Overview

• Critical Illness Product Background
  – Why should we be interested in neurology?

• Consult our doctor
  – How your brain works (assuming it does)
  – White matter and grey matter (and whether it matters)
  – How we can we look at the Central Nervous System
  – Changes in the way doctors diagnose and manage Stroke, MS and Alzheimer's Disease

• Critical Illness Pricing implications
Critical Illness Neurological cause of claim

Strokes, Multiple Sclerosis and Benign Brain Tumours are important causes of claim in this UK sub-population.

![Gen Re Dread Disease Survey](chart)

Critical Illness Neurological cause of claim

... and these are important for females too.

![Gen Re Dread Disease Survey](chart)
2012/2013 Claims statistics - a similar picture

Neurological causes still account for around 15% of CI claims

Sample of recently published CI claims statistics
(excluding death & terminal illness)

Zurich reported only on a few top causes of claim

What matters…………

The Brain
Neurons and other cells

- Basic functional unit of the nervous system
- 100 Billion cells in the brain
- 100 trillion synapses or connections
- Other supporting cells – Glial cells
  - Called astrocytes, oligodendrocytes

Neurons

Axons and dendrites - transport electrical and chemical messages

Axons covered by segment like myelin sheath

This assists speed of conduction

Connects brain to muscles (motor) and to sensory cells

http://kvhs.nb.ca/gallant/biology/neuron_structure.html
Brain appearance

Grey Matter, White Matter

http://www.humanconnectomeproject.org/gallery/
How can we look at the Nervous System?

- Symptoms – reported
- Clinical Examination of individual
- Test transmission of nerves
  - Nerve conduction
  - Visual evoked responses
- Imaging
  - X-Ray
  - CT
  - MRI
  - Functional imaging

CT or MRI?

CT
- Was more available
- Quicker
- Cheaper
- Possible with metal in body
- But radiation

MRI
- Now more available
- Longer process
- More expensive
- Claustrophobia in most machines
- Not possible with metal in body
- Different images possible (not just ‘MRI’)
- No radiation
# MS diagnosis

## MacDonald Criteria

<table>
<thead>
<tr>
<th>Clinical presentation (person presenting to neurologist)</th>
<th>Additional data needed for MS diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two or more attacks; objective clinical evidence of two or more lesions</td>
<td>None</td>
</tr>
<tr>
<td>Two or more attacks; objective clinical evidence of one lesion</td>
<td>Dissemination in space shown on MRI or Up to two MRI detected lesions typical of MS plus positive cerebrospinal fluid (CSF) or Await a further relapse suggestive of dissemination in space (ie affecting another part of the body)</td>
</tr>
<tr>
<td>One attack; objective clinical evidence of two or more lesions</td>
<td>Dissemination in time demonstrated by MRI or Second clinical attack (relapse)</td>
</tr>
<tr>
<td>One attack; objective clinical evidence of one lesion (known as ‘clinically isolated syndrome’*)</td>
<td>Dissemination in space demonstrated by MRI or Up to two MRI detected lesions typical of MS plus positive cerebrospinal fluid (CSF) AND dissemination in time demonstrated by MRI or Dissemination in time demonstrated by MRI (a new lesion seen on MRI at least 3 months after the original scan) or Second clinical attack (relapse)</td>
</tr>
<tr>
<td>Insidious neurological progression suggestive of multiple sclerosis (typical for primary progressive MS)</td>
<td>Positive cerebrospinal fluid (CSF) AND dissemination in space, shown on MRI or Abnormal visual evoked potential plus abnormal MRI AND dissemination in time demonstrated by MRI or Continued progression for one year (determined retrospectively or by ongoing observation)</td>
</tr>
</tbody>
</table>

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**MS diagnosis**

- Disseminated in time and space
- Evidenced by clinical examination
  - More than one clinical lesion
- Evidenced by more than one lesion on MRI
  - Different lesions in position and/or duration

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http://www.radiologyassistant.nl/en/p456dea65db62/multiple-sclerosis.html#i459758814a5eb
MS lesions on MRI over one year

MS attacks cause early inflammation – swelling and leakage of immune cells into area. Leaving scars - gliosis

Blood supply in the brain

Stroke
- Haemorrhage or Infarct
- Infarct when blood vessel is blocked – thrombosis or embolus
- Treatment with clot busting drugs if infarct
- New concept of ‘Brain Attack’
Stroke Vs Transient Ischaemic Attack (TIA)

- TIA: Change diagnosis to 'tissue based' diagnosis
- No time – 24 hrs no longer relevant
- Scans vital
- CT: Gold standard for haemorrhage
- DWI: seen within 3-6 hrs and virtually all are seen in 24 hours.
- Sensitivity of CT to diagnose stroke is 64% and the specificity is 85%
- 30% to 50% of classically defined TIAs show brain injury on diffusion-weighted magnetic resonance (MR) imaging (MRI).

