In today's competitive term life insurance market, direct writers are revisiting their list of pricing assumptions to develop more accurate forecasts of future performance. The mortality improvement assumption is one that is under close scrutiny. Historically, even companies that did not incorporate an improvement assumption benefited from the secular gains over time as actual mortality emerged more favorably than pricing originally assumed. In today's term market, however, there is little opportunity to arrive at competitive premiums without some type of mortality improvement built into the pricing. But there's a trade-off. While prices are more competitive, there is less margin for error should experience emerge more adversely than assumed ten, 20 or even 30 years later.

Even a small change in the mortality improvement assumption can have a disproportionately large impact on pricing and profitability. In tests we have conducted, a one percent incremental increase in the annual mortality improvement assumption can reduce the present value of claims from a block of term life business by up to nine percent. Thus, erring on the conservative side (a low or no improvement assumption) locks in a large margin for potentially positive error, but it also represents a price disadvantage. What's more, it can introduce adverse selection as higher quality lives gravitate toward the price leaders' products. An aggressive assumption wagers that the current high level of lifestyle, environmental and health care improvements will continue into the future more or less at the same rate as in the past. But if future experience does not reflect these optimistic expectations, the block of business ultimately may become unprofitable.

The pricing actuary's views on the mortality improvement assumption depend on answering three main questions, the first being: Is the high rate of mortality improvement experienced in the 20th century likely to persist into the future? Optimists may cite that the 20th century sustained a roughly 0.5 percent annual decrease in mortality that has extended into the 21st century so far, and episodes of more rapid improvement occurred as particular medical advances and lifestyle changes were introduced to the population. Others may note that the human body systematically fails past a certain age regardless of fitness, and the 20th century may have been an exceptional period of mortality improvement. In other words, mortality assumption improvements were possible because there was so much implicit “room for improvement” through health and medical improvements (see Chart 1).
Mortality Assumptions: Where Are We Going? (cont)

Question two is: How variable are annual mortality improvement rates around the long-term average? One side points out that most short-term mortality variance can be attributed to mortality’s random nature but that the long-term trend has been very stable. The other side notes that while some of the more dramatic downward shifts in mortality can be attributed to particular changes in lifestyle (rapid decline of male mortality in the 1970s due to reduced smoking) and medical advances (strong decline of female mortality through to the 1960s due to improvements in obstetrics), it is possible that other lifestyle changes (much increased rate of obesity across all age groups of both sexes) could actually threaten those mortality gains of the past.

The third question is: How do the mortality improvements in the general population translate into mortality improvement for the insured population? For example, any mortality improvements related to improved cancer treatments or methodologies may be blunted by an underwriting process that has traditionally screened against applicants who had exhibited markers or history of particular cancer risk. If a pool has no individuals that have a certain ailment, it cannot experience improvements in mortality based on greater treatment success for that ailment. However, as an extension of the discussion above, if the cancer incident rate converges to that of the uninsured population over the life of a closed block of insured risks, then a similar percentage mortality improvement may emerge among the insured population. Potentially increased benefits exist because the lives who demonstrate insurability (and the means to purchase insurance) tend to be the lives that seek routine or extraordinary medical care and are in a position to take advantage of medical breakthroughs.

This discussion highlights the importance of understanding the source of mortality improvements in the past and how companies responsibly address assumptions of future improvements in their current pricing. Transamerica Reinsurance continues to research the impact of mortality improvement on pricing by reviewing its own historical experience, modeling future trends, and working with clients to assess this important component of modeling term life insurance products. We look forward to discussion about these issues with our clients in the future and welcome any questions you may have.

Credibility Analysis for Mortality Experience Studies, Part 3

Editor’s Note: This is the third of a three-part series. Parts 1 and 2, available at www.TransamericaReinsurance.com, consider the tools that actuaries use to project variability around predicted mortality.

What actions should a pricing actuary take when a mortality study is deemed less than fully credible? Recall from Part 2 of this series that the number of claims used to define “fully credible” varies widely from company to company. However, one thing holds true: the fewer the deaths, the less likely the study can be relied upon in predicting future mortality. But how
much weight should the actuary then place on limited experience? This question falls under the topic of partial credibility.

