

# RECORD OF SOCIETY OF ACTUARIES 1980 VOL. 6 NO. 4

## IMPLICATIONS OF FUTURE MORTALITY TRENDS: FOLLOW-UP TO IDEAS PRESENTED AT THE CHICAGO MORTALITY SYMPOSIUM

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1. Brief review of the Mortality Symposium
2. Impact of possible future improvement in life expectancy on:
  - a. Life insurance industry
  - b. Private pension industry
  - c. Social insurance industry
3. Examples of what some companies have done or plan to do in reaction to these developments
4. Areas of research suggested to prepare actuaries to deal with possible changes identified

MR. WILFRED A. KRAEGEL: A symposium on mortality was held on March 10 and 11 in Chicago this year. Its title was "The Future of Life Expectancy: Economic, Social and Medical Implication of Living Longer." The symposium was sponsored by the Society of Actuaries in conjunction with the Association of Life Insurance Medical Directors in America and the Home Office Life Underwriters Association. Nearly 300 people from these organizations attended. The Society of Actuaries is currently publishing the proceedings of the symposium for those who are interested in more of the details.

The symposium began with a keynote speech on changing mortality patterns. This was followed by a panel session on mortality today, followed by another panel on mortality tomorrow (the next 20 years). In addition to the discussion of mortality, the impacts of the trends were considered outside the industry and within the industry. There was also a luncheon speech on "High Level Wellness: An Alternative to Doctors, Drugs and Disease."

The basis of my remarks will include, in addition to the Symposium, material from an article by James F. Fries, M.D., in the July 17, 1980 issue of The New England Journal of Medicine, titled "Aging, Natural Death, and the Compression of Morbidity." It is an especially perceptive and relevant article, which helps to clarify recent and potential developments in mortality.

### Mortality Today

When considering the trends in mortality today there are several significant factors which help to give perspective to the total subject. The first of these is that the maximum life span is fixed. What does that mean? It means that only one in 10,000 people lives beyond age 100. It means further that virtually no human being lives beyond 110. The greatest authenticated age is 114. Higher ages have been claimed in certain societies but

these have not been documented. In fact it is interesting to note that there is a correlation of .83 between the centenarians claimed in a given country or region and the illiteracy rate of that area.

No one knows why or how the maximum life span is fixed but there are a number of possible theoretical explanations of a finite life span. The first of these is that cells are limited to a finite number of doublings. This number is about 50 in human beings and it varies in other species of living things. Second, it has been observed that the pituitary produces a poison which "programs dying" by making it increasingly difficult for cells to accept thyroxine from the thyroid. A third possibility is the failure of the immune system. Another theoretical explanation is that chemical cross-linkages occur in the molecules of connective tissue. Two more relate to the accumulation of materials in the cells, one of them lipofuscin and the other free radicals, which interfere with the metabolic process. A seventh possible explanation is excessive oxidation at the cellular levels. Finally, it has been observed that there are DNA replication errors. The real secret of aging may be any one of these, or any combination of these, or one or more reasons not yet identified.

Another important fact about mortality today is that the average length of life is increasing. Life expectancies at birth were perhaps 20 years in the B.C. era. They have increased gradually over the millenia to 47 years in 1900. By 1980 they have reached 73 to 74 years in Canada, the United States and certain other developed nations. There was a particularly rapid increase from 1900 to 1950, then a plateau to the 1970s, and a renewed upswing in the 1970s. Life expectancies at ages 40 and above have shown relatively little change over the centuries, but a rather significant change in the 1970s. In fact, the increase in life expectancies for ages above 40 are likely responsible for the at-birth increase of at least three years in the 1970s.

There are a number of important influences on life expectancy. Genetic factors in general are ultimately most important as noted earlier, but individual hereditary characteristics are also of great significance for particular individuals and groups. Public health measures are another major influence. Personal health habits have increasingly become recognized as highly significant, including smoking, drinking/drugs, diet, exercise and sleep. Increasingly, too, we have noted the influence of socio-economic class and education level, along with cultural patterns. More recently, recognition has been gaining that even personal attitudes and feelings of self-worth can have substantial effects on mortality. Related to these is the subject of stress, or dealing with emotionally traumatic experiences. Of course, exposure to accidents and violence is very important. And, finally, we have medical care which is particularly significant after the illness has been initiated, while the others pertain more to whether or not illness will occur in the first place.

The third factor relevant to mortality today is the trend since 1900 of chronic illness superseding acute disease. In 1900, acute, infectious disease dominated the mortality patterns. Such diseases included particularly tuberculosis, rheumatic fever, smallpox, diphtheria, polio and pneumonia. By 1980, each one of those named constitutes less than 2% of its impact in 1900. Chronic illness on the other hand was relatively much less significant in 1900, but now is responsible for more than 80% of all deaths. Particularly

significant chronic diseases are arteriosclerosis, arthritis, diabetes, pulmonary disease, cancer and cirrhosis. These chronic illnesses, plus the gradually accelerating loss of organ reserve at the higher ages, have led to disability and lower quality of life.

Although a few knowledgeable persons have long recognized that chronic illnesses can be postponed, it is only in the last decade that widespread recognition has taken place. It has been made abundantly clear, for example, that elimination of cigarette smoking postpones emphysema, lung cancer and cardiovascular disease. Treatment of hypertension has been exceptionally effective in postponing coronary disease and stroke. The carefully selected diet postpones diabetes, coronary disease and digestive cancer. Well-moderated exercise postpones cardiovascular and pulmonary and metabolic disease. Weight reduction postpones cardiovascular and metabolic disease. Moderation in drinking and use of drugs also seems to control those two plus cirrhosis. And, finally, it may well be that all types of chronic illnesses can be postponed by various public health measures, proper sleep and proper amounts of love, interest and caring. Some of these relationships have been proven while others have been suggested strongly by associative data.

In summarizing mortality today, we can say that life span is fixed while life expectancy is increasing. We can say further that chronic illness has superseded acute disease and that some chronic illnesses can be postponed.

