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A Look at **Older Age Mortality Improvement**

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Life actuaries have increasingly been making assumptions about future mortality improvement in pricing and earnings forecasts. Today assuming future mortality improvement may be more the norm than the exception. Whether it is wise to make long-term rate guarantees that implicitly assume significant future mortality improvement is a subject for another article.

This article summarizes various historical and projected future rates of mortality improvement, with a focus on older ages, and provides some very high level comments on issues and opinions regarding estimates of future mortality improvement. Much of the discussion here relates to the U.S. population, although I make a few comments on insured life improvement. There are many papers and articles on the subject of historical and future mortality improvement, often of a highly technical nature and almost all of them are focused on population, rather than life insurance, rates of improvement. But an SOA research project on both U.S. and international insured and population mortality improvement is currently underway.

Before presenting any numbers, some general comments are:

1. Tables of population mortality rates for a given calendar year show surprising differences in calculated mortality rates depending on the source. Since calculations of annual rates of population mortality improvement in this article key off mortality rates for different calendar years, differences in those mortality rates can affect the calculated improvement rates.

2. Some experts caution against basing assumptions for future improvement on historical improvement rates observed over a short time interval. The technical panels that provide recommendations to the Social Security Advisory Board (most recently in 2007) suggest something on the order of 50 years to smooth out fluctuations between periods of rapid and slow improvement (or even disimprovement). It is very difficult to take a meaningful look at historical mortality improvement for insured lives over a 50-year time span because of changes in underwriting practices, risk classes and expected bases and because experience studies have only recently been available electronically.

3. There does not appear to be a consensus on future levels of (population) mortality improvement or whether there is a limit on human longevity. Outlier opinions range from assertions that the first person to live to 1,000 is alive today to the view that we may see future disimprovement due to the increasing prevalence of obesity. But my impression is that most experts believe there is room for future improvement.

4. The 2007 Technical Panel Report on Assumptions and Methods for the U.S. Social Security Advisory Board recommended that forecast best estimate (intermediate) average ultimate annual rates of improvement be increased from 0.70 percent to 1.00 percent. They recommended no change in the average low cost (i.e., low rates of mortality improvement) annual improvement assumption and a substantial increase in the high cost average annual improvement assumption (from 1.21 percent to 2.00 percent). Age-specific versions of these recommendations were not provided.

   That report also says (page 36)—emphasis added:

   "Although recent differential trends by sex could plausibly continue for another 10-20 years, ***the Panel recommends that ultimate rates of mortality decline be equal for men and women, derived from trends for the total population***.

   International comparisons can also be helpful as a guide to future mortality trends despite differences in levels. The U.S. differs from other wealthy countries in ways that affect the overall level of mortality (e.g., more inequality, a less extensive social safety net), and the current gap in levels could remain for

"There does not appear to be a consensus on future levels of (population) mortality improvement...most experts believe there is room for improvement."

many years. However, it seems much less likely that the pace of mortality decline will be vastly different over the long term amongst this close-knit group of nations. ***The post-1980 slowdown in mortality reduction for the U.S. was not typical; most high income countries have enjoyed an accelerated mortality decline at older ages during the last two decades****, sometimes starting from lower levels than the U.S. in 1980. These experiences support the Panel's recommendation for a projected recovery from the recent period of slow mortality decline in the U.S.*"

5. Behavioral changes have impacted historical population improvement rates and will impact future observed population improvement rates. Smoking habits are one example of this. But since population mortality tables are not on a smoker/nonsmoker basis, it is not easy to quantify these effects, although there is at least one paper ("Forecasting United States Mortality Using Cohort Smoking Histories," by Haidong Wang and Samuel H. Preston) that attempts to do so for purposes of forecasting future improvement rates:

    - Wang and Preston conclude that there will be a material amount of observed mortality improvement at older attained ages (their analysis focuses on 50 – 84) as cohorts with a history of less smoking move into that age range. For example, in Table 2 of their paper they estimate that the probability of a male surviving from age 50 to age 85 based on forecast mortality rates in 2034 is 0.5775 if the 2034 projected mortality rates reflect changes in smoking histories vs. 0.4714 if changes in smoking histories are not reflected.