**“Partial” Credibility**

In classic credibility theory, an experience study can be given “partial” credibility and weighted with another known and fully credible data source. This essentially places more weight on relevant prior knowledge until the studied block develops enough of its own specific claims experience. The more credible our information becomes on the particular lives under review, the less we rely on other sources. The weighting formula makes use of the *credibility measure* \( \frac{1}{\text{square root of [# claims]}} \) that we determined earlier in Part 1 of this series with the calculation:

\[
\text{Credibility Weight} = \sqrt{\frac{\text{# of actual claims}}{\text{# of claims needed for full credibility}}}
\]

We use this weight to combine our current study with the other data source:

\[
\text{Weighted Assumption} = (\text{Credibility Weight}) \times (\text{experience study mortality}) + (1 - \text{Credibility Weight}) \times (\text{other source mortality})
\]

As the number of claims in a study approaches our definition of full credibility, more weight will be given to our study results. Let’s take an example where a company has determined that 1,082 claims are needed for full credibility. In other words, the company is comfortable knowing that future mortality will be within plus or minus five percent of the fully credible current experience mean 90 percent of the time. Graph 1 shows how the credibility weighting varies by claim count.

**Sources of Fully Credible Data**

Of course, all of this discussion about partial credibility assumes that we actually have an additional source of relevant fully credible data. In reality, actuaries are hard pressed to find other experience studies that accurately represent the future experience of the product they are pricing. If such was the case, they might as well use that proxy as their assumption and eliminate the whole credibility discussion. Nevertheless, let’s investigate the pros and cons of alternative data sources.

- **Inter-company industry tables.** A typical Society of Actuaries Intercompany Study uses thousands of claims in determining mortality trends. While this gives an excellent and highly reliable view of historical industry experience, certain key characteristics of the contributing companies may not adequately represent the business under review. Differences to consider are product type, retail market, underwriting methodology, distribution channel, etc.

- **Other company experience.** A pricing actuary may have access to mortality results from a larger block of business that is known to have characteristics similar to the current

*Graph 1: Credibility Weighting by Number of Claims*

*The credibility weighting applied to a sample increases as the number of observations approaches “fully credible.” Note that the weighting’s slope tapers as observations increase, affording higher marginal weightings at increments when the number of observations is small.*

*Continued page 8*
Technology’s Effective Role in Underwriting

As we’ve expressed in past articles, using technology effectively can move the underwriting process to a higher level of sophistication, a level we refer to as mortality management.

Mortality management requires a comprehensive understanding of all the drivers of mortality, which includes literally every aspect of the new business acquisition process: product design, policy application, sales and distribution, underwriting criteria and guidelines, etc. It must electronically connect all steps in the new business acquisition process and capture relevant data along the way for both immediate usage and longer term analytics.

Building a bona fide mortality management solution is not easy, but the value-creating potential is too big to ignore. In the short run, a mortality management solution improves operational efficiencies and mortality results. In the long run, it captures data that provide essential insights for building competitive products and meeting evolving regulatory demands.

Rules-based Underwriting Engines

We’ve seen growing interest and investment in rules-based underwriting engines in recent months. This shows that life insurers recognize the value that can be created by investing in the underwriting process – a process still largely steeped in 1970s technology. At the same time, though, companies need to understand the capabilities and limitations of what they are buying, especially if they are partnering with a software provider who does not offer expertise in new business processes and the factors that impact mortality experience.

Just dropping a rules-based engine into existing new business processes with minimal process redesign limits the mortality benefits of rules-based underwriting. This often results in a misalignment of goals and expectations between the technology provider and the insurer.

- It takes anywhere from 12 to 24 months for a software provider to force a rules-based underwriting engine into existing new business infrastructure. And this is after the purchase decision has been made.
- The purchase price of a stand-alone rules engine is just the beginning of a company’s time and technology expenditures.
- A rules-based engine may increase efficiency but decrease effectiveness, because technology can place poorly underwritten business just as quickly as properly assessed cases.
- A rules-based engine is well suited for data-driven decisions such as preferred risk assessment, but impairment risk assessment requires the professional risk manager – the underwriter.
- Implementation of a rules-based engine is not an initiative to reduce underwriter headcount. Underwriting resources are scarce. A rules system can maximize underwriter productivity by automating workflow and clean cases.

Good data. The ability to capture, preserve and employ policy-level data is the biggest payoff of a well-implemented rules based underwriting engine. But the emergence of good data, which can be used for future product improvements and capital/reserve reporting requirements, depends on having the right system design and implementation.

