Minnesota Cognitive Acuity Screen (MCAS)
Cognitive screening for mortality risk assessment

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Agenda

- Cognitive impairment
- Underwriting Challenges
- Minnesota Cognitive Acuity Screen (MCAS)
- MCAS and Mortality
- Older Age Underwriting
Dementia

The progressive, nonreversible impairment in cognitive abilities, including short and long term memory, language, and judgment with disturbances in behavior and personality.

To be classified as dementia, the following criteria must be met:

- It must include decline in memory and in at least one of the following cognitive abilities:
  - Ability to generate coherent speech or understand spoken or written language;
  - Ability to recognize or identify objects, assuming intact sensory function;
  - Ability to execute motor activities, assuming intact motor abilities, sensory function and comprehension of the required task; and
  - Ability to think abstractly, make sound judgments and plan and carry out complex tasks.

- The decline in cognitive abilities must be sufficiently severe to interfere with daily life

Adapted from 2012 Alzheimer’s Disease Fact and Figures, Alzheimer’s Association
Alzheimer’s Type Dementia

Alzheimer's Dementia – most common form of dementia

- Cognitive impairment
  - Memory impairment
  - One or more of the following: Aphasia, Apraxia, Agnosia or Executive Function disturbance

- Impaired social or occupational functioning

- Gradual onset/continuing decline

- Not due to
  - Other CNS disease associated with dementia (e.g., Parkinson’s)
  - Systemic disease associated with dementia (e.g., hypothyroidism, HIV)
  - Substance induced dementia
  - Delirium
  - Psychiatric disorder

Adapted from DSM-IV; American Psychiatric Association
Causes of Dementia

Significant Diagnostic Overlap

- Other dementias including
  - Frontal lobe dementia
  - Creutzfeldt-Jakob disease
  - Corticobasal degeneration
  - Progressive supranuclear palsy

- Dementia with Lewy bodies
  - Parkinson’s disease
  - Diffuse Lewy body disease
  - Lewy body variant of AD

- AD and dementia with Lewy bodies

- Alzheimer’s disease
  - 5% 10% 65% 5% 7% 8%

Vascular dementias
- Multi-infarct dementia
- Binswanger’s disease

Vascular dementias and AD

Small GW, et al. JAMA. 1997;278:1363-1371
The Baby Boomer’s 21st Century pandemic

Today, >5.4 million Americans are living with Alzheimer’s disease
- 5.2 million are 65 years and older (<50% know they have the disease)
- 200,000 are less than 65 years of age
- More than 14% of those over age 70 years have dementia
- Nearly half of those over age 85 years have Alzheimer’s disease

Estimated more than 500,000 new cases of Alzheimer’s in 2012, one case per second yielding over 14 million cases by 2050

Alzheimer’s disease is the 6th leading cause of death in the U.S. (a 47.1% increase between 2000 and 2006)

Approximate 3-4 year lag in diagnosis after noticeable signs and symptoms emerge though disease may begin 10-15 years prior to first symptoms

Though some evidence that incidence is declining
Prevalence of Dementia in the USA

- By the year 2050 Alzheimer’s and other dementias will affect more than 14 million people

- Year 2000: 4.5 Million, 65-74 Years: Yellow, 75-84 Years: Beige, 85+ Years: Orange
- Year 2030: 7.7 Million, 65-74 Years: Yellow, 75-84 Years: Beige, 85+ Years: Orange
- Year 2050: 14.2 Million, 65-74 Years: Yellow, 75-84 Years: Beige, 85+ Years: Orange