#### Mortality Tomorrow

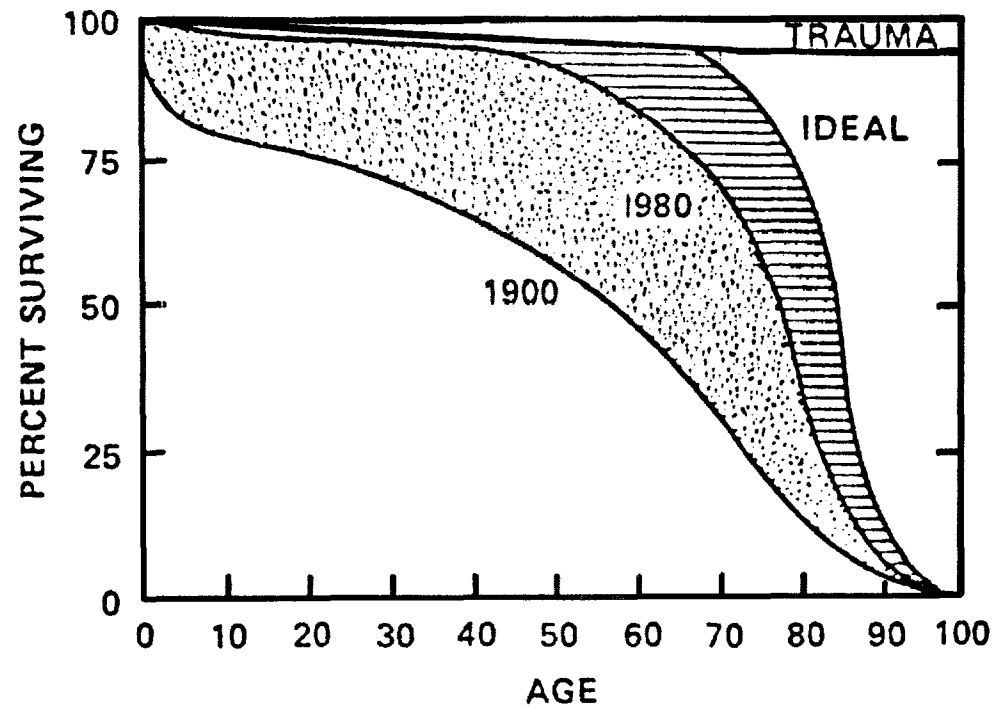
The graph which follows shows the survival curve in 1900 and the comparable curve in 1980. Note that the shape of the curve is moving closer to a square corner, and that is why this phenomenon has been called "squaring the curve" or "rectangularizing the survival curve." It is thought that the statistical ideal from a biologic standpoint is the third curve shown on this chart. Remember that the 1900 curve represents a life expectancy of 47 years, the 1980 curve 73 years and the ideal about 85 years.

Is that ideal curve of 85 years realistic? It is thought to be, under ideal societal conditions, assuming a normal biologic distribution. Various extrapolations of life expectancy improvements at different age levels suggest in one case an expectancy of 82.4 years in the year 2009, in another case 85.6 years in 2018, and in still another case 85 years in 2045. Another study, however, suggests a leveling off at less than 85 years. In a survey of the mortality symposium attendees (60 respondents) a strong majority expected an increase in life expectancy from 73 years currently to 77 years in 2000 or 2020. There was mixed opinion about a further increase to 82 years within that same time frame, and a strong majority felt that we could not expect an increase in that time frame to 87 years. However, in each case there were some at each end of the spectrum.

We may expect further increases in life expectancy because of continued improvement in certain influential factors. The elimination of cigarette smoking, for example, could add eight years to life expectancy in the 30% of the population who smoke. Elimination of alcohol abuse would reduce traffic deaths annually by 25,000 lives and homicides and suicides by 15,000 lives. Elimination of cancer is thought to have a potential of adding 3 years to life expectancy. Life-long behavior patterns set during adolescence can be very helpful in postponing a number of the chronic diseases discussed

# FURTHER INCREASE IN LIFE EXPECTANCY

## Squaring the survival curve



JAMES F. FRIES, M.D., THE NEW ENGLAND JOURNAL OF MEDICINE, JULY 17, 1980,

earlier. In fact, of the 10 leading causes of death, 7 would be reduced substantially by improving just 5 habits (diet, no smoking, exercise, alcohol moderation and use of anti-hypertensive medications). Increasing emphasis on education and on attitudes in the lower socio-economic levels could have an impact. Advances in clinical medicine certainly will have an impact; for example, the widespread availability of Interferon. Life expectancies for males and females are currently diverging, but it is possible that the increasing exposure of females to some of the life experiences of males, including much more cigarette smoking in recent years, could have some reverse effect. Finally, we may expect that the bulk of future increases will be in the higher ages because there is not much room left in the lower ages for improvement.

The concepts of holistic health and wellness will be influential in mortality tomorrow. Health is a function of four factors - human biology, environment, life style (both attitudes and actions) and the disease care system (medical model). Of course, each of those four factors is itself a composite of many additional factors. Holistic health strives to achieve the optimum balance among those factors, moving toward a more comprehensive view of individual health. Wellness on the other hand is particularly relevant to the life style approach, with positive attempts to enhance well-being and personal growth. There is increasing recognition that attitudes and self-concept can help to maintain the health of a well person and to restore the health of an ill person. It would seem logical then that attitudes and self-concept can help a person to live longer.

These improvements in life expectancy will have a most interesting effect on mortality tomorrow. If the maximum life span is fixed, and if the onset of disability and its attendant mortality is postponed, then the amount of morbidity is compressed. This means that the end of adult vigor comes later in life and that death and disability become increasingly unavoidable because they are occurring later. It means also that the marginal benefit of a medical procedure will be smaller in relation to its cost. In short, the future focus of health improvement will be on chronic instead of acute disease, on morbidity rather than mortality, on quality of life, not duration of life, and on postponement of disease rather than cure.

Along with the compression of morbidity we have the compression of aging. A shift is occurring in concepts of chronic disease and aging. We are coming to realize that premature organ dysfunction comes not generally from overuse but usually from disuse. Correspondingly, exercise presents a strategy for modifying the aging process. In marathon running the age-related decrement in capacity is only 1% a year. In fact, the variation within an age is far greater than the variation due to age for marathon runners. Similar observations may be made for intelligence testing, social interaction, health after exercise and memory. The inference then is that one can choose not to age within certain biologic limits.

This suggests a shift in research strategy regarding longevity. The current strategies concentrate on the analysis of mean values which of course decline steadily with age. The future emphasis should likely be on analysis of variation, particularly of the standard deviation between individuals. Doctor Fries suggests a new 3-stage research strategy: First, to measure variability of a marker of aging, for example, oxygen uptake, at a given chronological age. Second, to determine retrospectively the difference

between individuals regarding that marker, that is, those above the standard and those below. Third, to design prospective intervention studies to explore causality of those differences.

