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Session 36TS
Underwriting Concepts For Actuaries – Revisited

Track: Product Development

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Panelists: MARY ANN BROESCH
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Summary: This session discusses selected concepts that relate to risk appraisal in new business issuance and underwriting. Specific attention is focused on the relative values of underwriting tools, namely fluid collection: blood, urine, and oral fluid. The concepts of sensitivity and specificity are presented as examples of why certain testing protocols are "better" than others. Also included is a discussion of empirical tools available to support the mortality assumption setting process in connection with underwriting requirements.

MR. RICHARD L. BERGSTROM: A year ago, Jeff Marks from Northwestern Mutual and I put together a session in San Diego called "Underwriting Concepts for Actuaries." It was well enough received that we were asked to do something in addition to it, so I have compiled a separate panel of experts to talk about a variety of issues that relate both to mortality and risk assessment.

I'm Rick Bergstrom. I'm from the Seattle office of what is now known as Milliman USA, formerly Milliman & Robertson, Inc. I have been working with product development actuaries and the underwriting and medical directors of companies for many years now, and I find it very rewarding to move from more traditional actuarial concepts into those involving risk appraisal. I have encouraged the folks in the underwriting area to work more closely with their actuaries and actually develop products and set pricing based on the evidence of the risks collected. In fact, I think we all need to continue to move in that direction and to work more closely together to achieve the results that we're looking for.

Mary Broesch is our first speaker. She is executive director of research and consulting at ING Re in Denver. Previously, she was director of the Mortality Research Center. In her new role, she leads the Individual Life Product Development & Consulting area, which specializes in partnering with insurance companies to develop term life products in exchange for reinsurance. Mary is a Fellow of the Society of Actuaries and is a member of the Life Insurance Mortality & Underwriting

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Note: The chart(s) referred to in the text can be found at the end of the manuscript.
†Mr. Ingle, not a member of the sponsoring organization, is vice president and chief reinsurance underwriter for American United Life.

Survey Committee and the Individual Life Experience Studies Committee. Mary is going to be talking about both theoretical and empirical ways of developing mortality assumptions for preferred risk products.

Our second speaker, Doug Ingle, is vice president and chief reinsurance underwriter for American United Life's Reinsurance Division in Indianapolis. Doug holds the Fellow of the Academy of Life Underwriters (FALU) degree and also the Fellow of the Life Management Institute (FLMI) designation with distinction. Currently, Doug serves as chair of the Underwriting Experience Studies Committee, as a member of the Mortality and Morbidity Liaison Committee, and also as a member of the executive council for the Home Office Life Underwriters Association. He is an author for American United's journal *Medical Rounds* and is a contributing editor for *On The Risk*, the journal of the Academy of Life Underwriting, in which his latest article describes life table methodology. With that, I will turn it over to our first speaker, Mary Broesch.

MS. MARY ANN BROESCH: Today I'd like to cover two main areas: the theory of preferred risk classification and how to determine significant predictors of preferred mortality using an empirical approach.

As Rick suggested, I'm going to focus on preferred risk as a concept for underwriting. I'd like to start with some definitions so that we all can be on the same page.

Basically, the standard group can be split into both preferred and residual classes. What I mean by "preferred" is a class of risk that was created from a group of standard underwritten risks based on using a specific set of preferred underwriting criteria. The preferred class is expected to exhibit lower mortality than the standard group from which it was selected, so that discounted premium rates can be offered.

The residual class, also from the standard group, does not qualify for preferred, so this class would end up exhibiting higher mortality than the standard group and thus pay higher premium rates.

There are a number of considerations with respect to pricing and design of preferred risk that affect mortality. First, the number of classes that you have or that you choose for preferred makes a big difference. Next, I'll spend a fair amount of time going through some basic underwriting criteria to give you an idea of what is common and how this affects the qualification percentage. Then, I'll give an example of how to calculate expected mortality using a "conservation of death" approach.

The number of classes is really a tradeoff. A greater number of preferred classes could be better from the standpoint that you're better able to position your rates between the different classes, and you can actually peg where you want to be in terms of the competition. The more classes you have, the less premium differential between the classes. This is an advantage because it tends to lower the not-taken ratio. If there's less of a premium differential, those people who do not qualify for

preferred will be less likely to go somewhere else, and there's less pressure to make underwriting exceptions.

A greater number of preferred classes may not be better, however, because when you create more classes, you have to be able to statistically justify and gather and track experience information on each one of those classes separately. Each time you underwrite, you have to know how to classify the risk into the appropriate class, out of all those different classes. And there could be more pressure to make underwriting exceptions because of the greater premium rate differential between the classes. Now let's get more theoretical, so that you can see and contrast that to the empirical approach that I'll present later. What are you really looking at when trying to derive preferred criteria? You want to pick criteria that are going to give you the most significant predictors of mortality. Things like cholesterol, blood pressure, and whether a person smokes or not are real predictors of mortality. If you pick criteria that will select a preferred group out of the standard group, then the tighter the criteria, the lower your mortality is going to be. You want to pick criteria that will be easy to measure and verify. The criteria should be simple enough to apply and use. In addition, you need to be conscious of the cost. Clearly, you can pick things that are going to allow you to predict better mortality, but they come with a cost, so you have to evaluate the cost-benefit tradeoff, and Rick will talk more about that later.

Finally, underwriting exceptions result in increased mortality. If you price with a set of underwriting criteria, you need to make sure you follow that criteria. If you set certain thresholds for certain criteria and allow exceptions by accepting a risk even though it is outside of the acceptable range, you're going to have higher mortality. So it is very important that your underwriting exceptions are managed appropriately.

In terms of the preferred risk selection criteria, there are a number of different things that need to be considered.

