Chicago Actuarial Association March Workshops

Potential New Medical Markers in Underwriting

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Agenda

- Goals of the study
- Process for completing study
- Markers studied
- Key considerations for determining cost and benefit of markers
- Conclusions from study
- How you can use study results
- Other potential markers

Goals of study

- Independent review of potential new medical markers
- Goal was not to recommend or reject any marker
- Provide enough information for company to make own decision as to whether or not to implement new marker
  - Based on each individual company's unique situation
- Provide methodologies to do own analysis

- Note: Will be using marker and test interchangeably

Process

- Designed questionnaire to interview laboratories
- Compiled interview results
- Compiled list of potential markers from discussions with labs
- Had labs vote to help determine best markers to study
- Cost data came from combination of labs, POG, own knowledge
- Benefit data came from Internet research for mortality data on markers
- Compared cost and benefit information at various ages for both males and females
- Wrote report
- Peer review by POG and labs

Questionnaire

- Definition of desired markers:
  - Currently available, but not widely used
  - Applicable to life insurance underwriting (i.e., good indicator of mortality)
- Also asked labs for:
  - Explanation of marker and primary and secondary uses
  - Source of the test (i.e., blood, urine, saliva)
  - Stability of the marker
  - Whether marker would supplement or replace other current tests
  - Downsides to marker, including regulatory issues
  - Lab cost for administering the test
  - Age range applicable for test
  - Current and anticipated utilization of marker
  - Whether any of the information provided was proprietary

Markers Studied

- Apolipoprotein A-1 and B – Heart
- CBC (Complete Blood Count)/Red Cell Distribution width – All cause
- Cystatin C – Kidney
- Hemoglobin – Multiple causes (e.g., anemia, cancer)
- Hemoglobin A1c – Glucose
- Microalbumin – Kidney
- NT-proBNP – Heart
- Oxidized LDL – Heart
- Phospholipase A2 – Heart
- TNF Alpha – Immune system
- Troponins I and T – Heart

Cost Considerations

- Amount the laboratory charges to administer the test
  - Level of business with the lab
  - Routine vs. reflex
- Training costs
- Cost of underwriter and medical staff's time
  - Includes salary plus benefits
- Time spent on:
  - Reviewing case initially
  - Ordering APS, if necessary
  - Reviewing APS findings
  - Describing reason for decline, if necessary
- Cost of APS
- Mortality savings from test being replaced

Example 1 – NT-proBNP

- Cost calculation:
  - Average laboratory cost for administering marker is $25
  - Time assessed at $75,000 average salary, 35% extra for benefits and 40 hour work week - $0.81/ minute
  - Training time to learn about marker – 1 hour, amortized over 5 years and 500 new applicants ($0.02)
  - 2 minutes to review normal cases (90%) and 15 minutes to review abnormal cases (10%) – average time 3.3 minutes, time cost ($2.67)
  - Assume 10 minutes to order an APS in 10% of the cases ($0.81)
  - Cost of APS ($50) in 10% of cases ($5)
  - Assume 15 minutes to review APS in 10% of the cases ($1.22)
  - Assume 10 minutes to explain adverse decision in 5% of cases ($0.41)
  - Total cost = $25+ $0.02+ $2.67+$0.81+$5+$1.22+$0.41 = $35.13
- Assume 5% declines/not takens, spread over insureds
- Final cost = $35.13 / 0.95 = $36.98, assume **$37**

Steps to Determine Benefit

1. Find study(ies) that provides prevalence and mortality data for marker being studied
   - Mean, standard deviation, hazard ratios needed
2. Use mean and standard deviation to determine substandard reading
   - Assumed normal distribution and 5% substandard
   - Considered J- and U-shaped curves
3. Determine non-substandard reading
4. Use results from 2 and 3 and hazard ratios to determine extra mortality from substandard class

Steps to Determine Benefit (cont'd)

5. Determine mortality savings, need:
   - Standard mortality assumption
     - 94% of SOA 2008 VBT sex distinct, smoking composite, primary tables
     - Grading for last 15 years back to 2008 VBT
     - Cap of 75% mortality rate (substandard lives)
   - Percentage of savings uniquely identified by this marker
     - This will increase if it replaces another marker
   - Spread over all insureds (assumed 5% declined or not taken)
6. Cost savings from test this marker replaces
7. Compare cost of marker and benefit just derived

