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MORTALITY TRENDS

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1. Recent population experience, likely causes, probable future prospects:

   a. U.S. vs. foreign general populations
   b. Social Security recipients
   c. Adults at the working ages - reasons for recent rapid improvements in mortality from all causes, and from cardiovascular-renal causes in particular.
   d. Race and sex differentials and trends; effects of legislated changes in speed limits, etc., on population mortality.
   e. Projected impact on society

2. Industry mortality differentials and trends by product line, market and type of underwriting:

   a. Life vs. Annuity
   b. Term vs. Permanent
   c. Regular medical, nonmedical, "guaranteed issue", pension, etc.

3. What statistically credible evidence do we have for the efficacy of life insurance underwriting practices? What does the new Intercompany Standard Issues study show? What is the likely impact on industry mortality experience of mandated benefits for severely impaired lives?

4. Are there sound biological "laws" of mortality or do we merely have convenient formulas for smoothing and describing observed sets of rates? For example, is Gompertz a "law" or a convenient smoothing device? Are there corresponding "laws" for select and ultimate mortality, and for historical shifts in mortality by age and duration? What are the practical consequences of assuming "laws" for human mortality?

MR. EDWARD A. LEW: My remarks are addressed to the following questions.

1. What mortality trends have been observed in the general population?

2. What are some of the developments responsible for the observed changes in mortality?

3. What changes in mortality may be expected in the near future?

4. What mortality investigations appear desirable at this time?

Mortality Trends in the General Population

Overall death rates have been on a steady decline in the United States and Western Europe since the turn of the century, except certain temporary interruptions such as wars and influenza epidemics, notably those of 1918-19. From this perspective, we may consider minor fluctuations in the age-adjusted death rate of less than one half of one percent per year as representing a relatively stable situation, and focus attention on periods when the age-adjusted death rate changed by more than one half of one percent per year.

Since 1950 the age-adjusted mortality rates in the United States (adjusted to the 1940 population) have shown the following reductions:

Period	Decline in Age-Adjusted Mortality
	All Causes
1950 - 60	9.5%
1960 - 70	6.0
1970 - 80 est.	20.0 (actual decline for 1970-77 is about 14%)

Virtually all of the decrease in mortality during the 1950's occurred in the early years of that decade, reflecting largely the effects of the introduction of antibiotics and improvements in medical and surgical treatment in the aftermath of World War II. Between 1955 and 1970 the reduction in the age-adjusted mortality rate averaged less than one half of one percent per year. The decline in the age-adjusted mortality rate during the 1970's may well set a record and is likely to be twice as great as that registered in the 1950's.

Since 1950, more than two-thirds of the reduction in the age-adjusted death rate from all causes can be attributed to the drop in mortality from the major cardiovascular diseases. The actual decreases in mortality from these causes were as follows:

Period	Decline in Age-Adjusted Mortality
	Major CV Diseases
1950 - 60	8.0%
1960 - 70	13.5
1970 - 80 est.	27.0 (actual decline for 1970-77 is about 20%)

The main component of the broad category of major cardiovascular diseases- coronary disease - accounted for approximately two-thirds of the total death rate in this category. Coronary disease, unlike the other major cardiovascular diseases, at first registered a distinct upward trend in the United States and only since the mid 1960's has been on a clear cut downtrend, as indicated by the figures below:

Period	Change in Age-Adjusted Death Rate
	Coronary Diseases
1950 - 60	+16%
1960 - 70	+ 6
1970 - 80 est.	-27 (actual change for 1970-77 is about 20%)

There was a disturbing discontinuity in the coding of coronary and related diseases with the eighth revision of the international list of causes of death which became effective in 1968. It transferred about 15 percent more deaths to ischemic heart diseases than had been assigned by the seventh revision to the most nearly comparable title - arterio-sclerotic heart diseases, which included coronary disease. When some adjustment is made for this change in classification it appears that coronary disease may have begun to decline as early as 1963.

The international trends in the mortality from coronary disease have been very puzzling. The age-adjusted death rate for males from this cause has declined in the United States to a much greater extent than in Western Europe. In several Western European countries the male death rate from coronary disease actually increased during the 1970's. Table 1 shows the diverse patterns of mortality from coronary disease in various countries.

The factors influencing the trend to lower mortality from coronary disease in the United States have apparently not operated to anything like the same degree for men in Western Europe. The level of coronary mortality in the United States has fallen to approximately that in Canada and Great Britain, but remains significantly higher than on the continent of Europe. Only Finland, Scotland, Ireland, Australia, and New Zealand are currently reporting higher mortality from coronary disease than the United States.

By the way of contrast, the age-adjusted mortality rates from cancer have shown a slight increase since 1950, as follows:

Period	Increase in Age-Adjusted Mortality
	Cancer (All Forms)
1950 - 60	little change
1960 - 70	4%
1970 - 80 est.	4%

While cancer of the lung has been on a distinct upward trend, this has been largely offset by declines in other forms of cancer.

Developments Related to Decline in Mortality

It has long been recognized that no substantial decrease in mortality could take place without breakthroughs in the prevention or treatment of heart disease or cancer. The magnitude of the recent reduction in death rates from heart disease suggests that such a breakthrough has been achieved.

Even though a number of developments appear involved in the sharp decline in mortality from heart disease, stepped up efforts to detect hypertension, greater awareness of high blood pressure, and the introduction of more effective anti-hypertensive drugs stand out as major contributions to the control of heart disease, responsible for perhaps as much as a third of the reduction in heart disease mortality. Hypertension not only enhances the progression of coronary atherosclerosis but also operates as a precipitating factor in heart attacks. More widespread detection, awareness and better treatment of hypertension would accordingly be expected to lower the death rate from coronary disease as well as that from hypertensive heart disease and stroke. The hypothesis that anti-hypertensive treatment has been a major element in the reduction of heart disease mortality is supported by the fact that black women, who are particularly prone to hypertension, have exhibited the largest decline in coronary disease death rates.

