The History of Actuarial Mortality Tables in the United States
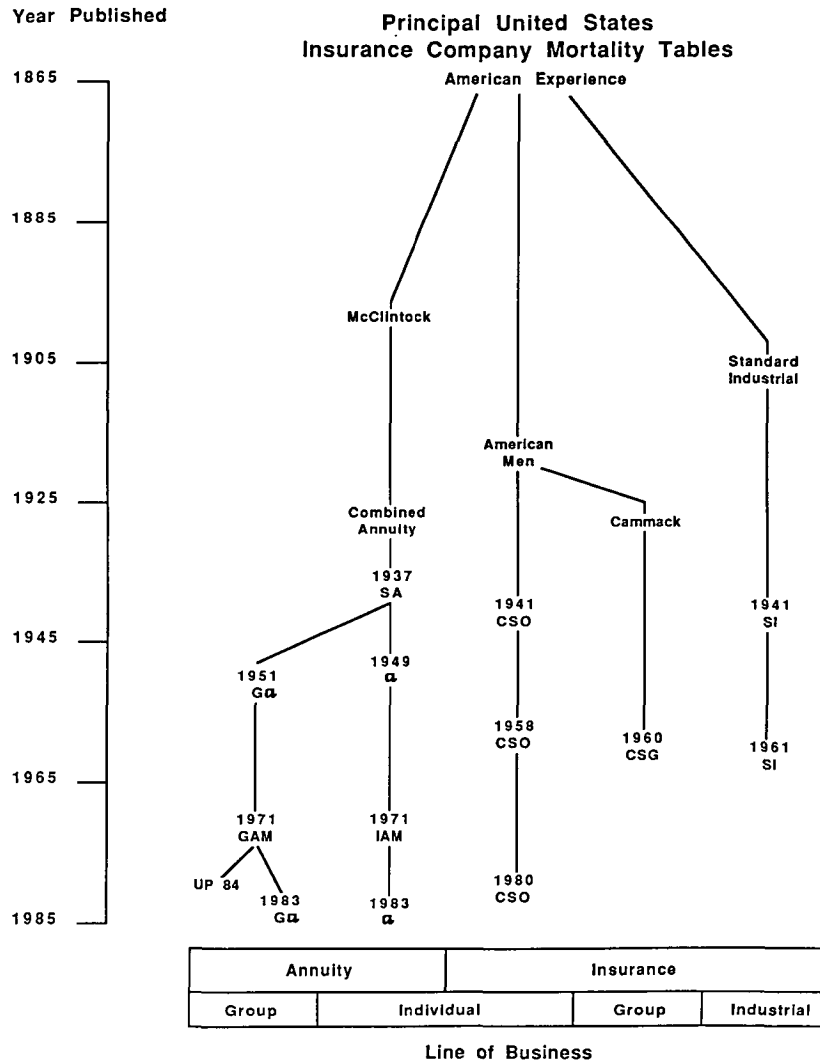
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This paper is taken from a larger study of the history of mortality, and mortality tables, that will be published in conjunction with the commemoration of the 100th anniversary of the founding of the actuarial profession in America. The paper focusses on the principal mortality tables used in State laws setting safe levels for insurance and annuity reserves. Many other tables are used by insurers to determine premiums or to measure the expected mortality for their policies. A set of "basic" tables is commonly used to measure the underlying mortality of a statutory table in determining whether or not specific experience is substandard.

Different mortality tables are now used for various segments of the insurance industry. Current tables include the Commissioners 1980 Standard Ordinary Mortality Table (1980 CSO) for individual life insurance, the Commissioners 1960 Standard Group Mortality Table (1960 CSG) for group life insurance, the 1983 Table A for individual annuities, the 1983 Group Annuity Mortality Table (1983 GAM) for insured pensions, and the UP-1984 table for uninsured pensions.

Chart I shows the genealogy of the principal tables developed from mortality experience in the United States and in use during the hundred year history of the actuarial profession in the United States.

Chart 1

Year Published

Principal United States Insurance Company Mortality Tables

American Experience

Annuity		Insurance	
Group	Individual	Group	Industrial

Line of Business

The earliest tables were used for all forms of insurance. However major segments of the industry soon realized that general mortality tables were not adequate for their specific lines of business. The first split was between insurance and annuity tables with McClintock's Annuitants' Table published in 1899. Another split occurred with the first industrial insurance table in 1906. A third early split, not shown on the chart, was a table for Fraternal Society policies in 1898.