    - It seems unlikely to me that much of such "improvement" in population mortality rates would translate into improvement for insured lives issued on a smoker/nonsmoker basis.

    Obesity is another behavioral factor which some experts expect to have a significant (adverse) impact on future mortality rates. For example, the abstract of the paper "Forecasting the Effects of Obesity and Smoking on U.S. Life Expectancy," by Susan T. Stewart, David M. Cutler and Allison B. Rosen (New England Journal of Medicine (NEJM), December 2009) says that, if trends in increasing BMI and declining smoking rates over the past 30 years or so continue, the negative effects of BMI increase will outweigh the positive effects of smoking decline on the life expectancy for a typical 18-year old. Another older paper (March 17, 2005) that also raised concerns about obesity and was also published in the NEJM is "A Potential Decline in Life Expectancy in the United States in the 21st Century" by S. Jay Olshansky, et al. Of course, as with smoking, past trends might not continue and people could change their habits.

6. Since insurance companies underwrite their risks, smoking and obesity effects should be less of a factor when estimating future improvement rates.

    More generally, it seems reasonable to suppose that improvement rates in early policy years might be less than overall population improvement rates since the underwriting process would, theoretically, remove people with, say, cancer or heart disease which should in turn mean that improvements in death rates associated with those sorts of illnesses should have less impact on early duration mortality for underwritten business. The duration of this underwriting effect would probably decrease as issue age increased. However, a statistical analysis of Canadian select and ultimate insured life experience by Siu-Hang Li, Mary Hardy, and Ken Seng Tan ("Report on Mortality Improvement Scales for Canadian Insured Lives"), concluded that they could not find statistical evidence to support different improvement rates during the select period.

7. There are at least two relatively recent papers that analyze the impact of education and socioeconomic class on changes in life expectancy. Both papers appear to conclude that, between roughly 1980 and 2000, people with more education (at least some college) or in a higher socioeconomic class experienced larger gains in life expectancy. The papers (both available on the Internet) are:

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- "Widening Socioeconomic Inequalities in US Life Expectancy, 1980 – 2000," by Gopal K. Singh and Mohammad Siahpush (published May 9, 2006 by Oxford University Press on behalf of the International Epidemiological Assocation); and

- "The Gap Gets Bigger: Changes In Mortality And Life Expectancy By Education, 1981–2000," by Ellen Meara, Seth Richards, and David Cutler (published in 2008 in *Health Affairs, (Millwood)*).

The papers note that this disparity in increase in life expectancies occurred despite significant efforts on the part of the U.S. government to reduce disparities in life expectancy across socioeconomic class, etc.

8. Although I think future mortality improvement is very likely, the theoretical basis for predicting future improvement rates simply based on an analysis of historical improvement rates strikes me as weak since drivers of future improvement will almost certainly differ from the various factors that drove historical improvement. Notwithstanding this concern, an understanding of historical mortality improvement is critical to developing an informed assumption. Much of the remainder of this article will focus on historical improvement rates.

Historical U.S. Population Mortality Improvement Rates

Table 1 shows calculated annual improvement rates for selected older attained ages using mortality rates from tables in the Human Mortality Database (www.mortality.org/). I have noticed that the tables and data in that database were often used by other researchers.

Observations:

1. Over 10-year periods, improvement rates vary considerably by attained age and gender and from period to period.

Table 1
Calculated Annual Rates of Mortality Improvement
For the Indicated Attained Ages and Periods Based on
U.S. Mortality Tables in the Human Mortality Database