The introduction of new hypertensive drugs - chlorthiazide in the late 1950's, alpha methyldopa in 1960, and propranol about 1970-fits into the pattern of decreases in heart mortality. The National Center for Health Statistics has reported that awareness of high blood pressure increased

from 56% in 1960-62 to 71% in 1970-74, and this has been reflected in the progressively greater use of anti-hypertensive drugs. Their effect can be estimated from the 1979 Blood Pressure Study which indicates that among hypertensives whose blood pressure returned to normal as a result of treatment with these drugs, the extra mortality was virtually eliminated. The extra mortality of hypertensives who did not respond as well to these drugs was, nevertheless, diminished moderately. During the past fifteen years other factors which can precipitate death from heart disease lost some of their force. The proportion of cigarette smokers in the adult population dropped from over 55% to less than 40%. At the same time, the tar-nicotine content of cigarettes was sharply reduced, and heart disease death rates among those smoking low tar-nicotine cigarettes were found to be appreciably lower.

Then, too, there were no severe influenza epidemics during the period under consideration. This undoubtedly operated to keep down the mortality rates from heart disease among the elderly and those suffering from heart disease. Improved medical care of heart disease has also figured importantly in the reduction of heart disease death rates, but its effects are difficult to quantify. Better treatment of heart disease, better emergency care of heart attacks and earlier admissions to hospitals have all played a part, as well as the general establishment of coronary care units in hospitals.

The principal reasons for the reduction in heart disease mortality must be sought in influences that have operated on the entire population because both men and women, whites and blacks, and low heart disease risks as well as high heart disease risks have all registered decreases in mortality from this cause in the United States. Such influences may have come from higher standards of living, greater awareness of health hazards and more healthful life styles. The latter probably took the form of more sensible diets, more exercise, better adaptation to stress (as in greater leisure time) and avoidance of harmful habits.

The nutritional changes have produced somewhat lower consumption of foods containing cholesterol and saturated fats, but overall meat consumption has risen. Moreover, men as well as younger women have put on weight. The net effect of these developments has resulted in slightly lower cholesterol levels. The growing popularity of physical activity is a phenomenon of the last two decades, and its effects are believed to be highly salutary. The trend towards more leisure time has been in the making for many years.

Other causes of death, with the noteworthy exceptions of lung cancer, chronic lung disease, suicide and homicide, have also decreased by about the same extent as coronary disease. This reinforces the supposition that a set of general influences for better health have been operating in the United States to a much greater degree than in other countries.

Mortality in Near Future

In seeking to visualize the mortality changes that are likely to occur in the near future, it is useful to enlarge on the general circumstances that work to yield lower mortality: higher living standards, increased awareness of health hazards and a trend towards more salutary modes of living.

The effect of higher living standards is illustrated by the progressive decrease in mortality with increases in income and socio-economic status. Several studies of the mortality among employees of large corporations engaged in non-hazardous activities indicate that death rates may vary from as much as 30 percent below average in the case of managerial and supervisory personnel to 10-15 percent above average for employees at the lower socio-economic levels. This differential matches that recorded for variations in mortality by educational attainment, which for white males aged 25 to 64 was found to range from 25 percent below average for those with some college education to 10 percent above average for those with less than eight years of formal schooling.

Lester Breslow has recently called attention to a study in the Human Population Laboratory in Alameda County, California, which attempted to measure the effect on death rates of different life styles. This study showed a greater than two-fold gradient in mortality between men who followed and those who did not follow seven common health habits: eating moderately, eating regularly, eating breakfast, drinking alcohol moderately or not at all, smoking no cigarettes, exercising moderately and sleeping 7 to 8 hours a night. A two-fold gradient was also found between men belonging and those not belonging to a closely knit social network (defined in terms of personal contacts and church or other group affiliation). A comparison of men with the best habits and a good social network with men reporting poor habits and little social involvement showed a five-fold gradient in mortality. The corresponding mortality differential for women was three-and-a-half-fold.

The effect of salutary habits is also illustrated by the mortality among Mormons and Seventh Day Adventists, who generally abstain from tobacco, alcohol, coffee and otherwise exercise moderation. Death rates in Utah, where the population is about 70 percent Mormon, have been about 25 percent below those for the country as a whole.

It is reasonable to expect that further increases in the standards of living and educational attainment, if translated into more salutary life styles, will continue to decrease death rates. Several of the components of life style, such as nutrition, smoking, and utilization of medical knowledge, are moving in the right directions.

In the area of better medical care it can be anticipated that more effective and greater use will be made of anti-hypertensive drugs. The discovery that HDL cholesterol is beneficial and that only LDL cholesterol is atherogenic should enable physicians to identify high risk individuals more readily.

It can also be anticipated that cigarette smoking will continue to decrease among men, but perhaps not among women. Moreover, both sexes should benefit from the introduction of cigarettes with progressively lower tar and nicotine content. These projections, if realized, will keep death rates from heart disease on a downtrend for some years to come.

There is little indication, however, of any major breakthroughs in cancer in the near future. The levels of cancer death rates in the years ahead are likely to depend mainly on the extent of cigarette smoking and on the tar-nicotine content of cigarettes.

Fears have been expressed that some new chemicals and a few of the old ones may turn out to be carcinogenic. Much effort is being expended to control toxic substances in the work place and the environment to prevent increases in cancer in the more distant future. Epidemiological studies are being pushed as a check on the effect of such substances and the measures taken to control them. For this purpose mortality investigations of insured lives exposed to various chemicals would be helpful.

While great strides are anticipated in the basic sciences in the next five years or so, it may take many years to adapt them for medicine and public health. However, advances in biochemistry, genetics, neurobiology, immunology, and pharmacology should yield tools for reducing mortality sooner.

A number of countries in Western Europe have already registered death rates some 20 percent below those in the United States. We ought to be able to approach such lower mortality levels in this country in the near future.

New Mortality Investigations

It has become increasingly clear that a better understanding of mortality trends may flow from analyses of death rates by socio-economic level, educational attainment and life styles.

Insurance records supplemented by some outside information provide a data base for mortality studies by socio-economic status, using income level and occupation as an indicator of socio-economic status. In special circumstances, such as where life styles are closely associated with people living in particular regions, it may be possible to investigate the death rates associated with modes of living in such regions. Mormons in Utah and the elderly in areas such as Southern Florida and California present examples of groups whose mortality experience can shed light on the relationship between death rates and life styles.

Holders of individual annuity contracts offer the most obvious material for a study of mortality rates among persons with low amounts of health hazards. Also, group life insurance records can be used as a starting point for comprehensive studies of mortality by occupation. In the early 1930's, much useful information about extra mortality by cause of death was obtained from the experience by industry under group life insurance.

