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PPO Working Party Update - Mortality

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22 October 2018

Session Overview

- About us
  - The purpose of the PPO Working Party Mortality Workstream is to be a focal point for the PPO Working Party on matters relating to the mortality of PPO recipients. This includes working in partnership with relevant third parties (eg universities, actuarial/ insurance consultancies) to:
    - Carry out research into the mortality experience of PPO recipients in general and segregated according to the nature/severity of their impairment(s) and other relevant factors;
    - In the longer term, construct tables of mortality rates to be available for use by actuaries engaged in the management of PPO liabilities;
    - Keep abreast of medical or social developments that could affect future trends in mortality experience and make estimates of future developments in mortality rates
- This session will give an overview of the latest work being undertaken in this area and background, covering:
  - Sources of mortality data and relevant studies
  - Future research and development plans
  - The impact of varying the modelling approach and assumptions

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Background

- For some companies, UK PPOs represent a large and growing percentage of their balance sheet. This covers companies based in the UK, as well as overseas motor insurers (e.g. based in Gibraltar which in recent times have captured up to c20% of the UK motor market). PPOs have now become a feature of the Irish market (from 1 October 2018)
- Future care worker wage inflation (ASHE 6115) and future mortality experience define the PPO exposure, together with the impact of excess of loss reinsurance cover in place
- Calculating the best estimate liability under Solvency II requires a view of the probability that each future PPO instalment will be paid. Requires an appropriate set of mortality rates to be determined for each claimant. SCR then based on a 1 in 200 stress, with that being represented under Standard Formula by a 20% reduction in mortality rates. But how appropriate is that?
- Setting mortality assumptions is relatively straightforward for a typical large book of pension annuities, but for a heterogeneous group of disabled lives it is more challenging:
  - What is the right reference mortality table?
  - How reliable are the opinions of medical experts on the expected lifespan for each case likely to be?
  - What adjustments should be made for the individual in terms of force of mortality and shape?
  - What allowance should there be for future mortality improvements?

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Why Does Longevity Estimating Matter?

- PPO Solvency II liabilities represent a very long term annual payment linked to wage inflation (typically 80th percentile ASHE 6115) discounted using very low risk-free interest rates. This is equivalent to discounting the current nominal PPO amount at a negative rate of interest, meaning payments long into the future have more significance
- Therefore, any increase in actual lifespan over expected (e.g. through mis-estimation) has a magnified impact on the actual liability value versus expected

Base PPO	
Age	34
Amount pa	£100k
Population Life Expectancy	54 yrs

	Impairment of 11 years	Impairment of 5.5 years	No Impairment
Life expectancy	43 yrs	48.5 (+12.5%)	54 (+25%)
BEL	£8.3m	£10.0m (+20%)	£11.9m (+43%)

Notes: (1) SII BEL for the typical PPO case is calculated as PV of probability weighted cash flows using assumptions at 1/7/2018 including the SII interest rate curve (2) Mortality rates are consistent with the 2014-based population projections published by the ONS (3) Gross PPO liability pre XOL reinsurance (4) Indexation based on RPI of 3.25% plus 0.5% margin for ASHE 6115.

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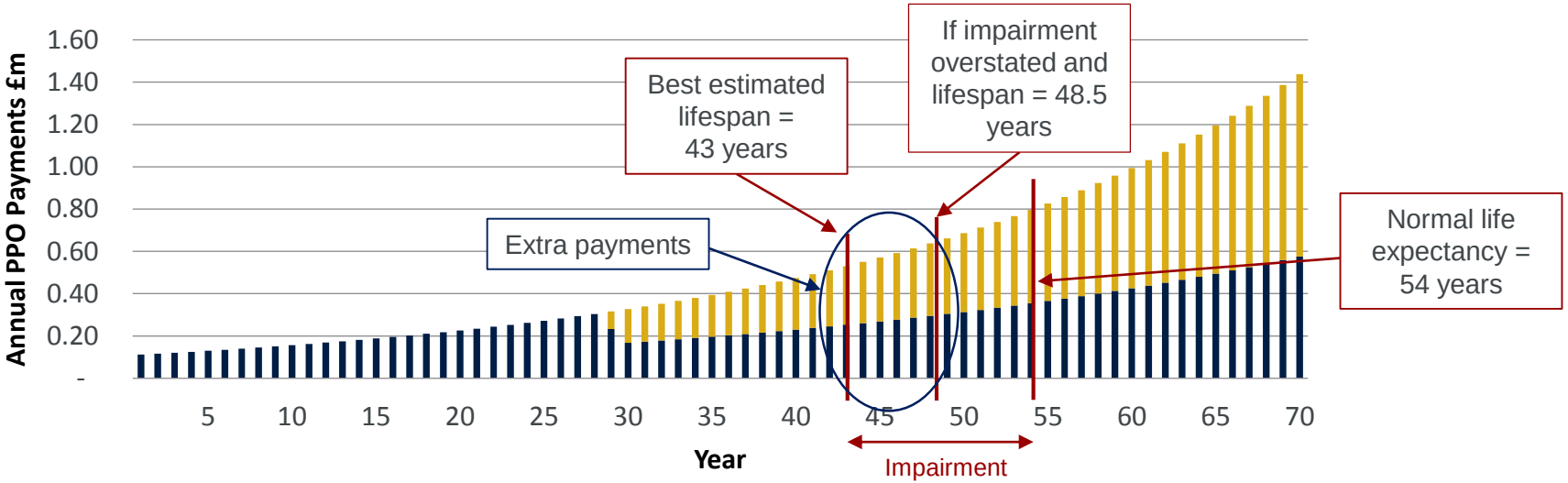
Impact of Life Expectancy Mis-Estimation

- The impact of an extended lifespan has a more material proportional impact on the XOL reinsurance BEL compared to the cedant retained BEL



Based on PPO of £100k pa with assumed ASHE 3.75% pa. Ignores Mortality. XOL cover with £5m retention (indexed from t=0). Assumes PPO starts at t=0.