Attained Age	1956-1966	1966-1976	1976-1986	1986-1996	1996-2006	1976-2006	1956-2006
Males							
70	(0.7)%	0.9%	1.8%	1.6%	2.7%	2.0%	1.3%
75	(0.1)	0.3	1.8	1.8	1.9	1.8	1.1
80	(0.4)	1.1	0.7	2.0	1.4	1.4	1.0
85	(0.2)	1.3	0.4	0.9	2.1	1.1	0.9
90	(0.2)	1.1	0.4	0.4	3.2	1.3	1.0
95	(0.2)	0.8	0.2	(0.4)	2.6	0.8	0.6
Females							
70	0.7%	1.5%	1.2%	0.8%	1.4%	1.1%	1.1%
75	1.1	1.4	1.7	0.9	1.1	1.2	1.2
80	0.3	2.3	1.1	1.3	0.7	1.0	1.1
85	0.4	2.1	0.9	0.9	1.1	1.0	1.1
90	0.4	1.6	0.9	0.4	1.8	1.0	1.0
95	(0.1)	1.2	0.6	(0.1)	1.4	0.6	0.6

2. Over the 50-year period from 1956 to 2006, improvement has (conservatively) averaged about 1.0 percent for both sexes for attained ages 90 and under and 0.6 percent for attained age 95.

Table 2 is conceptually similar to Table 1, but bases calculated improvement rates on population tables in Actuarial Study No. 120, "Life Tables for the United States Social Security Area 1900 – 2100," by Felicitie C. Bell and Michael L. Miller (August 2005). Improvement rates differ from those in Table 1, even over the 50-year period in the far right column, due to differences in both the mortality rates in the underlying population tables and the periods over which improvement is measured. Table 2.5, on pg 20, uses the same time periods as Table 2, but bases improvement rates on mortality rates from the Human Mortality Database. So, differences between Tables 2 and 2.5 are due solely to differences in the underlying mortality tables.

Table 2
Calculated Annual Rates of Mortality Improvement
For the Indicated Attained Ages and Periods Based on
U.S. Mortality Tables in Actuarial Study No. 120
(by Felicitie C. Bell and Michael L. Miller)

Attained Age	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000	1970-2000	1950-2000
Males							
70	0.1%	0.3%	1.2%	1.7%	1.5%	1.5%	1.0%
75	0.5	0.1	1.0	1.3	1.4	1.3	0.9
80	(0.1)	0.6	1.0	0.9	1.1	1.0	0.7
85	0.2	0.3	0.9	0.7	0.2	0.6	0.5
90	0.3	0.3	0.8	0.4	(0.4)	0.3	0.3
95	0.1	0.5	0.6	0.0	(0.8)	0.0	0.1
Females							
70	1.6%	1.6%	1.3%	0.8%	0.3%	0.8%	1.1%
75	1.7	1.4	1.8	0.8	0.2	0.9	1.2
80	0.5	1.8	2.0	1.0	(0.1)	1.0	1.1
85	0.3	1.5	1.7	1.1	(0.4)	0.8	0.9
90	0.3	1.4	1.2	0.8	(0.7)	0.5	0.6
95	0.3	1.4	0.7	0.4	(1.0)	0.1	0.4

Note: Page 33 of the October 2007 report to the Social Security Advisory Board entitled "2007 Technical Panel Report on Assumptions and Methods" says, "The 1999 and 2003 Panels suggested that unfavorable trends in old-age mortality during the 1980s and 1990s may reflect the delayed effects of increased levels of smoking among women; recent articles offer empirical support for this explanation."

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Table 2.5
Calculated Annual Rates of Mortality Improvement
For the Indicated Attained Ages and Periods Based on
U.S. Mortality Tables in the Human Mortality Database

Attained Age	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000	1970-2000	1950-2000
Males							
70	(0.2)%	0.1%	1.5%	1.9%	1.8%	1.7%	1.0%
75	0.1	0.1	1.5	1.5	1.4	1.5	0.9
80	(0.2)	0.7	0.9	1.1	1.5	1.2	0.8
85	0.4	0.6	0.9	0.9	1.2	1.0	0.8
90	(0.5)	0.7	0.8	0.4	0.3	0.5	0.3
95	0.0	0.6	0.3	0.3	(0.3)	0.1	0.2
Females							
70	1.1%	1.2%	1.8%	0.9%	0.7%	1.2%	1.1%
75	1.1	1.5	2.1	1.1	0.2	1.2	1.2
80	0.2	1.5	1.7	1.4	0.2	1.1	1.0
85	0.6	1.2	1.8	1.1	0.4	1.1	1.0
90	(0.6)	1.1	1.3	1.0	(0.1)	0.7	0.5
95	(0.2)	1.0	0.8	0.5	(0.6)	0.2	0.3