Investigations of impaired lives make it possible to determine whether mortality related to different diseases has been declining. Fragmentary evidence from clinical studies suggests that death rates among the sick have been decreasing more rapidly than among healthy lives. The same conclusion may be implicit in the experience on substandard risks.

Most needed, however, are studies that would point up the disparate mortality trends in different groups of insured lives, health insurance risks, and annuitants or pensioners. The records on active and retired lives in the insurance business, if supplemented by a modicum of outside information, could be used to associate different trends with specific characteristics. Such an approach would provide us with the means to a better understanding of mortality trends in specialized segments of the population.

MR. JOHN E. BAILEY: On the surface, mortality comparisons represent an almost purely mechanical process. Yet there are so many factors that can influence the result that it is easy to reach improper conclusions. Aside from the obvious variables of age, sex, and duration from underwriting, the actuary must recognize the influences of policy size, type of underwriting, plan, persistency, distribution of business by occupation, market, and income level and shifts in the mortality of the underlying population. In structuring and pricing life insurance, he must determine which of these factors are important enough to take into account and which may be ignored.

My job is to report on trends and differences in insured life mortality and suggest possible reasons; we must all be wary of the influence of unrecognized factors. I also will discuss the relationship of insured life to population mortality and touch on trends in insured life mortality by sex and by plan.

Relation to Population Mortality

Mr. Lew has described the recent improvements in population mortality. The insured life mortality has also enjoyed substantial, although irregular, improvements in experience. The degree of improvement in standard individual insured life mortality can be illustrated by comparing the claims that the mortality rates for different periods would produce in a static insured-life portfolio. For this purpose, I have used the total intercompany experience between 1976 and 1977 policy anniversaries. For that portfolio, total claims would have decreased:

11% in the 14 years 1951-55 to 1964-70;
another 8% in the 5 1/2 years 1964-70 to 1970-75; and
another 11% in the 3 1/2 years 1970-75 to 1975-77.

These claim totals are based on the experience contributed to the Intercompany Standard Ordinary study and thus are influenced heavily by the markets, underwriting standards, and distributions of business of the large mutual companies that dominate this study. As might be expected, this experience does parallel the population mortality improvements.

I am often asked how insured life mortality compares to population mortality. While this can be answered in terms of life expectancy, that doesn't really tell much. For a typical age, doubling the mortality level will reduce the life expectancy about one-sixth and quintupling the mortality will reduce the life expectancy by about one-third.

For the record, we can compare life expectancies for the latest ultimate basic table (1965-70) to the contemporaneous (1968) population mortality. Since the industry ultimate table begins at age 15, the comparison is between complete life expectancies at that age. For males, the population life expectancy was 54.6 years and

the individual insured life expectancy about 3.5 years longer. For females, the population expectancy was 61.5 years and the insured life expectancy about 2.2 years longer.

I prefer to express insured life mortality as a percentage of population mortality. Of course, there are still lots of problems; for instance, do you use the age mix of the population or of the insured life experience? Do you use select experience or ultimate experience, medical or nonmedical issues? It would be possible to calculate age-adjusted population mortality rates based on the 1940 population and compare these to the published rates, but such calculations are highly sensitive to rates at the very old ages where there is little reliable data. Instead, I chose to apply population mortality factors to the insured life distribution. On this basis:

> select nonmedical experience is about 47% of population mortality; select medical experience is about 67% of population mortality; ultimate mortality is about 94% of population mortality; and the total block of standard insured lives experience about 85% of population mortality.

This doesn't mean that medical experience is higher than nonmedical, rather that the entire insured life experience is higher at the medical ages than at the nonmedical ages. The very low nonmedical percentage is heavily weighted at the younger ages where it is quite easy to segregate those with life-threatening impairments. Also, nonmedical limits tend to exclude the very affluent who are subject to higher accidental risks of driving, flying, and other hazardous activities.

The select medical percentage probably provides the best measure of the impact of selection at the adult ages. The much higher ultimate percentage reflects the fact that the influence of selection has largely dissipated, although the underwriting process still retains some influence in screening out the worst of the lives.

These factors were based on the 1975-77 experience; corresponding factors for 1970-75 were similar.

Insured Life Mortality

Value of Difference Among Companies

Most of you are aware that the Society publishes a Comparative Mortality Study constructed from individual company contributions to its individual Standard Ordinary Study on a revolving five-year basis. The report indicates mortality ratios for each of the contributing companies in a number of select categories by age, duration, and underwriting basis--without revealing the identity of the individual companies.

With this information, it is easy to calculate the amount of death claims each (unidentified) company would have experienced on a fixed block of business. This provides a measure of the range of mortality experience among the companies contributing to this study.

For the latest such report, covering 1972-77, the average claims on our company's block of business in the first fifteen policy years would have been about $32.7 million. Claims for individual companies in the study ranged from $23.9 million to $38.1 million, or from 73% to 116% of the average. Stated another way, the total select claims for the company having the highest mortality were 60% higher than those for the company having the best mortality. The point is that even among these large companies with extensive underwriting facilities, the level of mortality can range widely.

In preparing for this talk, I studied the intercompany mortality trends over the past quarter-century for each of five blocks of business - medical issues in policy years 1-5 and 6-15, nonmedical issues in policy years 1-5 and 6-15, and ultimate business. However, that analysis proved to be too long and detailed for this forum. Fortunately, the patterns are similar and can be summarized generally.

Much of my data is based on the Mortality Trends section of the Standard Ordinary Mortality Report in the 1976 Reports plus an analysis of subsequent intercompany experience. The analysis is based on mortality rates rather than ratios since they are available for longer time periods and are not as subject to distributional influences. Periods from 1951-55 through 1975-77 are included, with 1964-70 as a reference point roughly corresponding to the experience period for the latest intercompany basic tables.

For attained ages under 35, mortality rates generally did not improve from the early 1950's until the base period of 1964-70. In fact, except for medical issues in policy years 6-15, there was an increase of 6-15% over that period. Since the late 1960's, however, this mortality has improved 10-15% in all categories and even more for nonmedical issues for the first five policy years.

For attained ages over 35, there has been improvement throughout the last quarter century. For medical issues, mortality rates decreased 15-20% from the early 1950's to the late 1960's followed by further decreases averaging 10% through 1970-75 and another 15% through 1975-77. The improvements were generally greater at the older ages and in the earlier policy years.

For nonmedical issues at ages over 35, the change has been somewhat less dramatic. Through 1964-70, there was about a 10% improvement in the "late select" business and a smaller improvement in the first five policy years. Since that time, however, nonmedical mortality has improved a total of about 20% in both select categories.