Mortality Management Solution

A mortality management solution requires a holistic view of the new business acquisition
process. To effectively implement such a solution, a company needs an interdisciplinary team of operational, underwriting, actuarial and IT experts. Too often we see technology just being sold to the chief underwriter as an efficiency play by a software provider with no “mortality” skin in the game. At best, this is a narrow perspective that produces limited payback.

Rules-based underwriting technology serves as the hub of a true mortality management solution. The technology is especially well suited for preferred risk term products because of its capabilities for aggregating data, applying rules and automatically assessing risk. (Remember that most preferred risk criteria are data-driven factors such as cholesterol and build.)

- **Data gathering.** The engines work extremely well for aggregating the application’s data-driven qualifying factors, such as Part II via tele-interview, MIB, MVR, lab and prescription drug results, and comparing them to preferred risk criteria.
- **The rules.** Programming the rules for prudent risk selection is central to the success of a mortality management solution. To avoid anti-selection, companies need to correctly define age/amount and stretch criteria, consider the position of peer companies and build in company-specific triggers to flag certain risks.
- **Automatic underwriting.** A data-driven platform allows the underwriting engine to assess risk consistently. For those risks that have factors that fall outside of the rules, underwriter review and assessment is critical.
- **Real time auditing.** Web-based solutions are designed to provide immediate feedback to underwriters and their management.

At all steps along the way, policy-level data is captured for future business analysis and regulatory needs. This data serves as the raw material for mortality studies and the refinement of preferred criteria as experience emerges on the block. The data also will be increasingly valuable in helping clients determine principles based reserves and capital requirements.

Rules-based underwriting technology is an excellent tool for connecting all parts of the new business acquisition process, but its value depends on how the tool is used, not the tool itself. Our experience has shown that simply plugging an underwriting rules engine into existing new business processes will not produce better mortality. Automating a step or two may save a few dollars but it will not transform a life insurer’s business or enhance its competitiveness. In fact, it may even cost the company more time and money.

**Focus on Mortality**

At Transamerica Reinsurance, we build mortality management solutions by applying what we know about mortality drivers and harnessing technology to help manage those drivers. We are not a software company. We don’t market a proprietary rules-based engine. Instead, our Product Consulting & Development (PC&D) team works with a carefully selected group of technology providers to build the best solution for our clients.

We are so confident that a properly designed and implemented mortality management solution will improve mortality that we offer significantly discounted mortality rates and will work with clients to amortize the cost of the solution in the reinsurance arrangement. This means our clients pay no out-of-pocket expenses for the technology tools – not even for the rules-based underwriting engine.

Mortality management is not a technology solution, but technology makes it possible.
Homeostasis

Homeostasis is either the equilibrium itself or the process through which equilibrium is maintained between various chemical compositions and/or physiologic function in the body. Homeostasis is achieved by what engineers call “negative feedback loops” – sensors detect deviation and trigger corrective forces to bring the system back into equilibrium. There are thousands of such equilibria in the body, and the condition known as frailty in the elderly is thought to result from impaired homeostatic processes.

The control of blood glucose within a narrow range is an important example of homeostasis. The brain requires blood glucose as an energy source, so the level cannot be allowed to be too low or coma, possibly even death, can occur. On the other hand, chronically elevated glucose levels will cause damage to a wide variety of organs and acutely high levels can be fatal. Homeostasis in blood glucose is maintained primarily by sensors that promote insulin secretion. Insulin binds to receptors on cells throughout the body. The binding signals each cell to take up glucose from the blood thus lowering the blood glucose concentration.

This homeostatic process works amazingly well, better than man-made devices can manage. However, if one loses the ability to secrete insulin (Type I diabetes), homeostasis can only be approximated with the use of insulin injections. More frequently, especially at older ages, insulin secretion is adequate, but the body’s insulin receptors do not respond well. This leads to delayed and inadequate uptake of blood glucose (Type II diabetes). Studies have shown that the average blood glucose after a meal rises 5.3 mg/dL every decade after age 30. Even as early as age 30, the homeostatic process for blood glucose is beginning to fail.

At older ages, a number of homeostatic processes can become impaired, often due to diabetes. For example, chronically elevated glucose damages the kidneys, and these organs play a role in a number of homeostatic processes: calcium and sodium levels, blood pH, red blood cell levels, heart function and blood pressure, to name a few. At older ages, the effect of single large deviation from homeostasis or the cumulative effect of multiple lesser homeostatic deviations can be fatal.

