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Extending the Critical Path

A presentation by the
Critical Illness Definitions and
Geographical Variations Working Party

17 February 2014

Agenda

- Background
- Hospital Episodes Statistics data set
- Methodology for aggregate population rates table CIBT08
- Example: Cancer
- CIBT08 composition by illness
- Comparisons with CIBT02 and ACL04
- Geodemographic variation investigations
- Discussion and questions

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Background

Evolution of a Working Party

2009
- Health & Care PEC launches member-led research initiative

2010
- CI Working Parties form late in 2010 and select two topics:
- **ABI+/non-ABI Definitions** & **Geographical Variations**

2011
- HES data request submitted
- Desk-based research commences

2012
- HES data analysis begins
- Initial findings presented at Health & Care Conference

2013
- Working parties merge with revised aims, including CIBT08
- Final report and presentation December 2013

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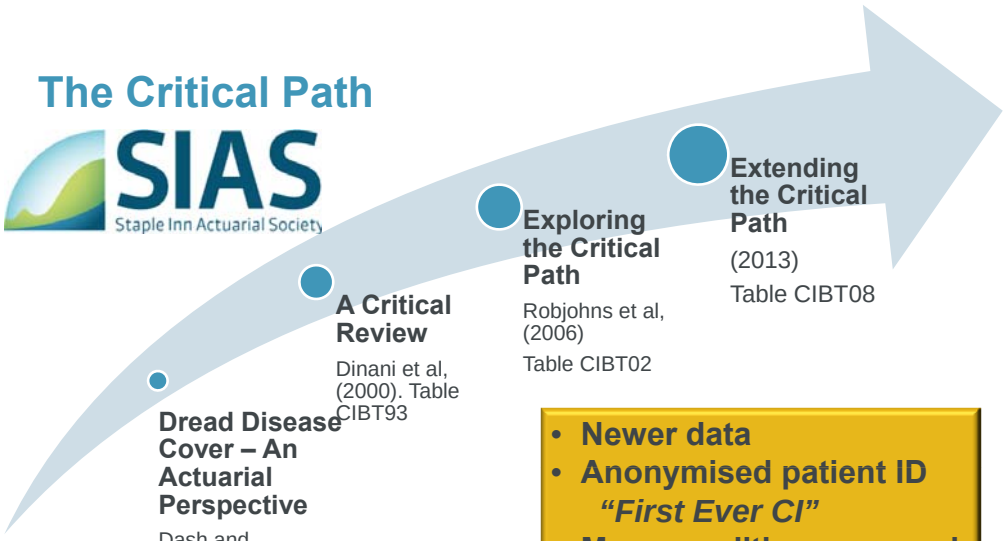
The Critical Path

SIAS
Staple Inn Actuarial Society



Dread Disease Cover – An Actuarial Perspective
Dash and Grimshaw (1990)

A Critical Review
Dinani et al, (2000). Table CIBT93

Exploring the Critical Path
Robjohns et al, (2006)
Table CIBT02

Extending the Critical Path
(2013)
Table CIBT08

- **Newer data**
- **Anonymised patient ID**
  "First Ever CI"
- **More conditions covered**
  Market forces
- **Geodemographic data**

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What is in the 2013 report?

- Data and methodology overview
- Illness-by-illness analysis
  - Cancer, Heart Attack, Stroke

  PLUS
  - 36 other CIs (in alphabetical order) of which:
    - 17 are ABI standard
    - 16 are non-ABI full payment
    - 3 are non-ABI partial benefits and not included in CIBT08
    - No TPD
- CIBT08 tables
  - Compared with CIBT02 and ACL04

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Report layout for each illness

- What is it?
- Symptoms & treatment
- Risk factors
- Insurance industry definitions
- **Derived incidence rates**
- **Geodemographic analysis** *selected conditions only*

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Working Party members

- Peter Banthorpe
- Phil Cleverley
- Christine Fairall
- Adele Groyer
- Jennifer Loftus
- Ketiwe Nhende
- Christopher Reynolds
- Daniel Ryan
- Matthew Smith
- James Tait
- Neelish Tiwari

- Thanks also to
  - CACI & Experian
  - Health & Social Care Information Centre
  - Oracle for MySQL (free)
  - Institute & Faculty of Actuaries
  - Former Working Party Members Aaron Tindale & James Shattock
  - Neil Robjohns and authors of “Exploring the Critical Path”

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HES data

Hospital Episodes Statistics data set

- Seriatim data of all finished consultant episodes in NHS hospitals
  - Inpatient and outpatient data
- Data years 1989/90 to 2009/10 received
  - 1997/98 to 2009/10 are coded with unique patient identifiers
- 18 million records for 2009/10 alone!

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What the HES data looks like

Patient Identifier	Unique identifier by patient – 47m of these
Basic Patient Information	Age, gender
Basic Episode Information	Date started, date finished, admission method, current status etc
Diagnosis Information	Up to 20 different diagnoses
Procedure Information	Up to 20 different operations, with date of operation
Geographical Information	Postal district, Lower Super Output Area, IMD Rank, Mosaic Type, ACORN Type, Health ACORN type