Annual improvement rates over the 50-year period of 1950 to 2000 in the last column of Tables 2 and 2.5 are quite similar, but there are more substantial differences over shorter time intervals. Comparing the 1996 – 2006 column of Table 1 to the 1990 – 2000 column of Table 2.5 suggests that rates of improvement since 2000 have increased substantially, particularly at the very old ages.

Table V.A1 in the 2009 OASDI Trustees Report implies the following annual rates of mortality improvement for attained ages 65 and older, males and females combined, based on the historical age-sex adjusted mortality rates shown in that table:

1950 to 2000: 0.82 percent
1950 to 2005: 0.88 percent
1960 to 2005: 0.96 percent
1970 to 2005: 0.93 percent
1980 to 2005: 0.76 percent
1990 to 2005: 0.64 percent
2000 to 2005: 1.46 percent

The calculated improvement rates in Table 3, on pg. 21, are based on white population mortality rates in tables found on the CDC website. There were different sources for different time periods:

1979 to 1998: www.cdc.gov/nchs/nvss/mortality/hist290.htm
1999 to 2005: www.cdc.gov/nchs/nvss/mortality/gmwk2925.htm
2006: www.cdc.gov/nchs/nvss/mortality/gmwk210r.htm

Finally, Table 4, below, shows implied improvement rates by gender for the 20-year period 1981 to 2001 based on central death rates shown in Table 2 (pgs 20 – 21) of Actuarial Study No. 120 (by Bell and Miller):

These improvement rates are quite different from those for the 20-year period 1986 to 2006 shown in the last column of Table 3.

Forecast U.S. Population Mortality Improvement Rates

There is a great deal of literature related to future (population) mortality improvement. Social Security Bulletin, Vol. 66 No. 1, 2005, "Literature Review of Long-Term Mortality Projections," by Hilary Waldron contains some high level discussion of various forecasts (particularly as they relate to those of the Social Security Administration) and a partial list of relevant papers. Some observations based on a more recent paper, prepared for the MacArthur foundation by S. Jay Olshansky, et al., are discussed after Table 7, on pg. 22.

Table 5, on pg. 22, shows implied forecast average annual mortality improvement rates over various future periods by gender and for selected attained ages based on mortality rates in the projected population tables of Actuarial Study No. 120.

Table 3
Calculated Annual Rates of Mortality Improvement
For the Indicated Attained Ages and Periods Based on
CDC Tables for the White Population

Attained Age Group	1986 to 1991	1991 to 1996	1996 to 2001	2001 to 2006	1986 to 1996	1996 to 2006	1986 to 2006
Males							
65-69	1.8%	1.7%	2.1%	2.5%	1.7%	2.3%	2.0%
70-74	2.5	1.3	1.9	2.7	1.9	2.3	2.1
75-79	2.1	1.4	1.2	2.4	1.7	1.8	1.8
80-84	1.5	1.0	1.5	1.9	1.3	1.7	1.5
85+	0.7	0.0	1.1	3.0	0.4	2.0	1.2
Females							
65-69	1.1%	0.5%	0.8%	2.1%	0.8%	1.5%	1.1%
70-74	1.4	0.1	0.7	1.8	0.8	1.2	1.0
75-79	1.3	0.1	0.2	1.8	0.7	1.0	0.8
80-84	1.4	0.0	0.1	1.8	0.7	0.9	0.8
85+	0.9	(0.5)	(0.3)	2.3	0.2	1.0	0.6