To pull this together, I calculated actual claims on a sample portfolio based on the 1976-77 intercompany experience. For all select medical business, the total claims decreased about 13% from the early 1950's through the base period of 1964-70 followed by further decreases of 9% through 1970-75 and another 14% through 1975-77. The total select medical improvement over this period was about 31%.

On the other hand, select nonmedical claims in the sample portfolio increased about 1.5% from the early 1950's to the late 1960's but then decreased by 7% and 13% in the subsequent periods. The overall improvement in select nonmedical issues was about 18%.

These are substantial changes and it's fun to speculate about the reasons. These improvements generally shadow those in the total population and presumably come about for the same reasons that Mr. Lew has discussed. With increasing nonmedical and paramedical limits, the distribution of policy sizes in medical issues has increased substantially. This implies a somewhat more selective market and, despite changes in other requirement limits, more complete medical information on which to underwrite. Better medical tests, such as exercise EKG's, are available. Companies are using driving data to a greater extent than ever before.

Trends in Selectivity

As a measure of selectivity in the experience, I compared the medical mortality rates in the first five policy years to the corresponding rates for policy years 6-15. While this comparison involves mortality experience derived from different issue periods under different underwriting standards, the results are of interest.

In the early 1950's, the "early select" mortality varied narrowly between 64% and 68% of the "late select" mortality at ages over 40, with somewhat higher ratios at the younger ages.

In more recent experience, these ratios decrease from about 85% at the younger ages to 52% at ages over 60. This decreasing pattern implies greater selectivity in underwriting at the older ages, which is generally true. Of course, the much higher mortality levels and the higher prevalence of serious impairments at the older ages provide more opportunity for better underwriting performance. This result is consistent with our asset share studies indicating that the select period is probably longer than 15 years at the older issue ages.

Medical vs. Nonmedical Mortality

It is not really appropriate to compare medical and nonmedical mortality results because of substantial differences in the populations. However, I did compare mortality rates for policy years 6-15 for attained ages 25-39 for various periods. Surprisingly, the nonmedical mortality rates were generally within 3% of the medical rates - higher or lower - indicating little real difference on a comparable basis at these relatively young ages. These ratios did tend to increase somewhat with calendar year.

Standard Ultimate Experience

The ultimate block of business includes all standard issues in policy years 16 and higher and is largely derived from medical issues. It represents the results of relatively ancient underwriting standards and thus is primarily of pricing interest. However, it does contain the majority of claim amounts for most companies.

Again comparing the experience of 1964-70 to that of the early 1950's, the mortality rates decreased 10% to 15% with little variation by age.

Since the late 1960's ultimate mortality rates have decreased 10% to the early 1970's and a further 12% in the last two years. Somewhat smaller decreases were experienced at ages over 65. Otherwise, the changes were surprisingly consistent by attained age category.

This overall pattern is remarkably similar to that for select medical business. For the entire period from the early 1950's, ultimate model office death claims decreased 26% as compared to 31% for select medical and only 18% for select nonmedical.

Ultimate vs. Select Mortality

As another measure of selectivity, I compared the ultimate mortality rates with the select medical rates in policy years 6-15 at the same attained ages. The select rates were generally about 85% of the ultimate rates, with higher ratios below age 50 and lower ratios above age 55. Again, this indicates the greater impact of underwriting at the higher ages.

Overall, this ratio has generally decreased over the period of study, possibly because of the lower average duration in the 6-15 block resulting from increased sales. Increased nonmedical limits have also contributed to better medical experience.

Mortality by Sex

Despite considerable recent legislation and litigation regarding equal costs and benefits by sex, mortality differentials by sex are widening. Many of you have read the recommendation for new valuation tables and seen the eye-opening trend in the ratios of male-to-female age-adjusted death rates. For whites, this ratio increased from 108% in 1920 to 175% in 1970 and for nonwhites the increase was from 97% in 1920 to 163% in 1970. Each of these ratios increased another six points through 1977.

The relationship between male and female insured life mortality is well defined by the male and female basic tables developed by the Special Committee. They used 1970-75 experience excluding the first five policy years. The ratios of male-to-female mortality form an "M" pattern by age. The actual ratios begin at 151% at age 0 and increase to more than 200% at ages 14-25 with a maximum of 271% at

age 18. Then they drop below 140% at ages 38-47 and increase again to more than 180% at ages 60-74, before grading off to 100% at age 100.

For a recent measure of aggregate female-to-male mortality, I applied these basic table male and female mortality rates to the 1976-77 ultimate distribution of business in force by attained age. On this basic, female claims were about 61% of male claims--surprisingly close to the 60% relationship that has held for many years.

The Standard Ordinary Mortality report annually includes a five-year comparison of female-to-male mortality by block of business. For the select medical business, these ratios have increased from 49% in the mid-1950's to a high of 65% for 1970-75 and then decreased slightly. For select nonmedical business, with a younger age distribution, the ratio has been surprisingly uniform at about 59%, with a maximum of 63% experienced in 1959-64. The ultimate ratio has also been surprisingly stable at about 60% with a maximum of 63.6% for 1971-76.

It is dangerous to draw many conclusions from this information since we don't know much about the distribution by age and duration or plan or amount of insurance. I did test the average age in the ultimate experience for 1957-62 and 1972-77 periods. Over this period of time, the average female age increased about 2.4 years to 49.5 while the average male age decreased 1.7 years to 53.0. This difference in average age may well account for any changes in this particular ratio.

It is clear that there are substantial differences in mortality by sex--but the trend of data among insured lives conflicts strongly with that in the population. Part of these differences may be explained by self-selection and by underwriting restrictions on male lives in the purchase of insurance. The strong influence of mortality differences at the older ages on population age-adjusted rates may be another factor.

Term Insurance

I'd like to comment briefly on term vs. permanent mortality. In recent years, sales of term insurance have increased as a proportion of total business. According to the Fact Book, purchases of "regular or decreasing term" increased from 21% to 34% of total purchases between 1967 and 1977. Many major companies introduced YRT or ART in the early 1970's and these plans have accounted for a large proportion of the total volume of new sales. The conventional wisdom in this area is that term mortality will tend to approach permanent mortality as term becomes a more normal sale. (If we may judge by the pricing of the term products we are competing against, term mortality has been very good indeed.) While I subscribe to this proposition to some degree, I am yet to be convinced that term mortality ever will reach the level of permanent mortality on a broad basis.