'TIA patients should undergo neuroimaging evaluation within 24 hours of symptom onset, preferably with magnetic resonance imaging'

Acute CT scans (top row) 1.5 hours and MRI diffusion-weighted images (DWI) obtained 3.5 and 36 hours after stroke onset in a woman with left hemiparesis

Sensitivity Specificity CT and MRI acute stroke

<table>
<thead>
<tr>
<th></th>
<th>Acute stroke</th>
<th>Acute ischaemic stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CT</td>
<td>MRI</td>
</tr>
<tr>
<td>Sensitivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>356</td>
<td>83% (71-88)</td>
</tr>
<tr>
<td>&gt; 12 h</td>
<td>115</td>
<td>93% (82-99)</td>
</tr>
<tr>
<td>3-12 h</td>
<td>115</td>
<td>94% (84-100)</td>
</tr>
<tr>
<td>&lt; 3 h</td>
<td>90</td>
<td>95% (90-100)</td>
</tr>
<tr>
<td>Specificity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>356</td>
<td>92% (82-99)</td>
</tr>
<tr>
<td>&gt; 12 h</td>
<td>115</td>
<td>94% (86-99)</td>
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</table>

Data in parentheses are 99% CI.


Stroke

- 55 year old man with weakness
- CT to rule out haemorrhage
- MRI next
- Angiogram
Cerebral aneurysm & Subarachnoid Haemorrhage

Dilatation of a blood vessel
Risk is that this may:
- burst – causing haemorrhage
- cause pressure on surrounding brain tissue

Clipping of cerebral aneurysm
Coiling of aneurysm

Brain covering layers – meninges - BBT
No classification of Benign Vs Malignant!!
Dementia

- Continuum of increasing memory loss
- Diagnostic criteria not objective – rely on impairment of everyday functioning and questions answered by patient (clinical medicine)
- Where does mild cognitive impairment end and dementia start?

Dementia

- Scans not diagnostic although supportive
- Clinical diagnosis
- Blood tests ? for early diagnosis
- Screening suggested - targets
Incidental MRI findings

White matter lesions on scan
Future changes in neurological imaging

7T vs 1.5T MRI scan

Positron Emission Tomography (PET) Scanning with Florbetapir in possible Alzheimer’s Disease

Detects β-amyloid deposition in brain
Blood markers

- ‘Holy grail’ of pharma/biomarker industry
- Massive investment ongoing
- Looking at:
  - Stroke
  - Dementia
  - MS
  - Huntington’s

Implications for insurance
Neurological CI claims triggers (typically 100% pay)

The list is long and includes many similar illnesses

**ABI/ABI+**

- Stroke
- Multiple sclerosis
- Benign Brain Tumour
- Parkinson’s Disease
- Alzheimer’s Disease
- Motor Neurone Disease
- Coma
- Traumatic head injury

**Non-standard full benefits**

- Devic’s Disease
- Benign Spinal Cord Tumour
- Progressive Supranuclear Palsy
- Multiple System Atrophy
- Dementia
- Bacterial Meningitis
- Encephalitis
- Creutzfeldt-Jakob Disease

**Definite diagnosis by a Consultant Neurologist PLUS Permanent Neurological Deficit or specific form of permanent impairment**

**ABI/ABI+**

- Multiple sclerosis
- Parkinson’s Disease
- Alzheimer’s Disease
- Motor Neurone Disease

**Non-standard full benefits**

- Devic’s Disease
- Progressive Supranuclear Palsy
- Multiple System Atrophy
- Dementia
- Bacterial Meningitis
- Encephalitis
Definite diagnosis by a suitable / specified medical professional
PLUS specific form of permanent impairment

**ABI/ABI+**

- + just "diagnosis" + PND

**Non-standard full benefits**

- + permanent symptoms (ABI standard)
- temporary / no symptoms (ABI+)

+ Some definitions are diagnosis only

- **Benign Spinal Cord Tumour +**
- **Dementia**
- **Creutzfeldt-Jakob Disease *”**

No specification of who makes the diagnosis

**ABI/ABI+**

- **Stroke +**
- **Benign Brain Tumour +**
- **Coma**
- **Traumatic head injury**

+ permanent symptoms (ABI standard)

+ temporary / no symptoms (ABI+)

* Permanent neurological deficit with persisting clinical symptoms

Two of the most common causes of neurological CI claim have the loosest definitions!
Neurological CI claims triggers

Does not specify who makes the diagnosis but requires specific surgery or procedure

Additional payments

- Arteriovenous Malformation of the brain
- Carotid Artery Stenosis
- Cerebral Aneurysm

How representative is the past data we see?