In summary of mortality tomorrow, then, we are likely to see a further increase in life expectancy as evidenced by a squaring of the survival curve. This increase may very likely rise from the current 73 years life expectancy to about 85 years. This can come about through a variety of factors including elimination of cigarette smoking and greater emphasis on personal responsibility for health. A most interesting and significant effect of this improvement will be the compression of morbidity and "old age symptoms" into a smaller period of time than is now experienced. In short, there is more truth than fiction in the expression "you are as young as you feel."

#### Possible Discontinuities

The discussion of improving mortality so far has dealt with trends which assume that the state of the world continues in essentially the condition in which we now find it - or better. There are, however, a number of possible discontinuities which could change the probabilities of those mortality increases significantly. One of these is in the positive direction while the others are negative.

The positive possible discontinuity is an increase in maximum life span. This may come about through genetic engineering techniques such as recombinant DNA. In effect, we would be unlocking the secret of aging and making it possible for human beings to live much longer lives. Some enthusiasts for this possibility suggest life spans of 125 years, or 200 years, or even more. In fact, some accept the possibility of near immortality.

There are at least two serious potential problems related to genetic engineering for increasing life spans. One of these is that the process may interfere with evolutionary adaptation. If so, then it is possible that the human race could be wiped out by the introduction of some new factor to which we could no longer adapt. Also, and much less serious potentially, is the possibility that these developments may help those with genetic problems to reproduce and thereby actually reduce average longevity.

Even less clear is the possibility of increasing the maximum life span by virtue of the power of the mind. It is said by some that we create our own realities, and aging may be a creation of the mind. If it is, then of course the process of aging could be changed by some kind of mind process.

There are also a number of extremely serious discontinuities on the negative side. Our current burgeoning world population is in effect a discontinuity. It is expected to level off in the next 50 years or so, but it could reach insupportable levels sometime prior to that. Various potential consequences of unrestrained population growth and other human failures include war, environmental deterioration and global food scarcities. In addition, there is always the possibility of new devastating disease strains and of natural catastrophes such as earthquakes and floods. In fact, environmental deterioration could manifest itself in possible new kinds of natural catastrophes such as climatic changes and/or too much carbon dioxide in the atmosphere and/or the desertification of large areas of the earth's surface.

To get back to the positive side of the street, those discontinuities are not likely to happen (except for natural catastrophes), unless human beings insist on being stupid and/or intractable. I am optimistic enough to believe human beings have much more sense than that, and so I anticipate the mortality improvements which we have been discussing.

MR. CHARLES N. WALKER: Mr. Kraegel has outlined both the nature and scope of two somewhat different future improvements in mortality, one of which has been described as "squaring the curve," the other resulting from increasing the maximum life span. One of these - lower mortality not significantly involving increase in life span - is already here. Mortality in the United States has improved significantly in the past decade. Even a cursory review of intercompany mortality experience under Standard Ordinary life insurance policies will show improvements in recent years which are on the order of 3% per year. Moreover, the improvements are coming in the very important areas of cardiovascular deaths and at older ages than before - the 50s and over. What is more noteworthy is that this trend can be expected to continue, with the most prominent changes occurring at the middle and older ages. This was one of the strong impressions which emerged from the Chicago Symposium.

Increases in the maximum life span are much more nebulous, both as to when this might commence and what form it might take. One came away from the Chicago Symposium with the strong impression that while this is a future, rather than current, development, it is very likely to occur, and to start doing so within a finite time period rather than "out there somewhere" - perhaps in the early part of the twenty-first century.

The next question is what effect these developments might have on social insurance, on private pensions, and on life insurance. For both social insurance and pensions a few ramifications are quite clear. One thing is so obvious it probably needs to be said to be sure it is not overlooked, namely, that in the absence of offsetting changes, improvements in life expectancies mean longer lifetimes and thus longer benefit periods and higher costs.

We should remind ourselves that the cost projections currently in use for both social insurance and private pensions already anticipate future mortality improvements. With respect to social insurance, Jim Hickman noted at the Chicago Symposium that the intermediate cost projections developed by the Office of the Actuary for the Old-Age, Survivors, and Disability Insurance system, and discussed in the 1979 Trustee's Report, incorporated assumptions for reduced mortality - reductions over the next 70 years which were on the order of 48% for ages under 20, 37% for ages 20 to 65, and 27% for ages over 65.

Similarly, the annuity mortality tables being used to project pension costs have, for 30 years or so, included assumptions for improving mortality. This does not remove a concern as to whether the assumptions regarding improvement are adequate, but it does mean that at least part of the trend to lower mortality has been anticipated and is provided for in current projections.

Note, too, that mortality changes affect annuity costs only slowly and gradually. Thus there is likely to be time to adapt to and make provision for future mortality improvements. Moreover, the higher costs will occur

only in the absence of offsetting changes, and changes toward higher retirement ages are already starting. If you think of today's typical pension as being an average benefit period of 17 years starting at age 65, then if a future typical pension, after mortality has improved, has an average benefit period of 17 years starting at age 75 rather than 65, it will not have a significantly different cost and it will be easier to provide because the financing period is 10 years longer.

Perhaps the greater concern in retirement schemes, whether public or private, is other types of changes which, because they can happen more abruptly than the slow effect of improving mortality, can strain retirement systems much more severely. In social insurance, changes in the fertility rate can be very important. The intermediate cost projections used a fertility rate of 2.1, i.e. ultimately a zero population growth rate. But fertility rates in the United States in recent years have been lower than this. There are also demographic considerations. The baby boom of the late 1940s produced a cohort which will reach 65 early in the next century. The combination of the two could produce a decrease in the ratio of workers to beneficiaries from the present three to one to as low as two to one, which would be a tremendous strain.

In pension plans, changes in cost due to mortality reductions can be greatly overshadowed by changes in the interest rate. A drop in interest rates to those of 20 years ago would impose far more strain on pension financing than would lower mortality rates.

It would be wrong to dismiss the effect improving mortality will have on social insurance and pension plan costs, but the fact is that these cost increases are predictable and emerge slowly and can be prepared for, while other types of variations can be less than predictable and more abrupt and hence more difficult to cope with.

The impact of improved mortality on life insurance is totally different. The emphasis is more on competitiveness than it is on solvency. Several different situations can be visualized.

For the younger ages - up to 50 or 55 - the continuing decline in mortality, particularly in cardiovascular mortality, will make medical examinations considerably less effective than they are now. It seems reasonable to assume that the chronic degenerative diseases will not be eliminated - at least not quickly - although their age at onset will be deferred. The difference between medical and nonmedical mortality thus will shrink. If a narrowing mortality difference is accompanied by continued increases in costs that would accompany a persisting inflation, higher nonmedical limits will be inevitable. If examination costs are doubled and mortality differences are halved, nonmedical limits will quadruple. Moreover, extension of non-medical underwriting to ages through the 40s and on into the 50s in meaningful amounts becomes feasible.