Demonstrations of a relationship between term and permanent mortality are harder to obtain. So far as I was able to determine, the Large Amount study represents the only regular intercompany study to compare term and permanent mortality. In that study, the aggregate level of term mortality has decreased from 130% of permanent mortality from 1953-58 to 112%, 111% and 101% in subsequent studies (ending with 1968-73).

In fact, for 1968-73, term mortality was lower for every age category below 50. However, I believe this result is misleading and largely due to different distributions of insurance in force by duration. This problem points out the difficulties of working with mortality ratios rather than actual rates. I suspect that if the actual term rates in this study were applied to a model office, the 101% experienced for the most recent study period would be in the neighborhood of 106% to 108%.

At my own company, we have recently completed a term study and found overall excess mortality of about 10%. This represents a slight improvement from the past but not much. There was considerable antiselection by amount, as might be expected. The mortality ratios were highly irregular by issue age group, but generally decreased by the policy year. Yearly Renewal Term--introduced in 1972 with a $50,000 minimum--experienced the highest mortality of any plan, explaining the antiselection by amount and the decrease in mortality by duration.

The excess mortality on term conversions was generally concentrated in the first five years after conversion, with excess mortality of about 60% in the first two years and 30% in years 3-5.

While I see some evidence of lower excess term mortality, I continue to believe that the lowest premium forms will still have the highest mortality experience when other factors are taken into account.

Conclusion

Tables 2-4 demonstrate some of the trends I have discussed. Time does not permit any comment on trends in annuities, group coverages, simplified issue or other areas. I hope these might be included in discussions from the floor and in the workshops.

In summary, the rate of improvement in mortality has accelerated considerably in the mid-1970's after a much more leisurely decrease in the 1960's. While there are probably many reasons, I would suggest the lower speed limit, the greater emphasis on exercise, diet, and non-smoking and the demonstrated value of treatment of blood pressure.

Perhaps the acceleration in mortality improvement requires somewhat more attention to this factor by pricing actuaries than it has been given in the last few years.

MR. JOHN H. COOK: It has been said that all of the people in the world are divided into two classes. One class consists of those who divide all of the people in the world into two classes, and the other class consists of those who do not. Life insurance underwriters belong to the first class. They separate those who are insurable at standard rates from those who are not insurable at standard rates. Based on the evidence available to me I am inclined to believe that legislators and insurance regulators belong to the second class. They consider that everyone is insurable at standard rates.

You and I know that this cannot be done. Some life insurance applicants are subject to a mortality risk that exceeds the average. Certain excess mortality risks may be relatively insignificant and these are readily absorbed by standard rate life insurance pricing. Certain excess mortality risks may be substantial, but the total cost of developing the underwriting characteristics may exceed the value of the information developed. These risks are absorbed by the expense margins. Certain excess mortality risks remain undetected at the time of the insurance contract and these excess risks are absorbed by the mortality fluctuation margins provided.

There are some situations where the excess mortality risks are not trivial, the expense of identifying the risk is not excessive, and the insurer (and often the insured) is well aware, prior to the contract, of the exposure to excess risk. These are the situations in which the insurer is obligated to protect his standard rate policyholder by charging a higher than standard rate premium to the excess risk applicant.

In the current picture and in the recent past, about 91% of life insurance applicants have been accepted at standard rates, about 6% have been accepted at rates higher than standard and the remaining 3% have been classified as uninsurable because of the high degree of risk involved. What will the picture be like in the near future? I don't know what will happen, but I'll tell you what I hope will not happen, and I will do all that I can to prevent it. I hope we are not forced to accept all life insurance applicants at standard rates, without regard to what we call their insurability.

Time does not permit me to elaborate this morning on the restrictions that are being placed on the risk classification process. It is important to note, however, one contributing factor. Lurking in the background of these restrictions is the suggestion that life insurance underwriting is based on prejudicial discrimination and subjective determination.

It was in recognition of this accusation that the Committee on Mortality Under Ordinary Insurance and Annuities initiated a mortality study of the experience of substandard risks. There was one purpose for this study and one purpose only. The purpose was to demonstrate the capability of the life insurance underwriter to assess the risk and to quantify the excess risk with a high degree of accuracy.

Many of you recently read an article written by Joe Wilber entitled "We're Doing Something Right But What Is It?" That article referred to reduction in cardiovascular mortality. I say that there is something else we are doing right - we are able to classify substandard risks, and the preliminary results coming out of the inter-company substandard mortality study are demonstrating the quality of the underwriting. Based on almost $50 billion of exposure and about $250 million of actual claims, the aggregate mortality ratio is about 170%. I think this is a dramatic demonstration that life insurance underwriting is based on something other than prejudicial discrimination and subjective determination. The truth of this is strengthened by the sub-division of the data into slight substandard, moderate substandard, and high substandard. The mortality ratios progress steadily by class approximately from 150% to 200% to 300%.

Not all contributions to the inter-company study have been received; not all contributions provide much sub-division of the data; and not all the contributions received have been processed by the compiling company. Some limited mortality results based on this incomplete data are shown in Table 5. Final results of the study will be published in the 1979 Reports Number of the Transactions to be released about a year from now.

So much for the inter-company substandard mortality study itself. When we consider mortality trends, it is important to keep in mind fundamental differences that distinguish standard business from substandard business. To begin with, changes in mortality patterns among the general population tend to be reflected in the pattern among standard insured risks. This is because the general population for the most part is made up of insured lives. Of course, there are differences. Primarily, the age distribution of insured lives differs greatly from that of the general population. Also, impaired risks among the general population are excluded from standard insurance, except to the extent that they were included before becoming impaired. Nevertheless, when population mortality goes down, insured life mortality can be expected to do the same. Can we look for this same correlation between standard insured lives and substandard insured lives? Here we have important cross currents.

Ninety-four percent of all insurance data are at standard rates. A small change to add a portion of the substandard business - or to transfer a small portion to the substandard business - will have very little effect on the standard experience itself. The same small change can have a dramatic impact on the experience of substandard business. Yet the composition of the substandard business is ever changing. The same medical advances that are improving population mortality are improving the underwriting classification of the affected lives. To the extent that these lives are removed from the substandard exposure and are added to the standard, the improved mortality fails to emerge in the experience of the substandard business.

