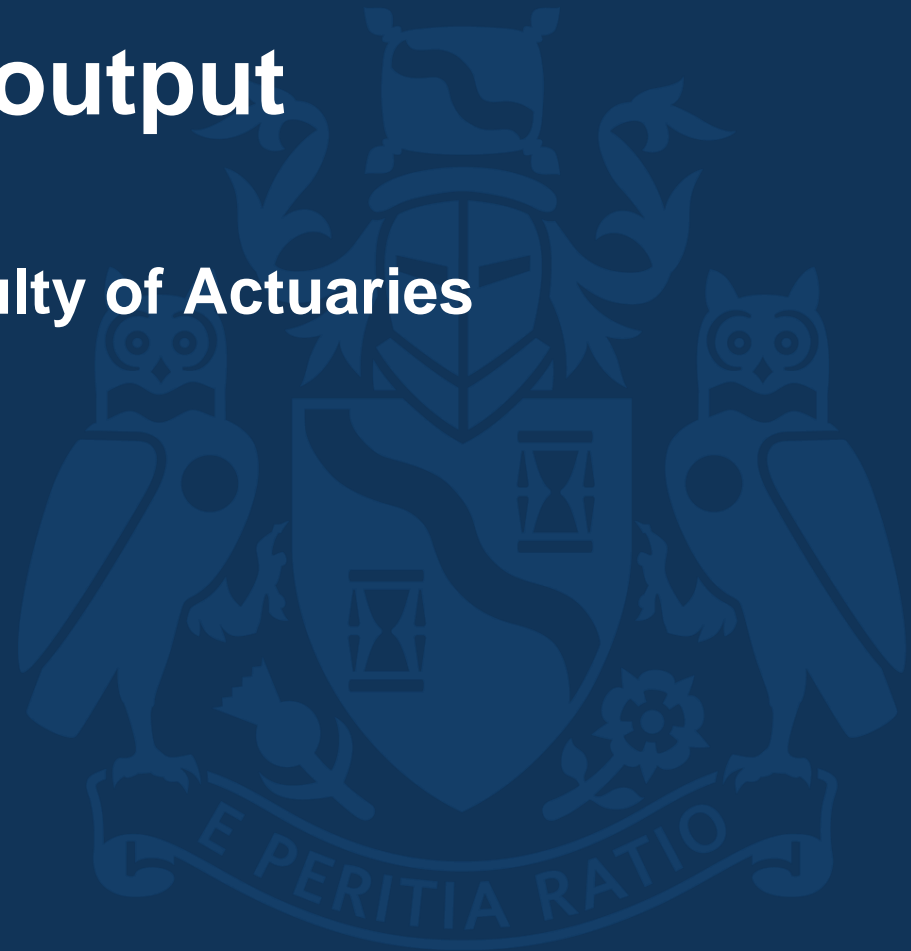




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Long and Short Term Survival of Total Hip Replacement Cases in United Kingdom

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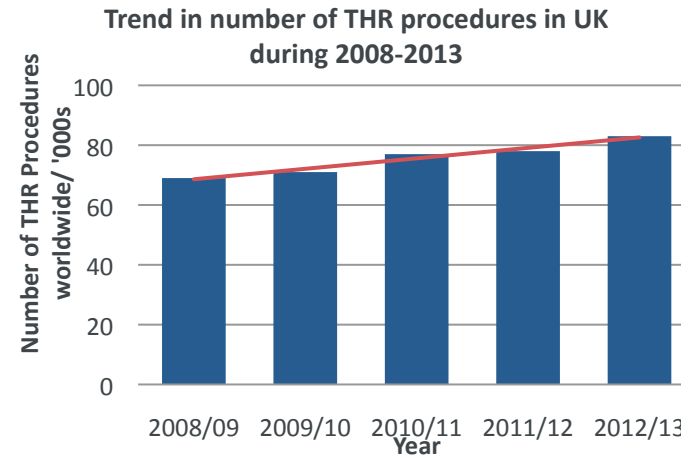
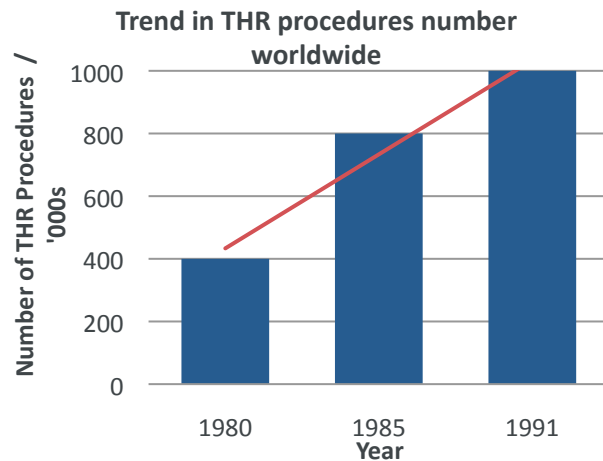
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12th January 2015

Contents

- **The actuarial implications of an increasing number of THR procedures**
- **The THIN Study - A frailty survival analysis study of 10,155 THR cases in England, Wales and Northern Ireland**
- **THR cases die earlier than matched controls in the short and long term**
- **Actuarial implications of higher mortality risk after THR**
- **Current research**

Increasing trends in THR procedures



An increasing number of THR procedures carried out across many countries (Levy, et al., 1985 and Soderman, 2000) while in UK alone, there is a yearly increase of 8% (NJR Report 2013).