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Example data

DIAG_01	DIAG_02	DIAG_03	DIAG_04	DIAG_05	DIAG_06	DIAG_07	DIAG_08	DIAG_09	DIAG_10	DIAG_11	DIAG_12	DIAG_13	DIAG_14
I423-	J439-	Z539-											
I499-	-												
I270-	I424-	I270-	J439-	I48X-	E039-								
S6250D	W198-A												
J181-													
J181-													
I423-	I48X-	I501-	J439-										
I423-	I48X-	I501-	J439-										
I48X-	I424-	J439-	I959-										
I270-	I509-	J449-	J90X-	J439-	I48X-								
I423-	I48X-	I501-	J439-										
R14X-	R060-	I423-	I48X-	I501-									
E876-	I500-	I48X-	E058-	Y522-									
J22X	I423	J439											
K621													
K602	E059	I424	I500										
I423	I48X	I10X	J439										
I424-	I48X-	I500-	I270-										
L918	D227												
I500-	S220-	X599-	I270-	I423-	J439-	J459-	Z950-	Z921-					
I424-	I500-	I270-	I081-	I48X-	E032-	Y522-	J439-	J459-					
K602	E059	I424	I500										
R074	I48X	J439	E039	J841	I423								
I423	I48X	I10X	J439										
I424-	I500-	I48X-	J439-	Z877-									
I425	Z048												
I424-	Z450-	I500-	I48X-	T462-	Y522-	E079-	Z867-						
J22X-	R060-	T818-	Y831-	Z950-									
I500-	I429-	I48X-	I270-	J439-	K602-	K625-							
I424-	I48X-	I500-	T462-	Y522-	E079-	Z950-	Z867-						
M1097	I10X	I48X	I500	E059	J449								
I500-	I429-	I48X-	I270-	J439-	K602-	K625-							
I500-	I424-	I48X-	I270-	Z950-									
I500-	I424-	I48X-	I270-										
E876-	I424-	I517-	I48X-	I270-	Z950-								
E876-	I424-	I517-	I48X-	I270-	Z950-								
I081-	I424-	I517-	I48X-	I270-	I959-	J439-	M8190	Z950-					
I424-	I500-	I48X-	I270-	L52X-	L270-	K148-	R061-	Y041-	R55X-	I10X-	J439-	M8199	Z950-

20 Diagnosis codes

Each record is an individual episode

Each ICD code could appear multiple times as a primary diagnosis (DIAG_01) or in secondary diagnosis fields

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Analysing the Data - a SQL algorithm

Single Life (HES_ID) → Derive complete episode history

20 diagnoses/ operations for each episode → Define the "order"

Choose the first event of interest

Map CIs to ICD-10 codes

All Data	Simply a sum of all episode counts that match the ICD/OPCS coding
First Ever	A sum of all episode counts that match the ICD/OPCS coding where only 1 is permitted per life
First Ever CI	A sum of all episode counts that match the ICD/OPCS coding assuming there is no relevant medical history that could qualify as a CI claim. Only 1 count is permitted per life.

Example to explain different HES counts

LEAD IN 1997 - 2006

INVESTIGATION 2007 - 2009

2005
- Heart attack

2008
- Cancer

2009
- Heart attack

	2008 Cancer	2009 Heart attack
All	1	1
First ever	1	0
First ever CI	0	0

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HES data adjustment and limitations

- Remove day cases and unfinished episodes
- Limitations
  - England only
  - No private hospitalisations / non-hospitalised treatments
  - No sudden deaths *we used other data sources to adjust for this*
  - Coding changes over time
  - Incompleteness of older data, especially multiple diagnoses
  - Inconsistencies between individual coders
  - Multiple HES IDs for one patient

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Methodology for CIBT08 rates

Summary of data inputs: CY 2007 - 2009

- HES first ever & first ever CI counts
- Sudden deaths (various research sources)
- Population count (ONS data, adjusted for 2011 census)
- Population prevalence of all* CIs (various research sources)
- 28-day mortality rates (various research sources)
  - for standalone rates only
- Proportion of deaths per illness (ONS Mortality in the 21st Century)
- Population death rate (ONS England Interim Life tables 2007-9)
- Graduated each of these using penalised B-splines

** Cancer, Heart Attack & Stroke only*

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Rate calculation steps

A: Crude first ever incidence

First ever HES count PLUS Sudden deaths	Gross population (ONS 2007 – 2009)

↓

B: Crude first ever CI incidence = A x (1- Overlap)

Overlap = First ever CI HES Count / First Ever HES Count

↓

E: Derived incidence rate (Ix)

First ever CI HES count PLUS Sudden deaths	Gross population LESS "All" CI Prevalence

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Standalone CI rates

E: **Derived incidence rate** (Ix)

First ever CI HES count PLUS Sudden deaths

Gross population LESS "All" CI Prevalence

G: **Standalone CI incidence rate (I'x)**
= Ix * (1 – 28-day mortality rate)

Convert from an "m_x-type" figure to q_x

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Accelerated CI rates

J: **Addition for Accelerated CI** ($I_x – k_x.m_x$)

First ever CI HES count PLUS Sudden deaths

Gross population LESS "All" CI Prevalence

Kx.mx = Proportion of population deaths in respect of that illness

Total accelerated rate all CIs
=$\Sigma_{\text{all CI}}$ $I_x + (1– \Sigma_{\text{all CI}} k_x).m_x$

Convert from an "m_x-type" figure to q_x

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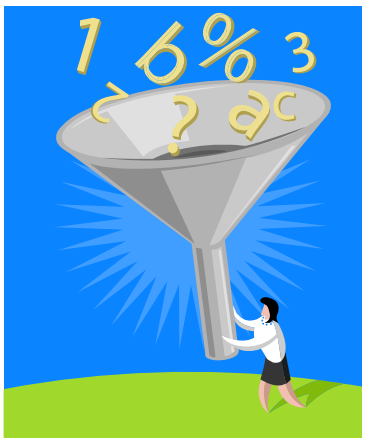
Main differences vs CIBT02: Data

- HES only
- Different ICD-10 codes used in places
  - e.g. Benign Brain Tumour rates increased significantly because of this
- No adjustment for insurance definition severity unless HES data allows this