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Impact of Impairment on Life Expectancy

- The start point in considering the life expectancy of PPO recipients is the life expectancy of the general population. A range of factors affect life expectancy of the general population with even more amongst people with disabilities
- Studies suggest that in non-progressive neurological disability (mainly traumatic brain injury, spinal cord injury and cerebral palsy), it is the disability itself that determines life expectancy rather than the cause of the disability
- Disabled people are as prone to the negative impact of lifestyle factors as the general population and these factors are more common – e.g. smoking, excessive drinking, lack of exercise and obesity
- Key additional factors that affect disabled lives include:
  - Immobility, with the degree of immobility being a longevity determinant. Consequent risks of pressure sores and osteoporosis leading to risk of limb fractures and more prone to respiratory and renal problems
  - Incontinence and consequent risk of infections, kidney problems etc
  - Swallowing difficulties, with those requiring tube feeding at risk of earlier death than self-feeders
  - Epilepsy, depending on seizure type and frequency
- Other factors that can affect an individual include chronic depression and suicide risk
- Plus living circumstances of the individual and quality of the care and rehabilitation package
- Do the factors that reduce life expectancy exert a separate or synergistic influence on survival?

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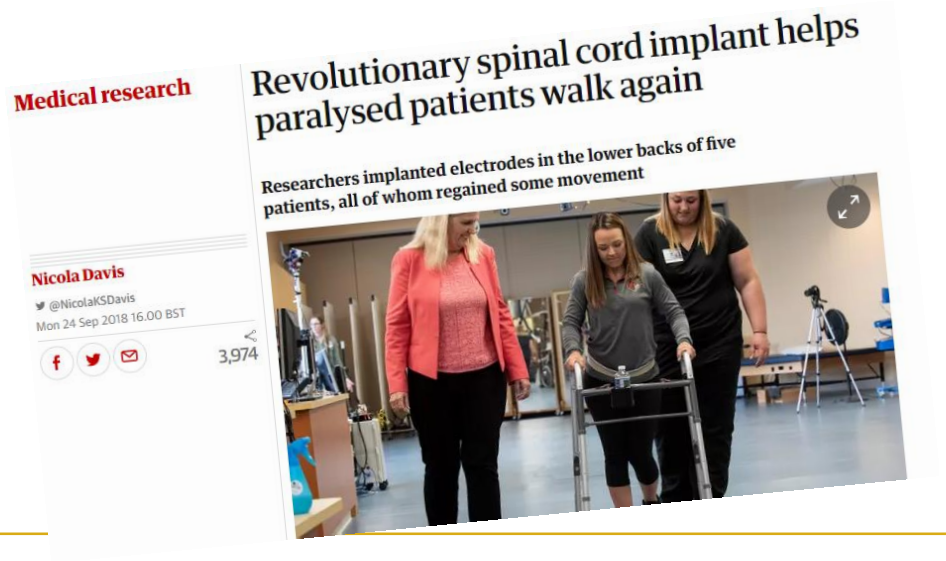
The Future?

- As treatments for the complications associated with these medical conditions continue to improve and rehabilitation techniques develop though enhanced multi-disciplinary rehabilitation support, so does life expectancy
- Also, new technologies may have a part to play



Medical research

Revolutionary spinal cord implant helps paralysed patients walk again

Researchers implanted electrodes in the lower backs of five patients, all of whom regained some movement

Nicola Davis

@NicolaKSDavis

Mon 24 Sep 2018 16.00 BST

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Sources of Mortality Data and Relevant Studies