Both the insurance and annuity families of tables later split to produce separate tables for individual and group business. The first group insurance tables were Cammack's tables published in 1927. Group annuity tables became a separate line beginning in 1951 and then split again in 1979 between tables for insured and uninsured pensions.

Margins in Mortality Tables

Mortality tables for a specific line of insurance or annuities are usually developed by analyzing experience on policies from that line. A common requirement of statutory mortality tables is that they contain a margin for safety. Margins mask the actual experience and are applied differently for insurance and annuities. Therefore, it is important for the user of the table to understand how and why the margins were applied.

A safety margin works in opposite directions for insurance and annuities. If, for example, fewer policyholders die than predicted by the table used to set premiums, the insurance plan will have a gain but the annuity plan will have a loss.

Chart II illustrates why different approaches are taken to provide a safety margin for annuities and life insurance. If the mortality table predicts that 50 out of 1,000 policyholders will die during a year, but only 45 of 1,000 die, an insurance line will show a ten percent gain. However, an annuity line will show a loss since there are more policyholders alive and, therefore receiving annuities, than expected.

One result of the difference in safety margins is that the secular improvement in mortality that has occurred in the last century has very different implications for insurance and annuity lines of business. Margins for insurance policies will develop or increase as mortality improves. On the other hand, even if there is a margin for safety in an annuity table, that margin will gradually disappear as mortality improves.

The effect of the improvement in mortality has led to different approaches by actuaries who develop mortality tables for insurance and annuities. Insurance tables are usually taken directly from recent experience with a margin added to permit the table to safely cover random fluctuations in mortality. Annuity tables are updated more frequently and the tables are accompanied by recommended projection factors to anticipate future improvements in mortality. These steps are in addition to the application of a safety margin by reducing the mortality rates.

Insurance Tables

When the Actuarial Society of America was founded in 1889, British tables were still used extensively by actuaries in the United States. The grandfather of insurance mortality tables developed in the United States is the American Experience table which well deserves its position at the head of Chart I. There had been other mortality tables developed in the United States — the first was produced by Professor Wigglesworth in 1789 — but the American Experience is the first table based on insurance experience and widely used by the industry.

The American Experience Table holds several unique positions in the history of mortality tables. It was the first widely-used table based on life insurance mortality experience in the United States. In its early years, it was the mortality basis for all lines of insurance and annuities. Perhaps most

Chart 2

Benefits to 1,000 Policyholders

Expected Deaths = 50

Actual Deaths   = 45

Insurance ($100,000 benefit each)

Expected Benefit	=	$5,000,000
Actual Benefit	=	4,500,000
Gain		$500,000

Annuity ($10,000 annual payment each)

Expected Benefit	=	$9,500,000
Actual Benefit	=	9,550,000
Loss		$50,000

remarkably, the American Experience table was used as the primary statutory table for individual insurance policies from its introduction in 1868 until it was replaced as the statutory table by the 1941 CSO table beginning in 1948. Since policies issued under the American Experience basis continued to be valued on that basis after 1948, the American Experience table was actually used for more than a century.

Despite the unique position of the American Experience Table, less is known about its construction than about any other table on Chart I. The table was the work of one man, Sheppard Homans, based on mortality experience of the Mutual Life Insurance Company of New York. Most of what is known about the table comes from comments by Homans as an extended toast after the first dinner of the Actuarial Society of America at the Astor Hotel in New York on April 25, 1889.

James S. Elston, in his 1932 study of the *Sources and Characteristics of the Principal Mortality Tables*, stated that the table was based on the experience of the Mutual from 1843 to 1860 and that Homans probably added a safety margin since he did state that he removed the effect of medical selection. Homans did not use the name "American Experience" but the name later became attached to the table through general use.

The next table for general insurance, produced in 1918, was the American Men table based on experience of 59 life insurance companies between 1900 and 1914. The male table produced by removing the first five policy years of experience (the period when medical "selection" would reduce mortality) was widely used as the AM$^{(5)}$ table.

The American Men table never became as widely used as the old faithful American Experience table and the latter remained enshrined in most State laws. As the American Experience table became more out-of-date, and more conservative with improvements in mortality, there was increasing public criticism of the insurance industry's use of that table. One view was that the use of such an old table lead to "unconscionable profits" by the industry.