1. Medical testing with a focus on the valuable information from blood or alternatives such as urine or saliva
2. Personal medical history
3. Lifestyle characteristics
4. Family history

Common medical tests include: blood pressure and blood lipids, pulse rate, blood glucose; HAAA or CDT, for ethanol or alcohol abuse; cotinine: Prostate Specific Antigen (PSA), HIV; Electrocardiogram (ECG), pulmonary function; AST (SGOT), ALT (SGPT) or GGT, liver function tests: BUN, kidney function tests; and creatinine.

Preferred criteria commonly include a review of an applicant's personal medical history, such as history of diabetes, heart disease, cancer, high cholesterol, stroke, hypertension, melanoma, and mental or nervous conditions. If the applicant has a history of these impairments, then you need to ask more questions to determine in which preferred class, if any, you should place the applicant.

Lifestyle risk factors are based on behavioral characteristics. Tobacco use is a lifestyle choice that has one of the greatest impacts on mortality. If you use tobacco, experience shows you will have higher mortality than if you don't. Alcohol abuse is another important risk factor for preferred, especially at the younger ages. At the younger ages, most deaths are related to traumatic causes, usually caused by accidents or from risky behaviors such as driving too fast or using illegal drugs. Private aviation, occupation, hazardous sports or avocations, foreign residence, and travel are among other lifestyle characteristics that affect mortality, which is why they're taken into account in the underwriting process.

You also must consider family history of certain impairments when underwriting preferred. There's no common definition for family history used by all companies, but here's one example: "No more than one parent diagnosed or died before the age of 60 from either heart disease, cancer, stroke, or diabetes." This example of a family history criterion for preferred may preclude an applicant from qualifying for preferred, depending on the situation.

Preferred criteria may also include socioeconomic status, education, activities of daily living (ADLs), or instrumental activities of daily living (IADLs), diet, exercise, and certain hobbies. Some of these items are getting a lot of attention and are important when underwriting the older ages, especially ADLs or IADLs, pet ownership, and gardening.

A key assumption in designing preferred risk products is the qualification percentage. This is the percentage of the standard class (remember the original definition) that you expect to qualify for the preferred class. If you use tighter underwriting criteria, a lower qualification percentage will result because fewer people will actually qualify based on that criteria. Conversely, less stringent criteria will qualify more applicants into the preferred class. The qualification percentage is directly related to the expected mortality. If you expect a lower percentage to qualify, presumably because you have tighter criteria, then you also expect to have lower mortality. This kind of assumption can be verified by actual experience.

Another key assumption in pricing preferred products is the expected mortality for the preferred and residual classes. In theory, you start with standard mortality because, again, you started with this combined group and selected out the preferred risks. From this perspective, you need to know what the mortality is for the combined group. In addition, you need to consider what underwriting screening tools are available, the preferred criteria, as well as the company's practice of underwriting exceptions and its effect on mortality experience. Lapses are directly related to mortality. You need to know your lapse assumption when setting your mortality assumption, especially when shock lapses occur (for example, at the end of a level term period).

Here's an example of how to calculate the expected mortality based on conservation of death principles. This is no different than what has been used in actuarial practice for many, many years. It's the same approach used to split an aggregate group into nonsmoker and smoker classes:

Equation 1

$$Sq = QP \times Pq + (1-QP) \times Rq$$

where: Sq = standard mortality rate
QP = qualification percentage
Pq = preferred mortality rate
Rq = residual mortality rate

If you know the qualification percentage and the relationship between either the preferred mortality to the standard mortality or the residual mortality to the preferred mortality, then you'll be able to solve for Pq/Sq or Rq/Pq.

An example might make this more clear. Let's assume that the preferred criteria are expected to qualify 40% from the standard class. The expected mortality for the standard non-smoker class is 50% of SOA 1975-80 basic mortality. So, what's the expected mortality for the preferred and residual classes?

To plug this into the formula, you need one other piece of information, and that's the relationship between standard and preferred or residual mortality classes. If you know either the preferred discount that you're going to offer or the ratio of residual to preferred mortality, you can go back to the formulas and solve for the unknown.

Now let's assume a 20% preferred discount. Take out 80% of the standard mortality assumptions to get the preferred assumption, which is 40% of SOA 1975-80. Then, go back through and do some algebra, plugging in the qualification percentage and what we just solved for as our preferred mortality. Use this to solve for the residual mortality.

In this example, starting with standard mortality of 50% of SOA 1975-80 and a preferred discount of 20%, preferred mortality is 40% of SOA 1975-80. This implies that residual mortality has to be 56.7% of SOA 1975-80 for the math to work out, assuming the conservation of deaths principle holds.

To summarize this theory, you must consider four interrelated decision points when designing preferred products:

1. The number of preferred classes
2. The underwriting criteria for each class
3. The qualification percentage for each class
4. The expected mortality for each class

You also need to be aware of how this will be implemented and what underwriting exceptions can be expected, if any, or your assumptions will not come out as you expected.

For the second half of my presentation, I'll be presenting an empirical approach, which is basically using statistical techniques to analyze mortality and compare the

results to the theoretical approach. This example serves as a way to show you what approaches might be out there to evaluate mortality. It's an illustration of an approach, and that's what I want you to take away from this more than the actual results or the numbers.

Our basic objective is to study the predicted capacity for mortality of the preferred criteria. First, we'll identify significant predictors of mortality using a Cox model. Then we will explore the mortality differentials between the preferred and residual classes using survival curves based on a Kaplan-Meier estimate.

The Cox model is a proportional hazard model that fits time to death as the outcome. It's widely used in medical, clinical, and public health research to identify risk factors.