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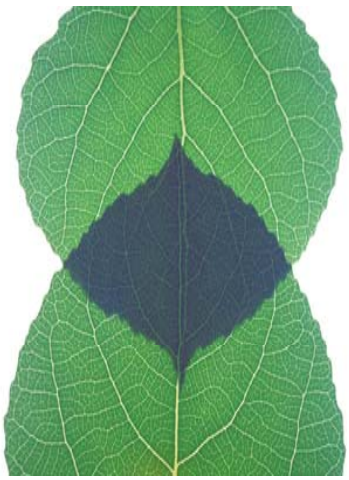
Main differences vs CIBT02: Method



- First ever calculated from data
  - not wider research
- Only adjustment to crude count is sudden death
- Remove all prior CI's from hospitalisations (overlap)
- Population denominator is reduced by prevalence of all* CIs
  - Largely offsets effect of the change to all CI overlap

* Cancer, Heart attack & Stroke only

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Example: Cancer

Insurance definition

Cancer – excluding less advanced cases (2011)

Any malignant tumour positively diagnosed with histological confirmation and characterised by the uncontrolled growth of malignant cells and invasion of tissue.

The term malignant tumour includes leukaemia, sarcoma and lymphoma **except cutaneous lymphoma (lymphoma confined to the skin).**

For the above definition, the following are not covered:

- All cancers which are histologically classified as any of the following:
  - pre-malignant;
  - non-invasive;
  - cancer in situ;
  - having borderline malignancy; or
  - having low malignant potential;
- All tumours of the prostate unless histologically classified as having a Gleason score greater than 6 or having progressed to at least clinical TNM classification T2N0M0.
- Chronic lymphocytic leukaemia unless histologically classified as having progressed to at least Binet Stage A.
- Any skin cancer (including cutaneous lymphoma) other than malignant melanoma that has been histologically classified as having caused invasion beyond the epidermis (outer layer of skin).

- All versions of ABI Statement of Best Practice definitions are reproduced.
- Examples of ABI+ versions are provided.
  - e.g. all skin cancers that have metastasised
- For other CIs examples of non-standard ABI definitions are provided.

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Cancer population CI incidence (males)

Age Band	20-39	40-59	60-79
Smoothed, Interpolated Crude Rate	5.92	31.25	166.96
Adjustment for Overlap	-6.9%	-9.8%	-21.5%
Prevalence Rate	0.7%	5.5%	25.3%
Derived Incidence Rate I_x	5.55	30.11	180.57
28 Day Mortality Rates	-0.6%	-0.9%	-1.1%
Stand Alone Rates I'_x	5.51	29.83	178.42
Mortality Rates	9.15	36.28	219.94
Proportions of Deaths k_x	10.1%	26.0%	37.2%
Addition for Accelerated Rates $I_x - k_x q_x$	4.57	19.30	103.74

Rates are per 10,000 population

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Cancer changes vs CIBT02

- Now includes overlap with all other prior CIs
- Additional ICD-10 codes D45, D46 and D47 (3%)
- Updated prevalence statistics (to reduce population count denominator)
- Updated survival rates (used in 28-day mortality adjustment)

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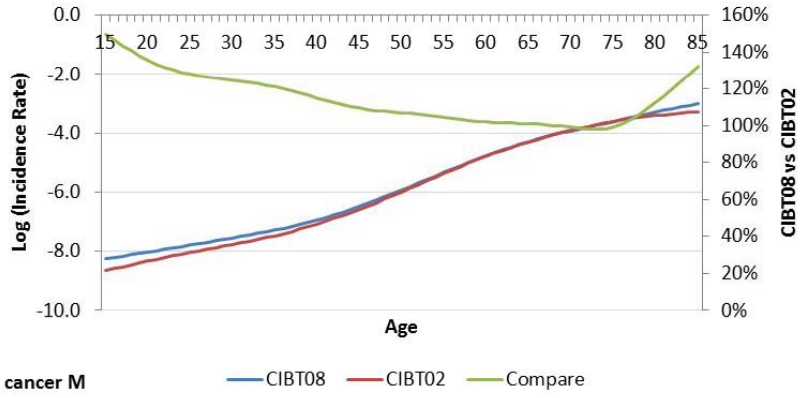
Cancer CIBT08 vs CIBT02 standalone rates



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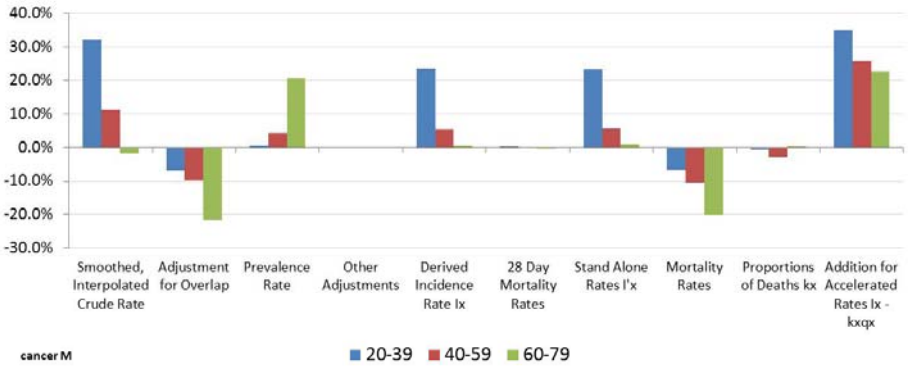
Cancer sources of change vs CIBT02