Table 4
Calculated Annual Rates of Mortality Improvement
For 1981 to 2001 and the Indicated Attained Age Groups Based on
Central Death Rates in Actuarial Study No. 120
(by Felicitie C. Bell and Michael L. Miller)

Attained Age Group	Males	Females
65-69	1.67%	0.60%
70-74	1.51	0.46
75-79	1.30	0.42
80-84	0.78	0.30
85-89	0.16	0.10
90-94	(0.41)	(0.26)

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Table 5
Calculated Annual Rates of Mortality Improvement for the U.S. Population and Selected Future Periods and the Indicated Attained Ages Based on Projected Population Tables in Actuarial Study No. 120 (by Felicitie C. Bell and Michael L. Miller)

Attained Age	Males				Females			
	2010-2020	2020-2030	2030-2040	2010-2040	2010-2020	2020-2030	2030-2040	2010-2040
65	0.9%	0.8%	0.8%	0.9%	0.8%	0.8%	0.7%	0.8%
70	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.7
75	0.9	0.8	0.8	0.8	0.7	0.8	0.7	0.7
80	0.9	0.9	0.8	0.9	0.8	0.9	0.8	0.9
85	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7
90	0.5	0.6	0.6	0.6	0.5	0.6	0.6	0.6
95	0.5	0.6	0.6	0.6	0.5	0.6	0.6	0.6

Table 6, below, shows implied forecast average annual mortality improvement rates for attained ages 65 and older, male/female combined based on the age-sex adjusted mortality rates in Table V.A1 of the 2009 OASDI Trustees Report. Improvement rates are shown for the Low, Intermediate and High Cost projections.

Table 6
Implied Forecast Average Annual Mortality Improvement Rates Male/Female Combined—Attained Ages 65 and Older—U.S. Population (Based on Table V.A1 of the 2009 OASDI Trustees Report)

Cost Estimate	2010 to 2020	2020 to 2030	2030 to 2040	2010 to 2040
Low	0.16%	0.33%	0.34%	0.28%
Intermediate	0.71	0.83	0.80	0.78
High	1.40	1.49	1.40	1.43

Table 7 compares ultimate (2031 and later) Low, Intermediate and High Cost improvement rate assumptions from the 2007 Trustees Report (for Social Security) to recommendations made in the October 2007 "2007 Technical Panel Report on Assumptions and Methods."

Table 7
Forecast Ultimate (Years 2031 & Later) Improvement Rates U.S. Social Security Projections

Sex	Attained Ages	High Cost	Intermediate Cost	Low Cost
2007 OASDI Trustees Report				
Male	65-84	1.30%	0.72%	0.31%
	85 & Older	1.03	0.62	0.25
Female	65-84	1.23	0.68	0.30
	85 & Older	1.01	0.61	0.26
Combined	All*	1.21	0.70	0.33
2007 Technical Panel Recommendations				
Combined	All*	2.00%	1.00%	0.33%

*Including ages younger than 65.

In December of 2009, a paper was published in *The Milbank Quarterly* entitled, "Aging in America in the Twenty-first Century: Demographic Forecasts from the MacArthur Foundation Research Network on an Aging Society." The authors are S. Jay Olshansky, Dana P. Goldman, Yuhui Zheng and John W. Rowe. The authors project life expectancies in 2050 under two scenarios and compare them to forecast life expectancies produced in 2008 by the Social Security Administration and the Census Bureau.

- **Scenario A**. "Assumes that advances in efforts to combat major fatal diseases (e.g., medical technology, modified behavioral risk factors, aggressive management of symptoms) will occur at an *accelerated pace* over the 50-year projected time frame. … By contrast, the SSA assumes that rates of improvement in U.S. mortality will slow in the coming decades."

- **Scenario B**. "Assumes that forthcoming advances in the biomedical sciences will lead to interventions that slow the rate of biological aging and have a systemic dampening effect on all fatal and disabling diseases simultaneously (Butler, et al., 2008)."

Among the comments made in the Conclusions section of the paper are:

- "A realistic view of the future would entail elements of both scenarios A and B occurring simultaneously."