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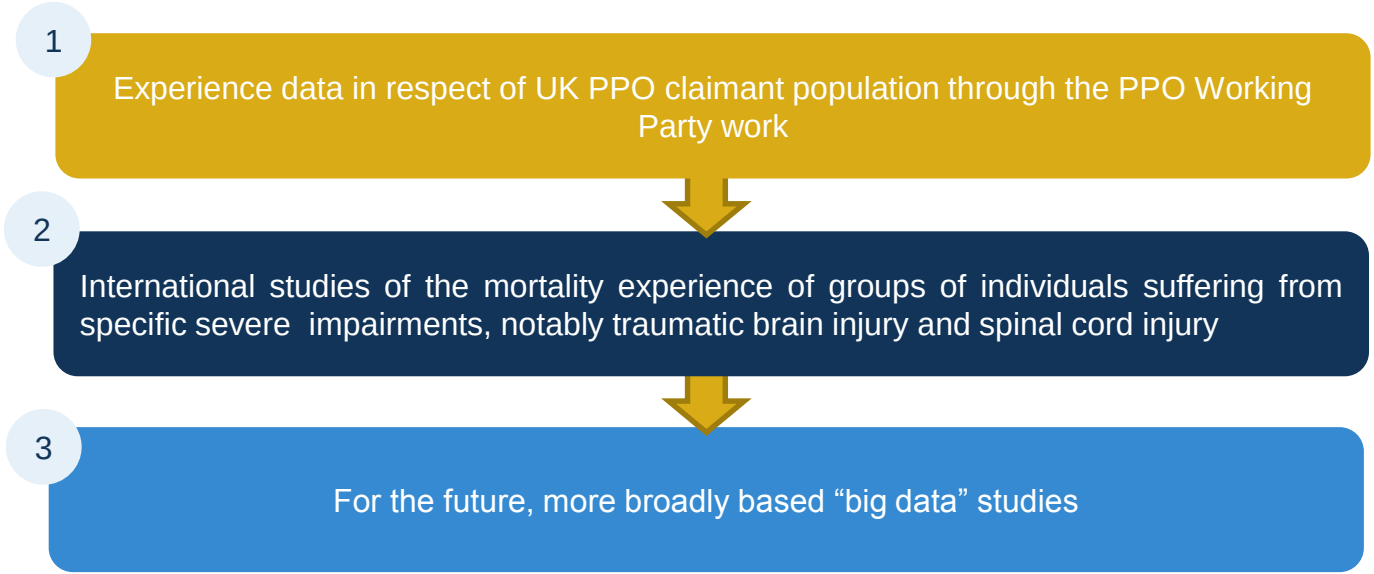
Sources of Mortality Data



But in assessing each case, statistics need to be overlayed with medical “expert judgement” based on the available individual medical, lifestyle and circumstantial information.

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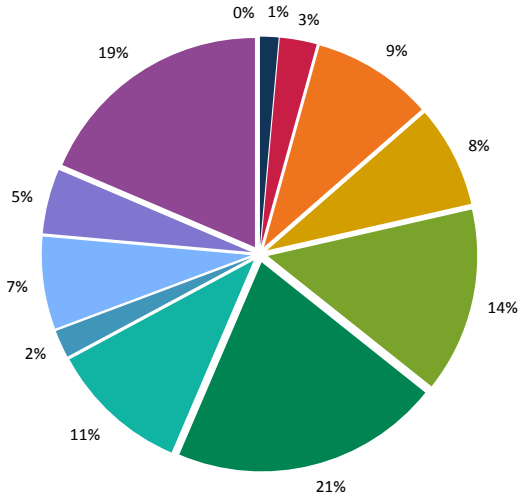
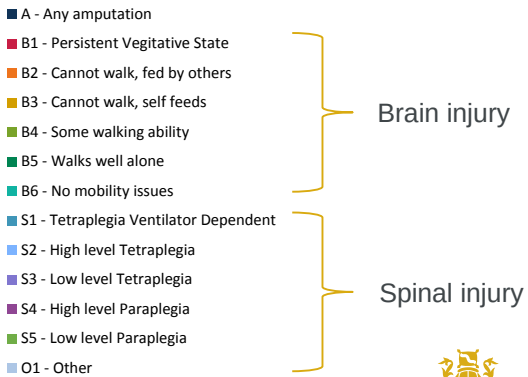
Categorisation of Injury Type

- PPO claimants represent a heterogeneous group. 70% of PPO claims relate to traumatic brain injury and 20% to spinal cord injury with the degree of impairment being a determinant of expected lifespan
- The PPO Working Party developed a categorisation with the intention that it became a standardised approach used by (re)insurers in the UK. Based on information covering 28% of motor PPO claims in the 2017 survey:





