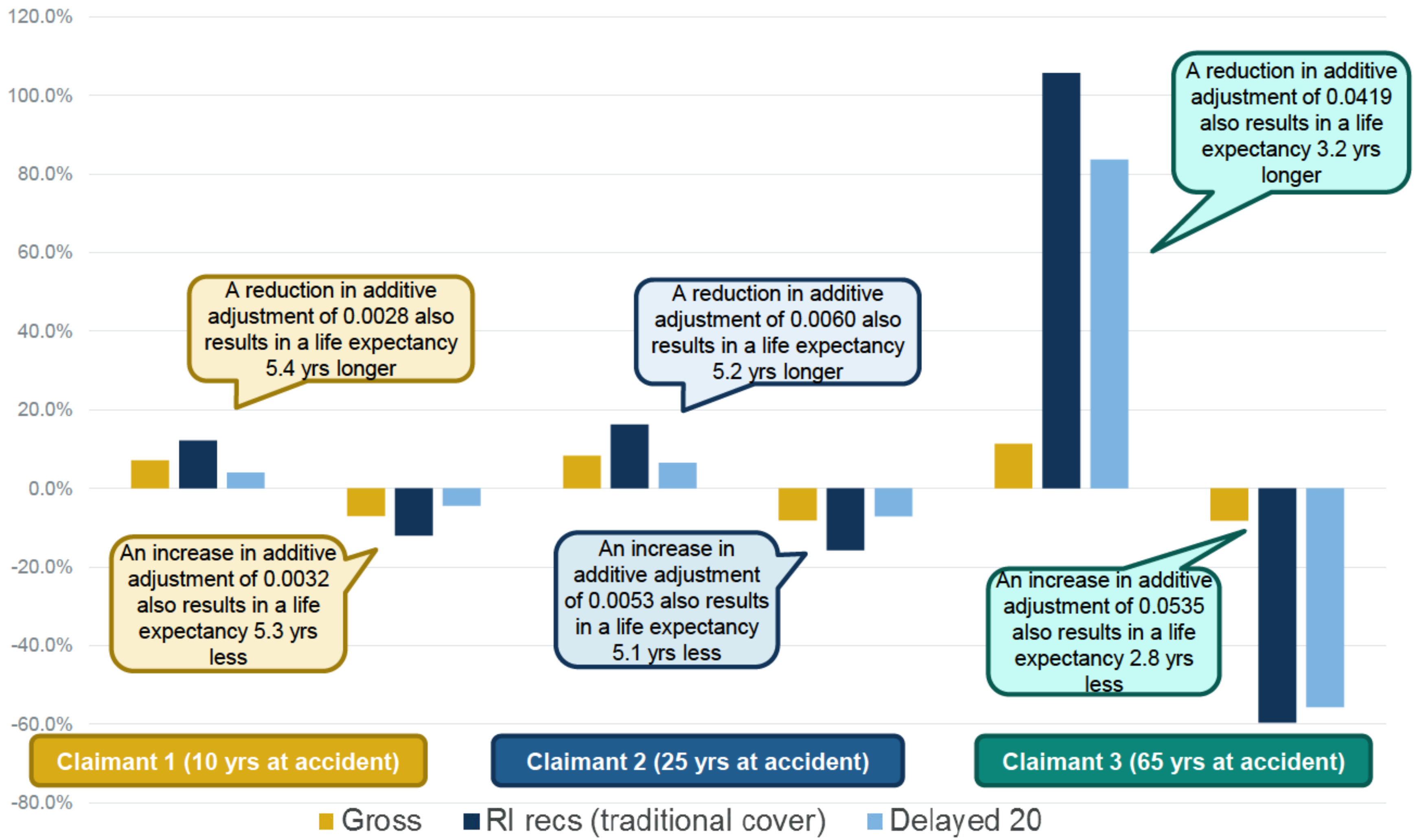
Multiplier approach



Additive approach



Additive approach



Summary of results

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

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Synopsis of relevant studies

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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.
  - Link: https://www.actuaries.org.uk/documents/periodical-payment-orders-working-party-update-giro-2015
- 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
  - Link:http://www.sciencedirect.com/science/article/pii/S0003999306004060

- Life Expectancy calculator and reference materials: http://lifeexpectancy.org/index.shtml