Other Benefit Considerations

- The study to use
  - Relevance of data to life insurance applicants
  - Lab data while possibly most accurate, conflicts with independence
  - US vs. foreign
  - Healthy vs. impaired lives
  - General population vs. insured lives
  - All cause vs. specific cause mortality
  - Length and dates of observation period
- Differences by age and gender
- Sentinel effect
- Challenges
  - Most studies in different format
  - Some data missing with most markers

Example 1 (cont'd) – NT-proBNP

- Cost / Benefit comparison
- Cost = $37
- Benefit = $316 for a 60 year old female with $100,000 policy
  - Benefit varies by age, gender and policy size
- Benefit being greater than cost implies marker is cost-justified in this specific situation
- However, there are other factors that must also be considered
  - Other markers currently used
  - Administration
  - Marketing
  - Competition

Example 2 - Apolipoprotein

- Marker for cardiovascular risk
- Two types of Apolipoprotein: A-1 and B
  - Apo B: Primary lipoprotein in LDL, delivers cholesterol to cells
  - Apo A-1: Major component of HDL, helps clear cholesterol from arteries
- Ratio of B to A-1 found to be better indicator of mortality than either A-1 or B alone
- Used one study: Apolipoprotein Mortality Risk Study (AMORIS)
- Population was people from Stockholm, Sweden
  - Studied those who submitted blood samples during medical checkups between 1985 and 1996 and did not have cardiovascular disease
  - Follow up period 7-17 years

Example 2 – Apolipoprotein (cont'd)

- Mean and standard deviation were provided
- Data was split between males and females

	Apo- Ratio	
	Male	Female
Mean	1.00	0.85
Standard Deviation	0.29	0.28

- No mention of J- or U-shaped curve, so we assumed:
  - Data was normally distributed
  - Substandard risks only at the highest 5% of the ratios
  - Average substandard was at the 97.5 percentile

Example 2 – Apolipoprotein (cont'd)

- Determined substandard ratio (1.57 for males and 1.40 for females) from normal distribution curve and mean and standard deviation provided
- Calculated non-substandard ratios using the following formulas:

$$\underline{Male: 95\% \times X + 5\% \times 1.57 = 1.00}$$

$$\underline{Female: 95\% \times X + 5\% \times 1.40 = 0.85}$$

- Resulting values were:

Apo Ratio		
	Male	Female
Average Substandard	1.57	1.40
Average Non-Substandard	0.97	0.82

Example 2 – Apolipoprotein (cont'd)

- Next step is to utilize hazard ratios and information just determined to calculate mortality savings

Item	Male	Female
A) Non-substandard risk	0.97	0.82
B) Substandard risk	1.57	1.40
C) B – A	0.60	0.58
D) Non-substandard standard deviation	0.29	0.28
E) C / D	2.069	2.071
F) Age-adjusted hazard ratio per one standard deviation	1.51	1.39
G) (F – 1) x E	1.06	0.81
H) Proportion of the distribution assumed substandard	**5%**	**5%**
I) G x H	**0.053**	**0.0405**
Additional mortality exhibited by substandard risks	**5.3%**	**4.1%**

Example 2 – Apolipoprotein (cont'd)

- Several more assumptions needed
  - Standard mortality assumption (94% of SOA 2008 VBT)
  - Percentage of cases where Apolipoprotein will uniquely find extra mortality
    - Since we assumed cholesterol test will continue to be used, assumed only 5% would uniquely be found by this marker
- With these additional assumptions, the present value of mortality savings using Apolioprotein (and still testing for cholesterol) for a 50 year old applying for $100,000 is:
  - $22 for males and $16 for females
- Compare this to a cost for the test of $21

Example 3 – Troponin

- Explanation of troponin
  - Troponin is a protein released by dying heart cells
  - Evidence of troponin in blood is indicative of previous heart attack or damage to heart
  - Troponin levels can rise due to strenuous exercise
  - Two components of troponin studied – Troponin-I and Troponin-T
- Found two studies
  - Both dealt with impaired lives, but studied all cause mortality
- Assumption of worst 5% being substandard won't work here
- Some individuals have no or just trace levels of troponin in blood (negative readings), rest positive readings

Example 3 – Troponin (cont'd)

- Need to determine substandard from among those with positive readings
- Those with positive readings split into multiple groups
  - Assumed worst group was substandard
- Mortality levels of groups given so didn't need mean and standard deviation
- Demonstration here will focus only on troponin-I
- AHF (Heart) Study
  - 2004-2009 study from Finland
  - Positive troponin values split into two groups
  - Assumed worst group was substandard
  - 51.1% had positive readings