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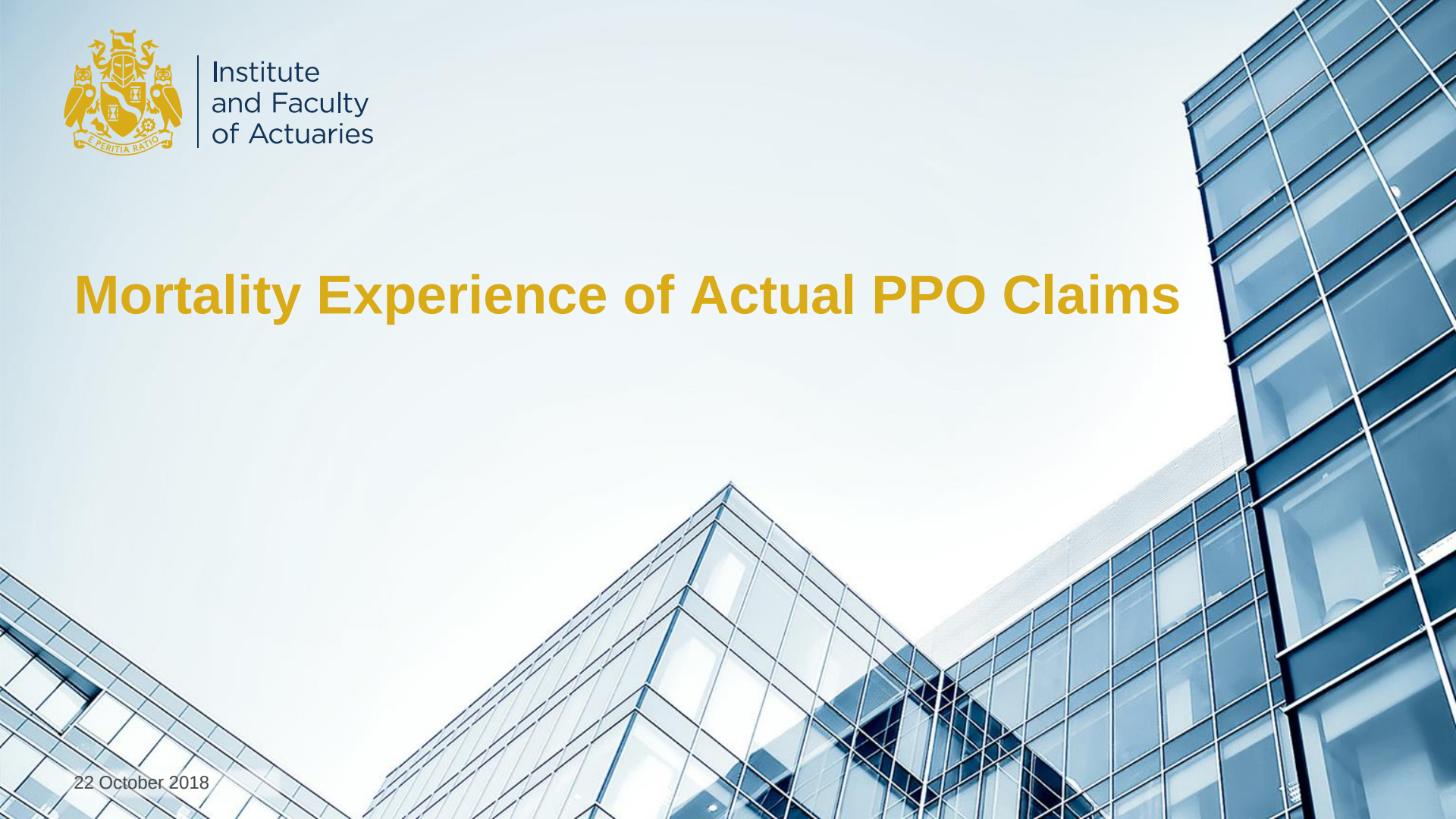

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Mortality Experience of Actual PPO Claims

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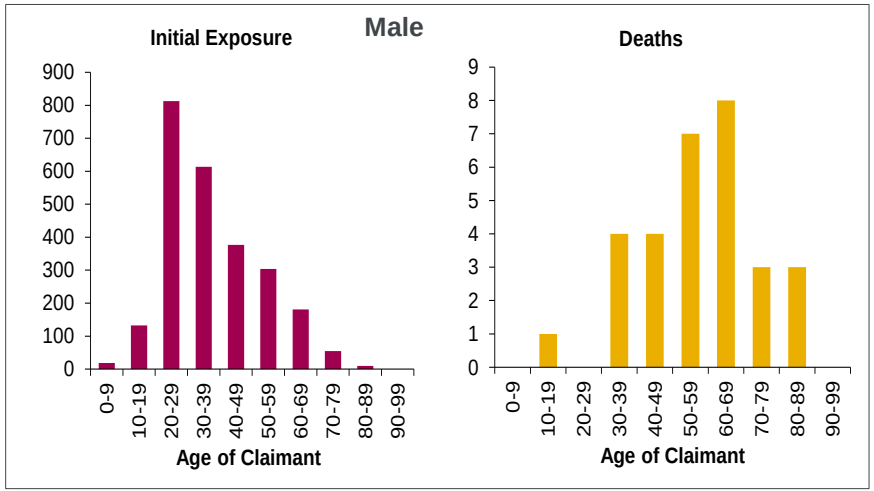
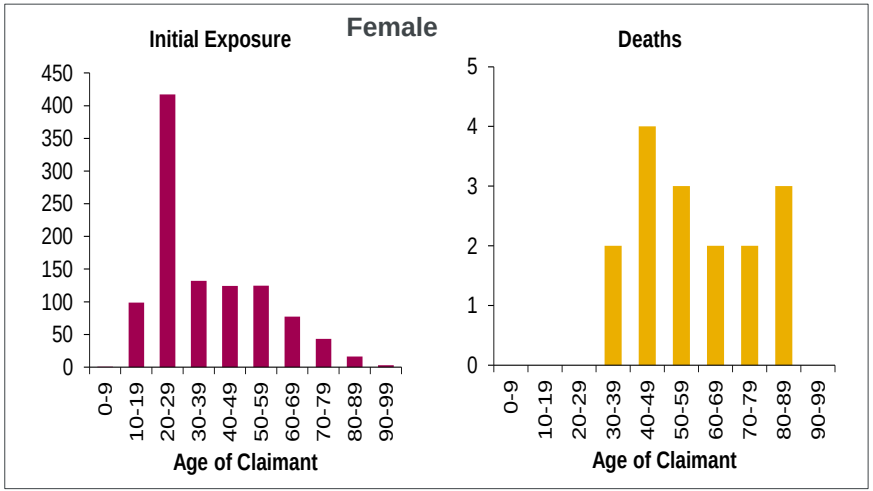
Observed PPO Mortality Experience

- Considering all PPO insurance claims combined, in total there have been 46 observed deaths since settlement





- Compares to expected number of 11.5 deaths assuming unimpaired population mortality
- Represents a multiplier of 4.0 (for male and female PPO claimants combined).

