The Actuarial Profession
making financial sense of the future

Mortality and longevity seminar
Daniel Ryan, Towers Watson

New possibilities in moving from individual patient records to assumption setting

17 March (London); 25 March (Leeds)

Overview

- Approaches to setting mortality assumptions
- Sources of individual medical records
- Reliability of new data sources
- Direct applications
  - enhanced annuities
  - geographical variations in health
- Value of predictive scenarios to thinking on mortality improvements by population sub-group

Approaches to setting mortality assumptions

- Current
  - own experience
  - collective experience – CMI, Club Vita
  - population experience – ONS, JPMorgan Lifemetrics
  - longitudinal cohorts for populations with prior history of disease
  - information from reinsurers or portfolio/mortality risk transfers
- Future
  - targeting
  - extrapolative / projection
  - explanatory / predictive
    - cause of death – multiple cause data from US/Holland
    - disease diagnosis, case fatality and/or key risk factor analysis
  - practical limits to life expectancy

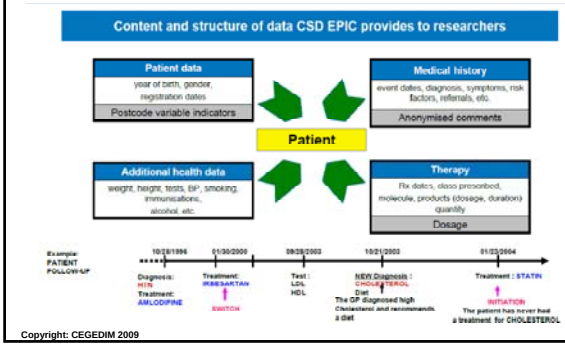
How realistic are blended mortality improvements?

- New treatment A fully introduced to population in 2010
  - Future A – No new treatment in 2011
  - Future B – New treatment with greater impact in 2011
  - Future C – New treatment with marginally less impact in 2011
- Multiple strands to research means new treatments introduced for different diseases in each year
- Treatments only authorised if more effective than existing
- Research builds on existing knowledge e.g. application of monoclonal antibodies to other cancers
- Treatments introduced gradually through awareness at different levels – clinical guidance, doctors & patients
- Cumulative impact of exposure to risk factors e.g. smoking

Individual medical records databases
Different types

- Snapshots from selected cohorts
  - Framingham. ACS Cancer Prevention Study, UK Doctor Study
- Vital statistics from selected cohorts
  - ONS Longitudinal study
- Ongoing monitoring of diffuse population
  - General Practice Research Database (“GPRD”)
  - The Health Improvement Network (“THIN”)
  - QRESEARCH at University of Nottingham
  - Hospital Episode Statistics

THIN data content (anonymised)

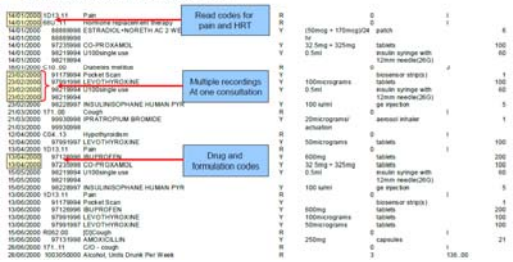


Individual medical records databases
Structure of medical record

- Unique patient ID or patient/practice combination
- Event-based rather than problem-oriented
- Use of READ codes
- Complete record for prescribed treatments
- Importance of diagnosis
- GP role as both gate-keeper and data warehouse
- Different sources of inputs – GP, practice nurse, laboratory
- Registration vs. later visits
- Linkages to other databases
  - Cancer registries, MINAP, primary/secondary care

THIN extract from specimen medical record

- All consultation events are recorded by Doctor in Vision system using Read codes (standardised clinical terms) and drug codes from Multilex and BNF coding systems
- Below is extraction from medical history of chronological events for a 65 year old female with diagnosis of Diabetes and Hypothyrodism



Individual medical records databases
Concerns over reliability of data

- Data not collected in systematic structure of selected cohorts
- Computerised medical record often only record
- Internal practice protocols & audit
- Review, comparative analysis and suggestions from external data group (e.g. GPRD, THIN)
- Quality Outcome Framework (2008/2009 version)
  - clinical care – 80 indicators in 19 domains
  - organisation – 36 indicators in 5 areas
  - patient experience – 5 indicators
  - additional services – 8 indicators in 4 areas
  - payments adjusted for surgery workload and prevalence of chronic conditions

Direct application from individual medical records
Enhanced annuities

- Prior reliance on tracking experience from relatively limited cohorts with potential selection bias
- Identify all individuals with prior history of selected diseases, correctly allowing for hierarchy of diseases
- Balance between credibility of data, age grouping and time segments
  - date of diagnosis vs. date of commencement
- Use of treatment information to differentiate severities of disease/condition
- Estimation of level & shape of excess mortality