Financial underwriting, as well as increasing attention to life-style, including smoking, avocations and drugs, will continue to be important. Medical history will continue to be of concern so the need for attending physician's statements will continue, but physical examination will be less important. The narrow underwriting classifications currently used will become difficult and impractical so far as medical impairments are concerned, so



there will be motivation to broaden them. Running counter to this will be the closer attention to nonmedical aspects of risk appraisal, so it becomes difficult to judge what sort of change might take place in rating practices.

For the older ages the effects will be somewhat different. Longer lifetimes, either with or without increases in maximum life spans, mean longer working lifetimes and hence continuation of the need for insurance to much older ages. In my own company the proportion of business issued at ages over 65 is quite small - less than 1% of the total by amount. I suspect this is fairly typical. This will increase, and in view of the small base against which it is measured, will increase dramatically.

Medical underwriting will continue to be as important and useful as it is now for the detection of overt disease and any sequellae. Future mortality improvements, especially those involving an increase in maximum life span, will be more and more related to increased knowledge about the aging process and, hence, the ability to influence it. Developments of this sort cannot be expected to evolve smoothly, so the aging process will proceed at quite different rates in different individuals.

The ability to influence the aging process will necessarily involve the development of ways to measure it. Techniques for doing so are being worked on now. To the extent that such measurements are simple and inexpensive enough to be feasible for underwriting purposes, they will be enormously important. The difference in mortality expectations at these older ages, even among those who have suffered serious disease incidents, is likely to become very great. Two 70 year old individuals, both free of current specific impairments, may have sharply different mortality expectations because the pace of the aging process differs sharply between them. Techniques which will let us measure the physiological age and its rate of change, rather than the chronological age, will permit the use of classification systems which will probably be more or less the same as those in use now. Indeed, continued success in an increasingly competitive environment will make it essential that we do so.

MS. MARY E. SABINE: My remarks deal with company response to the mortality trends in their pricing of ordinary products - both life and annuities. There is substantial variation among companies in their treatment of mortality in their pricing of the life products. The standard current combined smoker and nonsmoker mortality experience used ranges from less than 70% to well over 100% of the 1965-70 Basic Tables. This range becomes much greater when experience is split into nonsmoker and smoker experience. The variation among companies is further magnified by the fact that some of these companies are modifying current experience by projecting mortality improvements into the future.

Much of the variation in current experience assumptions can be explained by actual or expected differences in mortality experience due to (1) different underwriting standards; (2) demographic characteristics of the company's primary market; (3) smoker-nonsmoker mix of insureds; and (4) the distribution system. As John Bailey noted in the panel on Mortality Trends last year in Miami, even with the extensive underwriting facilities available to the large companies contributing to the Society Intercompany Studies, the select mortality of the company with the highest mortality was 60% greater than that of the company with the lowest mortality during the 5 year period

1972-77. When all companies are included, the mortality actually experienced can be expected to differ by much more than 60%.

Additional factors contributing to the variation in mortality assumptions include desired conservatism of assumptions, competitive pressures, and the actuary's expectations concerning future mortality. These factors may all influence the way a company responds to mortality trends in pricing.

Stock companies would appear to have greater leeway in setting their mortality assumptions, and they are currently using a variety of methods. Some companies are projecting improvements to current experience through the expected average year of issue for the product being priced, but do not project any further improvement in experience after issue.

One large company is projecting improvements for 30 years after issue. This company has developed a set of trend factors that vary by issue age and duration. Up through attained age 30 no future improvements are assumed. After this point, mortality improvements are assumed to increase with increasing attained age until reaching a peak for the middle aged insured, then decreasing with attained age at the higher ages. For combined smoker-nonsmoker mortality the maximum improvement projected over 30 years is 30%, for issue age 27. The total improvement projected for issue age 55 is 12 1/2%. The company does not vary these trend factors by sex.

The trend factors for the combined table were developed from three components: improvement in smoker mortality, improvement in nonsmoker mortality and an overall shift in the smoker-nonsmoker mix of the insured population towards nonsmokers. Fully a third or more of the projected combined experience is due to the projected shift to a higher nonsmoker content. The maximum improvement projected for the smoking population over a 30-year period is 20%, twice the maximum improvement of 10% that is projected for the nonsmoker population. The greater improvement in smoker mortality is related to anticipated improvement in the treatment of and possible development of a cure for cancer. When pricing its current series, this company projected improvements in the current experience table to the expected average year of issue for the series and then applied the 30-year trend factors to the updated table.

Of the 8 stock companies I talked with concerning mortality projection, 1 projected experience only to the average year of issue, 4 did some projecting of experience after issue, and 3 did no projecting of mortality experience when pricing the individual insurance products. This group was heavily weighted towards the large companies, and I expect that these companies are more likely to be projecting mortality than are smaller companies.

The projecting companies do not always use the mortality projections uniformly in pricing all products. At least one company used the projected mortality for pricing permanent and decreasing term but used current experience for level term.

The stock companies that currently are not projecting mortality expressed various reasons for not doing so. One company that markets predominantly term through brokers wishes to be fairly conservative in setting its mortality assumptions. It has been increasing its nonmedical limits to "keep up with the crowd" and feels uncertain that the higher limits are fully justified. Current pricing is at or above 100% of the 1965-70 Basic Tables.

Its products are competitively priced, perhaps due to the lower cost distribution system, so it is not feeling competitive pressure to improve mortality assumptions. A second large stock company also is not projecting because its rates are competitive without mortality projection. A couple of companies remain unconvinced that the current mortality trends will continue for the insured population. They cite increased nonmedical limits, other liberalizations of underwriting standards, and a concern that recent improvements have been partly due to a shift in the smoker-nonsmoker population mix which now may have stabilized. In contrast, some of the companies that are projecting mortality feel that mortality improvements must be projected to obtain a realistic view of the policy.