### How Prevalent is Dementia Worldwide?

<table>
<thead>
<tr>
<th>WHO Region Description</th>
<th>60-64</th>
<th>65-69</th>
<th>70-74</th>
<th>75-79</th>
<th>80-84</th>
<th>85+</th>
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</thead>
<tbody>
<tr>
<td>Western Europe</td>
<td>0.9</td>
<td>1.5</td>
<td>3.6</td>
<td>6.0</td>
<td>12.2</td>
<td>24.8</td>
</tr>
<tr>
<td>Eastern Europe (B)</td>
<td>0.9</td>
<td>1.3</td>
<td>3.2</td>
<td>5.8</td>
<td>12.2</td>
<td>24.7</td>
</tr>
<tr>
<td>Eastern Europe (C)</td>
<td>0.9</td>
<td>1.3</td>
<td>3.2</td>
<td>5.8</td>
<td>11.8</td>
<td>24.5</td>
</tr>
<tr>
<td>North America</td>
<td>0.8</td>
<td>1.7</td>
<td>3.3</td>
<td>6.5</td>
<td>12.8</td>
<td>30.1</td>
</tr>
<tr>
<td>South America (D)</td>
<td>0.8</td>
<td>1.7</td>
<td>3.4</td>
<td>7.6</td>
<td>14.8</td>
<td>33.2</td>
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<tr>
<td>South America (E)</td>
<td>0.7</td>
<td>1.5</td>
<td>2.8</td>
<td>6.2</td>
<td>11.1</td>
<td>28.1</td>
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<tr>
<td>Middle East</td>
<td>0.9</td>
<td>1.8</td>
<td>3.5</td>
<td>6.6</td>
<td>13.6</td>
<td>25.5</td>
</tr>
<tr>
<td>North Africa, Middle East</td>
<td>1.2</td>
<td>1.9</td>
<td>3.9</td>
<td>6.6</td>
<td>13.9</td>
<td>23.5</td>
</tr>
<tr>
<td>Japan, Australia, New Zealand</td>
<td>0.6</td>
<td>1.4</td>
<td>2.6</td>
<td>4.7</td>
<td>10.4</td>
<td>22.1</td>
</tr>
<tr>
<td>China and neighbors</td>
<td>0.6</td>
<td>1.7</td>
<td>3.7</td>
<td>7.0</td>
<td>14.4</td>
<td>26.2</td>
</tr>
<tr>
<td>Indonesia, Sri Lanka, Thailand</td>
<td>1.0</td>
<td>1.7</td>
<td>3.4</td>
<td>5.7</td>
<td>10.8</td>
<td>17.6</td>
</tr>
<tr>
<td>India and neighbors</td>
<td>0.4</td>
<td>0.9</td>
<td>1.8</td>
<td>3.7</td>
<td>7.2</td>
<td>14.4</td>
</tr>
<tr>
<td>Sub-Saharan Africa (D)</td>
<td>0.3</td>
<td>0.6</td>
<td>1.3</td>
<td>2.3</td>
<td>4.3</td>
<td>9.7</td>
</tr>
<tr>
<td>Sub-Saharan Africa (E)</td>
<td>0.5</td>
<td>1.0</td>
<td>1.9</td>
<td>3.8</td>
<td>7.0</td>
<td>14.9</td>
</tr>
</tbody>
</table>
Significant Driver of LTCI Claims Costs

Number one claimed event in LTCI in the USA

- By frequency, by average cost, by duration
- Pure dementia represents ~25% of new claims
- Cognitive impairment accounts for >40% of new claims
- Cognitive impairment underlies more than 50% of ongoing LTCI claims at 24 months
- Average claim duration creeping above 38 months
- Average LTCI expenditure now more than $88,100
Survival with Dementia

Dementia: a substantial impact on life expectancy

- Survival from diagnosis: range 4-9 years
- Survival Time, women diagnosed at age
  - Age 65 years: 7.5 years
  - Age 70 years: 5.8 years
  - Age 80 years: 4.4 years
  - Age 90 years and older: 3.9 years
- Men approximately 20-25% shorter survival times
- Canadian study – median survival 6.6 unadjusted years
- No apparent prolonged survival effect from cholinesterase inhibitors

Progression of Disease

Cognitive symptoms
Loss of ADL
Behavioral problems
Nursing home placement
Death

MMSE Score

Early Diagnosis
Mild-Moderate
Severe

Progression of Disease

Healthy Cognition-to-Dementia Continuum

- Normal Cognition
- Mild-Moderate-Severe
- Mild-Moderate-Severe
- Healthy Cognition
- Mild Cognitive Impairment
- Dementia
Mild Cognitive Impairment

“A syndrome defined as cognitive decline greater than that expected for an individual’s age and education level but that does not interfere notably with activities of daily living.”