Specimen diseases/conditions for enhanced annuity

- C1: Cancers such as stomach, oesophagus, lung & pancreas
- C2: Cancer such as colon, rectum, bladder & ovary
- C3: Cancers such as prostate, breast & malignant melanoma
- D1: Diabetes
- I1: Ischaemic heart disease, aneurysms & arteriosclerosis
- N1: Neurological conditions such as Alzheimer's disease, senile dementia, Parkinson's disease
- R1: Chronic obstructive pulmonary disease (COPD)
- T1: Heart failure, Renal failure, Cirrhosis
- O1: Other diseases such as valvular disease, rheumatoid arthritis, and hypertension
- Smokers

Prevalence of hierarchical groups in GPRD
Populations as at 1 January 2000

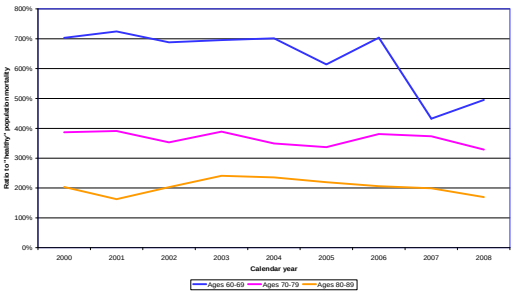
Men

Age group	Patient numbers as at 1 January 2000											Selected populations as % of All
	All	C1	T1	N1	C2	I1	R1	C3	O1	D1	SMK	
50-59	176492	157	1278	2078	699	9102	1815	387	19509	3027	30207	39%
60-69	123779	328	2932	4661	1285	15011	3249	761	20000	3170	12401	52%
70-79	87023	530	5110	6880	1584	14497	3704	1144	14452	2118	5116	63%
80-89	33614	236	4064	4184	776	5068	1447	604	4324	718	1362	68%
Total	420908	1251	13384	17803	4345	43678	10214	2896	58286	9033	49086	50%

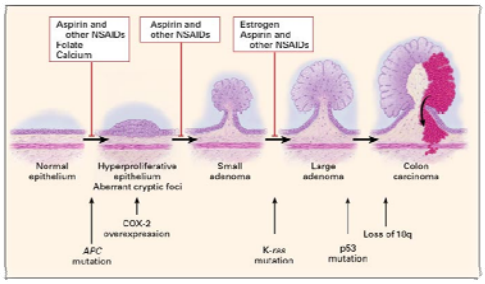
Women

Age group	Patient numbers as at 1 January 2000											Selected populations as % of All
	All	C1	All	C1	All	C1	All	C1	All	C1	All	
50-59	173142	92	765	1677	842	4585	1874	3654	23450	1765	24798	37%
60-69	128174	219	1960	3313	1473	8581	2908	3576	27276	1997	10787	48%
70-79	111057	304	5069	6793	1830	11929	3347	2734	27381	1735	5432	60%
80-89	62028	182	6642	6988	1108	6880	1430	1195	13488	934	1452	65%
Total	474402	797	14437	18771	5253	31975	9559	11158	91595	6430	42470	49%

Pattern of mortality for COPD vs “healthy” in GPRD
Any prior history of disease for men as at 1 Jan 2000



Underlying natural history of disease
Colo-rectal cancer



Source: New England Journal of Medicine, 2000

Distribution of cancer incidence
Stage at diagnosis

Colon & RS Junction - Stage (recorded in notes or Registry-assigned)

Dukes A and B tumours are confined to the bowel wall, while Dukes C tumours have metastasised to the regional lymph nodes. Dukes D indicates a tumour that has spread to other organs.

Stage	Number of Patients (%)			
	All Patients		Surgery Patients	
	1996 (n=524)	2001 (n=602)	1996 (n=463)	2001 (n=546)
Dukes A/TNM I	36 (7%)	57 (9%)	34 (7%)	50 (9%)
Dukes B/TNM IIA-IIB	187 (36%)	177 (29%)	185 (40%)	170 (31%)
Dukes C/TNM IIIA-IIIC	108 (20%)	190 (32%)	107 (23%)	188 (34%)
Dukes D*/TNM IV	142 (27%)	130 (22%)	109 (24%)	104 (19%)
TNM only staging recorded	2 (<1%)	4 (<1%)	2 (<1%)	4 (<1%)
Staging not possible**	51 (10%)	48 (8%)	26 (6%)	34 (6%)

* Modified Dukes stage ** Staging for these patients was not possible due to a lack of information recorded in the notes

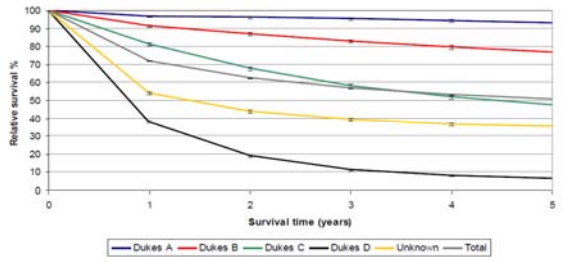
Rectum - Stage (recorded in notes or Registry-assigned)