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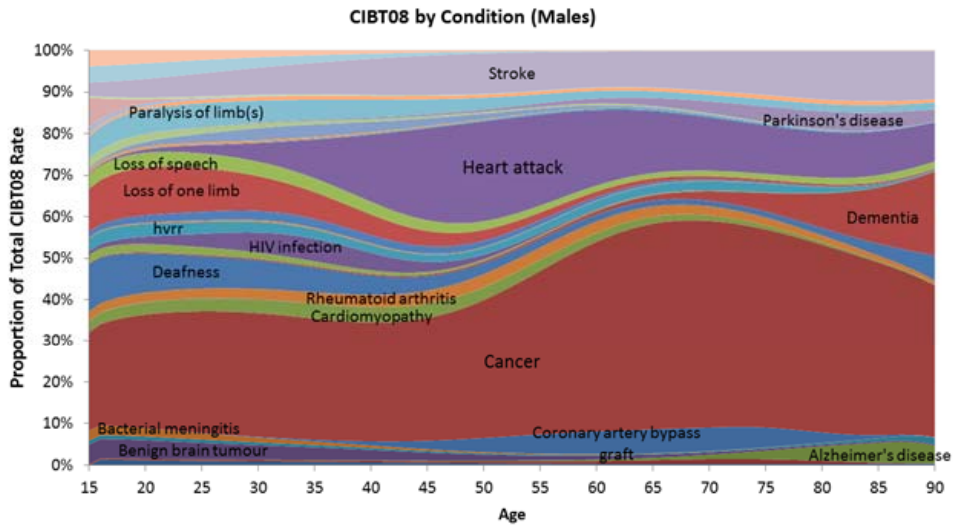
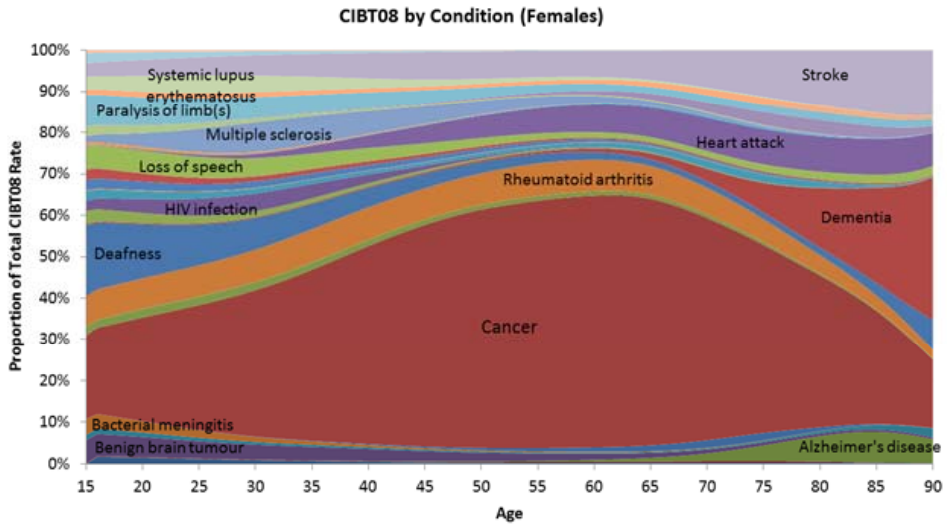
CIBT08 composition by illness

CIBT08 Composition: Males



CIBT08 Composition: Females



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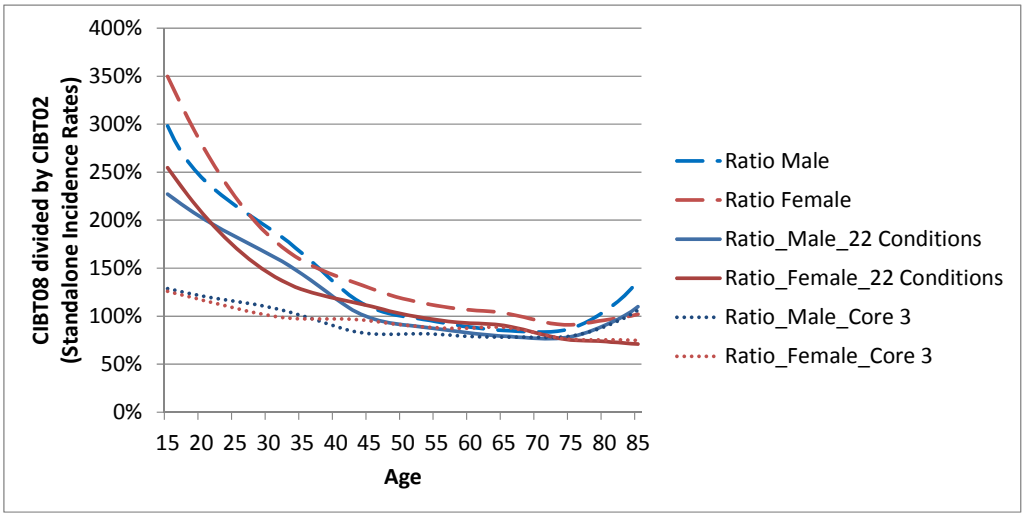
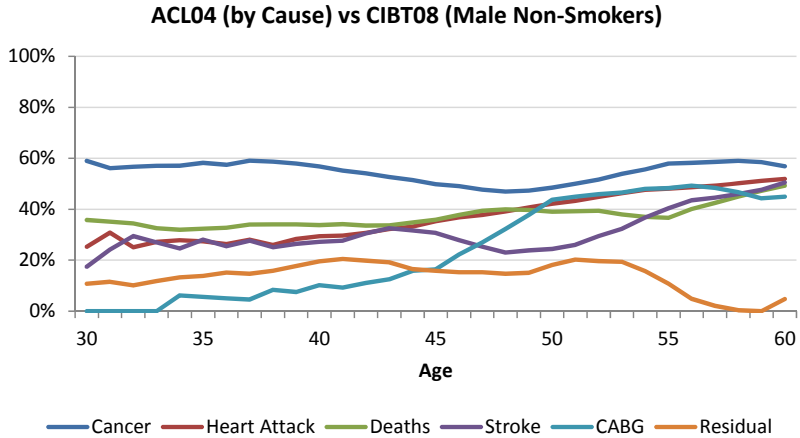
Combined CIBT08 comparison with other tables

