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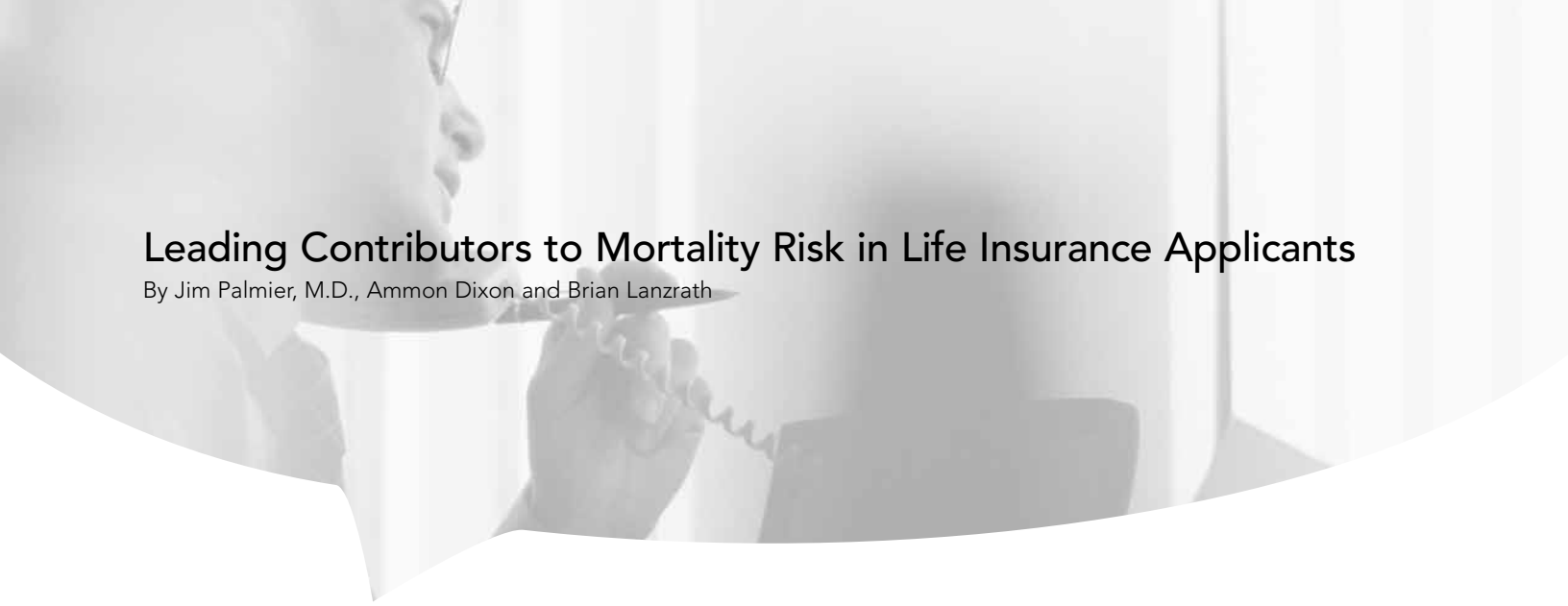

# Leading Contributors to Mortality Risk in Life Insurance Applicants

By Jim Palmier, M.D., Ammon Dixon and Brian Lanzrath

**Editor's note:** *This article is a continuation of an article published in the January 2012 edition of* smalltalk. *Inclusion of articles in* smalltalk *are for informational and educational purposes only and should not be considered an endorsement by the Smaller Insurance Company Section Council.*

Stratification of mortality risk in prospective insured individuals is a central function of underwriters, but one upon which the performance of actuaries' pricing projections is ultimately dependent. Until recently, life insurance underwriting was a relatively unsystematized offshoot of clinical medicine, tending to reflect the diagnostic preoccupations of practicing physicians concerned with the diagnosis and treatment of discrete medical conditions. In the last 12 months, Risk IQ, a data-analytics-driven prognostic system developed specifically for all-cause mortality prediction in life insurance applicants, has become a core element of the underwriting process at several major insurers. This de novo approach to applicant mortality prediction has generated a number of novel insights into the relative importance of various laboratory and biometric measurements, many of which are at odds with more conventional underwriting paradigms.