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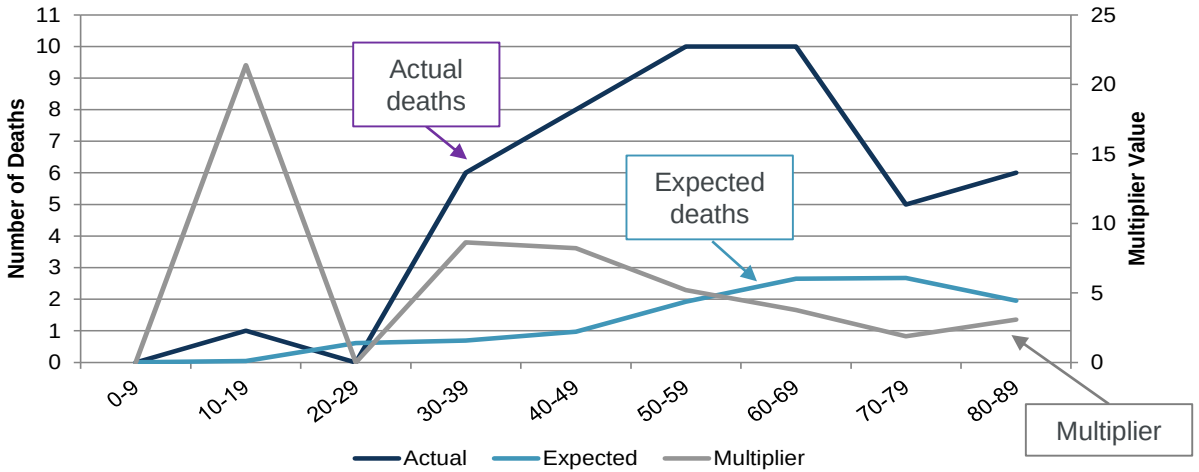
Source: PPO Working Party Update - GIRO 2017 Report. Motor (non-MIB) PPO claims, Liability PPO claims and Motor (MIB)

Observed PPO Mortality Experience

- Breaking the deaths down by age at settlement shows the following pattern:



Based on ONS forecast projections (National Life Tables, United Kingdom 2012-2014)

- But caution as small volume of data and this is experience from a relatively short 10 year period (2006 – 2016) and represents experience during the initial years post trauma when expect increased risk of death, albeit with settlement delay. At longer durations post trauma, lower multiplier likely to apply. Also, a heterogeneous group of lives, so likely to be wide range of underlying multipliers for a cohort of PPOs.

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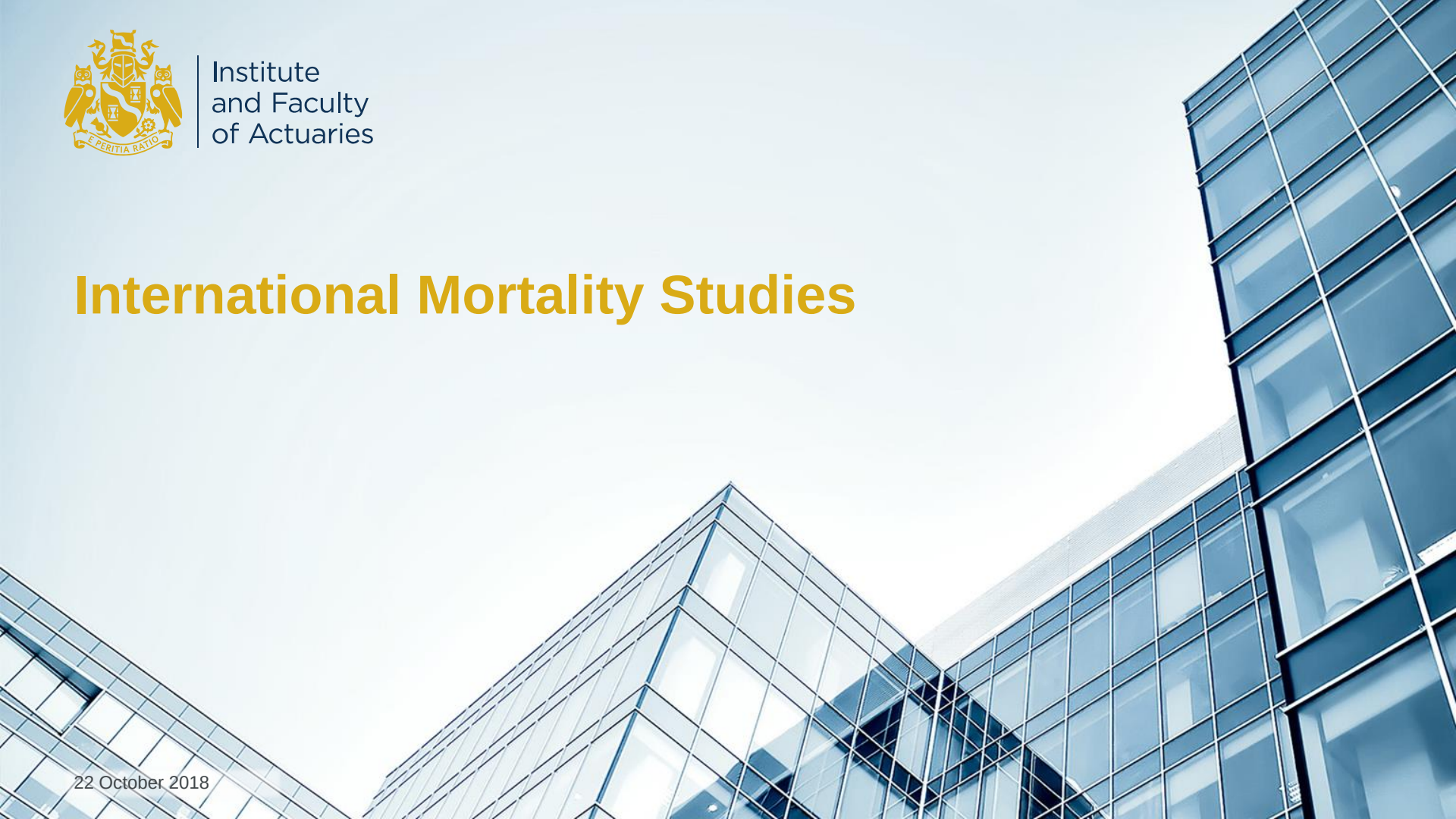