MCI Criteria (ADCS)

- Memory complaints (self or informant)
- Memory deficit on paragraph recall (age and education adjusted)
- CDR = 0.5 (questionable dementia)
- General cognition preserved (MMSE ≥ 24)
- “Not sufficiently impaired” in daily function for diagnosis of dementia
Conversion of MCI to Dementia

Amnestic Mild Cognitive Impairment
Annual Rates of Conversion

MCI and Dementia Rates

Wien Center Memory Screening
Community-based, self referred participants, 2001.
The Underwriting Challenge

Alzheimer’s Type Dementia

- Prevalence: 5,400,000
- Diagnosed: 3,291,800
- Treated*: 1,316,000
- Treated with Dementia Meds: 791,500

* Any drug treatment, not limited to acetylcholinesterase inhibitors.
Rarely Noted in Medical Records

Dementia/Alzheimer’s Type Dementia

<table>
<thead>
<tr>
<th>Stage</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms</td>
<td>Memory loss</td>
<td>Behavioral, personality changes</td>
<td>Gait, incontinence, motor disturbances</td>
</tr>
<tr>
<td></td>
<td>Language problems</td>
<td>Unable to learn/recall new info</td>
<td>Unable to perform ADL</td>
</tr>
<tr>
<td></td>
<td>Mood swings</td>
<td>Long-term memory affected</td>
<td>Bedridden</td>
</tr>
<tr>
<td></td>
<td>Personality changes</td>
<td>Wandering, agitation, aggression, confusion</td>
<td>Placement in long-term care facility</td>
</tr>
<tr>
<td></td>
<td>Diminished judgment</td>
<td>Require assistance w/ADL</td>
<td></td>
</tr>
</tbody>
</table>

Archives of Internal Medicine Study

- 297 outpatients age 65 and older: routine visits
- Internist scores as normal or cognitively impaired
- Researchers performs standard cognitive test
- Data on functional ability obtained from relatives
- 26 of 297 found to have dementia (9%)
- 67% of those with dementia scored as NOT demented by PCPs
- 65% with ADL deficits were NOT documented as impaired in chart
The Underwriting Challenge

Indications of Cognitive Impairment Rarely Noted in Medical Record

Univita LTCI Underwriting & Claims Database 2014
Future Underwriting Challenges

Biomarkers for Alzheimer’s Type Dementia

- New ELISA blood test (enzyme-linked immunosorbent assay)
  - Group of 18 proteins distinguish AD patients from controls
    - Identified AD patients with 90% accuracy
    - Identified normal controls with 88% accuracy
    - For Mild Cognitive Impairment
      - Identified those who develop AD within 2-6 years with 91% accuracy
      - Identified those develop non-AD dementia with 100% accuracy

- CSF, PET Scans, fMRI, vMRI, Amyloid imaging

- What are the implications for underwriting?