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As discussed in the January 2012 *smalltalk* article "Modeling Mortality in Life Insurance Applicants," Risk IQ is derived from a multivariate analysis of the laboratory results and physical measurements of more than 6 million life insurance applicants. The final result is a single, global rating of mortality risk (expressed as a percentile ranking); however, a necessary intermediate output is a matrix of risk coefficients for each of the more than 140 variables assessed in each of 10 demographic groups (males and females, 18 to 29, 30 to 39, 40 to 49, 50 to 59, and 60 to 79). The product of each of these coefficients and the appropriate lab/physical variable for a given applicant is the mortality contribution of a specific variable in a specific applicant (which may be either positive or negative). Aggregating these contributions into analytically meaningful groups (e.g., a lipid panel, a serum protein panel and various combinations of closely related liver function assays), and averaging their absolute values within a demographic, we are able to assess the relative importance of each for a given sex and age range. It is important to recognize that this process generates a population-level, not an applicant-level, metric of variable relevance. Under this method of assessment, a hypothetical test for a condition with a prevalence of 50 percent and a mortality effect of 10 percent would be ranked well above a test for a condition with a prevalence of 0.1 percent and a mortality effect of 300 percent. Although final Risk IQ scores are normalized by cotinine (tobacco-use) status, coefficients for this analyte are generated as part of model development and have been included here for the sake of completeness.

The table on page 16 lists the five underwriting variables with the largest effects on each demographic group, in descending order. In males, the two liver function test (LFT) groups are uniformly the most important predictors of risk, regardless of applicant age. The gamma-glutamyl transferase (GGT)-alkaline phosphatase (ALP) LFT group likewise dominates the assessment of women between the ages of 30 and 59, while aspartate aminotransferase (AST)/

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alanine aminotransferase (ALT) never rises above the third rank. The serum protein panel tends to follow the LFTs in younger applicants, while the relevance of urine protein (UPROT) and urine creatinine (UCREAT) increases steadily with age, becoming the dominant predictors in females age 60 to 79. Women under 30 are the clear outlier (as is often the case in mortality analysis), with a contributor ranking headed—perhaps counterintuitively—by the lipid panel, and including fructosamine, an analyte that is not among the leading five in any other group. Interestingly, fructosamine's second-highest standing is among males under 30, where it is ranked seventh (not shown).

## Top Five Underwriting Variables for Males and Females 18 to 79

| Age | 18 to 29 | 30 to 39 | 40 to 49 | 50 to 59 | 60 to 79 |
|---|---|---|---|---|---|
| Females | Lipid panel | GGT-ALP | GGT-ALP | GGT-ALP | UPROT/UCREAT |
| | Fructosamine | Pulse | UPROT/UCREAT | Protein panel | GGT-ALP |
| | Protein panel | Protein panel | AST/ALT | Lipid panel | Protein panel |
| | AST/ALT | AST/ALT | Protein panel | AST/ALT | AST/ALT |
| | GGT-ALP | Build/eCCr | Cotinine | Pulse | Build/eCCr |
| Males | GGT-ALP | GGT-ALP | GGT-ALP | GGT-ALP | AST/ALT |
| | AST/ALT | AST/ALT | AST/ALT | AST/ALT | GGT-ALP |
| | Protein panel | Protein panel | UPROT/UCREAT | Build/eCCr | UPROT/UCREAT |
| | Lipid panel | UPROT/UCREAT | Protein panel | UPROT/UCREAT | Protein panel |
| | Cotinine | Lipid panel | Build | Protein panel | Lipid panel |

| | | | | | |
|---|---|---|---|---|---|
| Lipid Panel: | Total cholesterol<br>HDL cholesterol<br>Triglycerides<br>LDL cholesterol<br>Ratios of above | Protein Panel: | Serum albumin<br>Serum total Protein<br>Serum globulin<br>Ratios of above | AST/ALT:<br>(Liver function) | Aspartate aminotransferase<br>Alanine aminotransferase<br>Ratios of above |
| GGT-ALP:<br>(Liver function) | Gamma-glutamyl transferase<br>Alkaline phosphatase | | eCCr: | Estimated creatinine clearance | |

The relative status of cotinine may be among the more counterintuitive findings of this analysis; it appears in the top five contributors of only two of the 10 demographic groups, and even then only in fifth place. The mortality effect of tobacco use is obviously substantial (approximately doubling risk on a multivariate basis for all groups), but its prevalence is comparatively low (9 percent in our data). Other, continuous variables, such as the LFTs, make contributions to risk assessment in all applicants, even when the values are well within the "normal" range. The lipid panel and build are also both ascribed much less importance in our analysis than in a typical underwriting context; with these variables, it is the lack of uniqueness (orthogonality) that limits their value in a multivariate system such as Risk IQ. In males 40 to 49, total cholesterol has a correlation coefficient of 0.20 with total protein, 0.16 with GGT and 0.18 with fructosamine, among many other variables. The partial multicollinearity of body mass index (BMI) with other profile variables (particularly AST/ALT) is stronger still—and most of these offer additional information, as well.

Taken as a whole, these results reinforce an emerging consensus on the centrality of the LFTs (particularly GGT) to the underwriting process, and serve as a reminder of the often-overlooked protein panel's importance—especially, though by no means exclusively, in younger applicants. They also reiterate the premise of earlier "Hidden Healthy" findings—that, *given a multivariate analysis of other variables*, the lipid panel and applicant build may be of significantly less relevance than is traditionally assumed. ●


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