Comparison with CIBT02



Observations vs ACL04



Residual line very much lower suggesting we are materially over-estimating some CIs which are also not well exposed in historic CMI data

Smoker rates are higher and >100% for heart attack

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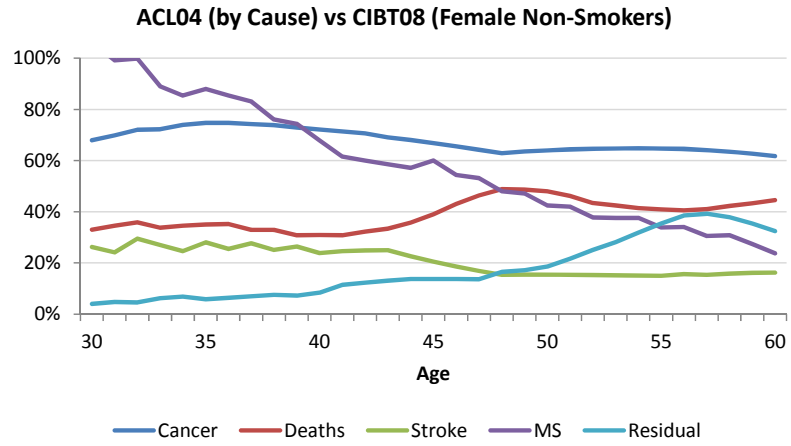
Other observations vs ACL04



MS appears high, especially at younger ages

HES data not ideal because of outpatient treatment

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Geodemographic Variation Investigations

Thought leadership · Progress · Community · Sessional Meetings · Education · Working parties · Volunteering · Research · Shaping the future · Networking · Professional support · Enterprise and risk · Learned society · Opportunity · International profile · Journals

Geodemographic Segmentation

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Geodemographic segmentation systems

Mosaic UK

acorn

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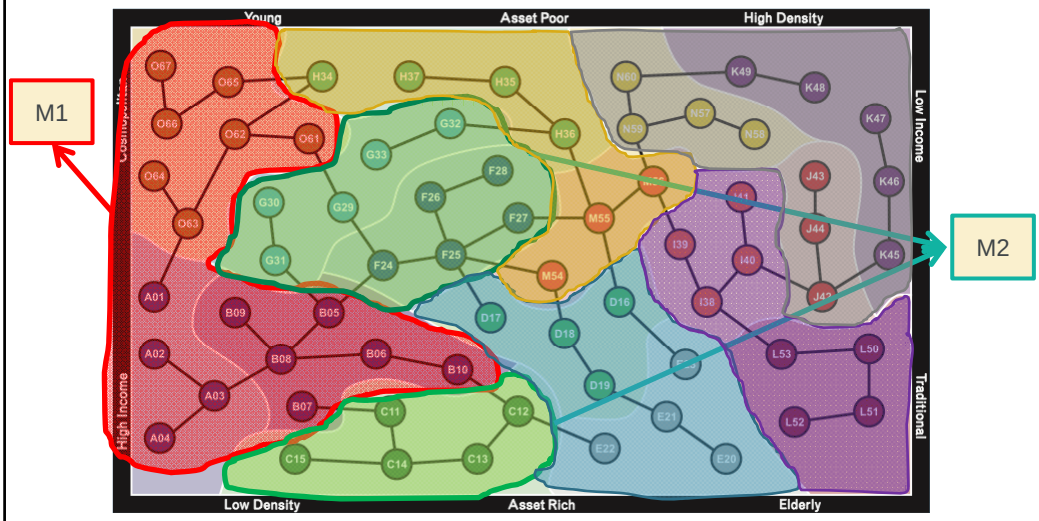
Top-down Grouping



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Top-down Grouping

Wealthy Executives

These are some of the most affluent people in the UK. They live in wealthy high-status suburban, rural and semi-rural areas of the country…

Affluent Greys

These people tend to be older empty nesters and retired couples. Many live in rural towns and villages, often in areas where tourism is important…

Prosperous Professionals

These are the most prosperous people living in our main cities. They are very well educated and tend to be employed in senior managerial and professional …

A1

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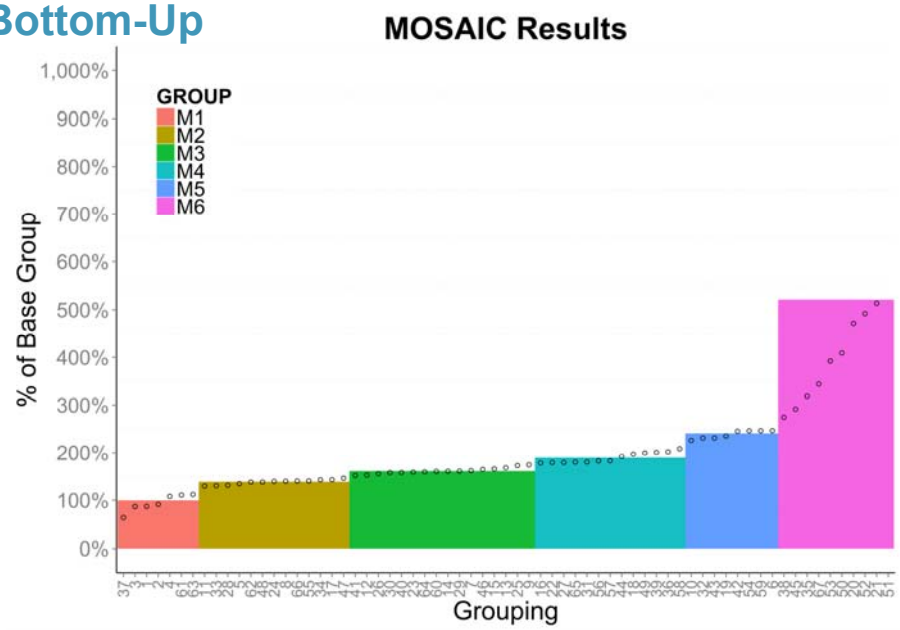
Bottom-Up