Today’s Underwriting Challenge

Cognitive Impairment

- Initial signs and symptoms are subtle and insidious
  - Is it normal forgetfulness, MCI or early dementia?
- Long timeline to earliest symptoms
- Family often notice earliest signs of cognitive loss
- Very little clinical screening by physicians
  - Lack of simple effective office screening test
  - Lack of effective therapy for early disease
- Reluctance to record diagnosis in medical record
Minnesota Cognitive Acuity Screen (MCAS)
10 years of experience with cognitive screening and its impact on mortality

August 26, 2013
Minnesota Cognitive Acuity Screen (MCAS)

- A leading cognitive test in the US Insurance market with over 1 million test performed to date
  - A simple, non-threatening, telephone or in-person interview designed to detect cognitive impairment in its earliest stages
  - Developed and statistically validated in 1998 in a blinded trial by a team of physicians and scientists
  - Published results showing that the MCAS significantly distinguishes the relative mortality risks of individuals applying for insurance

MCAS

- Designed and developed for use in insurance underwriting and claims
  - Designed to efficiently and reliably provide insurers with accurate, conveniently obtained and cost-effective information in-person or over the phone
  - Identifies mild to moderate cognitive impairment 97.5% sensitivity and 98.5% specificity
  - Identifies those with MCI who are destined to convert to dementia and exhibit functional decline
  - Rigorously scripted, trained and quality controlled; internal checks for “cheating”, no educational or age bias
  - Multiple insurance conversions from other cognitive tests without difficulties over past 13 years
MCAS Subtests

- The MCAS has validated sensitivity for detecting the earliest types of cognitive changes that would occur in patients who are destined to have Alzheimer’s type dementia or who have mild forms of AD.

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>Short and long term memory</td>
</tr>
<tr>
<td>Attention</td>
<td>Immediate recall</td>
</tr>
<tr>
<td>Delayed Word Recall</td>
<td>Short term memory</td>
</tr>
<tr>
<td>Comprehension</td>
<td>Ability to concentrate and follow directions</td>
</tr>
<tr>
<td>Repetition</td>
<td>Speech and language skills</td>
</tr>
<tr>
<td>Naming</td>
<td>Word finding skills</td>
</tr>
<tr>
<td>Computation</td>
<td>Basic math skills</td>
</tr>
<tr>
<td>Judgment</td>
<td>Ability to reason and use good judgment</td>
</tr>
<tr>
<td>Verbal Fluency</td>
<td>Word finding ability and complex thinking</td>
</tr>
</tbody>
</table>

- Each subtest has been demonstrated to add to the statistical power of the overall screen. The MCAS questions relate to basic orientation, problem solving, memory and reasoning skills.
MCAS and LTCI

Proven value in LTCI underwriting

5-year retrospective study of a large LTCI carrier >250,000 insureds under age 72 years, more than 3 years post underwriting

• Majority of MCAS testing via phone history interview
• Based upon age and specific triggers to the MCAS
• Less than 1 in 10,000 initial cognitive claims
  - Less than 0.008% prevalence
  - Population-based prevalence estimated between 1.1 – 3.0%*
• MCAS False Negative Rate of 1 per 13,000 administrations

“The MCAS shows improved expected profitability compared to any other cognitive screen on the basis of claims savings and increased premiums alone (i.e. ignoring expense savings)” Milliman USA

* Report to the Secretary of Health and Human Services: Alzheimer's Disease, Estimates of Prevalence in the United States. 2010
Minnesota Cognitive Acuity Screen

- Moving beyond LTCI Underwriting and Life insurance
  - Highly effective as a cognitive assessment tool for establishing moderate to severe cognitive impairment (LTCI Claims)
  - MCAS’ evolving healthcare focus
    - Now used in Transition Care Management programs for major Medicare Advantage Plans
    - Plays an integral role in care management programs for complex chronically ill patients (dual eligible patients, Managed Medicaid and MA populations)
  - Significant ongoing research by a major Alzheimer’s research center
  - Selected for use in Brown University’s NIH Alzheimer’s type dementia Prevention Trial
The Minnesota Cognitive Acuity Screen (MCAS) and Mortality
MCAS Mortality Research

Univita Mortality Study

• The purpose of study: to examine mortality of MCAS test recipients to determine whether MCAS scores are predictive of mortality outcomes.
• Understand the protective value of Cognitive Testing in life insurance underwriting.