- "Although there currently are substantial differences in life expectancy in the United States according to race and social class (Meara, Richards, and Cutler 2008; Singh and Siahpush 2006), an underlying premise of the forecasting scenarios described here is that by midcentury, all segments of the U.S. population would benefit equally. Worrisome trends in health (and limits on health care spending) are emerging, however, that could attenuate or even reverse the anticipated rise in life expectancy in the coming decades in unequal measure, by differences in social class. ..."

- "These Network forecasts are based on the premise that the health and longevity challenges now faced by the U.S. population (e.g., smoking and the rise of obesity) will be resolved by midcentury. But this indeed is an optimistic assumption. ..."

- "The Network's future research will, in part, be devoted to documenting how the health and size of the U.S. population would change by midcentury if we fail to reduce or eliminate prevailing health and mortality disparities or if we fail to modulate trends in life-shortening behavioral risk factors."

With all of that as background, Table 8 compares some forecast life expectancies in 2050 under Scenarios A and B to those of the Census Bureau (CB) and the Social Security Administration (SSA).

Table 8
Comparison of Forecast Life Expectancies in 2050*

Gender	SSA	CB	Scenario A	Scenario B
Life Expectancy at Birth				
Male	80.0	80.9	83.2	85.9
Females	83.4	85.3	89.2	93.3
Life Expectancy at Age 65				
Male	19.3	20.6	23.4	27.1
Females	21.4	23.2	27.4	32.4
Life Expectancy at Age 85				
Male	6.5	7.6	9.7	13.6
Females	7.6	8.9	12.3	17.8

* From Table 2 of the paper "Aging in America in the Twenty-first Century: Demographic Forecasts from the MacArthur Foundation Research Network on an Aging Society."

Table 9, on pg. 24, compares forecast life expectancies in 2050 under three alternative annual improvement rate assumptions starting with the 2006 U.S. population table from the Human Mortality Database. The three alternatives are:

- **Alternative 1**. Nineteen years of improvement from 2006 (15 years from 2010) at 1 percent per year for all ages. No improvement after 2025.

- **Alternative 2**. Varies by attained age—0.25 percent to 0.95 percent for attained ages under 29, 1.00 percent for attained ages 29 through 90 then decreasing by 0.1 percent per year of attained age to 0 percent for attained ages 100 and above.

- **Alternative 3**. Assumes that improvement between now and 2050 will result in mortality rates for attained age x in 2050 being identical to the attained age x-8 rate in 2006 for x >= 15. Implied annual improvement rates vary by attained age, but are about 1.7 percent for attained age 80 and still 1.2 percent at attained age 100.

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Table 9 Comparison of Forecast Life Expectancies in 2050			
Gender	Alternative 1	Alternative 2	Alternative 3
Life Expectancy at Birth			
Male	78.0	80.7	83.3
Females	82.9	85.1	88.5
Life Expectancy at Age 65			
Male	19.1	21.1	23.5
Females	21.8	23.6	26.8
Life Expectancy at Age 85			
Male	7.3	8.2	9.9
Females	8.3	9.0	11.6

Comparing Tables 8 and 9, it seems we can conclude that:

- Alternative 1 improvement rates produce shorter life expectancies than Census Bureau assumptions at the ages shown, but the difference is small at age 85. Comparing to SSA forecasts, life expectancies are comparable at age 65, but Alternative 1 has a longer life expectancy at age 85. To get approximate SSA age 85 life expectancies, annual improvement rates (for 19 years) would have to be about 0.3 percent for both males and females.

- Alternative 2 improvement rates produce life expectancies that are fairly close to those of the CB, except for males at age 85.

- Alternative 3 improvement rates produce life expectancies fairly close to those for Scenario A. For attained ages from 85 to 100, those annual improvement rates gradually decrease from 1.7 percent at age 85 to 1.2 percent at age 100 for males and from 1.8 percent to 1.5 percent for females.