Equation 2

$$h(t) = h_0(t)e^x$$ Where: t = time to event (e.g., death)

$h(t)$ = hazard function
$h_0(t)$ = baseline of hazard function
x = row of potential predictors
β = vector of parameters to estimate

The formula reflects the impact on a baseline function of varying certain risk factors and then evaluating the result. X represents the actions of the potential predictors or risk factors. This includes things such as the level of cholesterol and whether or not the person smokes. The beta are parameters determined from the model. One advantage of the Cox model is that it is a semi-parametric approach. A lot of other approaches for regression analysis use a parametric approach, which means you need to know or assume the distribution of death, and that's not always an easy assumption to make. This Cox model does not require an assumption for the distribution of time to death. The model is easy to apply, and the results are easily interpreted.

By rearranging the formula and moving over one of the functions, the formula becomes:

Equation 3

$$\lambda = \frac{h(t)}{h_0(t)} = e^x$$

with lambda defined as the hazard ratio. When the event is death, the hazard ratio represents the relative mortality of the varied predictor compared to the baseline risk factor. By varying that one factor, the hazard ratio then represents whether the results are higher or lower than the baseline.

The model produces hazard ratio results for each risk factor. But what does a hazard ratio really tell you? It depends on how significant the result is. Within the Cox model, there's a P value that determines whether or not the results are statistically credible. The lower the P value, the more significant the result, which means you can have more trust in the hazard ratio results.

The significance of P values are defined as follows:

≤ 0.01 = very significant
≤ 0.05 = significant
≤ 0.1 = marginally significant

If a hazard ratio is not significant, it really doesn't mean anything. In this context, a hazard ratio represents the risk of preferred value persons dying of the criterion, compared to standard nonsmoking persons who do not qualify on that criterion, holding all other criteria constant.

To illustrate this model, five fairly generic criteria were chosen. Furthermore, in the industry today, there is really no difference in underwriting requirements for different ages. While some requirements may vary by age, the criteria don't. Starting with a standard nonsmoker group and standard underwriting criteria, we've created some additional criteria to qualify for preferred:

• No tobacco used in the past five years
• Not a heavy drinker
• Blood pressure lower than 145/85
• Total cholesterol lower than 240
• Body mass index (BMI) between 22 and 28

Table 1

Generic Preferred Significant Predictors
Hazard Ratios for Generic Industry Preferred Criteria by Age Group
General U.S. Population with annual income >=$20,000

Criteria	Ages 18-39	Ages 40-69	Ages 70+
No tobacco use in 5 years	-	0.61**	-
Not a heavy drinker	0.23***	-	-
Blood Pressure <= 145/85	-	.77**	-
Cholesterol <= 240	-	-	1.78**
BMI 22-28	-	-	0.49***
Sample Size	1396	1462	138

***Very significant (p-value <=.01)
** Significant (p-value <=.05)
* Marginally significant (p-value<=.10)

Table 1 shows hazard ratios that are statistically significant of the five preferred

criteria. The results are split into three age groups: 18-39, 40-69, and 70+. Only the statistically significant hazard ratios for each of these cells is shown so that we can focus on the meaningful results.

Here's how to interpret the table. For ages 40-69, someone who has not used tobacco in five years will likely have 61% of the mortality of someone who did use tobacco in the past five years. For ages 18-39, out of these five given criteria, the most significant criterion is the question of drinking. A person who is not a heavy drinker will likely have 23% of the mortality of someone who is a heavy drinker for ages 18-39. Blood pressure is significant for ages 40-69, so someone with a blood pressure of less than 145/85 would likely have 77% of the mortality of someone who had blood pressure higher than 145/85.

The cholesterol results are interesting. At the older ages, a person with a cholesterol rating of less than 240 will have 178% of the mortality of someone who has a cholesterol rating higher than 240. That seems somewhat counterintuitive, since it is common knowledge that the lower the cholesterol, the healthier the person. At the older ages, however, low cholesterol can sometimes be just as indicative and predictive of adverse mortality as high cholesterol. Low cholesterol may be an indication of early cancer, for example. This is a good example of why you should use the empirical approach to see if you can learn something that you may not have known.

BMI is also significant at the older ages. People over age 70 who have a BMI within the 22 to 28 range would have 49% of the mortality of those who have a BMI less than 22 or greater than 28.

Based on these results, each age group has significant predictors of mortality. Now we need to see whether or not these significant predictors will actually produce a preferred class that has different mortality from the residual class. We're using Kaplan-Meier (K-M) survival curves to look at this, using the following formula:

Equation 4

$$S(t) = \prod_{j=1}^{k} \left(\frac{n_j - d_j}{n_j} \right)$$

where n_j = number of subjects alive just before time $t_{(j)}$
       d_j = number of deaths at time $t_{(j)}$

Medical studies often use the K-M estimate, which uses the exact time of event (deaths), while a life table uses time intervals.

The first result for the 18-39 age group is a P value of 0.028, which is statistically significant. With the 40-69 age group, the P value is too high to be statistically significant. So even though significant predictors are identified for that age group, they are not enough to draw a distinction between preferred and residual.

The same thing happens for the 70+ age group—preferred is higher than residual. With the P value so high, it's not statistically significant, so we can't draw any conclusions. In other words, there's really no difference between the two groups that we've identified based on those criteria.

We thought, "Can we do something better? What can we do that would allow us to really see the difference between the two classes?" We tested some age-specific criteria using an iterative process. It wasn't easy, but we changed the thresholds until we were able to determine which predictors were significant.

In this test, BMI is significant for ages 18-39, so a person with a BMI between 20 and 24 has 29.4% of the mortality of one with a BMI less than 20 or more than 24. Another significant predictor is not being a heavy drinker, which showed up before. We tested on just these two criteria because they are the most significant and predictive for the younger ages.

For ages 40-69, we determined three criteria to be significant predictors of mortality: BMI, blood pressure, and serum albumin. For a serum albumin level of greater than 4.2, the mortality is 68.5% of someone who has a serum albumin level of less than 4.2.

For ages 70+, a person with no weight change is likely to have 53.5% of the mortality of someone who has a lot of weight change. An active person will likely have 44.3% of the mortality of someone who is inactive.

