Comparisons of BioSignia's Mortality Assessment Technology with Life Insurance Company's Existing Underwriting System in Defining Preferred Class

Abstract

BioSignia's Mortality Assessment Technology (MAT) is a patented statistical modeling procedure for predicting future mortality of subjects who do not have overt clinical impairment. It is especially suited to differentiating relative health status among the unimpaired for identification of "Preferred" applicants. A life insurance company recently provided BioSignia a dataset of 7,503 recent life insurance applicants. The data included limited risk factor information as well as the risk classification assigned by the company's existing underwriting system. According to its existing classification, 37% of the applicants were classified as preferred class. After applying MAT to the data and calculating the predicted mortality ratio (PMR), 37% of the subjects with the lowest PMR values were classified as the MAT-defined preferred class. Differences between the two classifications were then compared. There was 66% agreement and 34% disagreement between the two classifications. Among the subjects on which the two methods disagreed, the subjects who were classified as Preferred by the existing classification but not by MAT tended to be younger, have a higher ever-smoking rate, and higher age-adjusted values for cholesterol, total/HDL ratio, glucose, triglycerides and blood pressure, and lower age-adjusted HDL than the subjects who were classified as Preferred by MAT but not by the existing classification. This suggests that the future age-adjusted mortality of the Preferred class defined by the existing underwriting system would have higher mortality rates than the MAT-defined Preferred class. This analysis further confirms the findings from other data sources, including a dataset with ***observed mortality outcomes***, that MAT would significantly improve the classification of preferred classes in life insurance underwriting.

Introduction

In our earlier analyses and reports we have introduced the Mortality Assessment Technology (MAT), which is based on multiple evidence-based disease prediction models, and a calculation of predicated mortality ratio (PMR). By applying MAT to a national longitudinal cohort dataset, it was shown that MAT accurately predicted mortality and yielded better mortality risk discrimination power than a conventional underwriting method. More specifically, the preferred class defined by MAT had significantly lower mortality outcomes than the preferred class defined by conventional criteria. Subsequently, several life insurance companies have provided recent life insurance applicants' data and their existing classification status. Even though different companies may have different criteria and with different thresholds for classifying preferred or preferred plus or super preferred classes, in our analysis, MAT has consistently outperformed all existing classifications. In this analysis we compared the classification of MAT with the existing classification by one of the life insurance companies. Since there are no mortality outcomes in the data, the comparisons were made on the available risk factors, which have been shown to be associated with mortality.

Method

Data and the existing classification

The data includes 8,134 recent issued policies with assigned classifications. There were 340 current smokers who were classified as "smoker" class and were consequently excluded from the analysis. An additional 291 subjects were excluded because they were either younger than 20 or older than 70, or they had blood glucose values higher than 126 mg/dL (the diagnostic criteria for diabetes). This yielded a final dataset of 7,503 subjects.

Of these subjects, according to the company's existing classification, 37% were classified as Preferred, 63% as Others.

MAT classification

The application of MAT was based on the assumption that all the applicants do not have overt clinical impairment. In other words, an effective screen was applied to screen out the impaired cases. Predicted Mortality Ratio (PMR), which represents the predicted mortality risk in a given age and gender group, was computed using the risk factor data that included age, gender, history of smoking, height, weight, blood pressure, cholesterol, HDL, fasting blood glucose and fasting blood triglycerides. These variables represent the minimal input requirements of MAT. PMR is a continuous variable and a cut-off point is needed to make the classification. It is understood that the proportion of the applications to be classified as preferred class is more of a business decision than an underwriting decision. In this case, we set up the cut-off point so that the same proportion (37%) of the subjects would be classified as preferred class by MAT. Therefore the 37% of subjects with the lowest PMR value (PMR less than 0.988) were classified as MAT-defined preferred class.

Comparison

The concordance and discordance between the two classifications were examined. Since there were no mortality outcomes data, the comparisons between the two methods were mainly focused on the well-known risk factors. ***All risk factor values were age and gender-adjusted before comparison***. A general linear regression approach was used to make the age and gender adjustment. For a given risk factor a regression model was first fitted in the data using the risk factor as the dependent variable and age and gender as independent variables. The age and gender-adjusted values were the sum of the overall mean of the given risk factor and the regression residual from the age and gender regression. Below are examples of calculating the age and gender-adjusted cholesterol value.

First a regression of the association of cholesterol with age and gender was fitted. Following is the fitted regression equation:

Cholesterol=189.5+0.46388*age-0.95663*gender (0 female, 1male)

For a 30 year old female subject with a cholesterol level of 210, based on her age and gender her predicted cholesterol level using the above equation is 189.5+0.46388*30-0.95663*0 = 203. This will give a residual of 210-203=7. The residual plus the overall mean of cholesterol, which is 209, will give the subject's age and gender-adjusted cholesterol level of 209+7=216.

For another subject, an age 50 female, with a cholesterol level of 210, based on her age and gender her predicted cholesterol level using the above equation is 189.5+0.46388*50-0.95663*0=213. This will give a residual of 210-213=-3. The residual plus the overall mean of cholesterol will give the subject's age and gender-adjusted cholesterol level of 209-3=206.

The above two examples demonstrate that even though the two subjects have the same cholesterol level of 210, their age and gender-adjusted cholesterol level can be very different. The younger subject has a significantly higher age and gender-adjusted cholesterol (216) than the older subject (206).

Results

Table 1 shows the general statistics of the data used in this analysis. It is well representative of the overall life insurance applicant population in the US.