Historical U.S. Insured Mortality Improvement Rates

Quantifying historical mortality improvement rates for insured lives, particularly during the select period, would be extremely challenging with the data available. Changes in observed insured mortality are materially affected by not only real mortality improvement, but also such factors as:

- Changes in the list of companies participating in the industry mortality studies and changes in the relative contributions to that experience from those companies.

- Changes in underwriting practices and requirements.

- Changes in risk class structure and impacts those changes have on premium rates and mix of business. For example, when the nonsmoker class is split into multiple preferred classes, the most preferred risks tend to buy larger policies (since the unit cost is less) which skews experience by amount toward the better risks.

- Changes in product design which affect policyholder behavior and observed mortality experience, such as the shock lapses and accompanying anti-selection on level premium term policies.

Even if the issues cited above could be ignored, it is also very difficult to look at long-term trends in experience because the expected basis (e.g., the 1975 – 80 tables) used to measure mortality experience changes periodically and very little historical experience is available electronically.

One additional problem arises when the focus is on experience at older ages because insurance companies have not sold material amounts of business at older issue ages until recently.

Bearing these *caveats* in mind, various insured life improvement rates are shown in Tables 10 and 11 on pg. 25.

Table 10 shows ultimate experience A/E ratios (1975 – 80 expected basis) and calculated average annual "improvement" rates by gender for the 1982-83 (the first study showing experience relative to the 1975 – 80 tables) and 2005 – 07 study periods.

Table 10
Ultimate* U.S. Life Mortality Experience and Implied Improvement Rates
(1975 – 80 Expected Basis)

Attained Ages	Males			Females		
	1982 to 1983 A/E	2005 to 2007 A/E	Annual Imprmnt	1982 to 1983 A/E	2005 to 2007 A/E	Annual Imprmnt
65-69	89.6%	52.4%	2.3%	101.8%	75.1%	1.3%
70-74	91.6	55.7	2.1	103.0	76.0	1.3
75-79	95.1	63.7	1.7	86.7	75.4	0.6
80-84	93.8	67.7	1.4	84.9	75.4	0.5
85-89	96.8	78.2	0.9	99.8	80.9	0.9
90-95	91.9	87.7	0.2	102.5	87.0	0.7

*Policy years 16+ for 1982 – 83 and years 26+ for 2005 – 07.

Some additional comments on Table 10:

- 2005 – 07 experience for attained ages 90 – 95 is really for attained ages 90 – 94.
- 2005 – 07 experience is by amount and for all companies (as opposed to common companies). I believe that is also the case for the 1982 – 83 experience, but I did not see a clear statement of that in the report (Table 16 on page 46 of the TSA 1983 Reports). There was not a great deal of overlap in the list of companies contributing to each of these studies.
- In both cases, experience is for all amounts combined since there was no information on 1982 – 83 experience for other amount groupings.
- With one exception (Females, Attained Ages "90 – 95"), the 2005 – 07 A/E ratios would be lower (and implied improvement rates higher) if we used A/E ratios for policy years 16+, consistent with the 1982 – 83 experience. I did not include policy years 16+ because then distortions related to the inclusion of smoker distinct experience would be introduced.

Table 11 shows older age ultimate experience (2001 VBT expected basis) for experience years ending in 2003 and 2007, face amounts of $25k and higher and the 21 "common companies" that contributed to each of the five experience years 2002 – 07. To give a sense of the credibility, the number of actual deaths is shown in parentheses below the A/E ratio. Table 11 was developed from the Common Companies ILEC 2002 – 07 pivot table included with the SOA's 2005 – 07 experience study added to the SOA's website earlier this year.

Table 11
Ultimate* U.S. Life Mortality Experience by Amount and Implied Improvement Rates
Face Amounts of $25k and Higher—Common Companies
(2001 VBT Expected Basis)

Attained Ages	Males			Females		
	2002 to 2003 A/E	2006 to 2007 A/E	Annual Imprmnt	2002 to 2003 A/E	2006 to 2007 A/E	Annual Imprmnt
70-79	75.3% (1,209)	68.3% (1,878)	2.4%	93.0% (93)	67.8% (137)	7.6%
80-89	85.8% (1,251)	72.5% (2,194)	4.1%	95.7% (130)	100.1% (286)	(1.1)%
90+	87.1% (295)	87.7% (553)	(0.2)%	133.3% (65)	98.5% (125)	7.3%
70 & Older	81.0% (2,755)	72.1% (4,625)	2.9%	101.6% (288)	88.8% (548)	3.3%

*Policy years 26+.