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International Mortality Studies

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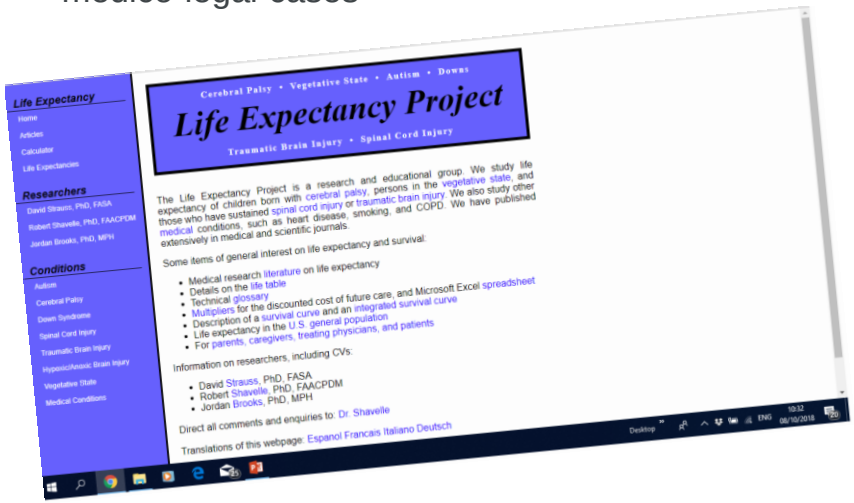
The Life Expectancy Project (“LEP”)

- The LEP is based at the University of California in San Francisco headed by statisticians Professor David Strauss and Robert Shavell. They study a wide range of conditions and the website has a wealth of information based on their own work and bibliographies of work by others. Widely used with PPOs and other medico-legal cases



- Example is their 2015 study on the long term survival after traumatic brain injury. Based on two cohorts of long term survivors of TBI. The first cohort was 7,365 people from across the US who had received care in one of the specialist Traumatic Brain Injury Model Systems (TBIMS) units. The second of 5,116 people with TBI who had received long term services from the California Department of Developmental Services (CDDS)
- Confirmed that age, gender and level of disability were significant predictors of increased long term mortality rates.

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Findings

- Authors conclude:
  - The life expectancy of persons with TBI varies considerably, from <40% of the normal life expectancy for those who do not walk and are fed completely by others to > 85% of the normal life expectancy for those who walk well alone
  - Mortality rates did not improve and the standardized mortality ratio increased over the study period from 1988 to 2010

Table 1 Life expectancy: Additional years (SE) for persons with TBI

	CDDS				TBIMS				
Sex/Age (y)	Does Not Walk, Fed by Others	Does Not Walk, Self-Feeds	Some Walking	Walks Well	Does Not Walk, Fed by Others	Does Not Walk, Self-Feeds	Some Walking	Walks Well	General Population
Female									
10	26 (1.4)	47 (1.8)	57 (1.9)	62 (1.5)	ND	ND	ND	ND	71.2
20	24 (1.6)	38 (1.7)	47 (1.8)	53 (1.4)	25 (2.5)	38 (1.6)	47 (1.7)	54 (1.7)	61.4
30	21 (1.8)	30 (1.5)	38 (1.7)	44 (1.4)	19 (1.9)	30 (1.4)	38 (1.6)	45 (1.7)	51.6
40	17 (1.9)	23 (1.3)	30 (1.6)	35 (1.3)	14 (1.4)	23 (1.2)	30 (1.4)	37 (1.6)	42.0
50	13 (2.1)	16 (1.1)	23 (1.4)	27 (1.2)	10 (1.0)	17 (1.0)	23 (1.3)	29 (1.5)	32.8
60	8 (2.5)	11 (0.9)	16 (1.2)	20 (1.0)	7 (0.8)	12 (0.8)	17 (1.1)	22 (1.3)	24.1
Male									
10	26 (1.4)	47 (1.8)	51 (1.5)	57 (1.1)	ND	ND	ND	ND	66.3
20	24 (1.6)	38 (1.7)	42 (1.5)	47 (1.1)	25 (2.5)	38 (1.6)	40 (1.1)	48 (1.1)	56.6
30	21 (1.8)	30 (1.5)	33 (1.4)	39 (1.1)	19 (1.9)	30 (1.4)	32 (0.9)	40 (1.0)	47.4
40	17 (1.9)	23 (1.3)	25 (1.3)	30 (1.0)	14 (1.4)	23 (1.2)	25 (0.8)	32 (0.9)	38.1
50	13 (2.0)	16 (1.1)	19 (1.2)	23 (1.0)	10 (1.0)	17 (1.0)	18 (0.7)	24 (0.9)	29.2
60	8 (2.4)	11 (0.9)	13 (1.0)	16 (0.9)	7 (0.8)	12 (0.8)	13 (0.6)	18 (0.8)	21.1

NOTE. The TBIMS does not contain data for persons under age 17.
Abbreviation: ND, no data.