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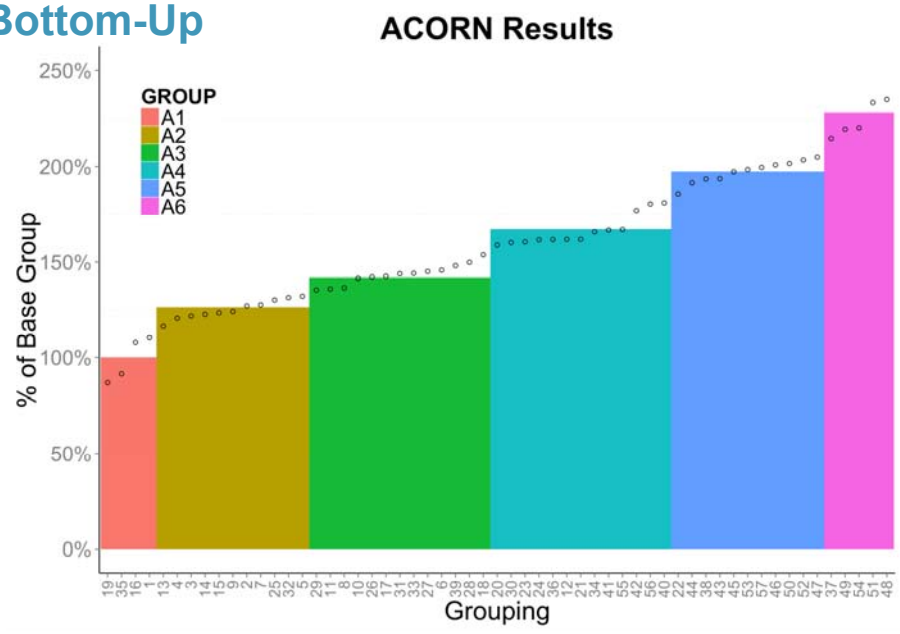
Bottom-Up



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Index of Multiple Deprivation

- IMD provides a relative measure of deprivation at small area level across England (LSOA)
- Deprivation domains used include:
  - Income;
  - Employment;
  - Health and disability
  - Education;
  - Crime;
  - Barriers to housing and services
  - Living Environment.
- We consider quintiles I1 – I5 where I1 is the most deprived.
- Our HES dataset includes the 2004 version of IMD.

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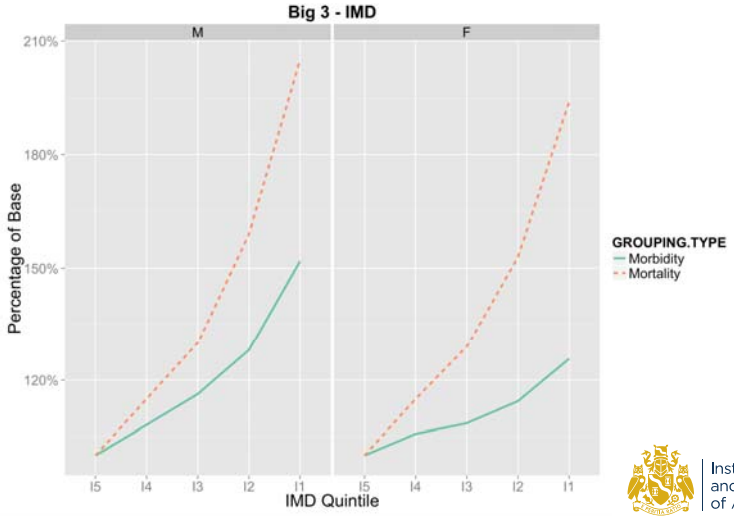
Index of Multiple Deprivation



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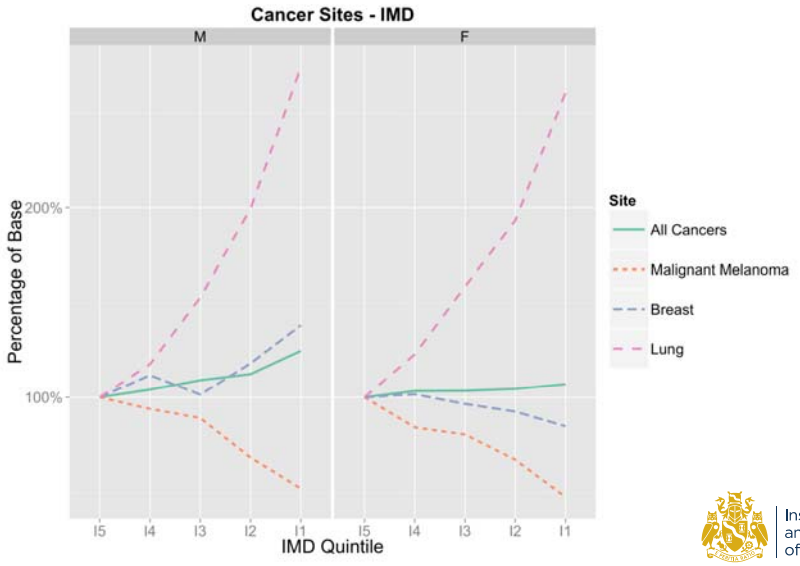
Cancer Sites – IMD