Some comments on Table 11:

- The annual improvement rates vary enormously.
- The four year time interval over which "improvement" is being measured is almost certainly too

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short to be meaningful as a predictor of future improvement rates. Moreover, any point-to-point calculation such as this can produce misleading results if the experience for the endpoints is anomalous (i.e., better or worse than "normal" due to random fluctuations, changes in the mix of experience by contributing company, or other factors).

Forecast Insured Mortality Improvement Rates

The only quasi-official improvement rate assumptions for U.S. life insurance business that I am familiar with are those used to bring experience underlying the 2001 and 2008 VBT's forward to 2001 or 2008. Those assumptions, which are not really future improvement rate assumptions, are summarized below:

Table 12
Improvement Rates Used to Project Observed Experience to 2001 for the 2001 VBT

Attained Ages	Male	Female
0-45	0.0%	0.0%
55-80	1.0	0.5
85	0.5	0.5
90 & Older	0.0	0.0

Table 13
Improvement Rates Used to Project Observed Experience to 2008 for the 2008 VBT

Attained Ages	Improvement Rate	Attained Ages	Improvement Rate
0-20	0.0%	0-35	0.0%
30-80	1.0	45-80	0.5
90 & Older	0.0	90 & Older	0.0

Notes:

1. Improvement rates grade linearly between attained ages shown. For example, for the 2001 VBT, the male improvement rates grade linearly from 0 percent at attained age 45 to 1.0 percent at attained age 55 and then grade from 1.0 percent at attained age 80 to 0.5 percent at attained age 85.
2. Assumed improvement rates used to develop the 2008 VBT were presented in a table on page 15 of the 2008 VBT Report & Tables .pdf file found on the SOA website under Research, Experience Studies, Individual Life, 2008 Preferred Mortality Reports.
3. Assumed improvement rates used to develop the 2001 VBT were on page 24 of Appendix K (SOA Report of the Individual Life Insurance Valuation Mortality Task Force, November 2001).

There have also been at least two SOA surveys containing some information on the assumptions some actuaries are making for future mortality improvement:

- The first was published in March 2003 (but reflecting practices and views in mid-2000) and was entitled, "Report of the Society of Actuaries Mortality Improvement Survey Subcommittee." At that time only 16 of the 67 companies responding to the study assumed future mortality improvement in pricing. Not much information is provided in the survey on actual assumptions, but Table 12 in the survey report did summarize the assumptions for policy years one through 10, male, issue age 45, best nonsmoker class of 12 companies and the mean annual improvement rate assumption was 0.89 percent.

- The second is the "Report of the Society of Actuaries Mortality Table Construction Survey Committee," which was published in June 2007 and reports on the results of a July 2006 survey on methods used to develop pricing mortality tables for fully underwritten life insurance. According to Table 42 on page 24 of the report, 39 percent of the respondents reflect mortality improvement in their pricing mortality. Some limited information on the respondents' mortality improvement assumptions is provided on pages 24 and 25 of that report.

Concluding Remarks

When and to what extent future mortality improvement will occur is currently impossible to predict with confidence since forecasting improvement necessarily entails predicting such things as:

- The timing and nature of medical breakthroughs, how quickly and widely those breakthroughs get translated into improved treatments for individuals and the impact of the new treatments on mortality; and
- Behavioral changes.

Obviously, financial results for YRT reinsurance and products such as term insurance, for which mortality is a key risk, are very sensitive to mortality improvement. So, actuaries need to stay abreast of the latest thinking on the subject and have a good awareness of the impact on profitability if the future does not emerge as expected. □

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