Furthermore, there are strong competitive pressures that operate in the substandard market. This serves to keep at a low level the average amount of extra premium charged on substandard business. Also, many impairments which had formerly been considered uninsurable are now being accepted at high substandard rates. All of these elements serve to increase the observed mortality ratios for substandard business. I suggest to you that a mortality study ten years from now, similar to the one I reported to you a few moments ago, could show even higher mortality ratios, not lower ratios. The interesting part is that the lower the mortality rates will become on standard business, the higher will be the mortality ratios on substandard business.

When we consider the wide variations in mortality levels for substandard versus standard risks it is conspicuous to us that there must be pricing variations that correspond. It is so conspicuous to us that we do not always keep in mind why this is so. We are so impressed with the obvious equity of the risk classification system that we tend to forget what its purpose is. A risk classification system that is based on equality, instead of on equity, is not intrinsically wrong but it fails to avoid the financial chaos that could result from unrestricted anti-selection. Direct writing insurance companies attempt to avoid that financial chaos by setting a price for their product that will be commensurate with the risk of loss.

Many years ago substandard pricing was typically at a conservative level. Various pressures have since served to "take the fat" out of the substandard extra premiums. Today it is typical for a direct writer to price the substandard product as close to the line as possible. In doing so, it is not uncommon to put a dollar sign to the indirect results of substandard underwriting. One of the indirect results with a big dollar sign is agency morale.

One of the devices currently being used to enhance the competitive position of the substandard product is reinsurance shopping. This phenomenon is relatively recent in terms of its impact on substandard sales, substandard pricing, and substandard mortality experience. Nevertheless, it is a phenomenon that will have to be kept in mind when we try to interpret the mortality experience of substandard business over the next few years.

There is another important influencing factor we must keep in mind when we try to anticipate the trend of mortality results on business that is classified standard as well as on business that is classified substandard. There is legislation on the books today whereby the insurance industry is obligated to insure impaired risks at standard rates. There are underwriting characteristics that have been declared off limits in the function of classifying the risk. These restrictions currently apply in a number of states to such characteristics as mental retardation, genetic diseases, blindness, loss of limb and other severe disabilities. For each of the restrictions that have been adopted there have been many other restrictions proposed.

Just to consider one such restriction, there exists a law in California which mandates pricing of the life insurance product for male and female risks based on the experience of their own sex. This law will be effective with issues of 1981 and later. There is also a proposal in the Federal Congress which, if adopted, will forbid any differential in pricing of the life insurance product by sex. If this comes to pass, then in California we will be damned if we do and damned if we don't.

Here we are dealing with an underwriting characteristic for which there has been a long standing demonstration of a differential in mortality levels. The mortality rate among female risks has for many years been approximately 60% of the rate for males. If a life insurance company is forbidden from reflecting these mortality differentials in pricing its products we face a situation where the repercussions are quite complicated, and in the final analysis are somewhat unpredictable.

As an initial reaction, it would appear that those companies which currently serve a higher percentage of the female market would enjoy a competitive advantage over those companies that serve predominately a male market. A second order correction for this, however, is that such a company will attract an increasing percentage of male applicants and this will serve to erode the mortality advantage that formerly existed. I hesitate to speculate on the eventual outcome of these complicated influencing factors.

The analysis I have just presented pertains to mortality differentials between male and female lives. There are mortality differentials that are even more dramatic that separate standard risks from severely impaired risks. The final result, if we are forbidden from recognizing these differences in underwriting characteristics, can be frightening to think of. Rather than to speculate on the operations of the future under such controls, I prefer to assume that we can avoid being forced into such a position.

One of the best ways to protect our right of risk classification is to exercise that right in a fair and equitable manner. Correlation between emerging mortality statistics and underwriting classification at time of issue is our best protection. It is a natural objective of pricing our product that we charge substandard risks at least enough to offset the excess risk of loss. An equally important objective now is that we not charge more than enough to offset that excess risk. We must establish and maintain the image that we price in a fair and equitable manner.

It is for this reason that I am particularly pleased with the success of our underwriting performance of the past. This one page report which I brought to your attention earlier this morning bears witness to the need for and to the equity of the increased premiums that have been charged for insurance on impaired risks.

MR. SMITH (Presenting Mr. Vanderhoof's paper): In recent years the actuarial profession has traveled very far from the idea of laws that govern human life and behavior. While general respect is paid to Gompertz's law, most of the work done in the smoothing of mortality experience is done using graduation techniques. These techniques have become most refined and have now reached the stage of including in their formulation the most recent and sophisticated mathematical techniques. If we are faced with variations in the values of our parameters because of chance fluctuations in the controlling conditions of the world, or because of measurement errors, then there is adequate reason for the use of purely smoothing techniques. However, in the regular application of graduation to mortality data it seems to me that we have gone one step further. We have abandoned the attempt to discover the mathematical laws that describe mortality. In doing so I claim we have submitted to a kind of intellectual suicide. In using graduation techniques we disavow any understanding of the processes that are actually taking place. After we have made our disavowal we assume that it will keep going on in exactly the same way in the future.

Obviously I do not agree with the trend. I believe that it is not only possible to understand this basic controlling fact of our profession, but that it is incumbent upon us to do it. I realize that this is a minority position, but extreme minority positions are frequently looked on as romantic. Since the opportunity for assuming a romantic posture seems to become less frequent with increasing age, I obviously welcome this chance.

I will therefore argue that laws of mortality are possible and useful, more useful than graduation techniques. I will further argue that Gompertz's law is appropriately named as constituting a law of mortality and I will finally present a new formulation of a law of select mortality as a further demonstration of the possible existence of such laws.

In talking about a law of science there seems to me to be a series of requirements. A scientific law is best formulated in quantitative terms. It should have been observed as applying under a wide variety of circumstances and not just once, and it should be consistent with other bodies of knowledge and be plausible. We usually like to have some logical model from which the mathematical form can be developed, rather than a simple statement that a relationship between certain numbers has been observed.

In looking at Gompertz's law we can be impressed by its great success in meeting some criteria and failure in the meeting of others. From Gompertz's original observation that mortality increases as an exponential function of age this law has been found to reasonably well fit the data for humans in many countries and at different times.

It even fits well the data on the mortality of other species such as experimental rats and even the house fly. It fits the data better than most laws of physics and any of the laws of the social sciences. Any argument against the acceptance of this as a scientific law would have to be won on other grounds.

