Future Mortality as a Function of Discontinuous Change

THE SOCIETY OF ACTUARIES is the only professional organization in the United States that recognizes the emerging field of futures studies as an important strategy for long-range forecasting and a complement to the considerable tools of actuarial science. A common interest in the future draws actuarial science and futures studies together, but each has a distinct role to play in preparing for future eventualities.

Actuarial science is a quantitative assessment of probable risks and rewards associated with investment in insurance, annuities, and other financial instruments. Futures studies, on the other hand, is qualitative, focusing not on the extrapolation of trends and the construction of models, but rather on the disruptive effects of sudden and fundamental change. While the exact nature of those changes is hard to predict, their consequences can be significant, particularly given the sums of money that actuaries deal with.

The purpose of this study, sponsored by the Actuarial Foundation and the futurism section of the Society of Actuaries, is to gauge the effects of three potential future disruptions that could affect mortality rates in the United States over the next 20 years. The three disruptions, chosen by the study sponsors, are genetic technologies, anti-aging research, and emerging diseases.

The Impact

Discontinuities and disruptions affect all manner of conditions and trends. In this research, we focus on one specific measure of impact: mortality rates.

Mortality rates have been declining throughout the 20th century, sometimes in dramatic ways. The Social Security Administration reports that mortality improved 1.12 percent per year from 1900 to 1998, and more slowly (0.65 percent per year) from 1982 to 1998. This rate of mortality improvement, year-to-year comparisons of mortality, is the outcome measure for this study.

The more specific research question, then, is whether the target disruptions can change the base rate of mortality improvement.

The Delphi Approach

Predicting potential disruptions from existing data is impossible. Forecasts based on existing data must, in fact, assume no fundamental disruption in existing conditions or trends, since any unforeseen disruption renders the model or the extrapolation invalid. The forecasting of disruptions, therefore, must resort to more subjective sources of data.

Subjective data is less valuable for traditional forecasting, but it is indispensable when other sources of data are inappropriate. For instance, assuming that the future is partially a function of what people expect or want to happen, sometimes called self-fulfilling prophecy, researchers must ask them what they in fact expect or want in order to make those forecasts. Similarly, in forecasting disruptions, the human assessment of the effects of such disruptions is still the best source of data available.

Subjective assessments, however, are prone to two sources of error. One is that people can be so swayed by mainstream opinions or consensus judgments that they lose an independent point of view. They fail to provide interesting differences from the mainstream because

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TABLE 1: Mortality Rate Improvements Start Times

	GENETIC TECHNOLOGY	ANTI-AGING RESEARCH	EMERGING DISEASES
Which is true?			
Effect has already started	7%	20%	67%
Effect will start before 2020	47%	40%	20%
Effect will start after 2020	40%	13%	7%
Effect will never start	7%	27%	7%
What year will it start?			
1st quartile	2011	2001	1982
Median	2020	2010	1985
3rd quartile	2050	2014	1998

they're afraid of being wrong or different.

An equal and opposite error occurs when people differ from the consensus. They're often ignored out of hand because their views aren't mainstream. The rest of the group fails to recognize that once in a while, people have good reasons for their differences, reasons that could even change the majority view if they were given a fair hearing.

The Delphi technique for gathering subjective assessments was developed by Norman Dalkey in the 1960s to counteract both of these tendencies (Dalkey et al., 1969). The Delphi is fundamentally a multi-round survey with interspersed discussion.

The first round of the survey allows respondents to make subjective judgments anonymously and without the influence of other group members. Respondents then discuss the summary results of the first round, paying particular attention to reasons that individuals might disagree about their subjective judgments.

A second-round questionnaire measures how the discussion may have changed respondents' views. Alternating questionnaires and discussions can go through multiple rounds, but Helmer (1983) reports that most of the adjustments take place in the second round. Further rounds are therefore usually unnecessary.