We found these results encouraging. On the Kaplan-Meier curve, for the young age group, the P value is very, very small. That means we've made significant progress in producing a set of criteria that are not only significant predictors of mortality, but also result in a significant difference between the preferred and residual classes.

For the middle age group, the P value again is very, very small, which is statistically significant. For the older age group, the very low P value is again very significant.

Please note some caveats about using this model. The results are very sensitive to the requirements included in the model, so if we were to change the criteria used, we would end up with a different result. The list that I presented with two or three significant predictors for each of the age groups is not a list of all of the significant predictors. We based our analysis on using a U.S. secular population data set and made some adjustments to simulate an insured population; using insured data is preferable for this kind of analysis. For the data to be useful and to show the mortality differentials, it has to be historical, and there needs to be enough credibility in the mortality experience so that you can use it to predict mortality. When using historical data, changes in recent years may not be reflected. These caveats are why this analysis is an illustration of an approach rather than a takeaway in terms of the results.

Finally, it's important to realize that it's possible to choose preferred criteria that are significant predictors of mortality, resulting in a statistically significant difference

in expected mortality between the preferred and residual classes. And, as we've also demonstrated, preferred criteria should vary by age.

MR. DOUGLAS INGLE: I'm the one non-actuary on the panel, and I'm honored to have been chosen. I hold the actuarial profession in very high regard. On the underwriting side, I give speeches at national meetings in which I tell the underwriters to get together with their actuaries to discuss issues that are common to both groups. The main issue is analyzing mortality. So, we're both very responsible for the mortality assumptions used in pricing of the products, and we need to be working together on that.

While Mary talked about an empirical methodology using empirical tools, I'm going to go in a different direction with my presentation and talk about the existing tools and data in each one of our life insurance companies right now. I'm going to use the value of blood as an example of how actuaries and underwriters can get together and determine the morality implications for changes in those guidelines. So this is also about paradigm shifting using data that you've got in your companies and working with your underwriter to look at it.

I know a lot of you are thinking, "I already work with my underwriter quite a bit, so that's not a new thing to me." If so, that's fine, because the other reason for this presentation is to present data from a study I did of the protective value of blood. For most of you that know underwriters, you know that "Debits R Us." The original position paper on debits was written in 1919 by Oscar Rogers and Arthur Hunter, both employees of New York Life. They said, "You know, we need to be able to stratify risk mathematically. It's not either accept or reject. There are risk classes in between those extremes, and we need to figure out a way to quantify that and talk about that."

They basically came up with the concept that one debit equals 1% increase in mortality. That's all there is to it. Since 1919, this has become the mainstay of the industry, and if you go to an underwriting meeting, you'll hear underwriters talking to each other about debits and knowing exactly what they mean. This is the way we think and speak, and obviously, that's how it relates to mortality.

When doing a protective value of blood study, you can take advantage of this underwriting concept and define things in terms of debits. This will allow you to answer questions about what happens with blood if you eliminate just the blood profile from your underwriting requirements. The assumption is that you would retain the HIV, cocaine, and cotinine information and would get that in some other manner—perhaps saliva, urine, or some other medium.

What would happen to your company's mortality based on the elimination of blood testing alone? Will it vary by test? Will it vary by age? Hypothetically speaking, if I get cholesterol on a 32-year-old man, what good will that do me? He's not going to die of a heart attack at age 33, is he? What about the other profile analytes that are in there? Are they really that important?
I prefer going the mathematical route to answer this question quantitatively rather than theoretically. That's the reason for doing a study like this. You can actually lay

out data and see the results. Your company's results may be different, but here is one such study.

Seeing that this was becoming a big issue in the underwriting community, I decided to obtain some data from American United Life's direct side. In our insurance company, there is also a direct division, so I went to them and asked if I could look at their blood profile results, and they agreed. I decided to study the debits and the information that one would get as an underwriter. If the underwriters are talking about changing age and amount guidelines, throw it back to them. Ask them to help you define what the mortality implications are.

To do this study, I first had to collect data that included name, policy number, number of debits, age, smoking status, and gender. In a situation such as this, make sure to account for all cases, including those with no debits. Often, we underwrite cases and the blood profile is normal. It's a super preferred risk and out the door it goes. Don't forget to collect data on those cases as well.

Next, I wanted to see what the blood profile could tell me. Before I discuss that, though, I want to talk a little bit about what a blood profile really means to an underwriter.

I mentioned that in a protective value study, you accumulate the number of debits. Many people believe that underwriters think in terms of the gamma-glutamyl transpeptidase (GGTP) getting, say, 75 debits and the cholesterol getting 25, and they add them all up. Underwriters don't really think about blood profiles that way. We see a blood profile as telling a story about an individual. In fact, the blood profile could be any of a number of different things. When I started underwriting 27 years ago, the blood profile was called an "SMA-12" (sequential multiple analyzer). At that time, it was a real big deal because they had machines that could take 12 different analytes out of one blood profile. They called it an SMA-12 because they were doing 12 tests on one blood specimen.

Perhaps you have seen the TV show *ER*, and you hear them ordering Chem 7s all the time. Obviously this means the blood profile panel contains seven tests. You can get SMA-20s, SMA-40s—there's no magic number of chemistries you can get out of the blood. But the insurance industry has settled on about 12, and the labs have built a profile that offers a reduced cost for a 12-panel profile.

These tests are not individual and unrelated but are instead a constellation of tests. For instance, out of most 12-panel chemistries, six of the tests are actually related to liver function. They are:

1. GGTP or GGT
2. Serum glutamic oxalacetic transaminase (SGOT) or AST

3. Serum glutamic pyruvic transaminase (SGPT) or ALT
4. Lactate dehydrogenase (LDH)
5. Alkaline phosphatase (AP)
6. Total bilirubin

These tests do more than describe whether or not the liver is functioning; they indicate whether the applicant has an obstructive disorder or a cellular disorder.