Those other grounds exist. They are that there has never been a generally accepted explanation for the reasons that this particular form should apply. Several attempts have been made in recent years. Brillinger, in the Transactions, used extreme values theory to develop a model that included Gompertz's law as a very special case. No reason was developed, however, as to why the very special case should seem to be universally applicable. Strehler and Mildvan have championed a theory that assumes that the risks of life follow a Maxwell-Boltzman distribution. This assumption introduces the exponential form. Sacher and Trucco have argued that the reason for Gompertz's law is that vitality in a population of a given age follows a normal distribution around a mean that decreases linearly with age. Again the exponential form has been introduced as one of the assumptions.

We know something about vitality in the human organism. For most of the systems of the body the ability to function decreases linearly with age. If this leads to an exponential form in a model describing mortality then we could say that Gompertz's law was consistent with biological data and was plausible.

I believe that such a rationale does exist - as follows:

Let us assume that the human body is composed of a large number of systems and that the failure of any one of the systems results in death. Let us further assume that a system fails only if all components of the system fail and that the number of components in any system decreases linearly with age. Under these circumstances the probability of death will take the following form as a function of age "x".

$$q_x = B_1 c^x + B_2 c^{2x}.$$

The first term is obviously Gompertz's law. Gompertz's and this law do not fit perfectly because the members of a given age group are not homogeneous, because they are subject to differing strains during the remainder of life, because not all systems lose vitality at the same rate, and because the requirement that all components must fail in order to cause death is probably too severe. The above formulation, which must result if the separate causes of death follow Gompertz's law, fits the data about as well as any of the other complex formulations of Gompertz's law.

The next step is obviously the development of a law of select mortality that is plausible and fits the data. Assume that Gompertz's law fits the group of lives that are always select (at least during the years of interest to life insurance actuaries). Assume also that it fits the ultimate group. The progression of mortality rates during the select period would then be some form between these two forms.

Assume that each year during the select period a constant percentage -"s"- of the select lives remains select and that the remainder will, in the future, exhibit ultimate mortality. The mortality for the group of lives originally selected will then be

$$s^t \, B_s \, c_s^{x+t} + (1-s^t) B_u \, c_u^{x+t}$$

If we replace the arithmetic average with a geometric average (for ease of computation) then we would get

$$(B_s \, c_s^{x+t})^{s^t} \quad (B_u \, c_u^{x+t})^{1 - s^t}$$

or finally

$$Bc^{x+t} \quad (B_3 \, c_3^{x+t})^{s^t}$$ where B and c represent the effects of selection.

The formula has been tested with a wide variety of data and some of the values of the coefficient of determination, R^2, are shown below:

65-70 Basic Select Male	99.1%
55-60 Basic Select Male	98.9
1944-1948 Experience Table of Institute and Faculty of Actuaries	98.4
American Mens	91.5

The Society of Actuaries graduation of the 65-70 and 55-60 data develops slightly higher values of R2. They couldn't be very much higher. The Society of Actuaries graduation, however, provides no smoothness between ages at issue. This technique does. The graduation approach also does not implicitly provide a method of extrapolating to ages beyond those included in the original data while this technique does.

A paper detailing the logic of the approach and the mathematical techniques involved in the solution of the equations was prepared by Aaron Tenenbein and myself. The models were developed by me, the mathematical techniques of solution by Aaron. It has been accepted for publication by the Society.

MR. ERNEST J. MOORHEAD: I had some difficulty with Mr. Cook's presentation. I would be astonished if it could be said that there is yet a strong degree of cooperation between the actuaries who are engaged in determining substandard premiums and the actuaries who are engaged in underwriting. Certainly, within the past few years, it was true that underwriters were using the numerical rating system and there was some assumption that if the rating produced an answer of 200 percent mortality, then therefore a substandard premium based on an assumption of a continuing 200 percent of normal mortality was appropriate. However, I think there was more and more evidence that the mortality being experienced on such a block of business was not a continuing level percentage as duration increased. On the contrary, taking the block as a whole and not relating it to an individual impairment, there was a declining mortality experience as a percentage of standard which was not being reflected at all in the substandard rate. I, for one, would be reassured if Mr. Cook was able to say there has developed a strong degree of cooperation in those two actuarial activities of pricing and underwriting, but until something is demonstrated I'm inclined to be skeptical on that score. Would he care to comment on that?

MR. COOK: What is currently going on in terms of the cooperation between the actuaries studying mortality and the actuaries determining pricing? I can speak directly in terms of my own company and I know there is a great deal of communication that does take place. We attempt to reflect what we believe will be the future mortality trends in pricing our substandard product. One sells a product based on a price that was established many years ago, and that product stays there for 5, 10, 25 years. Table 5 contains experience that runs to the 15th anniversary. This table shows a very strong correlation between the pricing and the mortality experience in the first 5 years and a very similar trend for durations 6 to 15. All I can say that the proof of the pudding is in the eating, right on Table 5.

MR. PHILIP F. FINNEGAN: I'd like to comment on the remarks made by John Bailey and Court Smith with respect to mortality on term insurance. Prudential looks at its term mortality experience annually by plan and consistently the experience on our Renewable Term (both 1-Year and 5-Year) is lower than on any of the other plan groups. Most of it is due to the large average size of these groups, and we, as with all companies, experience better mortality on our larger size plans, but even when you look at it broken down by size, the term insurance mortality is still superior. We rationalize that these plans are probably bought by more sophisticated buyers who are also more sophisticated in other things such as taking care of their health.

MR. JOHN O. MONTGOMERY: I would like to address this question to Mr. Lew. Having survived the worst air pollution situation in Los Angeles on record in September, I feel that in measuring the effects in the future you are going to have to consider air pollution a factor which could cause an increase in mortality due to emphysema and lung cancer. It's a very definite problem in Southern California, and I think it could be a problem elsewhere too.