Study Design

• 10 years of MCAS testing, over 575,000 tests
• Match to Social Security Master Death Files (SSMDF)
• Analyze MCAS impact on Mortality (Mortality Ratios)
Mortality Data

- For each MCAS test subject, studied the probability of death from the test date to the earlier of:
  - Death
  - End of study period
  - Subsequent test
  - 38,467 deaths between 1999-2011

- Applicants matched against Social Security Death Master File (SSDMF) to identify deaths

- Subjects without a matching record in the SSDMF were assumed to live until the end of the study (June 2011)
### Characteristics of Test Population

<table>
<thead>
<tr>
<th>Age at Test</th>
<th>Exposure Years (%)</th>
<th>Deaths (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;60</td>
<td>445,855 (19)</td>
<td>1,568 (4)</td>
</tr>
<tr>
<td>60-64</td>
<td>396,208 (17)</td>
<td>2,927 (8)</td>
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<tr>
<td>65-69</td>
<td>581,019 (24)</td>
<td>5,990 (16)</td>
</tr>
<tr>
<td>70-74</td>
<td>468,806 (20)</td>
<td>8,215 (21)</td>
</tr>
<tr>
<td>75+</td>
<td>483,594 (20)</td>
<td>19,597 (51)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>Exposure Years (%)</th>
<th>Deaths (%)</th>
</tr>
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<tbody>
<tr>
<td>Male</td>
<td>955,968 (40)</td>
<td>19,084 (50)</td>
</tr>
<tr>
<td>Female</td>
<td>1,419,513 (60)</td>
<td>19,213 (50)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total</th>
<th>Exposure Years (%)</th>
<th>Deaths (%)</th>
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<tbody>
<tr>
<td></td>
<td>2,375,482 (100)</td>
<td>38,297 (100)</td>
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## Characteristics of Test Population

<table>
<thead>
<tr>
<th>Duration</th>
<th>Exposure Years (%)</th>
<th>Deaths (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>529,036 (22)</td>
<td>3,059 (8)</td>
</tr>
<tr>
<td>2</td>
<td>444,504 (19)</td>
<td>4,223 (11)</td>
</tr>
<tr>
<td>3</td>
<td>372,849 (16)</td>
<td>4,722 (12)</td>
</tr>
<tr>
<td>4</td>
<td>301,998 (13)</td>
<td>4,918 (13)</td>
</tr>
<tr>
<td>5</td>
<td>225,963 (10)</td>
<td>4,771 (12)</td>
</tr>
<tr>
<td>6</td>
<td>165,005 (7)</td>
<td>4,421 (12)</td>
</tr>
<tr>
<td>7</td>
<td>127,667 (5)</td>
<td>3,996 (10)</td>
</tr>
<tr>
<td>8</td>
<td>89,895 (4)</td>
<td>3,169 (8)</td>
</tr>
<tr>
<td>9</td>
<td>59,697 (3)</td>
<td>2,356 (6)</td>
</tr>
<tr>
<td>10</td>
<td>36,977 (2)</td>
<td>1,506 (4)</td>
</tr>
</tbody>
</table>
Study Methodology

• Calculated an expected number of deaths based on the gender, age at testing and duration since testing of each subject and the 2008 Valuation Basic Table (smoking unknown, select and ultimate, age last birthday)

• Compared actual deaths to expected deaths to generate mortality ratios.

• Analyzed the relative mortality ratios of various subpopulations.
Mortality Study Results

- 95% of exposure in study is “Not Impaired” = MCAS score > 0.0
- Impaired: Significantly worse mortality than expected
- Not Impaired: Slightly better mortality than expected
- 95% confidence intervals are relatively narrow due to large number of deaths included in study
Results by Gender

Mortality Ratios by MCAS Score and Gender

Gender

Female

Male

Impaired

Not Impaired
Mortality Results by Age

Mortality Ratios by MCAS Score and Test Age

Test Age Band

- Under 60
- 60-64
- 65-69
- 70-74
- 75+

Mortality Ratio
- 0.000
- 0.500
- 1.000
- 1.500
- 2.000
- 2.500
- 3.000
- 3.500
- 4.000
- 4.500
Mortality Results by Duration