SGOT is now referred to as AST, and SGPT is now referred to as ALT. However, a lot of doctors are still using the old acronyms SGOT and SGPT. Supposedly, an international congress got together and decided to change the names to AST and ALT, but they haven't caught on around the world yet.

Let's talk about these briefly. AST and ALT are referred to as transaminases; if they're elevated, that's when something is going on. If I, as an underwriter, get a case that has elevations in AST and ALT, I would assume that some sort of cellular damage is occurring rather than an obstruction.

AST is an enzyme found not just in liver cells but also in brain cells, heart cells, muscle cells, and kidney cells. For cellular damage, think of it as the cell breaking open and leaking out its contents. That is what is measured in the blood profiles. Therefore, just because AST is elevated does not mean the only consequence is liver disease. For instance, a blood draw on an athlete right after he has run a marathon would probably show elevations of AST and ALT because of the muscle trauma involved in running a marathon.

ALT is more related to the liver than is AST. Although it is more specific to liver pathology, it also depends on the numerical ratio between AST and ALT. If AST is greater than ALT, the differential diagnosis often includes things such as obesity and alcohol. ALT that is greater than AST generally indicates a viral infection, typically hepatitis.

Hank George was the original purveyor of GGT or GGTP as a marker for alcoholism. He went to the insurance industry and started talking to all of us about that. GGTP means a lot of different things in a lot of different situations. In fact, GGT becomes elevated in both cell damage situations or in obstructive situations. Actually, only 10% of the content of GGT resides in liver cells. The other 90% is located in the kidney, the small intestines, and the pancreas. So elevated GGT it is not necessarily due to alcoholism. Other causes of elevated GGTP include diabetes, emphysema, and kidney disease. Also Dilantin and Phenobarbital are examples of seizure medications that produce elevations in GGTP. I would guess about 95% of the time, if I see the person is taking one of these medications, even before looking at the blood profile, I will suspect the GGTP is going to be elevated. Digoxin is used for atrial fibrillation, and it elevates GGT. Advil and Motrin are over-the-counter anti-inflammatories and these medications can also cause elevations in GGTP. Mevacor and Zocor are cholesterol lowering medications. These too can elevate a GGT. So, when looking at a case, not only note the elevated GGT, also look to see if the person on a seizure medication.

Elevations in AP suggest biliary or obstructive disease rather than cellular damage. If AP and either ALT or AST are elevated, the liver is probably the problem. The same thing is true if GGT is elevated. If AP is elevated by itself and GGT is normal, the problem is probably not with the liver. It's likely due to something with the bones, such as Paget's disease, a broken bone, or cancer of the bones.
So you get the idea of what I'm doing as an underwriter. I'm seeing more than just debits and credits on the blood profile. This person's blood profile is actually telling me a story.

Glucose metabolism looks at blood sugar levels. Elevated blood sugar is the method used by the American Diabetic Association to diagnose diabetes. In general, three glucose tests are used to determine elevated blood sugar:

•Blood glucose or blood sugar tests measure the blood sugar level as it currently stands.

• Fructosamine and glycohemoglobin are a couple of other tests that also measure quantity of glucose, but they describe different findings. Basically, fructosamine is a glycated protein. In other words, glucose likes to bind to things. It doesn't like to swim around by itself. It wants to attach to something. One of the things it attaches to is protein. Proteins generally hang around the body for two to four weeks and then they're eliminated. By mesuring the amount of glucose attached to protein, you have an idea of what the average glycemic level is for that person for two to four weeks.

• Glycohemoglobin is similar to the fructosamine test, except that it tests for glucose attached to the hemoglobin in red blood cells. Red blood cells exist for two to three months, so the glycohemoglobin test describes the average amount of glucose in the body over a three-month period.

Let's relate this back to my protective value study. Based on the two tests, I'm going to rate the case at 150 debits, which will be 250% mortality. Should I give 75 debits to each? Do I give more weight to one than the other? I have to make an arbitrary decision and notify the actuary that I'm doing this so that we can work together effectively on this analysis.

Perhaps the most important pieces of a cost-benefit study are the declinations. We don't do mortality studies on declined cases, but to do a cost-benefit study, I have to decide how many debits I'm going to award to the declined cases. Underwriters generally rate up to 400 debits to declined cases; some companies go to 500 or 600 debits. This is four to six times standard mortality and, thus, four, five, or six times the standard mortality premium. These very high substandard premium increases are tough to sell at the highest levels. Generally they don't get placed; if they are, watch out.

So in general, underwriters feel 500 debits must be close to one foot in the grave, but that's not true. Mathematically, using 65% of the 75/80 basic table, a 25-year-old male nonsmoker rated 500 debits has a life expectancy of 40 more years. This would surprise most underwriters. Even with 1,000 debits, his life expectancy is 35

more years, which is still a long time.

From the perspective of a cost-benefit study, many debits are awarded to the blood profile for declined cases. This makes their value that much greater from a mortality protection standpoint. Often, the CEO sees today's expenses and doesn't see the mortality savings from cases that were not placed.

Even though 1,000 debits could be construed as a conservative estimate of future mortality, we generally find ourselves using debit assumptions even more conservative than that in cost-benefit analysis. The reason for this is to show that we're not trying to promote the value of a test artificially. Most cost-benefit studies use only 500 debits (500% increase in mortality). And 500 debits were used for this analysis.

There are approximately 8,600 profiles altogether. Table 2 shows how the debits accumulate for each of the tests in all the blood profiles.