For mutual companies the situation is somewhat different. Although they may be highly optimistic about future improvements in mortality, it is more difficult for them to reflect this in their current pricing. As mutual companies, they can be expected to base current pricing and dividend scales on current experience and reflect future improvements in future dividend scale changes. I know of no mutual companies doing otherwise. However, even there it is possible for companies to reflect their optimism about future mortality trends. For example, one mutual company updated its experience mortality table based on 1971-75 experience in its 1979 dividend scale. It plans on using an updated table based on 1974-79 experience in its 1981 dividend scale. The most recent table reflects the substantial improvements in mortality this company experienced in the late 1970s. In addition, in the most recent experience table the company has not included a 5% margin that it traditionally included. Although perhaps a response to competitive pressures, the more frequent update and the removal of the margin also reflect its expectations that current trends of improving mortality will continue and prior conservatism is not necessary.

With reinsurers there is also a variation in the treatment of mortality. Some project, some are looking into the possibility of projecting, and others are not at this time considering it. Within a given company, the reinsurance and ordinary departments generally appear to be consistent in their approaches.

Whereas there is substantial differentiation of the treatment of mortality between stock and mutual companies in the individual insurance products, no such distinction appears in the treatment of mortality for annuities and settlement options. Companies have been projecting annuitant mortality for a long time. For immediate annuities a common method is some projection of the 1971 Individual Annuity Mortality Table. One company is projecting improvements at twice the improvement provided by Scale B. The company that developed the 30 year trend factors for insurance has developed comparable factors for annuities. However, these have a maximum improvement of 90% over a 30 year period, and the pattern of projected improvements by attained age is modified so that the relative improvement at the higher attained ages is greater than for the insurance factors. These factors are applied to the experience underlying the 1971 Individual Annuity Mortality Table as previously updated by projecting improvements through 1980.

Many companies noted reviewing settlement options when developing their most recent series but did not necessarily revise them. Most actuaries expressed little concern over the conservatism or lack thereof in the underlying mortality assumptions since the guaranteed interest rate is so low and

the settlement options experience a low selection rate. One company did note that the mortality underlying its guaranteed settlement options at ages 85 and above is comparable to that underlying current immediate annuity rates. However, this is overshadowed by the substantial difference in interest rates. In the Monday General Session Ashby Bladen suggested that stabilization at very low interest rates might be more likely than stabilization at 8-10%. If this eventuality should occur, companies might find their guaranteed settlement options have become very attractive.

Long term mortality projection is difficult to do with any degree of accuracy, and the most recent past does not always provide a good predictor for the future. In preparing for this meeting I read the record for a prior panel on Mortality Trends published in the 1967 Transactions. This panel took place during a period when mortality improvements had leveled off. At that time Robert Myers noted that part of the improvements in social security benefits then being proposed in legislation before Congress was being financed with cost savings from the revised 1965 population projection that assumed smaller declines in mortality rates than had been assumed in the prior projection of 1957. It was not long after this that mortality improvements accelerated. More than 2/3 of the current Social Security deficit, amounting to about 1 1/2% of payroll, can be attributed solely to revisions made in the past 3 years to the mortality assumptions used in the population projection.

MS. DAPHNE D. BARTLETT: The implications of squaring the mortality curve are dramatic and serious for society, for actuaries, and for the life insurance and pension industries. What will things be like in the year 2000 if the mortality curve is squared?

We will have many more older people. Some will be retired, some semiretired.

Society will be thoroughly adjusted to the life style changes occurring today. There will be more working couples, with fewer children.

Younger people will have a greater likelihood of having aged parents. Will they be willing to support them?

Obviously, I have not included everything that might affect us in the year 2000. However, what I have listed provides cause to worry. Among my concerns are the following:

Will there be enough money in the pension system to support the number of older people projected?

What will attitudes of young people be to life insurance if the risk of death from any cause other than accidents is minimized?

Will improved mortality result in greater demands for health care and a greater use of more sophisticated and expensive medical techniques?

Will there be more and longer disabilities instead of deaths?

I do not know the answers to these questions, but they suggest that there is a need for research. I am defining research very loosely for these purposes, as follows:

1. What questions should we be asking ourselves?
2. What can we do to encourage the right people to seek answers to these questions?
3. What can we, as actuaries, do to think of other questions and find solutions to some of the problems that appear to be developing?

The issues raised by improved mortality appear to present a threat to all the traditional lines of business of insurance carriers and to the traditional work areas of actuaries. There are two alternative strategies for addressing this threat:

1. Do not worry about it. There are always other forces operating which may prevent the consequences I foresee.
2. Start thinking - performing research. Actuaries have a responsibility to suggest what might happen. They should offer ideas for new approaches toward solving these problems to their employers, to regulators, and to government. Even a small effort by each of you - a conversation at lunch, or a presentation at an actuarial club-might inspire someone else to build on your ideas or think of something else. If we start thinking and talking, it might encourage others to do so. This may result in research being performed not only by the Society, but also by insurance carriers, government, or social scientists.

Having urged all of you to do a little thinking about this, I felt that I had to make some effort myself.

### Pensions

Has anybody ever tried to find out what the total annual pension payout would be to provide a reasonable amount for the retirees we expect to have in the year 2000? If those payouts were to be translated into employer and employee contributions, do they make any sense when related to ability to pay? Are we expecting employers to fund amounts significantly in excess of what they are doing now?

If the answer is "yes," what can actuaries suggest as alternatives? Here are a few:

1. Stimulate the development of tax incentives for savings to provide retirement income for all employees - not just the self-employed.
2. If there is going to be a vast retired population, and not enough money to fund adequate pensions for all, what considerations have been given to development of job-sharing for employees over age 65 or 70? Such a program would create a feathering-in of the need for pension income, and would additionally provide a useful social

benefit in that an individual would not suffer the painful transition from being a busy executive one day and a has-been the next!

3. Perhaps our thinking could stretch to something even more exotic. Is retirement, in its traditional sense, really necessary? Might something be done to change our attitudes, so that we stop thinking of retirement as an automatic step in the average person's life span? I wonder if the concept of retirement exists only in industrialized societies. Why does today's society accept the concept of retirement income for an individual who goes to work every day, but not for the homemaker?

### Life Insurance

I had a little more difficulty when I was trying to think of ideas for how we might handle life insurance in an environment where the mortality curve was squared. In this environment I see less enthusiasm for the purchase of life insurance by young people, since the likelihood of unexpected death from other than accident would be severely reduced, and also because, as a result of newer life styles, the need for protection to satisfy traditional needs is somewhat reduced. The demographics for traditional life insurance markets are good. There will be many young families in the year 2000. But will they want to buy our product?