Example 3 – Troponin (cont'd)

- Calculated non-substandard mortality to be 15.87%:

$$\underline{Troponin\ I: [48.9\% \times 13.5\% + (51.1\% / 2) \times 20.4\%] / [48.9\% + (51.1\% / 2)]}$$

- Substandard mortality (last group) given to be 26.9%
- Mortality savings for Troponin-I determined to be 70%:

$$26.9\% / 15.87\% - 1$$

Example 3 – Troponin (cont'd)

- ESRD (End Stage Renal Disease) Study
  - Minneapolis and St. Paul, MN study, began in 1998
  - For Troponin-I, groups were only positive and negative
  - Assumed positive group was substandard
  - Troponin-T positives were split into 3 groups
- Calculated mortality savings directly to be 73%:

$$52\% / 30\% - 1$$

Example 2 – Troponin (cont'd)

- To determine mortality savings, weighted AHF (70%) and ESRD (73%) studies by number of lives in study
- Mortality savings we assumed for Troponin-I was 72%

Item	Troponin I	Troponin T
A) AHF study	70%	91%
B) ESRD study	73%	131%
C) Weighted average	72%	118%
D) Proportion of the distribution assumed substandard	5%	5%
E) C x D	3.6%	5.9%
Additional mortality exhibited by substandard risks	**3.6%**	**5.9%**

Example 3 – Troponin (cont'd)

- Several more assumptions needed
  - Standard mortality assumption (94% of SOA 2008 VBT)
  - Percentage of cases where troponin will uniquely find extra mortality assumed to be 25%
- With these additional assumptions, the present value of mortality savings using Troponin-I for a 70 year old applying for $100,000 is:
  - $114 for males and $109 for females
- Compare this to a cost for the test of $31

Conclusions from Study

- All markers studied could potentially be used
  - Need to determine age and face amount limits
- Considerations beyond cost and benefit
  - Anti-selection from all others using
- Various cardiovascular markers
  - Not likely all will be used

How can you use the study

- Review analysis of individual markers
- Talk to labs so you don't start down wrong path
  - Favored marker(s)
- Methodologies provided to allow you to do own calculations
  - These markers or others

Other Potential Markers

- Aldosterone – Renal function
- Alpha 1 and Beta 2 microglobulin – Kidney function
- Alpha Fetoprotein – Fetus test for later cancer
- CDT (Carbohydrate-Deficient Transferrin) – Alcohol abuse
- CEA (Carcinoembryonic Antigen) – Cancer
- CRP (C-Reactive Protein) – Non-specific inflammation
- EtG (Ethylglucuronide) – Alcohol abuse
- Fibrinogen – Cardiovascular
- HIV 4
- Homocysteine – Cardiovascular
- Hyaluronic Acid – Hepatitis C
- Methamphetimine
- Pre-PSA Marker
- Triumph – Cardiovascular

What else is new?

- Lab risk profile/score
- BioSignia – Uses traditional markers
- Aviir – TruRisk
- Superior Metrics
- Telomere Health

Questions?

- Link to study: http://www.soa.org/research/research-projects/life-insurance/research-medical-markers.aspx

Bio – Al Klein, FSA, MAAA

- Al is a consulting actuary with Milliman's Lake Forest / Chicago office. He joined the firm in 2009.
- Al's primary responsibilities include industry experience studies and helping clients with life and annuity product development and reinsurance related issues. His expertise includes mortality and underwriting related issues, including older age, simplified issue and preferred.
- Prior to joining Milliman, Al most recently worked for a large stock life insurance company where he was responsible for experience studies across all lines of business. He has also worked for other life insurance companies, a reinsurer and consultant, where he has been responsible for strategic planning, product development and traditional reinsurance aspects of the business.
- Al is a frequent speaker at industry meetings and is currently involved with a number of industry activities, including:
  - SOA representative for the Mortality Working Group (MWG) of the International Actuarial Association
  - MWG Underwriting Sub-group chair – goal is to study underwriting done around the world
  - SOA Mortality and Underwriting Survey Committee
  - Joint American Academy of Actuaries (AAA) / Society of Actuaries (SOA) Preferred Mortality Oversight Group
  - Joint AAA / SOA Underwriting Criteria Team
  - 2014 SOA Valuation Basic Table (VBT) Older Age Subgroup
  - SOA Longevity Game Development Team
  - Longer Life Foundation Advisory Board
- Al received a Bachelor of Science degree in Actuarial Science and Finance from the University of Illinois, Urbana.

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