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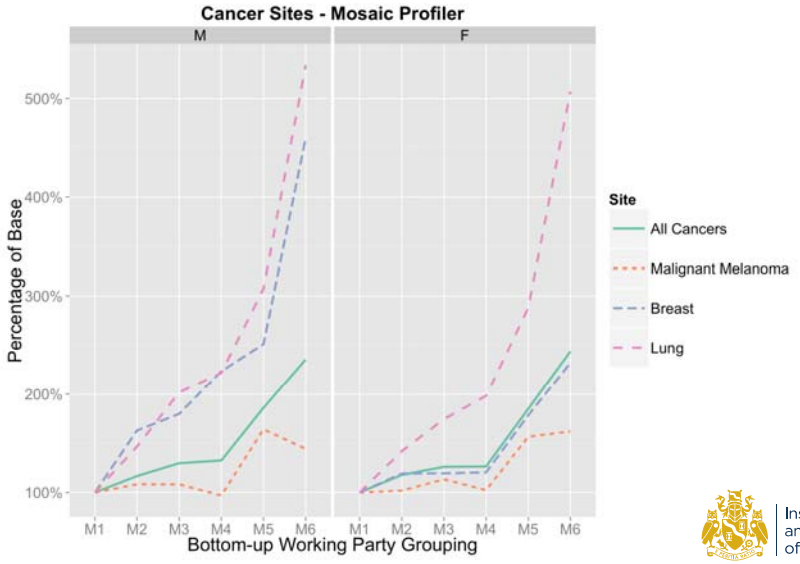
Cancer Sites – Bottom-Up



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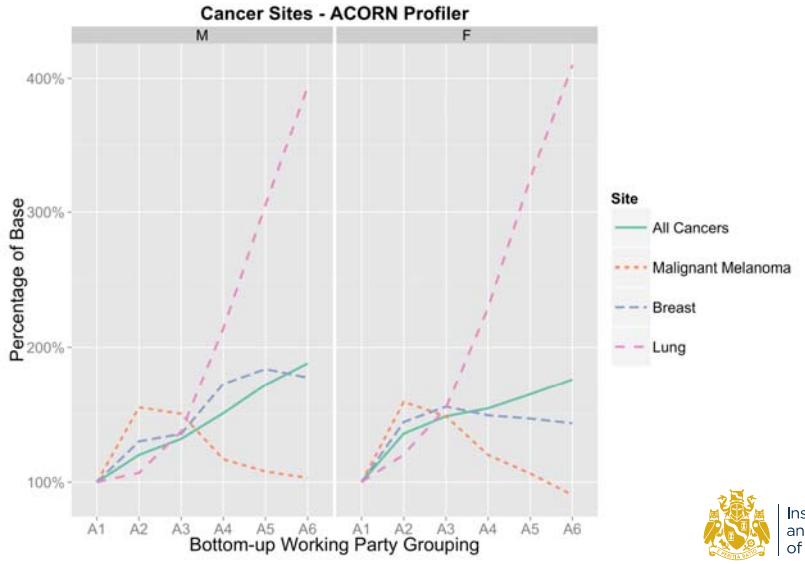
Cancer Sites – Bottom-Up



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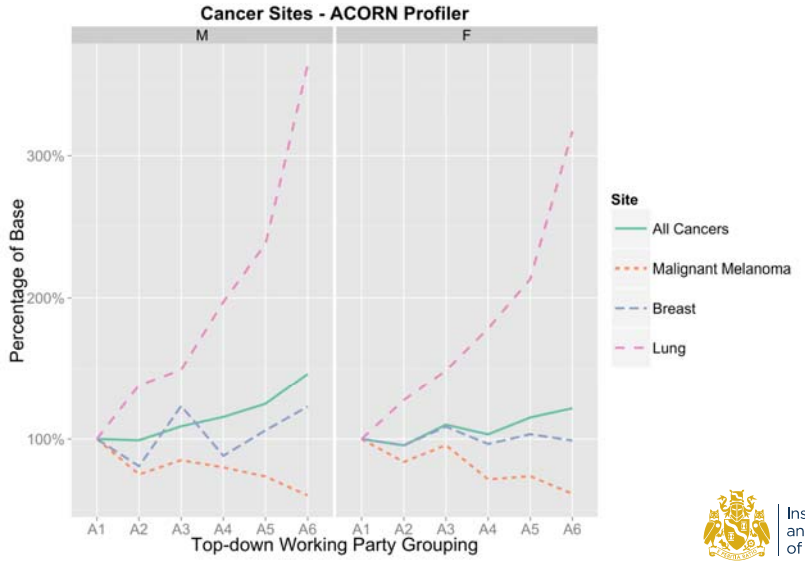
Cancer Sites – Top-Down



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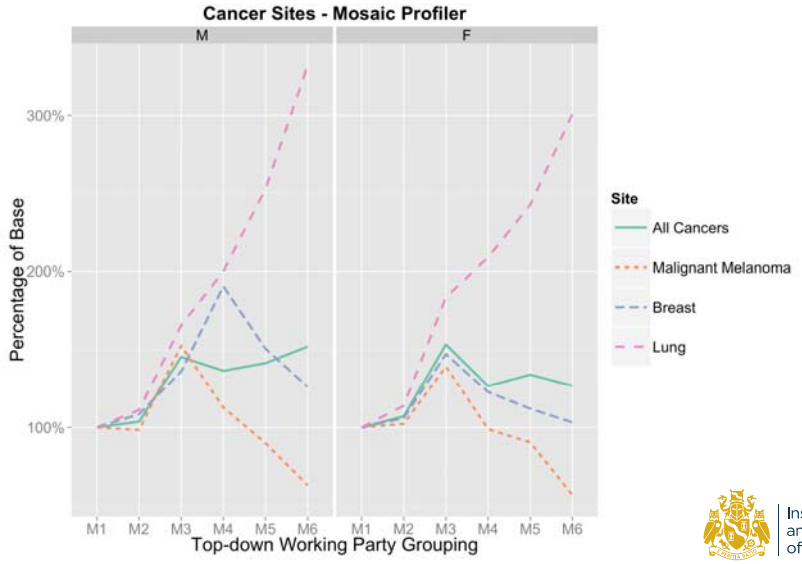
Cancer Sites – Top-Down



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What conditions have we considered?