Here are a few suggestions:

1. Take a look at what the needs for life insurance really are in this changed climate. For example, if both parents are working in reasonably well paying jobs, there is probably less need for the traditional "protection until the youngest child reaches age 21." But might there not be a need for life insurance to cover estate taxes, given the relatively high combined purchasing power? (The "middle-class working couple market" has been sadly neglected by the life insurance industry in all respects, but particularly those involving the personal and estate tax advantages of our product.)
2. Instead of needing life insurance to support a homemaker wife and children, will a new need develop to provide financial support to surviving aged parents? Might a nontax-qualified product like Retired Lives Reserve be useful to provide deferred life insurance benefits?
3. Group term insurance is likely to cost less for active employees, because there would be relatively fewer claims. What group insurance products can be developed in order to maintain premium income and provide additional coverage where it is most needed?
4. This environment might encourage a more sophisticated analysis of the reverse mortgage concept by insurers. Perhaps an individual's fully-paid-for home could be used as the single premium for a life annuity. The annuitant would continue to occupy the residence. There might be some interesting possibilities for combining insurance with annuities under such an approach, so that the home could revert to the annuitant's beneficiaries on death.

5. The concept of the financial advisor is a relatively new one, at least when it relates to providing a service to other than the very wealthy. Young families in the year 2000 might find such services useful, because of their joint incomes and attendant tax problems. I am troubled, however, by the conflict of interest which currently exists in many such programs as a result of the substantial early compensation on the sale of life insurance relative to that from other possible investment media. Is the time right to start thinking about changes in traditional life insurance compensation structures to something more level, in some manner which might reduce or avoid severe damage to agency forces?

The squaring of the mortality curve indicates that the next few decades may result in a dramatic swing in actuarial areas of involvement in life insurance. Instead of a heavy concentration of effort devoted to developing new and better forms of protection for the young, we shall be directing our energies into finding ways to use life insurance as a means of providing coverage and services to the elderly.

#### Health Insurance

I am encouraged by the opportunities in this area which the squaring of the curve might bring. Regarding medical expense coverage:

1. Increased longevity may be accompanied by more expensive and elaborate medical treatments, and more extensive hospital stays. Even if National Health Insurance comes into effect in the U.S., there will still be a demand for supplementary coverages. This may give us the opportunity to design them properly this time. We must avoid providing the administrative monster of first dollar coverage, where a ten dollar claim costs twenty dollars to process! How can we educate the public that expecting first dollar coverage is very costly?
2. Why don't Health Maintenance Organizations work better and have better public acceptance?
3. Could some regulatory changes be developed to make it possible to provide reasonable group insurance benefits for divorced spouses, or for the temporarily unemployed?

Regarding disability income coverage:

1. How might we encourage regulators to be flexible enough to permit us to do more experimentation, particularly in the area of coordination of benefits?
2. Could a new definition of disability or some other control be developed so that needed coverage for homemakers (there may be a few left) could be offered at a reasonable price?
3. Similarly, with some regulatory blessing, it might be possible to find ways to insure others who need coverage but are unable to obtain it under our traditional approaches to definitions of disability and issue limits.

Conclusion

Please think about what it will be like with a squared mortality curve, within your own area of expertise. In other words, do some "research" in your own minds. Then do some talking about whatever you come up with.

As my final prediction of the day, I'll suggest to you that this small effort by each of you will set the wheels in motion for the real research in these areas to start being formulated and developed!

Discussion

MR. ALAN HOFFMAN: From the period 1965-69 to 1970-74, group mortality declined at an annual rate of less than 1%. A valuation study on 1974-76 experience under the Federal Employees' Group Life Insurance by the Office of the Actuary, U.S. Civil Service Commission, showed a drop in mortality of about 5% per year over that period. A preliminary report on the latest intercompany experience under group life insurance, for calendar years 1975-79, is expected to be submitted to the Committee on Group Life and Health Insurance in February or March, 1981 and published in the 1980 TSA Reports.

It was noted at the Chicago Symposium that group insured mortality is essentially population mortality to age 65. Group mortality is, in fact, substantially lower. The following Table 1 gives mortality rates from the 1970-74 Intercompany Group Mortality Study (1975 Reports of Mortality and Experience, pages 189 - 239) and the United States Life Tables of 1969-71. The latter gives age specific mortality rates based on data of the 1970 total population census and deaths in the United States in the years 1969-71.

TABLE 1  
Annual Mortality Rates  
(Rates per 1,000)

Age	1969-71		1970-74	
	United States Life Tables		Intercompany Group Mortality Study	
	Male	Female	Male	Female
22	2.26	.72	1.50	.43
27	1.91	.83	1.21	.58
32	2.19	1.14	1.33	.80
37	3.00	1.73	1.76	1.10
42	4.54	2.62	2.98	1.86
47	7.14	3.99	5.21	2.67
52	11.15	5.87	8.65	3.84
57	17.54	8.58	15.90	7.13
62	26.26	12.46	18.04	7.38

The ages represent the central age of the quinquennial age brackets used in the Intercompany Group Mortality Study. The group rates include the combined experience under the Waiver of Premium, Extended Death Benefit, and Total and Permanent disability provisions. Only 75 percent of the Waiver of Premium disability claims are included in the mortality rates. Also, the population mortality rates have been trended to 1972, for comparative purposes, assuming a 2% per year decline in mortality. The following Table 2 compares the rates.



TABLE 2

Mortality Rates Comparison

1970-74 Intercompany Group Mortality Study  
As Percent of United States Life Tables 1969-71

<u>Age</u>	<u>Male</u>	<u>Female</u>
22	66%	60%
27	63	70
32	61	70
37	59	64
42	66	71
47	73	67
52	78	66
57	91	83
62	69	59

Table 2 indicates that group mortality rates are substantially lower for most age/sex configurations. Except for the age 57 figures, group rates are about 20% - 40% lower for males and 30% - 40% lower for females than the corresponding population mortality rates. The higher age 57 percent-ages may be attributable to company administrative processing practices of assigning disability claims for ages 60 and above to the age group 55-59 for Age 60 Waiver of Premium and Total and Permanent Disability experience. Also, there may be improved reporting of disability claims.

The impact of these favorable mortality trends in group life insurance should be recognized. With any decline in mortality, it can be expected that group term rates will be even lower. Since a greater proportion of the population will be covered under the group concept, given the increasing number of spouses in the workforce and the growing coverage of smaller size groups, there may be an effect on the individual life market.

MR. WILLIAM D. SMITH: If we reach a point where 50% of our population is aged and not working and expecting to receive retirement income, then all the goods and services being produced by the 50% that are working are going to have to be spread amongst the 100%. We cannot do all of the things that we want to do and still give that much to the aged population. That analysis does not involve the monetary system or inflation or any other complications which sometimes obscure the results of an analysis projected in actual dollars.