The Questionnaire

The questionnaire instrument consisted of three identical parts of two sections each. Each part was devoted to one of the three target disruptions—genetic technology, anti-aging, and emerging diseases. The objective of the first section, consisting of four questions, was to gather general data about the disruption in question. The four questions were

- Has the disruption already started to affect mortality, will it start before or after 2020, or will it never have an impact on mortality?
- If it is already affecting or will affect mortality, in what year did it or will it start?
- In what year will the effect be largely complete?
- What will the peak rate of mortality improvement be for men and women due to this disruption?

The second section of each part focused on age-specific mortality rates for men and women. Four age groups were selected: 20- to 24-year-olds, 40- to 44-year-olds, 60- to 64-year-olds, and 80- to 84-year-olds. The respondent was given the current morality rate for each age-sex group, the rate predicted for that age group in 2020 by the Social Security Administration as reported in the Berkeley Mortality Database (http://www.demog.berkeley.edu/wilmoth/mortality/), and the percent improvement that the prediction requires. The respondent was then asked to enter a new percent improvement for that period given the potential effects of the target disruption.

The Panel

Selecting the panel of respondents for a Delphi study is crucial, since it's their judgment that's being used to probe the future. The initial panel was supposed to be experts in the three fields of study: genetic technology, anti-aging, and emerging diseases. On reflection, however, it was decided that, while these experts would know a lot about the research areas under investigation, they wouldn't be in a position to judge the effect of that research on mortality rates.

A more general strategy was adopted. Questionnaires were mailed to all the medical schools, schools of public health, and departments of demography in the country. An accompanying letter asked the dean or chair to select a member of the faculty who would be the best person to answer the questionnaire.

Although better than selecting national experts in the field, this approach was also not ideal for two reasons. First, the two-part process probably reduced the overall response rate since some deans and chairs may not have passed the questionnaires to any faculty member at all.

TABLE 2: Overall Mortality Rate Improvements

	BASE RATE 2020	ANNUAL IMPROVEMENT IN 2020 AFTER THE EFFECT OF. . . GENETIC TECHNOLOGY	ANTI-AGING	EMERGING DISEASES
Men				
1st quartile		0.64%	0.71%	0.48%
Median	0.58%	0.78%	0.83%	0.53%
3rd quartile		1.00%	1.00%	0.55%
Women				
1st quartile		0.64%	0.63%	0.38%
Median	0.58%	0.78%	0.87%	0.49%
3rd quartile		1.08%	1.00%	0.53%

Second, the researchers did not have control of who exactly would answer the questionnaire.

The original mailing went to 119 medical schools, 34 schools of public health, and 26 departments of demography. We also mailed the survey to six actuaries. Individuals could register these responses in three ways: 1) by mailing back the form, 2) by faxing back the form, and 3) by taking the survey online at http://gyford.com/mortality/.

From these, we received 16 responses: 10 from schools of medicine, 0 from schools of public health, 3 from departments of demography, 1 actuary, and 2 unknown. The questionnaires returned represent an 8.6 percent response from the original 185 mailed out.

As expected, individuals believed that genetic technology and anti-aging research might improve the overall mortality rate in 2020 by some amount. By the same token, emerging diseases might retard that improvement. Respondents also made adjustments for different target disruptions and for different age groups.

Section One: Overall Improvements

The results from the first two questions relating to the beginning of improvement due to the target disruption showed distinct differences among the three target areas. The results are reported in Table 1.

Individuals were evenly split on whether genetic technology will begin before or after 2020. Fifty-four percent felt that the effect had started or would start before 2020, and 40 percent felt it would start after 2020.

Not so with the other target areas. Respondents felt that if anti-aging research

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TABLE 3: Median Age-specific Mortality Rate Improvements

	BASE RATE 2020	ANNUAL IMPROVEMENT IN 2020 AFTER THE EFFECT OF. . . GENETIC TECHNOLOGY	ANTI-AGING	EMERGING DISEASES
20–24 years				
Men	1.15%	1.35%	1.25%	1.05%
Women	1.23%	1.43%	1.24%	1.18%
40–44 years				
Men	1.42%	1.67%	1.45%	1.37%
Women	1.55%	1.75%	1.60%	1.50%
60–64 years				
Men	1.08%	1.28%	1.24%	1.03%
Women	0.53%	0.73%	0.72%	0.49%
80–84 years				
Men	0.47%	0.57%	0.72%	0.44%
Women	0.58%	0.68%	0.86%	0.55%

was to have any effect at all, it would be sooner than the effect of genetic technology. Fully 60 percent felt the effect would be before 2020 with only 13 percent seeing an effect after that date. More than one-fourth (27 percent), however, didn't think anti-aging research would ever affect mortality rates.