Table 2

Cholesterol	26,560	Alk Phos	9,000
GGT	19,491	Triglycerides	7,967
ALT	16,731	Creatinine	1,396
A1C	13,204	BUN	832
Glucose	10,505	Fructosamine	750
Alk Phos	9,000	T. Billirubin	450

Total individuals tested = 8,694

You might notice that a lot of weight has been given to A1C, which is another term for glycohemoglobin, while fructosamine is hardly worth anything. That is because I think three months' worth of information is better than two to four weeks of information. So I awarded most of the debits to the glycohemoglobin. Is a glycohemoglobin study that much better than a fructosamine study? No. That's just what I did for the methodology that I used here. That's exactly why it is important to communicate with your actuary about the assumptions used in the analysis.

So if you add the debits by test and divide the sum by the number of people tested, you end up with the change in mortality by test.

One of the other things I wanted to mention is, if I just looked at the 26 glycohemoglobins, 25 of them were abnormal. What's not taken into consideration is that a glycohemoglobin is generally done as reflex test rather than a routine test. If you get a blood profile and the glucose is 250, which is extremely high, most labs will automatically reflex to a glycohemoglobin. The glycohemeglobin is not done routinely. So very few glycohemoglobins show up in profiles, and most of them are abnormal because the profile is set up to do it that way.

As I mentioned previously, constellations make a difference. Basically, if I have just a GGTP of 112, the upper limit of normal is 65. Yes, that's double, but that doesn't mean as much as if I know that the AST and ALT are elevated as well.

It's important to take into consideration whether these blood profiles were done "for cause," meaning something prompted you to get the profile, or as age and amount requirements. If they're for cause, the underwriter would expect to get some abnormalities. If they're just done routinely, and the abnormal results come as a surprise, then the blood profile found something.

So I've answered a major question now. If I get rid of blood profiles, the change in mortality would be about 13.39% for my block of cases. But this doesn't take into consideration other market forces at work in the insurance industry. If your company decides that's not very much mortality, you can absorb that with the expense savings that you would get.

Will your company be the only company that does not do any blood testing until $3 million of life insurance is paid out? This raises the issue of the sentinel effect. If applicants are aware that they have some disorder and they know the insurance company is going to test for that disorder, they will tend not to apply for insurance with that company.

Are you giving up anything else? If a paramedical examiner (typically a nurse trained in drawing blood) collects the blood profile, will that examiner ask medical history questions as part of the service as well? Remember that if these questions are asked by the agent (who has a vested interest in what the answers are) rather than a disinterested third party (such as the paramedical examiner), the quality of the answers elicited from the proposed insured will improve.

Returning to the blood profile, wouldn't the amount of mortality uncovered vary by age? Chart 1 presents the number of debits by quinquennial age bands, or every five years. It shows there is some truth to the statement that mortality is much lower at the younger ages. Note that as the insureds get older, the number of debits increases by an almost exponential function.

MR. BERGSTROM: My presentation is quite small compared to all the blood analysis. I'm going to talk about two things. First is oral fluid testing, as contrasted to blood tests. Second is preferred risk mortality, which Mary brought up earlier, but I'm going to approach it from more of a distribution perspective than from the empirical perspective that she used.

Any time you want to determine the value of a test as an underwriting entity, you need to know:

1. Basic data
2. The goal you're trying to accomplish with the test
3. The costs of testing with oral fluids, urine, or blood

Clearly, you need to compare the value of the test results to the costs of performing the test. Value at this point is defined as the present value of death benefits that you expect *not* to have because you did the test.

I'm going to focus on the oral fluid test and explain how to determine at what face amount it becomes cost effective to test under the assumptions that I've chosen to use. Incidentally, the numbers that you will see are from a national case study. This was done on a client several months ago.

So the real question is, what is my mortality savings, and at what point does it exceed the cost of the test? When it exceeds the cost of the test, then the test becomes "protective." Now that doesn't necessarily mean that an underwriter will jump to use that test. Underwriters also have budgets that they have to stay within, and some agents may balk at doing certain new tests. So even though we can do the math, and the math may show something positive, that doesn't mean the underwriting community can automatically embrace that particular test.

The way that I do protective value studies is by defining five different components that make up the test savings:

Equation 5

$$\text{Savings} = R \times S \times T \times PVB$$

R is the prevalence of what I find in doing the test. This is essentially the number of impairments and the frequency with which they occur.

S is the sensitivity of the test to determine if I am really finding all of the information out there. If a test is very sensitive, then I'll be confident that it works. If a test is not very sensitive, then I need to lower the overall value of the test based on the sensitivity level.

T, the attribution factor, is an estimate of how exclusively a test shows whether or not an applicant has a certain impairment.

PVB is the present value of excess mortality. I assign a mortality level to the particular impairment that I'm looking at and then add together the excess mortalities for the various impairments tested for, and the result is the total present value of excess benefits.

In the numbers you're about to see for mortality, (Table 3) I used 95% of the U.S. 1990-95 tables that were published last year. In doing any kind of protective value test, you need to remember to use lapse rates, because people do lapse policies. You will overstate the value if you do not accommodate persistency. I used a lapse rate of 15% graded down to 8%. I also used a discount rate of 8% for the present value. I chose 8% because underwriters get the money to underwrite and test from their budgets, and the budget money comes out of unassigned surplus—in effect, that's where they have to "borrow" the money from to do the testing. A surplus usually earns an investment percentage of less than 8%, so 8% is better than surplus returns. My point in using 8% is that it's not an investment return, but it's better than what you're currently earning.

What I'm going to show you first are values—testing thresholds—based on the

discount rate that I've chosen. And I've chosen a study period of 20 years. I think if you go beyond 20 years, you probably overstate the value.

An oral fluid test looks at three particular factors: cotinine, cocaine, and HIV. Cotinine is a metabolite of nicotine and indicates that the person tested is a smoker.

Table 3
PVB (per 1000)

Age	Cotinine	Cocaine	HIV
25	$2.30	$3.35	$138
35	$4.16	$5.23	$137
45	$11.75	$10.62	$131
55	$31.46	$18.77	$120

Table 3 shows my calculations of the values of each of those factors. For example, cotinine at age 25 is worth $2.30 per thousand of present value of mortality. At age 55, it's worth $31. HIV is obviously worth a lot to find it, and we'll find out later that even though it's worth a lot, because the prevalence is so low, the actual value of testing for it is lower as well.