We now expect someone to work until about age 65. Under current conditions, life expectancy at 65 is roughly 15 years. If retired between 65 and 80, on the average, we have people inputting for 40 years and collecting for 15. If the expectation of life at age 0 moves from about 75 to about 85, we have added ten years and the ten years are mostly at the upper end. Mortality is very low until retirement age, even now. Instead of living to 80, people will be living until 90. It seems obvious that a retirement age of 65 is no longer going to be viable. We will have to move to a retirement age of 75 over the next 20 or 25 years. We ought to be preparing for it because many of our retirement plans do not lend themselves to adjustments like that for people already in the system. Specifically, public employee plans have

built a body of long judicial decisions and tradition which makes difficult any changes for members already in the system. We must be thinking 40 or 50 years ahead about changes we want to make.

One of the clients I work for in California is the state teachers retirement system. All teachers in California are on a single system with a huge plan. An idea currently on the drawing board is to provide that teachers entering in the 1980s will have a retirement age of 61. That is one year higher than the present age of 60. Those entering in the 1990s would have a retirement age of 62. That system would be built into the law. The actuarial valuations would not assume this change in the system, nor would they assume any future mortality improvements. We could adopt assumptions for mortality improvements and build that into the system, but that seems a little frivolous. If this works, we will have given a 50-year advance on the idea. If it is necessary to change (should our assumption be incorrect and there is not a one-year increase in life expectancy for every ten calendar years) it would be easy to change the system by improving benefits.

It is almost impossible to change by taking away benefits from someone now in the system. The balance between active and retired lives has to be kept in perspective. The balance is already in the process of being adjusted in the sense that retirement ages have started to move towards ages beyond 65.

MR. KRAEGEL: Certainly there is thought about such change. However, the change in retirement age is much more politically controlled than actuarially controlled. Maybe we should try to change and influence that balance.

MR. CARL J. STRUNK: The projection of continued large mortality decreases as in the past decade could be dangerous because a significant portion of the mortality improvement may have been caused by the massive shifting of smokers to the non-smoking category. Smokers now comprise less than 40% of the population.

The difference between male and female mortality may well decrease in the future, at least above the child bearing ages, for two reasons:

1. More women are taking on the life style of men, i.e., working and thus sharing the responsibility of earning the family income with all the stress that it entails.
2. A philosophical argument that nature or divine intervention would not have different mortality in the same species.

MR. WALKER: The improvement of mortality that takes place with discontinuance of smoking is not an overnight affair. The mortality on cessation of smoking is demonstrated to continue to improve for something on the order of 10 to 15 years so that the continued trend of nonsmoking has longer term impact on the mortality that emerges.

MS. BARTLETT: I would first like to comment that it is a great deal more fun to attend a Society meeting and participate in a panel than it is to stay home and do housework. I do feel that the change in women's roles has

influenced the mortality of women. I do not believe that it will tend to deteriorate more.

MR. EDWARD A. LEW: In discussing future mortality it is necessary to speculate. Speculations provide hints as to the directions for our thinking. This session has focused on a number of possible developments.

However, it is essential to hedge our speculations by the implications of existing knowledge or, as the Society's motto would have us do, substitute facts for impressions, whenever feasible. Let me cite a few facts which impinge on the comments made by previous speakers:

1. When we project an improvement in life expectancy at birth of about ten years, it implies an increase of only about three years in the life expectancy at age 65. Such a change over a period of years is not necessarily a dire threat to pensions.
2. Men and women in active employment are subject to distinctly lower death rates because of selection for work and survival at work. The experience under group life insurance for all industries combined (1975 Reports of Mortality and Morbidity Experience) shows that actively employed men and women have recently exhibited mortality rates at ages over 30 that are below those of ordinary life insurance policyholders after 16 or more years have elapsed since issue of insurance. Studies of industrial cohorts compared with the general population manifest large mortality differentials.
3. A great deal of new information on death rates at ages 65 and older in the general population has been assembled and analyzed by the Office of the Actuary, Social Security Administration, drawing on the experience among Medicare recipients. I understand that this information will shortly be presented to the Society. It shows that mortality at ages 85 and older has declined by more than 25 percent during the past two decades and that the mortality curve in the nineties clearly falls away from a Gompertz curve and becomes increasingly flatter with advance in age. There is, of course, still considerable doubt about the accuracy of the data at ages 95 and older. I have had the privilege of examining the mortality in a cohort of about 50,000 men and women aged 88 or older in 1959. This cohort was selected for study by the American Cancer Society in 1959 and has been traced for nearly twenty years. Very few are still alive. This independent investigation corroborates the flattening of the mortality curve in the nineties. Our knowledge of mortality in extreme old age is fragmentary and we will have to conform our projections of future mortality at these ages to the patterns brought out by new figures.
4. Optimistic projections of death rates from cancer are contrary to recent trends which show an appreciably greater increase in cancer incidence and mortality of certain sites than in the past. The effects on cancer mortality of various kinds of pollution over the past two or three decades are yet to be felt.
5. The experience among non-smokers reflects not only an absence of

the harmful effects of cigarette smoking but also the generally salutary life styles of non-smokers. Non-smokers as a group tend to be more prudent, drink less and are more moderate in their habits than smokers. If cigarette smoking were stopped, we probably could not get down to the level of death rates among non-smokers.

6. Reports of the Committee on Mortality under Lives Individually Insured have recently indicated an increase in the ratio of female to male mortality from about 60% to 62.5%. Thus, in some groups of insured women mortality has risen in relation to that of insured men.
7. Remarks about the tendency towards a squaring of the survival curve have some important implications, assuming that there is a fixed limit on human life. If there is such a limit on the human life span then decreases in mortality up to some advanced age must inevitably produce higher death rates at still more advanced ages. Thus far there has been no evidence of mortality increasing beyond age 90, which - if confirmed - may indicate that the human life span is actually increasing.
8. The likelihood of further declines in mortality is suggested by the fact that certain large groups in the U.S. population have been experiencing death rates approximately 30% lower than those in the general population. For instance, Mormons have exhibited mortality approximately 70% of that in the general population, as have Seventh Day Adventists. College professors and nonsmokers have been subject to even lower death rates. Such death rates are believed to reflect the effects of more healthy modes of living.

