



**A series of statistical prediction models
to aid preferred risk underwriting**

Risk Classification

Stratification of risks into categories:

- Classification by actuarial established standards
 - Age, gender and smoking
- Classification by underwriting criteria
 - Preferred risk and Substandard risk
 - Age and gender independent

Preferred Risk vs. Substandard Risk

- Preferred risk: healthy
 - Relative term, age and gender dependent
 - No established cut-off that can dichotomously separate preferred from others
- Substandard risk: impaired
 - Absolute term, not age and gender dependent
 - Established diagnosis criteria

Conventional Underwriting

Rules-based:

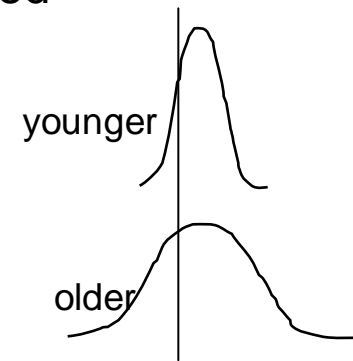
- Multiple dichotomous criteria
 - Substandard: such as diagnosed of diabetes, history of a certain disease...
 - Preferred: such as BMI<25, Cholesterol<200, BP<135/85
- Mostly not age and gender specific
- Most risk factors were evaluated independently

Conventional Underwriting

- Substandard risk: Working well
- Preferred risk: NOT working well
 - Lack of risk differentiation
 - Lack integration of multiple risk factors
 - Age and gender were unintentionally counted, while they should not

Intention of Preferred Class

- Enhanced marketing tool:
 - Better risk differentiation – increase of business
- Preferred with lower mortality across all age and gender groups (for example 80% of standard)
 - Higher proportion of older by definition qualified preferred



Underwriting Preferred Class with Conventional Algorithms

- Lower risk differentiation
 - Cases with lower mortality may not be selected as preferred, and vice versa
- Age and gender have become major reasons to qualify as preferred
 - Higher proportion of younger and female were classified as preferred
 - Preferred in younger female are not that different from the standards, while the preferred in older male may have far low mortality than their peers
 - Different mortality assumption has to be in place to adjust the different meaning of 'preferred' in different age and gender group

Mortality Assessment Technology (MAT)

- A series of statistical models to aid preferred underwriting
- All risk factors were calculated into composite risk with better association with mortality outcome
- Fully age and gender adjusted therefore age and gender independent
- Objective and can be automatically executed

MAT: Step 1

- Calculate multiple disease or condition prediction equations
- Produces a probability of onset for each specific disease or condition within a given period of time
- Morbidity models include CHD, stroke, diabetes, cancer (lung, breast, colon, prostate, and COPD)

Condition Specific Prediction

- Synthesis Analysis: A patented technology—Allows construction of multivariate prediction equation while the risk association of each risk factor may come from disparate studies
- Easily integrates new risk factors into the equation (comprehensive) and continuously updateable

Cohorts Used in Developing Each Prediction Model with Synthesis Analysis

Some of more than 100 Cohorts used in Synthesis Analysis:

Framingham Heart Study

Multiple Risk Factor Intervention Trial

Honolulu Heart Study

Women's Health Study

Atherosclerosis Risk in Communities

Lipid Research Clinics Coronary
Primary Prevention Trial

Quebec Cardiovascular Study

NHANES I Epidemiological Follow-up
Study

Paris Prospective Study

Physician's Health Study

Nurses Health Study

San Antonio Heart Study

Iowa Women's Study

Birmingham (UK) Stroke Case-Control
Study

MAT: Step 2

- Converts condition-specific probabilities into a Predicted Mortality Ratio (PMR)
- The PMR is a weighted average of mortality ratios
- The weights are contributions of the disease-specific mortality over the total mortality in each age and gender group

MAT Versus Conventional Underwriting Method

- Does MAT better differentiate mortality between preferred and standard class compared to conventional method?
 - Underwritten life insurance data with mortality outcomes

Data

- From a US life insurance company's recent 8 years accumulated data
- Subjects were included if they were classified as standard and above by the company's existing underwriting
- Subjects were further excluded if certain risk factors fall into some predefined outside range (for example: BMI>30 or cholesterol>300...) Total N=52,338 represent 216,250 person-years
- 178 death claims occurred during the observation

Classification by Existing Underwriting and MAT

| | | MAT | | | |
|-------------------------|-----------|--------|-----------|----------|--------|
| | | Super | Preferred | Standard | Total |
| Existing classification | Super | 6,123 | 7,153 | 1,202 | 14,478 |
| | Preferred | 6,826 | 16,553 | 5,275 | 28,654 |
| | Standard | 1,529 | 4,948 | 2,729 | 9,206 |
| | Total | 14,478 | 28,654 | 9,206 | 52,338 |

Classification by Existing Underwriting and MAT

| | Actual | | | MAT | | |
|------------------|---------------|-------------|-----------|---------------|-------------|-----------|
| | N | age | % F | N | age | % F |
| Super | 14,478 | 45.5 | 20 | 14,478 | 45.0 | 14 |
| Preferred | 28,654 | 43.5 | 23 | 28,654 | 44.2 | 23 |
| Standard | 9,206 | 48.3 | 14 | 9,206 | 46.8 | 22 |
| Total | 52,338 | 44.9 | 21 | 52,338 | 44.9 | 21 |

Mortality Comparison: A/E Ratio

| | | MAT | | | |
|-------------------------|-----------|--------|-----------|----------|--------|
| | | Super | Preferred | Standard | Total |
| Existing classification | Super | 0.5921 | 0.9758 | 1.4444 | 0.8808 |
| | Preferred | 0.6247 | 0.7766 | 1.3323 | 0.8670 |
| | Standard | 0.4812 | 1.2863 | 1.4965 | 1.2215 |
| | Total | 0.5906 | 0.9454 | 1.4037 | 1.000 |

Conclusions

- MAT has significantly better mortality differentiation power than conventional underwriting algorithms
- The preferred group selected by MAT has lower mortality than that of the conventional method
- The preferred group selected by MAT has better overall risk factors than that of the conventional method's preferred group
- MAT is a powerful underwriting tool which can lower overall mortality experience in a direct writer's preferred group, ultimately increasing its completion advantage



Thank you very much for your kind attention.