"To summarize, the calculation of an individual's life expectancy is a complex task. Although table 1 provides a rational starting point, many other factors must be considered. For completeness, we remind the reader that the actual survival time of any particular individual may well be longer or shorter than the life expectancies reported herein. The life expectancy is the average survival time."

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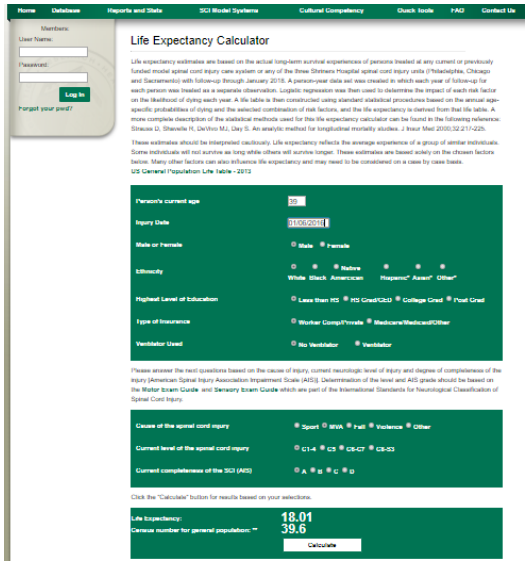
Source: Brooks JC, Shavelle RM, Strauss DJ, Hammond FM, Harrison-Felix CL (2015). Long-term Survival after Traumatic Brain Injury. Archives of Physical Medicine and Rehabilitation, 96 994 - 1005

National Spinal Cord Injury Model Systems Database

- The SCIMS Database has been in existence since 1973 and captures data from an estimated 6% of new SCI cases in the US. Since its inception, 29 federally funded SCI Model Systems have contributed data to the National SCIMS Database. As of March 2018, the database contained information on 33,016 persons who sustained traumatic spinal cord injuries. Michael De Vivo former Director.



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Other Academic Studies

- Extensive number of academic studies from the UK and around the world. Some are now quite old dating from the 1990s and so not necessarily capturing most recent advances in rehabilitation or other medical interventions, but body of work continues to grow
- An example from Israel

……with a very extensive bibliography

Survival and mortality following TBI

Zeev Groswasser and Israela Peled

TBI Research Unit, Loewenstein Rehabilitation Hospital, Raanana, Clalit Health Services, and Sackler Faculty of Medicine, Tel-Aviv University, Israel

Introduction

Survival and life expectancy are inherent issues in the study of traumatic brain injury (TBI). Estimations of these issues are complex, because the possible outcomes depend on multiple factors, like the severity of the injury, age, gender, employment, disabilities at the time of discharge from rehabilitation, socio-demographic background, previous medical history, availability of medical facilities and the speed of evacuation from the injury site to a primary care hospital. As noted by Zasler (1), the statistical methods and the parameters used may play a crucial role in the analyses (2). Parameters such as the number of participants and the number of the deceased during the follow-up period influence the statistical methods used and can lead to divergent

BRAIN INJURY
https://doi.org/10.1080/02699052.2017.1379614

ABSTRACT
Objectives. Evaluation of life expectancy (LE) post traumatic brain injury (TBI) is important for planning services for patients and for dealing with medico-legal aspects. We hypothesized that LE for patients who survived 2 years post injury is equal to that of the general population (GP).
Methods. A cohort of 279 patients (11.5%) died, creating a huge censored data (88.5%). 22–27 years. During follow-up, 32 patients (11.5%) died, creating a huge censored data (88.5%). Analyses included standard mortality ratio (SMR), Kaplan–Meier method (KM), Cox proportional hazards regression analysis (PH) and calculations of life expectancy.
Results. About 77% of the patients were under 35 years of age at injury. This age cut-off point yielded differences for survival longevity by χ^2 tests ($p < 0.0001$), by KM analysis ($p < 0.0001$) and by Cox PH regression analysis ($p < 0.0001$, HR = 13.95). SMR for the entire cohort was 1.86. Shortening of LE in comparison with the GP is 3.58 years. Estimated shortening of LE by severity for mild, moderate and severe injury were ~0.51, 4.11 and 13.77 years, respectively.
Conclusions. Patients with mild TBI have a LE similar to the GP, and a reduction in LE was closely related to moderate and severe brain injury.