The State Insurance Commissioners, while not agreeing with the public criticism, did believe that there should be a new statutory table and asked the actuarial profession to develop a such a table. The result was the Commissioners 1941 Standard Ordinary Mortality (1941 CSO) table which was the first in a series of "CSO" tables.

The 1941 CSO table was based on the experience of sixteen principle life insurance companies in the United States and Canada from their policies between 1931 and 1940. The table was graduated and loaded to provide a table with smooth rates that had a margin for safety. The 1941 CSO table was accompanied by a "basic" table with the margins removed so that insurers could measure their own experience against the actual experience of the sixteen companies.

The next in the series was the Commissioners 1958 Standard Ordinary Mortality Table (1958 CSO-. The 1958 CSO, and the accompanying basic table, were derived from insurance company experience between 1950 and 1954 by adding margins and graduation.

The 1958 CSO was followed by the 1980 CSO, and basic table, based on 1970 through 1975 insurance company experience. This table has been used as the valuation standard since 1981. Unlike the 1958 table, the 1980 table included policies issued on a nonmedical basis since it was becoming less and less common to use medical underwriting.

The first tables developed for specific use for group insurance were the Cammack Mortality Tables based on the experience of six companies for 1913 to 1926. One table provided rates based on general experience and the other on the experience of "clerical" employees. The latter was used extensively as the Cammack Clerical table. The current group table is the

1960 CSG which was constructed from insurance company experience between 1950 and 1958.

Annuity Tables

A distinct family of mortality tables has been used for annuities since 1899. The first annuity table, McClintock's table, was based on experience of fifteen American companies on their annuity policies before 1892. The next table in general use was the American Annuitant table derived from experience of twenty American companies through 1918.

The next in the series was the 1937 Standard Annuity table. The 1937 Standard Annuity table was not, however, based on a new study of mortality. The table was largely based on a two-year set back of the American Annuitants table at the older ages.

In 1949, two predecessor organizations merged to from the Society of Actuaries. Volume I of the Transactions of the new Society included a paper by Wilmer Jenkins and Edward Lew presenting the 1949 Standard Annuity table (a-1949). The a-1949 table was the first to be presented as a "basis" table that actuaries should build on by projecting experience to a year that would represent the average mortality of annuitants.

The next individual annuity table was the 1955 American Annuity table. The table was derived from experience under individual annuity contracts between 1948 and 1953. This was followed by the 1971 Individual Annuity Mortality (71 IAM) Table. The current table in this series is the 1983 Table A based on 1971 to 1976 annuity experience.

Since much of the annuity business in the United States is for group annuities issued for pension plans, there was an early interest in separate group annuity tables.

The first such table was the Combined Annuity table created by blending Cammack's Clerical Mortality table at the younger ages with the American Annuitant's Table at the older ages. However, the Combined and 1937 Standard Annuity tables were used for both group and individual business.

Distinct series of group and individual annuity tables began in the early 1950s. The a-1949 table for individual policies was quickly followed by the Group Annuity Table for 1951 (Ga-1951) for group annuity mortality. Both the 1971 and 1983 individual tables had a group counterpart in the 1971 Group Annuity Mortality Table (1971 GAM) and the 1983 GAM.

The group annuity tables split into two branches in 1979 with the publication of the first table based on uninsured pensioner experience. The first in what may become a series of tables is the UP-1984 table produced from experience of large uninsured pension plans. The U stands for Unisex since the tablef does not split male and female mortality and the P stands for Pension. The table was published in 1975 but projected to 1984.

Industrial Insurance

Other families of tables have been developed to measure and value the mortality for specific lines of business. One type of table that was once very important is for industrial insurance. Industrial insurance experienced higher mortality than standard life insurance because there was no medical selection and the policies were written for people with lower incomes than the incomes of the typical standard life insurance policyholder.

The first Standard Industrial Mortality Table was based on the experience of the Metropolitan Life Insurance Company between 1896 and 1905. The table was adopted as the standard for New York State in 1907. Successor tables were the 1941 Standard Industrial table and the 1961 Standard Industrial Table, both based on Metropolitan experience.

Comparison of Mortality

Chart III compares the remaining life expectancy at age 20 as measured by the United States Census to the life expectancy measured by some of the principal mortality tables. Life expectancy at age 20 is used since insurance tables are constructed to show the mortality of adults. Where there are separate tables, the male experience is shown since that has been the primary focus of life insurance mortality tables. The U.S. Census data are for White Males since that is the most comparable historical series.