Hemoglobin A1c

One of the ways that elevated blood glucose can cause organ damage is by binding chemically to proteins (glycosylation). The rate of this chemical reaction is proportional to the concentration of glucose, i.e. higher blood glucose promotes more glycosylation. Blood glucose rises and falls during the day in response to food intake and insulin secretion. As the homeostatic response to high glucose is blunted, the blood glucose concentration is higher for longer and more proteins are glycosylated.

Hemoglobin is the oxygen-carrying protein found in red blood cells. Hemoglobin molecules have a normal lifespan of 90-120 days. During this lifespan, adult hemoglobin molecules (hemoglobin A) are exposed to ambient levels of glucose which causes glycosylation of their 1c component. Normally, a small percentage (< 6 percent) of hemoglobin A1c is glycosylated, but this percentage varies with average blood glucose. A recent study has established a strong linear relationship between A1c percentage and average blood glucose levels.

A1c is not yet accepted for making the diagnosis of diabetes, but values < 6 percent are
considered normal. Values in the range of 6.0 to 6.4 percent are borderline, and values of 6.5 percent or higher probably represent diabetes. Values of 9.0 percent or greater suggest poorly controlled diabetes.

**A1c and Life Insurance**

Many studies have shown the association between diabetes and mortality. A recent report in the *Journal of Insurance Medicine* made a direct connection between higher A1c levels and increased mortality.  

There is a higher prevalence of diabetes, impaired fasting glucose (IFG, a borderline state) and elevated A1c levels at older ages. A recent study based on the 1999-2002 National Health and Nutrition Examination Survey (NHANES) found the following prevalence rates at ages 65 and over: diabetes 15.8 percent; IFG 39.1 percent; and undiagnosed diabetes 5.8 percent. Our own study of the NHANES3 data showed a clear association between older age and abnormal A1c’s (see sidebar).  

Life insurers have long used A1c, but usually as a reflex to a less expensive test such as a random blood glucose or a urine glucose. Blood glucose levels can only be a snapshot of glucose at the moment the blood was drawn – if blood glucose were in a trough instead of a peak, the A1c reflex would not be triggered. Urine glucoses are even more unreliable.  

A1c testing would be much more effective if done on all proposed insureds, but insurers balk at the cost (approximately $10 per test). A recent cost/benefit analysis reported in an industry newsletter suggests there would be an average mortality savings of over $662 per $500,000 policy if A1c’s were used on all 65-year-old male applicants – an excellent return on a $10 blood test.  

**Conclusion**

Reflex testing with A1c served our industry well enough when insureds were rarely over age 65; however, those insurers who choose to serve the older age market should consider A1c as an age and amount requirement. We would be glad to assist a client in determining at what ages and what face amounts A1c testing would make sense.  

Credibility Analysis for Mortality Experience Studies, Part 3 (cont)

experience being analyzed. That block may be used as the fully credible component in our weighting formula, but the actuary should be aware of the number of claims in the block’s experience. The number of claims needed for full credibility should be adjusted to match that of the block and the weighting formula modified accordingly. However, it is important to be aware of the consequence of making this adjustment. For example, the number of claims in the block may only be sufficient to make the statement that future mortality will be within plus or minus 20 percent of the experience mean 85 percent of the time. Understand that accepting fewer claims in the definition of “full” is tantamount to increasing the company’s tolerance for uncertainty.

- Reinsurance experience. Transamerica Reinsurance maintains a large experience database that allows us to create detailed studies on different slices of our business. We have tagged the data with company, product, market, underwriting, sales and other codes, enabling us to examine mortality trends within meaningful groups. Thus we can achieve high credibility (i.e., a large number of claims) while being confident that the trends relate to risks having a similar profile. When faced with a client’s less-than-fully-credible experience study, we can often use our highly credible grouped data to calculate a credibility weighted mortality assumption.

Series Conclusion

Experience studies provide the pricing actuary with an invaluable source of data for determining appropriate mortality assumptions. However, one needs to be aware of a study’s inherent limitations when presented with only a handful of claims. Within this series of articles, I have demonstrated a theory that actuaries can use to assess mortality study credibility. More importantly, it provides a consistent context by which the actuary can articulate the financial consequences of using historical experience as the basis for predicting future outcomes.

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