ARTICLE HISTORY
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KEYWORDS
TBI; severity of injury; life expectancy

A. Causes of death following 1 year post injury among individuals with traumatic brain injury. J Head Trauma Rehabil. 2006;21:22–33. doi:10.1097/00001199-200601000-00003.
12. Ratcliff G, Colantonio A, Escobar M, Chase S, Vernich L. Long-term survival following traumatic brain injury. Disabil Rehabil. 2005;27:305–14. doi:10.1080/09638280400018338.
13. Liddell FDK. Simple exact analysis of the standardised mortality ratio. J Epidemiol Community Health. 1984;38:85–88. doi:10.1136/jech.38.1.85.
14. Bagley II, Nott MT, Slewa-Younan S. Long-term mortality trends in functionally-dependent adults following severe traumatic-brain injury. Brain Inj. 2008;22:919–25. doi:10.1080/02699050802448578.
15. Colantonio A, Escobar MD, Chipman M, McLellan B, Austin PC, Mirabella G, Ratcliff G. Predictors of postacute mortality following traumatic brain injury in a seriously injured population. J Trauma. 2008;64:876–82. doi:10.1097/TA.0b013e318044493e.
16. Harrison-Felix CL, Whiteneck GG, Jha A, DeVivo MJ, Hammond FM, Hart DM. Mortality over four decades after traumatic brain injury rehabilitation: A retrospective cohort study. Arch Phys Med Rehabil. 2009;90:1506–13. doi:10.1016/j.apmr.2009.03.015.
17. Baguley I, Slewa-Younan S, Lazarus R, Green A. Long-term mortality trends in patients with traumatic brain injury. Brain Inj. 2000;14:505–12. doi:10.1080/026990500120420.
18. Cameron CM, Purdie DM, Kliewer EV, McClure RJ. Ten-year outcomes following traumatic brain injury: A population-based cohort. Brain Inj. 2008;22:437–49. doi:10.1080/02699050802060621.
19. Kao TW, Huang JW, Hung KY, Chang YY, Chen PC, Yen CJ, Chen YM, Chu TS, Wu MS, Tsai TJ, et al. Life expectancy, expected years of life lost and survival of hemodialysis and peritoneal dialysis patients. J Nephrol. 2010;23:677–82.
20. van Straten AHM, Soliman Hamad MA, van Zundert AAJ, Martens EJ, Schönberger JPAM, de Wolf AM. Preoperative renal function as a predictor of survival after coronary artery bypass grafting: comparison with a matched general population. J Thorac Cardiovasc Surg. 2009;138(4):971–76. doi:10.1016/j.jtcvs.2009.05.026.
21. Stavem K, Guldvog B. Long-term survival after epilepsy surgery compared with matched epilepsy controls and the general population. Epilepsy Res. 2005;63:67–75. doi:10.1016/j.eplepsyres.2004.11.003.
22. Bramer S, Ahm VS, Soliman Hamad MA, Berrekloww E, Martens EJ, Maessen JG. The impact of preoperative atrial fibrillation on

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Proposed Research Study

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Research Using UK “Big Data”

- The number of PPOs in force is currently small and extends over only a 10 year period and there is a question over how relevant studies from California or elsewhere are in a UK context. Therefore another source of data on lives which suffer from the impairments normally associated with PPOs in a UK context is required
- Two possible approaches:
  - **Period study**: considering the mortality experience of a large group of lives over a short period (e.g. 1 – 3 years) and deriving mortality rates according to, say, age, gender, type of impairment and severity of impairment. Depending on the size of the data base and the information available, other factors could be also brought into account – e.g. smoker status, geographical area, type of care being received
  - **Cohort study**: Following up a large number of lives over a prolonged period to enable trends in mortality experience to be identified
- There are large UK medical databases that potentially could be used as the basis for such a study and the PPO Working Party is developing a proposal to commission an academic institution to undertake such a study
- The Actuarial Research Centre has provisionally agreed to fund the study and is interested in attracting support from a small number of (re)insurers to help shape and fund that work
- The possible databases under consideration are CPRD and THIN.

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UK Data Sources

CPRD – Clinical Practice Research Datalink

- A research service which is jointly sponsored by the Medicines and Healthcare Products Regulatory Authority and the National Institute for Health Research, as part of the Department of Health and Social Care
- Collects de-identified patient data from a network of GP practices across the UK, linked to a range of other health related data providing a longitudinal, representative UK based health dataset which is “invaluable for the study of chronic diseases or conditions”
- Data encompasses over 35 million patient lives, including 10 million currently registered patients

THIN – The Health Improvement Network

- Established in 2002, the THIN data available for research includes the electronic medical records from over 17 million patients in the UK, 3.1 million of which are registered with actively contributing THIN GPs
- Data is continuously updated and can be followed longitudinally
- Data includes non-identified data about demographics, consultations, medication etc.

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An Example Current Actuarial Study

- A comparable study is the research programme “Use of Big Health and Actuarial Data for Understanding Longevity and Morbidity Risks” which is being undertaken by the School of Computing Sciences at the University of East Anglia and funded by the Actuarial Research Centre
- The UEA team is using The Health Improvement Network (THIN) primary care data to develop statistical models of longevity and morbidity
- In their presentation during the ARC Webinar on 17 September 2018 they explained:
  - The advantage of using individual level medical data is that it is possible to model both the uptake of medical treatment and the effect of that treatment on longevity conditional on the individual sociodemographic and health factors instead of the aggregated profile.
  - Survival models, usually the Cox’s regression, are fitted to individual level data with the conclusions being generalisable to the general population
  - The conditions and interventions being considered by the project cover: • Statin prescription • Intensive systolic blood pressure control • Stroke • Diabetes Mellitus Type 2 • Hormone Replacement Therapy
- The hope is that this approach can be adopted to examine the various PPO disabilities
- Scoping work and tendering process planning underway. Initial results in 2019.

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Modelling Considerations

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Questions

Comments

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