Cocaine is worth more when you find it at the younger ages than at the older ages. The reason for that is because people are more inclined to be exposed to accidental risk when they're on cocaine. When they're exposed at the older ages, even though there's an increased accidental risk, people do die of other things as well.
When the company ran its study, I forget whether the cutoff was $100,000 or all amounts. But the company ran thousands of oral fluid tests, and these are the prevalence rates that they found (Table 4).

Table 4
Prevalence Rates

Age	Cotinine	Cocaine	HIV
25	22.3%	0.84%	0.12%
35	22.4%	0.78%	0.23%
45	24.2%	0.95%	0.25%
55	20.5%	0.47%	0.12%

You can see that the cotinine prevalence was fairly constant. Roughly 22% of the people tested smoked or used tobacco in some form at age 25. Twenty-five is a surrogate for the 20-29 age group. Almost 1% of the people in this age group tested positive for cocaine. That's a high percentage, because the metabolites for cocaine do not stay in your system that long. These people have ingested this drug fairly soon before taking the test, so either they don't know that oral fluid tests for this, or they're just habitual users.

What's interesting about HIV is that with oral fluid testing, the prevalence rates for HIV tend to be about two to four times higher than with blood testing. My suspicion is that many applicants do not know that oral fluid tests for HIV. You can also say that many people who get tested and are found positive do not know they're HIV positive either.

I chose a sensitivity of close to 1.0 for each of these three tests because oral fluid analysis is extremely sensitive. The attribution ratio is interesting. It estimates the exclusivity factor that this test is the only method of telling the underwriter that this person is HIV positive, uses cocaine, or smokes. Are there any other ways you can find out?

Not too many applicants will admit they're HIV positive. Not too many applicants will admit they use cocaine. You can find out, however, if someone is HIV positive by looking at medical records, hospital records, or the regimen of drugs he or she is taking. Since there are other ways to find out without admission that a person is HIV positive, I must give it an attribution value of less than 1.

The cotinine issue is interesting because many people admit they smoke. If they say they smoke, why test for cotinine? Well, it's part of the test. So, for cotinine, the exclusivity factor is really quite small, and rightly so.

If you put all of this together, you end up with the value of mortality: excess mortality identified for each of these components for these various age groups (Table 5).

Table 5
Excess Mortality
Identified By Testing

Age	Cotinine	Cocaine	HIV
25	$0.14	$0.03	$0.14
35	$0.26	$0.04	$0.26
45	$0.71	$0.09	$0.28
55	$1.98	$0.08	$0.12

If you were to add across, there's roughly about $0.31 per $1,000 of value in the 20s, then $0.56 per $1,000 in the 30s, and so forth until you get to a little over $2.10 at the older ages on a present value basis.

If we have a cost to test of $18, $28, or $40, given the excess mortality we just discovered, the break-even thresholds, or mortality equivalents, for using oral fluid testing are the numbers shown in Table 6.

Table 6
Breakeven Threshold
(Mortality Equivalents)

COST	25	35	45	55
$18	$59 K	$32 K	$17 K	$8 K
$28	$91 K	$50 K	$26 K	$13 K
$40	$130 K	$72 K	$37 K	$18 K

If you test for any amounts above those, your test is considered protective. For amounts lower than those, it is too expensive to test for the benefit you're getting out of it.

So, if you had a situation in which your company wanted to use an oral fluid test on young applicants, you would need to get an agent-collected specimen involving very little cost other than the cost of the test itself. If a paramedic or nurse collects the specimen, you have additional costs involved, and the test is not very protective until you get above the $130,000 range. The older ages show a different story.

In using an 8% discount rate in my present value calculation, I was able to determine the break-even thresholds. What if you wanted to test at $50,000? What would the return be on your testing investment? In other words, you're calculating now the return on investment that compares to the 8% number. The results showed little return at age 25 at the $50,000 level. There was quite a bit of return at age 55 at the $50,000 level, however.

At the $100,000 level, with just one exception, the return exceeded the 8% that I had used as my original discount factor

Even for standard mortality, about 90% of the people who apply for life insurance get accepted for what we'll call a standard rate. In a mortality profile for people accepted at age 45, 1.0 is the midpoint. The 1.0 is the 100% mortality; that's standard mortality. But there is a definite distribution of people who are much healthier than that, and some who are less healthy than that. A 0.5 on the left of the distribution curve represents very healthy people with standard issues at mortality ratios of about 50%. Also, some companies do actually accept standard issues at mortality ratios of roughly 150%, which is 1.5 on the right-hand side of the distribution curve.

At age 25, we still have the 50-150% range, but the curve becomes narrower. At age 65, it becomes broader.

Let's look at a hypothetical example. Assume you're going to come up with a preferred criterion, making 65% of the applicants preferred and 35% residual standard, as Mary discussed. Also assume that the residual standard-to-preferred mortality ratio is 150%.

I suggest that perhaps it's a myth that those two boundary conditions—65% preferred and 150% standard-to-preferred mortality ratio—are achievable at all ages.

If you look at how some actual numbers turn out, with 85% as the mortality assumption for preferreds at age 45 and 128% of standard as the residual standard at age 45, then the standard/preferred ratio is indeed 150%. But at age 25, you can't get a 15% discount. If you do, you won't get 65% of the bodies. So, even though the math works, it doesn't necessarily mean that we'll get the percentages we want in the pools that we underwrite. I suggest if you're not doing it already, you should look at the various age groups and your classifications to come up with the basic mortality assumptions for your preferred risks.