What constitutes “Definite Diagnosis” and how protective is this requirement?

Currently undiagnosed / asymptomatic cases

- Prevalence detectable by MRI
- Use of MRI
- Robustness of exclusion
  “abnormality seen on scans without definite related clinical symptoms”
Incidental MRI findings
Do the statistics suggest an Illness headache?

Context

Some rough tools to estimate impact of increased neurological claim rates on total Accelerated Illness cost

• Probability of death or CI claim by age 69 for someone aged 50
  - Male non-smoker: 23%
  - Female non-smoker: 16%

CMI AC04 tables (Working Paper 50)
Based on UK insured lives experience 2003-2006
MRI findings

Morris Z et al, "Incidental findings on brain magnetic resonance imaging: systematic review and meta-analysis", BMJ 2009;339:b3016 doi:10.1136/bmj.b3016

MRI findings: Silent stroke

Morris Z et al, "Incidental findings on brain magnetic resonance imaging: systematic review and meta-analysis", BMJ 2009;339:b3016 doi:10.1136/bmj.b3016

Silent stroke prevalence ages 50 - 69: 2%

UK population stroke diagnoses ages 55 - 69*
- 0.1% p.a. incidence
- 1.1% prevalence

5% of Accelerated Illness claims are for stroke

20% probability of Accelerated Illness claim aged 50 - 69

Worst case scenario could add 10% to total risk cost
more of an issue at older ages

Do patients “fully recover” after stroke?

- 19% of stroke survivors aged 50 – 69 were classified as “fully recovered” 6 months after stroke
  
  Source: International Stroke Trial database US and UK statistics
  
  Trial was conducted in the 1990s

- Changes from reclassification of some TIAs as strokes more recently

- “fully recovered” label has been modified and incidental findings have been associated with poorer cognitive performance

MRI findings: Benign Brain Tumours


Neoplastic incidental findings: 1%

approx. 50% of which are meningiomas (paid as BBT)

Next most common are pituitary gland tumours

2% of claims are currently for benign brain tumour

20% probability of Accelerated Illness claim aged 50 - 69

Worst case scenario could add 2.5% to total risk cost
**MRI findings: aneurysms and AVMs in the brain**


Prevalence of incidental findings aged 50 - 69: 2%
~20% of these are aneurysms or AVMs

Additional payment definition requires surgery.

20% probability of Accelerated Illness claim aged 50 - 69

Worst case scenario could add less than 1% to risk cost

**MRI findings: white matter hyperintensities**


These findings are common and increase further at ages 70+

They are not directly associated with an Illness definition at present.

Indicate 2 to 3x increase risk of dementia, stroke & death
MRI scans are being done more often

**Insufficient evidence to justify asymptomatic screening**

Incidental findings on brain magnetic resonance imaging: systematic review and meta-analysis

Zoe Morris, senior clinical fellow in neuroradiology,1 William N Whiteley, CSO clinical academic fellow,1 W T Longstreth Jr, professor of neurology and epidemiology;2 Frank Weber, consultant neuroradiologist;3 Yi-Chung Lee, attending physician; Yoshio Tsuzuki, associate professor of diagnostic radiology;4 Hannah Alphs, medical student;5 Susanne C Ladd, consultant radiologist;6 Charles Warlow, emeritus professor of medical neurology;7 Joanna M Wardlaw, professor of applied neuroradiology,8 Rustom Al-Shahi Salman, MRC clinician scientist and honorary consultant neuroradiologist7

**ABSTRACT**

Objective To quantify the prevalence of incidental findings on magnetic resonance imaging (MRI) of the brain.

Design Systematic review and meta-analysis of observational studies.

Data sources Ovid Medline (1950 to May 2008), Embase (1980 to May 2008), and bibliographies of relevant articles.

Review methods Two reviewers sought and assessed studies of people without neurological symptoms who underwent MRI of the brain with or without intravenous contrast for research purposes or for occupational, clinical, or commercial screening.

Main outcome measures Overall disease-specific and age

MRI exams per 1,000 population

OECD Health Statistics 2013

- **UK (in-hospital only)****
- **USA****
- **Australia****
- **Belgium****
- **Ireland (in-hospital only)**

**Average cost per scan in the NHS**

CT: £54 to £268

MRI: £84 to £472

National audit office 2008-09

**Insufficient evidence to justify asymptomatic screening**
Concluding thoughts

- **Neurological CI definitions are complicated**
  - Information sharing between disciplines helps

- **Diagnostic criteria and technology in the clinical setting continue to change**
  - Screening is a possibility but is not clearly beneficial now
  - Insurers need to remain vigilant and participate regularly in industry discussions

- **There is some risk attached to the existing definitions**
  - Especially the “diagnosis only” variety
  - But worst case scenarios appear less catastrophic than other triggers

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.