The decennial census results show the secular increase in mortality in this century. The average white male reaching age 20 in 1900 could have expected to survive 42.2 years. By 1980, his remaining life expectancy had increased to 52.5 years. The chart shows continual improvement in mortality between the decennial censuses. A year-to-year comparison would show continual improvement in almost all years but there was a significant drop in life expectancy in 1918 as a result of the influenza epidemic. The full set of life expectancies by year can be found on page 13 of Actuarial Study No. 102 of the Social Security Administration by Alice Wade.

Chart 3

Expectation of Life After 20 for Males
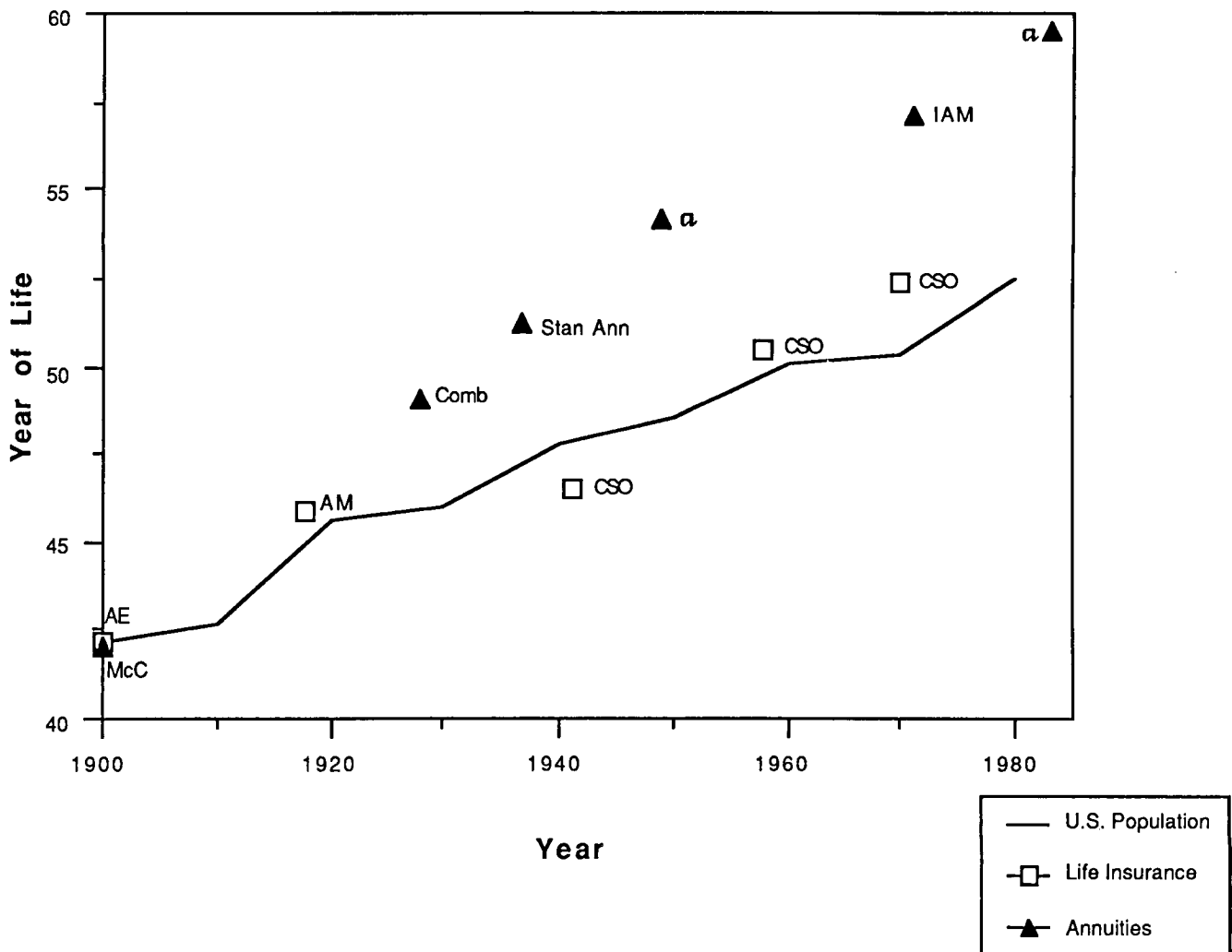
Both insurance and annuity tables reflect the improvement in mortality. The statutory insurance tables produce life expectancies that are about equal to those of the U.S. census while the annuity tables show significantly higher life expectancies. The differences between the three types of mortality table are largely explained by the use of margins in the insurance and annuity tables. Insurance company mortality is lower than that of the general population so unloaded tables would show a longer life expectancy. However, the increase in the mortality rates to provide a margin brings these tables close to the average mortality. On the other hand, the mortality of annuitants is better than that of the general population but the difference is exaggerated by the reduction in the mortality rates used to provide a margin in these tables.