Actuarial implications

- Possible increasing number of THR procedures among population of customers buying life assurance, pension and annuity products.
- Does this give rise to mortality/longevity risk and eventually basis risk?
- Impacts of benefits allocation to customers with THR procedures, for example enhanced benefits.

A Review of Literature on Mortality Risk after THR Procedures

- Identified 30 published articles reporting mortality risk after THR procedures

	Follow-up Time After THR	Do THR Cases survive longer than controls?	No. of Studies
Short Term	0-30 days	Yes	3
	0-30 days	No	1
	30-90 days	No	5
	1 year	Yes	4
Long Term	2 years	Yes	1
	2-5 years	Yes	4
	2-5 years	No	2
	5-10 years	Yes	5
	5-10 years	No	2
	10-15 years	Yes	5
	15-20 years	Yes	2
	20+ years	Yes	2

- No conclusive pattern in reported mortality risk between THR patients and controls
- Medical studies with selected participants from one particular hospital
- No account of grouping and spatial effects of patients/residential ward
- Social factors such as deprivation/mosaic score are not included in analysis

The THIN Study

Purpose

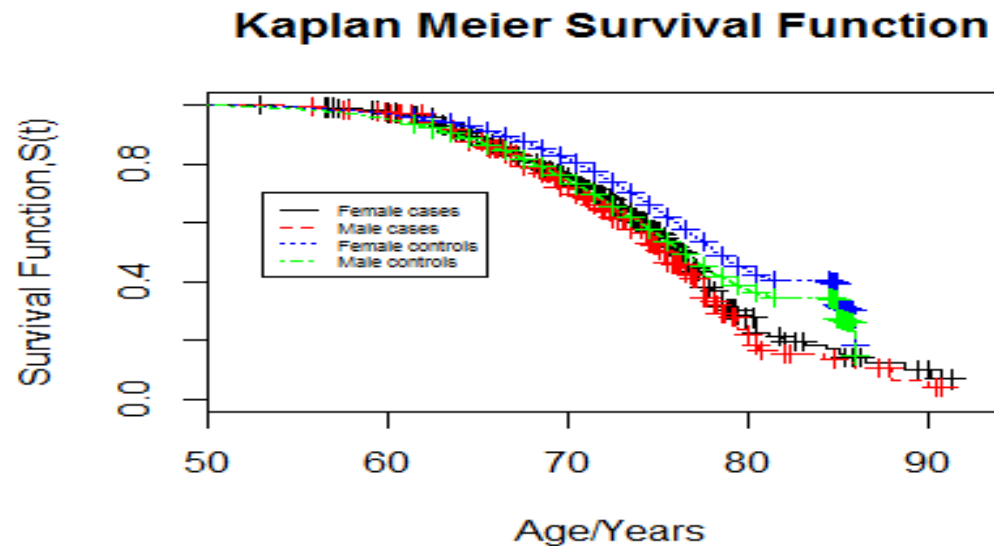
- A retrospective cohort matched study design.
- To study the direct effects of THR procedures on short and long term survival for individuals with different characteristics.

Patients Selection

- Identified 10,155 primary THR cases and 49,557 controls from THIN database.
- Assumed same exposure to death for patients in same GP practice matched by age and sex.
- Demographical, lifestyle, medical and geographical variables were extracted.

Statistical Analysis

Preliminary analysis



- Include deaths in short and long term.
- Cases survive less than controls.
- Female cases survive less than female controls.
- Male cases die earlier than male controls.
- Female cases survive longer than male cases.

The Survival Model – Frailty Cox Model

$$\lambda_{ki}(t) = \varepsilon_k \lambda_0(t) \exp(\beta^T Z_{ki})$$

- Post-THR hazard of death for i^{th} individual from the K^{th} GP Practice.
- ε_k measures the frailty associated with each GP Practice.

Statistical Analysis

THIN Project – Summary of Results

Short-term v/s Long-term results

- Deaths within 2 years - 968 THR cases died within 2 years of surgery.
- Higher risk of deaths associated at the early post-surgery stages (≤ 2 years).

Cases vs Controls	Estimation of hazard of death	
	THR cases dying within 2 years of surgery	THR cases surviving beyond 2 years post-surgery
<i>Controls</i>	1.00	1.00
<i>Cases</i>	1.49	1.08

Variability of hazard of death post-THR surgery

- Males THR cases have a **higher** post-THR risk of death than female.
- Being overweight **increases** hazard of death post-THR in the short term only.
- Post-THR risk of death **increases** with the deprivation score of the individuals residential area (1.00-1.19) in the short and long term.
- **Higher** hazard of deaths post-THR surgery (1.08-1.20) in residential areas with high proportion of white individuals ($\geq 40\%$).