Mortality Ratios by Duration

Duration from Test Date (Years)

Mortality Ratio
Mortality Results by MCAS Score

Mortality Ratios by MCAS Score

-5.00 to -1.51
-1.50 to -0.51
-0.50 to 0.00
0.01 to 0.50
0.51 to 1.50
1.51 to 5.00
Study Results and Conclusions

- MCAS test scores are useful in stratifying relative mortality risk of applicants.

- Relative mortality is:
  - Significantly worse than expected for Impaired lives
  - Slightly better than expected for Non-Impaired lives

- Mortality differentials exist by:
  - Age and gender
  - Duration - differentials wear off slightly by duration from test date but persist to later durations

- Finer gradations may be useful for life underwriting (ratings) versus LTCI “Impaired” versus “Non-Impaired”
Protective Value

- Value of Cognitive Screening is positive if:
  - Cost of the test < Mortality savings

- Mortality savings = Excess mortality * Insurance amount * Prevalence * Sensitivity * Exclusivity factor, where
  - Excess mortality = present value of excess death benefits per $1,000 of face amount
  - Insurance amount = death benefit amount in $1,000s
  - Prevalence = impairment prevalence of the population applying for insurance
  - Sensitivity = how good the test is at finding impaired risks
  - Exclusivity factor = how often is this test the only means to uncover or illuminate an impairment that would cause the underwriter to rate up or decline the application

Protective Value

Sample Model: 10 Year NPV for male age 67

- PV(Impaired death benefits) = $150.34 per $1000 of face amount
- PV(Not Impaired death benefits) = $73.88 per $1000 of face amount
- Impaired prevalence = 3.76%
- Sensitivity = 97.5%
- Exclusivity unknown = z

Protective Value

- For $500,000 face amount
  - PV(mortality savings) = ($150.34 - $73.88) * $500 * 3.76% * 97.5% * z
  - Where z is the exclusivity factor
  - If cost = $40, z > 2.89% implies positive protective value

- Exclusivity must be higher for smaller face amounts and younger ages (and is smaller for larger face amounts and older ages)

- Studied all cause mortality, therefore exclusivity must be measured relative to all underwriting information, not only information about cognitive impairments

<table>
<thead>
<tr>
<th>Test Age</th>
<th>$250k</th>
<th>$500k</th>
<th>$1 million</th>
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<tr>
<td>57</td>
<td>24.9%</td>
<td>12.5%</td>
<td>6.2%</td>
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<tr>
<td>62</td>
<td>15.3%</td>
<td>7.7%</td>
<td>3.8%</td>
</tr>
<tr>
<td>67</td>
<td>5.9%</td>
<td>2.9%</td>
<td>1.5%</td>
</tr>
<tr>
<td>72</td>
<td>2.7%</td>
<td>1.4%</td>
<td>0.7%</td>
</tr>
<tr>
<td>77</td>
<td>1.6%</td>
<td>0.8%</td>
<td>0.4%</td>
</tr>
</tbody>
</table>
Additional Results and Conclusions

• MCAS test results likely have positive protective value for high face amounts and older ages

• Age-specific prevalence rates of dementia and insurance amount must be considered

• Exclusivity of the MCAS must be high because other sources of data to identify early cognitive impairment are often lacking

• Another reminder that cognitive impairment impacts life expectancy
Older Age Underwriting

**Why is a cognitive testing critical for older age underwriting important?**

- A major risk factor for premature mortality
- Growth in prevalence of cognitive impairment as age increases
- Little information available in medical records
- More and larger life insurance policies are being written at the older ages
- Asymmetrical information, biomarkers, genetics
- Important to protect against anti-selection when other companies have implemented programs (Sentinel effect)
- Don’t forget about frailty, function, etc.