Now this is actually a teaser for a talk that we're going to be putting together for one of the SOA meetings next year. We'll get into this a lot more in depth with more statistics, and if you're really interested in the preferred risk category, you'll want to join us for that.

FROM THE FLOOR: Talking about conservation of deaths, on another issue, we're taking a group of, say, 100 people, and based on our criteria, we're going to break off 40 and call them preferred, break off 60 and call them residual. And we're all assuming that it's going to add up to that same mortality as a whole for the 100 people. In the real world, though, our competitor down the street might be breaking off the 20 healthiest, and giving them a lower premium. So we're not going to get all 40 of those people. Have you developed any methods when evaluating your expected mortality to take into account that you're going to get skimmed by other companies within your various groups?

MR. BERGSTROM: You ask a question that's going to take about three days to answer. The answer to the question is there are some theoretical ways to do that. I have not done that to the extent of being able to, for example, publish a paper or something that could be presented at this point in time. But there's no question that what you're saying is true. This is one of those issues that goes back to the fact that we either make some assumptions and do it, or we talk to the real underwriters of the world and ask them what they're seeing. By coming up with their plan, have they lost market share or have they gained market share? Doug, do you have anything you want to add to that?

MR. INGLE: That's right. We do have a statistical model we're using at our company that does take that into consideration. In our model, you can actually take market forces into consideration and adjust mortality assumptions for these forces. Our model considers a number of factors, so although it is hypothetical, it is mathematically based, and it is a good point and a feature that needs to be considered when setting pricing assumptions for your preferred products.

FROM THE FLOOR: This is for Rick Bergstrom. I'd just like to confirm — in the data that you were showing with those high incidences of cocaine usage, were those people being underwritten for life insurance policies?

MR. BERGSTROM: As opposed to disabilities?

FROM THE FLOOR: I mean that people had that test run because they went to LabOne or something.

MR. BERGSTROM: This is actually LabOne data. And it's definitely life applicants that we're testing. I should also say that if you look at the prevalence rates by face amount applied for, you will see a tremendous variability. So, people applying for amounts of $25,000 or less may have 10 times the prevalence of a certain impairment than somebody applying for $500,000. Clearly, there's a sentinel effect involved here, and people who apply for that kind of coverage know they will be tested. I'll say this, too. We have learned in the history of testing that when a test has been available for a while, it's going to reach a more natural level of uncovering impairments than it does when it first is offered. When we first did oral fluids in 1997, those prevalence rates for cocaine were like 3%. People didn't know they were being tested for that.

FROM THE FLOOR: I was just wondering if any of you could comment on the shape of the substandard mortality curve at ever-increasing substandard categories and whether you think it's really a one-to-one relationship between debits and extra mortality. So if you have 100% extra, if you put a table 4 on a policy, is it 100% extra? Versus if you put a table 16, is it 15 times the standard mortality? Or is it 13 times?

MR. BERGSTROM: I'll just make a comment. I don't know if this will answer your question. But if companies look at ratios of, let's say, present value of benefits for substandard versus standard, we don't necessarily discount with interest at the moment. We really don't discount with lapses either — we just discount what is the natural runoff of death benefits. Comparing the present value of benefits for a table 16 applicant to a standard applicant does not yield a ratio of 5. It's going to be much less than that, and the reason for that is because people are dying off much faster. So if you're asking if we have ratios of mortality, can we therefore tell what the actual rating should be? The answer is yes, you could do that. If you're talking about the shape of the curve…

FROM THE FLOOR: Yes, I am talking more about the shape of the curve.

MR. INGLE: What we see is that the distribution of mortality is almost a gamma-shaped curve. On the healthy left side of the curve, mortality can only get down to, say, 50% of standard. On the other end, you've got this really long tail out to the right. You can have people at 500 and 600% mortality. The Society of Actuaries has done substandard studies. There's the 1983 Medical Impairment Study that looked at impaired-risk underwriting. By the way, Rick Bergstrom is the chairman of the Morbidity/Mortality Liaison Committee, and I'm on the committee. Our job is to analyze impaired-risk mortality and see if the actual-to-expected ratios work for the high substandards as well. And in general, underwriting has been doing pretty well. If we rate 250% of the expected standards, often we've come out pretty close to that. Certain people, like diabetics and alcoholics, tend to get higher mortalities than we've anticipated as underwriters, but on the whole, we don't do

too bad of a job.
FROM THE FLOOR: Does preferred underwriting wear off over a period of time? And does the mortality in preferred underwriting approach standard at some point, or does that effect continue throughout life?

MR. BERGSTROM: You know, I don't think we've really had enough experience out there to know for sure, but I think the intuitive answer would be that, depending on the level of mortality that we're trying to get down the effect of that will likely wear off and approach standard. But if it's a big early mortality discount, my guess is that it will never actually come back up to standard, at least not for many years.

MS. BROESCH: I agree with Rick. I think we have yet to see what is going to happen, and we're basing it on what we think is going to happen. Traditional thinking suggests that the more you underwrite, the steeper the slope, which means that it will wear off. However, when talking about lifestyle issues as the reason for classifying a person as preferred, if that person continues on with the same lifestyle, why should it ever converge back to standard? I tend to think that it's not going to completely revert back to standard, because those effects that are creating that differential will still be in effect.

MR. BERGSTROM: And the flip side of that is, for those who are then residual standard, their mortality is starting to approach standard, and I think the answer to that is probably yes, too. The longer you live, the more likely mortality will approach standard.

MS. BROESCH: What's interesting is that we can also compare this to what we've seen with nonsmokers and smokers because, clearly, the point at which those two converge was a question back when we started splitting out from aggregate nonsmoker and smoker. What we're seeing is that at the older ages, smoking is not as much of a concern as it is at the younger ages, presumably because those people who smoke are dead by then.

MR. BERGSTROM: It's like Woody Allen said one time, "I prefer to achieve immortality not from the work that I have done, but from not dying."

Chart 1