Statistical Analysis

THIN Project – Summary of Results

Variability of hazard of death post-THR surgery

- Being a THR patient and having one of these comorbidities pre-surgery time **increases** the hazard of death after THR procedures: **high cholesterol (with or without medication), hypertension, osteopenia, osteoporosis and myocardial infarction.**
- Having **Type II diabetes** pre-surgery **decreases** post-THR risk of death by 2% and 3% in the short and long term.

Conclusion

- Gender, Year of birth, BMI pre-surgery time, Townsend score and proportion of white individuals living in same area of individuals, BP, Cholesterol level and event of MI prior to THR have a **direct impact** on **risk of death** for **THR cases** after surgery in the **short** and **long** term.

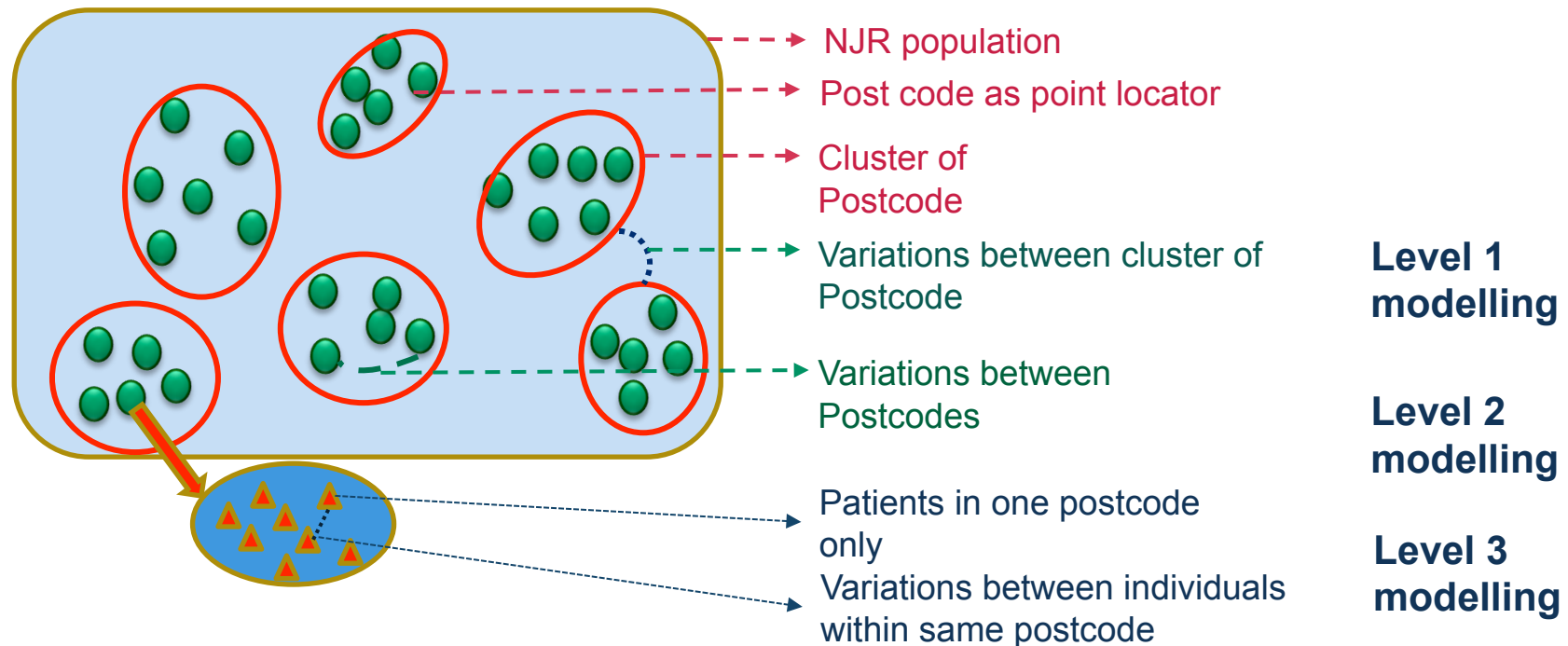
THIN Project – Implications of Results

- The THIN study demonstrated that THR procedures alone increase the risk of death by 49% and 8% in the short and long term respectively – Higher mortality associated with THR customers.
- This is a source of basis risk for actuarial assumptions and a concern for the life assurance, pension and annuities selling industry
- Higher mortality risk for life assurance.
- Premiums, reserve and benefits calculations need to take account of the 'THR procedures' factor.
- Reduced longevity risk for pension and annuity businesses
- THR customers can be granted additional bonuses besides their basic pension benefits.
- Annuitants can be allowed to receive enhanced annuities.

Further Research

NJR Project – An Overview

- Permit full spatial survival analysis.
- 3 level Survival model - An extension of the shared frailty model used for THIN analysis.





Questions



Comments