Stage	Number of Patients (%)			
	All Patients		Surgery Patients	
	1996 (n=160)	2001 (n=203)	1996 (n=164)	2001 (n=171)
Dukes A/TNM I	24 (15%)	39 (19%)	23 (14%)	36 (21%)
Dukes B/TNM IIA-IIB	52 (27%)	41 (20%)	51 (31%)	41 (24%)
Dukes C/TNM IIIA-IIIC	40 (21%)	48 (24%)	40 (24%)	46 (27%)
Dukes D*/TNM IV	42 (22%)	42 (21%)	36 (22%)	27 (16%)
TNM only staging recorded	1 (<1%)	1 (<1%)	1 (<1%)	1 (<1%)
Staging not possible**	32 (17%)	33 (16%)	14 (9%)	21 (12%)

* Modified Dukes stage ** Staging for these patients was not possible due to a lack of information recorded in the notes

Source: Northern Ireland Cancer Registry, 2005

Colo-rectal cancer survival by stage at diagnosis



Source: NYCRIS, 2009

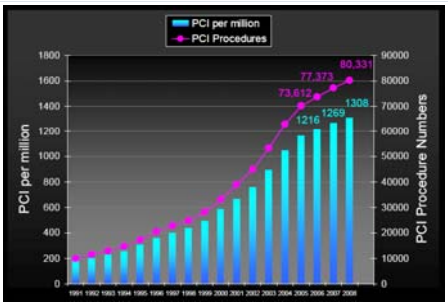
Direct application from individual medical records
Geographical variations in health

- Comparative analysis on ANY of overall mortality, disease diagnosis OR prevalence, case fatality rates, prescribing rates OR outpatient & inpatient activity
- Patient must remain anonymous (and GP practice)
- Postcode data collected on GP practice or patient
- Collated data for different geographical areas with balance between age aggregation and size of area
  - Government Office Region. Strategic Health Authority
  - Primary Care Trust. lower layer super output area (“LSOA”)
- Stratified data by postcode based on grouped index values
  - Townsend, Index of Multiple Deprivation
  - Towers Watson Postcode Mortality Tool

Individual medical records
Relevance to predictive scenarios

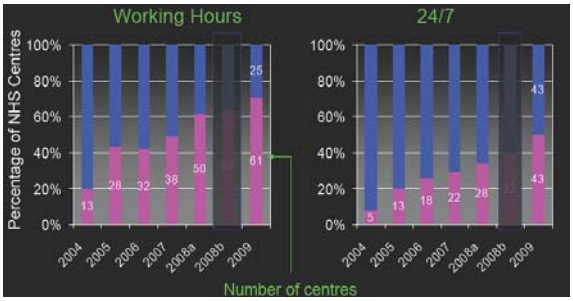
- Essential to understand current prevalence of disease and access to treatment
- Identify potential areas of improvement through comparisons at each level from patient to country
- Efficacy over time of current treatments acting singly or in combination – appropriateness of clinical guidelines
- Assessment of risk factors in comparisons to clinical guidelines
- Distinction between “threshold events” and “detection events”

Impact of interventionist cardiologists
Angioplasty – threshold & detection



Source: British Cardiovascular Intervention Society – 2008 Audit

Treatment of heart attack (STEMI)
Availability of primary angioplasty



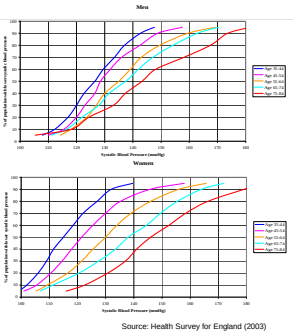
Source: British Cardiovascular Intervention Society – 2008 Audit

Individual medical records
Mortality improvements by population sub-group

- Uneasy consensus as to applicability of mortality improvements to different population sub-groups
- Predictive scenario based on clinical guideline or achievement in other country:
  - common attainment throughout population
  - maintain variation between different groups
  - related but distinct scenarios for different groups
- Differences relate to existing risk factors, disease prevalence, access to current treatments & willingness to adopt new treatments and change behaviour

Use of clinical guidelines for predictive scenarios

- Systolic blood pressure target guidelines:
- Quality Outcome Framework
  - 150mmHg
- Joint British Societies 2
  - 130mmHg
- AHA Strategic Impact Goal through 2020
  - 120mmHg
- Promotion of combination therapy (CG 34)
  - ACE inhibitor
  - Calcium channel blocker
  - Thiazide diuretic



Source: Health Survey for England (2003)

Expected developments in 2010

- Credible linked data to support time and age structure of mortality estimates
- Widespread access to mortality models that cover full spectrum of disease and health
- Future mortality improvements may be differentiated by:
  - prior history of disease
  - generations of new policyholders
  - socio-economic status

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23