MR. ROBERT J. JOHANSEN: Speaking as Chairman of the Society's Committee to Recommend a New Mortality Basis for Individual Annuity Valuation, future mortality trends are of considerable interest to our Committee. One of the main tasks of the Committee is the development of mortality projection factors; first, for the period from about 1973, the midpoint of the most recent annuity mortality experience, to 1983, the year in which the new annuity tables would likely become effective; and second, for the period beyond 1983 to replace the projection factors currently in use, e.g., Projection Scale B.

In projecting the experience from 1971-76 anniversaries (centering on 1973.5) to 1983, it will be necessary to take into account what appears to be a considerable degree of improvement at the higher ages. In examining possible sources indicating the degree of mortality improvement, we examined the Social Security projections appearing in Actuarial Study #82, published in June 1980. In projecting the U.S. population into the future, a set of 5-year age group mortality improvement rates by cause of death for each of 10 cause-of-death groups had been developed separately for males and females. These rates were intended to be applied to 1977 population death rates.

Using the Social Security improvement factors by cause, we developed estimates of the assumed annual improvement in all-cause mortality over a 10-year period from 1977. Our results indicated that for males the annual improvement rate ranges downward slowly from 1.8% at ages 60-64 to 1.0% at

75-79 and .6% at 85 and over. Female improvement rates however increased over these same ages from 1.6% at ages 60-69 to 1.9% at 75-79 and 2.4% at ages 85 and over. Both sets of factors are at considerable variance with Projection Scale B, which assumed the same improvement rates for both males and females, grading down from 1.2% at age 60 to .5% at age 80 and zero at 90.

A comparison of immediate annuity mortality improvement rates between 1963-67 and 1971-76 with the Social Security rates indicates that the two have opposite trends by age with respect to male lives, but in the case of females both increase with age, although the annuity improvement rates are somewhat lower than the Social Security rates. I suspect that the U.S. population improvement rates may reflect changes in socioeconomic status, including better access to medical care--factors which should have much less effect among annuitants.

Annual Rates of Improvement in Mortality

<u>Age Group</u>	<u>Estimated from Social Security Factors*</u>	<u>Age Group</u>	<u>Immediate Annuities, 1963-67 to 1971-76+</u>		
			<u>Refund</u>	<u>Nonrefund</u>	<u>Combined**</u>
<b>Males</b>					
60-64	1.8%	60-69	2.3%	-6.3%	0.8%
65-69	1.6				
70-74	1.3	70-79	1.7	-2.8	0.4
75-79	1.0				
80-84	.8	80 & over	2.5	2.5	2.5
85 & over	.6				
<b>Females</b>					
60-64	1.6%	60-69	1.0%	-4.2%	0.3%
65-69	1.6				
70-74	1.8	70-79	2.1	.9	1.8
75-79	1.9				
80-84	2.1	80 & over	1.7	2.4	1.9
85 & over	2.4				

\* OASDI Study #82, June 1980: Derived from annual improvement rates by cause applied to 1977 population death rates by cause for ten years.

\*\* 1963-67 experience weighted on 1971-76 exposures.

+ Pension trust business excluded from 1971-76 experience, probably immaterial in 1963-67 experience.

An article published in the Proceedings of the Conference on the Decline in Coronary Heart Disease Mortality and dealing with recent heart disease trends indicated fairly consistent decreases in mortality from ischemic heart disease for white males and females over the period 1969-76 for each age group in the range 35-84. This article, "Trends in Cardiovascular Mortality with a Focus on Ischemic Heart Disease; United States, 1950-1976" by Harry M. Rosenberg, Ph.D., and A. Joan Klebba, M.A., noted that mortality from hypertensive heart disease has declined steadily and dramatically since 1950 with an overall drop of 81%. The authors attributed this decline to the improvement in public awareness of hypertension, changes in physicians' attitudes and the efficacy of treatment. Considering that effective treatment for hypertension has become available only in fairly recent years, we can expect to find a continuing decrease in mortality from these causes at the high ages, as those who were first treated in their 60s or 50s advance in age.

The Committee welcomes comments and suggestions on future mortality improvement as to sources of data and ways of evaluating the data, as well as ideas as to the improvement factors themselves.

MR. JOHN HAYNES MILLER: I heard the presentation of the new papers and the one about select and ultimate mortality intrigued me. About ten years ago one of my good friends wrote what sounded like the same paper. Unfortunately, it was turned down by the papers committee. He made the point that there is really no such thing as ultimate mortality at least in the way we have conceived it. If you could take any group of people in their 70s or 80s or 90s there would be some who would qualify for new insurance. These lives, although ultimate by all conventional approaches, are truly select.

A very simple thing that would greatly advance our mortality study would be to stop limiting the publication of select mortality to the 15th year. I presume the original idea of cutting off the select period of mortality at 3, 5, 10, or 15 years was to eliminate the tedium of a lot of manual work. Today there is no reason for that. If you take the most recent of the standard tables that are used as a standard of reference and put down the mortality rate for the 13th, 14th, 15th year and then the ultimate you will see a shocking gap. This is particularly true at the higher ages. I trust that companies using this for dividend purposes do something to eliminate the jump. We would have more knowledge of what is actually going on and also a marvelous opportunity to study generation mortality. Unfortunately, we cut it off in the middle of the first generation. Figures from Sweden are available showing generation mortality going back to the 17th century. If the research committee can persuade the mortality committee to let these figures run, it would be well worth it.

MR. KRAEGEL: I think that the paper by Aaron Tenenbein and Irwin Vanderhoof is a landmark paper that will have great significance in the future. It is very timely because we are recognizing that mortality is in the process of change. This paper may help us to understand better what is going on, so that we may both anticipate future change and have a better idea of what to do to generate desirable directions and minimize undesirable directions.

MR. DAVID S. WILLIAMS: In Canada, there exist great geographical differences in mortality. The Canadian government publishes mortality rates on an age-sex

specific basis every five years. This is population mortality by province in Canada, and the western provinces show for a large range of ages a mortality rate of only about 50% of the mortality rate in the eastern provinces and Ontario. This is a remarkable differential and yet I have never seen any studies which suggest what the reasons for this might be. The U.S. Public Health Service has accumulated a lot of data. I've seen color coded maps of the states showing pockets of high morbidity and low morbidity and also mortality changes by region, and yet there has been very little published analysis of the rationale for these differences. This is a politically sensitive subject because one can think of several reasons why the government might not want to know exactly what the reasons are for pockets of high mortality or morbidity in certain areas. If data are available they certainly should be researched and there should be some attempt to find out what underlies the differentials. That might add a great deal to our work in examining what potential improvements in mortality are able to be achieved.