The Future of Mortality

Underwriters of insurance and annuities will continue to produce new tables as long as mortality continues to improve. Mortality has improved almost continuously for the last 200 years and most observers expect mortality to improve in the near future. There are, however, differing views as to how long the improvement will continue.

Shigekazu Hishinuma studied all of the old mortality experience he could find for a paper presented to the Institute of Actuaries of Japan. He decided that there had been little improvement in life expectancy from the Bronze Age until the advances in health care and hygiene beginning in the 18th

century. The life expectancy at age 20 ranged between 20 and 30 years from the Bronze age to the Middle Ages. By the late 18th century, the life expectancy at 20 had increased to 35 years and by 1900 it had improved to 42 years. Thus, after a long period with little or no improvement, life expectancy after age 20 increased five years in the 18th century, seven years in the 19th century, and ten years in the first 80 years of this century.

Hishinuma noted that the highest expectation of life in the early 1970s was 72 years for males and 78 years for females in Sweden. He projected improvements in mortality due to various diseases and estimated that the longest life expectancy would be 77.4 years for males and 81.7 years for females. He assumed that there would be an end to significant improvements in mortality by the time these expectancies were reached.

Wade observed that the life expectancy in the United States was 71.5 years for males and 78.5 years for females in 1987. She also examined mortality by disease to predict a maximum life expectancy under the Social Security actuaries' most "pessimistic" assumptions of 83.6 years for males and 90.1 years for females in the year 2080. From the point of view of the Social Security system, improvements in mortality are pessimistic assumptions. The Social Security actuaries' moderate assumptions predict a life span of 78.2 years for males and 84.9 for females. Unlike Hishinuma, however, Social Security actuaries assume that mortality will continue to improve after that time.

Bibliography

Much of the information in this paper is based on or derived from an important series of studies by the Tillinghast Company. The latest study, Principal Mortality Tables Old and New, was published in 1987 by Tillinghast, A Towers Perrin Company, in Atlanta. The Tillinghast study contains complete tables of mortality and life expectancy, and a brief description, of most of the tables referred to in this paper. Information on the older tables was largely drawn from Sources and Characteristics of the Principal Mortality Tables, by James S. Elston — Second Edition, published 1932 in New York by The Actuarial Society of America. Other sources used in the paper are:

Cammack, E. E., Mortality Tables Constructed Upon the Experience under Group Policies, TASA XXVII (1927) pg. 247 ff

Craig, J.D. - Discussion of E. E. Cammack's 1927 paper, TASA XXIX (1928), page 247+

Fellers, William W. and Jackson, Paul H., Noninsured Pensioner Mortality, Proceedings of the Conference of Actuaries in Public Practice, XXV, 456

Hishinuma, Shigekazu — Historical Review of the Longevity of the Human Beings — Unpublished paper presented to the Institute of Actuaries of Japan

Homans, Sheppard, speech before the Actuarial Society of America, Transactions of the Actuarial Society of America (TASA) Vol I (1889-90), page 33

Jenkins, Wilmer A. and Lew, Edward A., New Mortality Table for Annuities, TSA I (1949), page 369 ff

Kineke, Frank D. — A New Annuity Mortality Table — TASA XXXIX (1938) pg. 8

Peterson, Ray M. — Group Annuity Mortality — TSA IV (1952), pg 246+

Thompson, John, The Commissioners 1941 Standard Ordinary Mortality Table, TASA XLII (1941), page 314

Wade, Alice — Social Security Area Population Projections 1988 Actuarial Study No. 102, Social Security Administration, 1988SSA Pub No. 11-11549

Wattenberg, Ben J., The Statistical History of the United States — From Colonial Times to the Present, Basic Books, Inc, New York, 1976

Report of the Special Committee to Recommend New Mortality Tables for Valuation, TSA XXXIII (1981), page 617 ff