- See the full paper for geodemographic analysis for:
  - Aorta Graft Surgery;
  - Benign Brain Tumour;
  - **Cancer** (All, Breast, Lung, Melanoma)
  - Heart Valve Replacement and Repair;
  - Kidney Failure;
  - Major Organ Transplant;
  - **Heart Attack**;
  - Multiple Sclerosis;
  - **Stroke**.
- Summary results follow:

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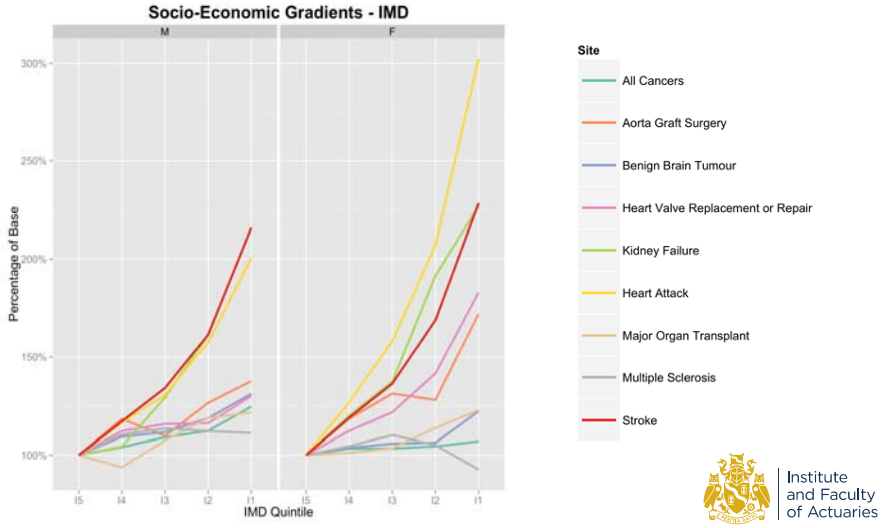
Major Conditions - IMD



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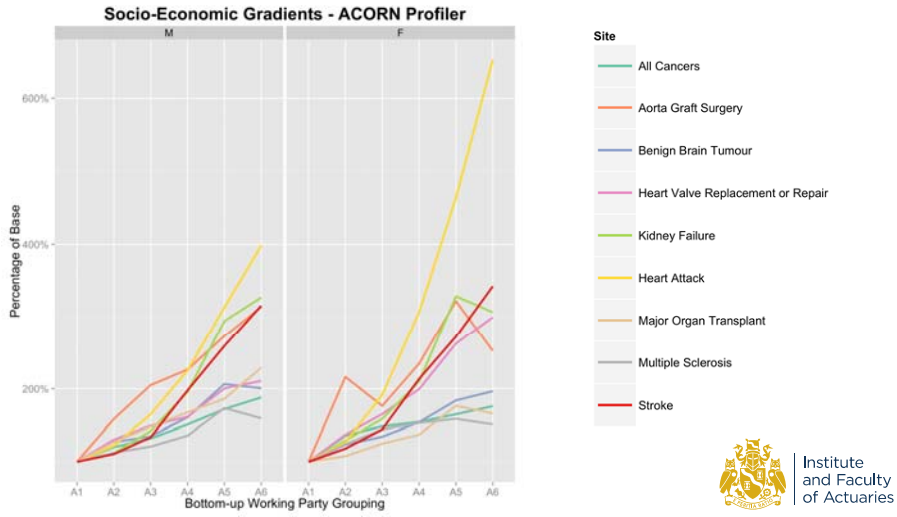
Major Conditions - ACORN



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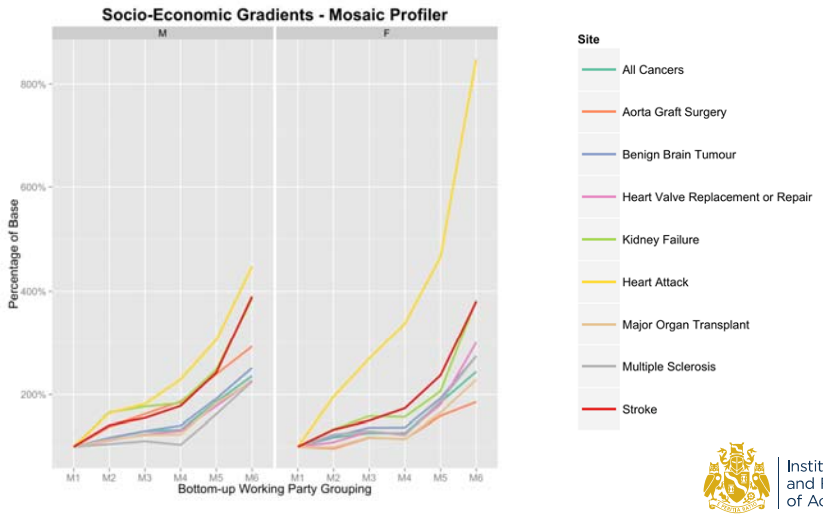
Major Conditions - IMD



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Questions

Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.

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