The near-term effect was even more pronounced for emerging diseases. Sixty-seven percent felt that new emerging diseases were already affecting the mortality rate, and another 20 percent thought they would start to do so before 2020.

So overall respondents felt that the target areas could have some impact on mortality rates. The exact size of that effect is reported in Table 2. There the overall mortality rate for men and women is compared with a 2020 base rate of 0.58 percent improvement in mortality per year.

According to the table, respondents felt that anti-aging research had the largest potential improvement to the mortality rate. The median improvement was 0.25 percent over the base rate for men and 0.30 percent for women. The quartiles didn't show that degree of improvement, however, differing only slightly from the quartiles for genetic technology.

Genetic technology could also be expected to provide a significant boost to mortality improvement, 0.20 percent over the base for men and women both.

The effect for emerging diseases was the least. The decline was less than 0.10 percent for both men and women. The low effect could have been for a number of reasons:

Almost two-thirds of respondents (60 percent) felt that the effect of emerging diseases was already being felt.

The United States, with its vast medical establishment, isn't as prone to emerging diseases as other countries are.

Other medical advances, including genetic technology and anti-aging research themselves, might protect the United States even more in the future.

For whatever reason, the effect of emerging diseases on future mortality was considered minimal.

Section II: Age-Specific Improvements

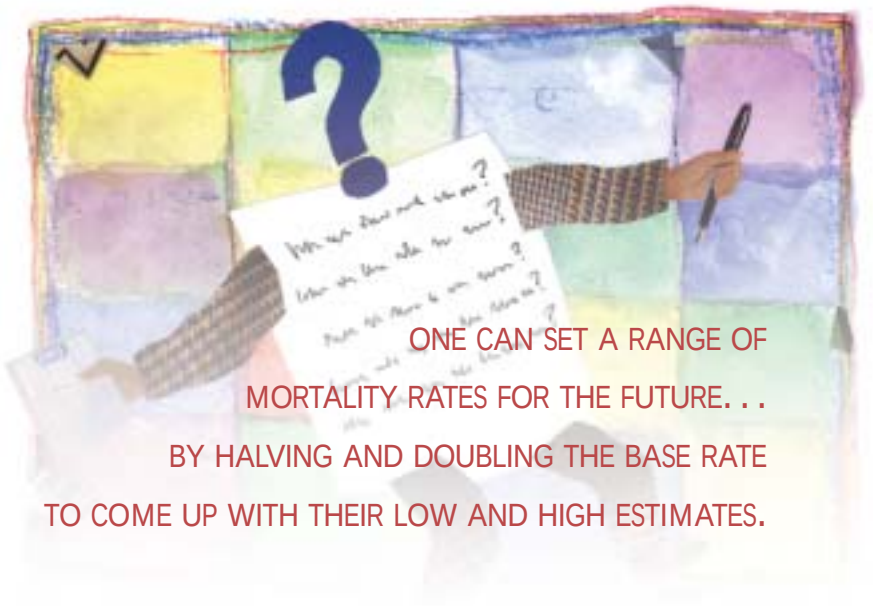
Respondents were also asked to compare possible improvement rates following the effects of these disruptions with the forecasted base rate for specific ages in the year 2020. The results are reported in Table 3.

Genetic technology could improve mortality for every age and sex group. The effect is an extra improvement of approximately 0.20 percent for every age group, except 40- to 44-year-old men, where it's 0.25 percent, and for 80- to 84-year-old men and women, where it's only 0.10 percent. The result is consistent with the 0.20 percent effect reported for genetic technology above.