MR. LEW: Several studies have been made of the effects of air pollution in California, and thus far they have not shown that the effects of the periodic heavy smog affect the functioning of the lungs or even the further point of longevity over a short period of time. I don't think this is a final answer, by any means, because it is generally accepted that lung cancer is a disease which takes maybe 10, 15, 20 or 25 years to develop. Therefore, you will not know whether or not the harmful effects of the smog will result in cancer until many more years have elapsed. This phenomenon you refer to has been in existence for some time, yet its current strength is really what you're talking about. If you go sufficiently far back, the situation was perhaps not as frequent. The studies that I am referring to are from 5 to 10 years old, and it is hard to tell at what point the threshold is reached where serious damage to the lungs is done. All we can say is that in the past, the Los Angeles smog has not proven to be harmful. There are many areas where the situation is much worse and it's not traceable so much to air pollution, but to such things as exposure to wheat dust. It's very difficult for us to imagine that states like Kansas have a fantastic rate of emphysema due to the exposure to wheat dust, whereas the air pollution problem in Los Angeles simply is not reflected by the health statistics.

I'm sure it will be in the next 20 years.

MR. JOHN W. TOMLINSON: I have a question for Mr. Lew. You listed four or five factors which have helped decrease mortality from coronary artery disease. Although you did mention better and earlier care of hypertensive patients, you did not specifically mention better surgical methods. Was this a deliberate omission on your part and, if so, why?

MR. LEW: I'm not sure about the impacts from new surgical methods. I think no one is as yet sure about the beneficial effects of coronary bypasses or similar operations, but there is no doubt that some of the reduction in mortality is because patients are brought to hospitals earlier. A large proportion of people having severe coronary attacks die before they reach the hospital, so the fact that a much smaller proportion of people now fail to reach the hospital is regarded as perhaps the most important contribution that has been made, with Coronary Care Units' contribution second. I think the question of the coronary bypasses is still an open issue. There are people who argue one way, and people who argue the other way, and each one has managed to produce some statistics that seem to support their case. In my judgment, it is clear that the operation enables you to go on with considerably less pain and embarrassment, but whether the operation actually prolongs life sufficiently to be able to be responsible for the kind of effects that we've been discussing is still moot.

Table 1

Changes in Coronary Disease Mortality 1969-76 (est.)

Ages 35 - 74

Country	Males	Females
United States	-20%	-24%
Canada	- 7	-11
Australia	-15	-19
New Zealand	- 7	- 8
Israel	-14	-12
Sweden	+10	*
Holland	+ 4	- 8
Germany	+11	-13
France	+10	*
Switzerland	+11	- 8
United Kingdom	*	*
Ireland	+ 7	*

* means there was little change

Table 2

Mortality Rate Per 1,000
For Intercompany Standard Ordinary Experience Between Anniversaries
in 1975 and 1977
Based on Amounts of Insurance

Approximate Attained Ages	Block of Business and Policy Years Included				
	Select Medical		Select Nonmedical		Medical and Nonmedical
	1-5	6-15	1-5	6-15	over 15
20-24	.728	1.290	.674	1.001	-
25-29	.894	.801	.611	.800	1.060
30-34	.701	.844	.657	.880	1.058
35-39	.885	1.124	1.060	1.195	1.297
40-44	1.451	1.905	1.676	2.078	2.056
45-49	2.259	3.041	-	-	3.571
50-54	2.943	4.767	-	-	5.733
55-59	3.988	6.991	-	-	9.239
60-64	6.132	11.464	-	-	15.237
65-69	8.168	15.781	-	-	24.293
70-74	-	-	-	-	38.005
75-79	-	-	-	-	60.175
80-84	-	-	-	-	91.363

These rates may be compared to those on pages 32-35 of the 1976 Reports, TSA.

Table 3

Selectivity in Intercompany Standard Ordinary Mortality Experience
Between Anniversaries in 1975 and 1977
Based on Amounts of Insurance

Approximate Attained Ages	Ratio of Mortality Rates		
	Nonmedical 1-5 to Nonmedical 6-15	Medical 1-5 to Medical 6-15	Medical 6-15 to Ultimate
20-24	.67	.56	-
25-29	.76	1.12	.76
30-34	.75	.83	.80
35-39	.89	.79	.87
40-44	.81	.76	.93
45-49	-	.74	.85
50-54	-	.62	.83
55-59	-	.57	.76
60-64	-	.53	.75
65-69	-	.52	.65

Table 4
Model Office Death Claims
For Intercompany Standard Ordinary Experience of Various Periods
Based on 1976-77 Intercompany Insurance In Force
Amounts in Millions

Year of Experience	Block of Business and Policy Years Included							
	Select Medical			Select Nonmedical			Ultimate	All Select
	1-5	6-15	1-15	1-5	6-15	1-15	over 15	& Ultimate
1951-55	$170	$388	$558	$54	$60	$114	$2,919	$3,591
1959-64	167	354	521	53	58	110	2,735	3,367
1964-70	152	339	491	58	58	116	2,603	3,210
1970-75	138	309	447	53	55	108	2,399	2,953
1975-77	121	264	385	44	50	94	2,154	2,633

Table 5

INTERCOMPANY SUBSTANDARD ORDINARY MORTALITY EXPERIENCE
SELECT EXPERIENCE BETWEEN 1972 AND 1977 POLICY ANNIVERSARIES
MALES & FEMALES COMBINED - ALL PLANS COMBINED

Duration	Exposed Amount (000's)	Actual Death Amount (000's)	Expected* Death Amount (000's)	Expected* Death Cost Per $1,000 Insurance	Ratio A/E
		Slight Substandard			
1 - 5	$18,981,840	$ 61,082	$ 42,201	$2.22	144.7%
6 -15	11,246,473	98,845	61,622	5.48	160.4
1 -15**	30,952,144	163,633	106,867	3.45	153.1
		Moderate Substandard			
1 - 5	$ 6,236,742	$ 25,609	$ 14,524	$2.33	176.3%
6 -15	2,847,399	35,973	16,814	5.91	213.9
1 -15**	10,390,986	71,564	37,033	3.56	193.2
		High Substandard			
1 - 5	$ 1,464,422	$ 11,091	$ 3,669	$2.51	302.3%
6 -15	739,371	12,570	4,224	5.71	297.6
1 -15**	2,509,162	27,112	9,066	3.61	299.1
		All Substandard			
1 - 5	$26,683,004	$ 97,782	$ 60,394	$2.26	161.9%
6 - 15	14,833,243	147,388	82,660	5.57	178.3
1 -15**	43,852,292	262,309	152,966	3.49	171.5

* Expected deaths based on individual company's own Standard Ordinary Mortality.

** One company submitted data for duration 1-15 combined only, did not subdivide data by duration groups.

NOTE: THE ABOVE TABLE PRESENTS PRELIMINARY RESULTS BASED ON INCOMPLETE DATA.