Table 1. General statistics of the dataset

Categorical variables (%)	
Existing rating	
Rate as preferred	37
Rate as other	63
Gender	
Male	66
Female	34
Smoking	
Ever smoking	25
Never smoking	75
Continuous Variables (mean±SD)	
Age (years)	44 ± 10
Weight (lbs)	176 ± 38
Height (inches)	69 ± 4
Systolic blood pressure(mmHg)	120 ± 13
Total cholesterol (mg/dL)	209 ± 37
HDL (mg/dL)	55 ± 15
Fasting glucose (mg/dL)	86 ± 17
Fasting triglycerides (mg/dL)	152 ± 85

Table 2 shows the concordant and discordant classification of the preferred class by the existing classification and MAT classification. Overall, there was about 66% agreement and 34% disagreement between the two methods.

Tables 3 through 11 show the values of each risk factor in the different classification groups defined by MAT and the existing classification. They show that for the group that was defined as preferred by MAT but not by the existing classification the smoking rate was lower (Table 3), age and gender-adjusted cholesterol was lower (Table 5), age and gender-adjusted HDL was higher (Table 6), age and gender-adjusted blood pressure, BMI, glucose, and triglycerides were all lower (Table 8–Table 11) than the group defined as preferred by the existing classification but not by MAT. The average age of the preferred class defined by MAT (45) was higher than the average age of the preferred class defined by the existing classification (42) (Table 4). In other words, the preferred class defined by the existing classification tends to be younger applicants. Although being young in this group may cause them to have lower absolute values for many risk factors, the age and gender-adjusted values, which are what need to be evaluated, would be higher. ***It is especially important to note that the underwriting effort should be age independent since age is accounted for in the actuarial analysis. Our***

analysis demonstrates that the existing classification is age dependent, even though it's unintentional. We believe that a significant market opportunity exists among the relatively healthy within older age groups that is not presently being served by the industry.

Table 2. Cross-table on classification of preferred class by MAT and the existing rating. The number in parenthesis is the percentage.

		Existing classification		
		Preferred	Others	All
MAT	Preferred	1,462 (20%)	1,295(17%)	2,757(37%)
	Others	1,295(17%)	3,451(46%)	4,746(63%)
	All	2,757(37%)	4,746(63%)	7,503(100%)

Table 3. Past smoking rates of different groups

		Existing classification		
		Preferred	Others	All
MAT	Preferred	6%	8%	7%
	Others	29%	31%	30%
	All	17%	25%	22%

Table 4. Average age of different groups

		Existing classification		
		Preferred	Others	All
MAT	Preferred	43	47	45
	Others	40	45	44
	All	42	46	44

Table 5. Age and gender-adjusted cholesterol of different groups

		Existing classification		
		Preferred	Others	All
MAT	Preferred	193	202	198
	Others	209	218	216
	All	201	214	209

Table 6. Age and gender-adjusted HDL of different groups

		Existing classification		
		Preferred	Others	All
MAT	Preferred	63	65	64
	Others	51	49	50
	All	57	54	55

Table 7. Age and gender-adjusted Total cholesterol/HDL ratio of different groups

		Existing classification		
		Preferred	Others	All
MAT	Preferred	3.1	3.1	3.1
	Others	4.2	4.6	4.5
	All	3.6	4.2	4.0

Table 8. Age and gender-adjusted systolic blood pressure of different groups

		Existing classification		
		Preferred	Others	All
MAT	Preferred	116	117	117
	Others	125	127	126
	All	121	124	123

Table 9. Age and gender-adjusted BMI of different groups

		Existing classification		
		Preferred	Others	All
MAT	Preferred	23.4	24.5	23.9
	Others	24.7	28.1	27.2
	All	24.1	27.1	26.0

Table 10. Age and gender-adjusted glucose of different groups

		Existing classification		
		Preferred	Others	All
MAT	Preferred	83	83	83
	Others	88	88	88
	All	85	86	86

Table 11. Age and gender-adjusted triglycerides of different groups

		Existing classification		
		Preferred	Others	All
MAT	Preferred	115	119	117
	Others	167	190	183
	All	137	170	159

Discussion

This analysis further confirmed the findings from other data sources; i.e., that using MAT to define the preferred class could generate significantly lower mortality experience. In one previous analysis from a national dataset with mortality outcomes, the ***observed mortality*** proved the superiority of MAT to conventional methods in defining the preferred class.

One of the reasons that MAT is superior to conventional methods is that MAT correctly adjusts for age and gender in its calculation of PMR. In underwriting, the classification of the preferred class should be wholly independent of age and gender as mentioned previously and as further discussed below.

The classification of life insurance polices are generally done in at least two steps. First, the class is defined by the applicant's age and gender, sometimes including smoking status. This classification determines the standard price (premium) of the policy. Secondly within each age and gender group the applicants can be further classified as preferred, standard or substandard. This classification determines the discount rate of the policy. It is very important that age or gender not be considered in the second step of classification. Unfortunately however, when the conventional criteria were set-up to define the preferred class, such as by defining cholesterol, blood pressure or BMI below certain cut-off points, age effects were unintentionally included again because of the high association of age with all those known health (risk) factors. The result of such classification is that more younger applicants tend to be qualified as preferred class than older applicants. In other words, younger applicants are offered lower prices in the first underwriting step because they are younger and many of them are also given higher discount rates in the second step because they have "younger" risk factors. In actuality, the distribution of health status (area under the curve) is much wider for older age groups than for younger age groups (all relatively healthy). Logically and biologically, the proportion of applicants who are a meaningful distance from the mean (both higher and lower) is larger within older verses younger age groups.

This problem can be effectively solved by BioSignia's mortality assessment technology (MAT). MAT provides a mathematical tool to calculate mortality risk while the effect of age and gender are fully adjusted for, in addition to its ability for accurate risk prediction. Therefore MAT could be very useful in defining the preferred class in life insurance underwriting, with a higher level of ***objectivity*** and ***consistency***, and indeed with ***greater confidence in ultimate mortality experience.***