The distribution of effects for anti-aging research are predictably quite different. The effect for younger people (20 to 24 and 40 to 44 years old) is never more than 0.10 percent (for 20- to 24-year-old men) and is usually negligible. The effect becomes more pronounced for 60- to 64-year-olds with improvement of 0.16 percent and 0.19 percent for men and women respectively. The effect is, of course, most pronounced for the very old (80- to 84-year-olds) where improvements over the base rate of 0.24 percent

to 0.25 percent are possible. The effects are similar for men and women, except for the anomalous large improvement for 20-year-old men.

The effect of emerging diseases was considered the least strong in the overall results, and those results are repeated here. A decline in mortality improvement from 0.03 percent to 0.05 percent is reported for all age groups, and for men and women alike. In other words, respondents now see real disruptive effects due to emerging diseases in the future.



ONE CAN SET A RANGE OF MORTALITY RATES FOR THE FUTURE. . . BY HALVING AND DOUBLING THE BASE RATE TO COME UP WITH THEIR LOW AND HIGH ESTIMATES.

Results of Round Two

Respondents were asked if they would like to participate in a discussion of these results as part of the Delphi process. Four respondents answered that they would, but only three could be scheduled in the two-week period set aside for that discussion. Thus, a telephone conference was held on Friday, January 25 among three respondents and two of the researchers.

The respondents were quite interested in the results, and they provided their overall impression for why the results turned out the way they did. Overall, they felt that the median values for improvement in the first-round results overstated the potential disruptive effect of each of the target areas. They pointed out how long it took to develop significant therapeutic treatments from basic and laboratory-based experiments. They also pointed out that most of the work in genetics and anti-aging is not directed at the major causes of death (cancer, cardiovascular, and pulmonary disorders). Genetic research is focused largely on diagnostic and screening technique, and anti-aging research is attacking the effects of senescence such as bone loss and mental impairment. As a result, they would consider the improvements reported as the top of the plausible range of effects, at best.

On the question of emerging diseases, they felt that even negligible effect may have been overrated because of the recent experience with AIDS and its surprising and persistent onset throughout the country. Again, however, they pointed out that even AIDS doesn't materially alter the overall mortality rate of the country because it affects such a relatively small number of people.

In general, then, the participants were quite sanguine that mortality rates would improve incrementally, as they had over the last few decades, with only minor disruptions at best. Whether these views are representative of all respondents, of course, is another question. Might all respondents have voiced this concern about deviating too far from the base rates if they'd had the chance to reflect on the first-round results? Or was this a somewhat more conservative group of respondents who saw less chance of disruption than most would have?

The participants were asked to take the survey again based on the discussion, but only one had the opportunity to do so. Notably, he showed no effect of disruption at all for genetic technology and anti-aging research, reflecting the conservative nature of the discussion. He did report lower mortality rates due to emerging diseases on the order of 0.01 percent to 0.05 percent, consistent with, but slightly less than, the rates reported in the first round.

Conclusion

Our objective was to assess the impact of potential medical disruptions on future mortality rates. Those disruptions have happened before, and no one could categorically discount they're happening again. The purpose of this research was to measure just how large that disruption could be.

The results speak for themselves. Respondents did believe that some change in mortality rates was possible due to advances in genetic and anti-aging research and less so for the emergence of new diseases.

On the other hand, the data are subjective, and the sample was small and self-selected. The chance to discuss the results and engage in a second round of polling was diminished by the smaller number of respondents who could participate in the first-round discussion and send in second-round results.

In the end, however, one can set a range of mortality rates for the future the way the Social Security Administration does, by halving and doubling the base rate to come up with their low and high estimates. That is a rather arbitrary procedure. This research has tried to provide an alternative perspective to how to set ranges on future mortality rates for actuaries who must base their forecasts on those rates every day. ●

Resources

Dalkey, N., B. Brown, and S. Cochran. "The Delphi Method, III: Use of Self Ratings to Improve Group Estimates." RAND Corporation, 1969. (http://www.rand.org/publications/classics/delphi3.pdf).

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