8 PRIORITIES FOR RESEARCH ON THE BENEFITS OF HEALTH, SAFETY, AND ENVIRONMENTAL REGULATION

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The benefits of health and safety regulation and, to a considerable extent, environmental regulation are a function of the number of deaths, illnesses, and injuries averted. Our workshop concurred that the top priority for research on the benefits of this social regulation should be more and better counting of these mortality and morbidity effects. Research studies here would address the following kinds of questions: How many lives and limbs have particular regulatory standards and strategies saved? How many lives and limbs could alternative standards and strategies save? Which regulatory strategies adopted by different agencies and different countries are most effective in reducing mortality and morbidity? In which areas are the prospects for saving lives and limbs most promising?

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The perceived benefits of various health and safety regulations often differ radically from the benefits as measured by the actual reduction in mortality and morbidity. Our workshop agreed that the number two priority for research on the benefits of social regulation should be studies of why and how public perceptions of and concerns about various health, safety, and environmental risks deviate from the levels actuarial calculations would suggest. The purpose of these studies would be to help policymakers: (1) better respond to public concerns, and (2) better inform and educate the public.

In deciding which regulatory standards to enact, it is necessary to weigh and make tradeoffs among various competing objectives. In determining the overall benefits of some regulatory policy, averting a sprained ankle clearly should count less than averting a death, averting a death at age ninety less than averting a death at age twenty-five, and averting a death thirty years from now less than averting a death today. Our workshop felt that the third priority for research on the benefits of social regulation should be studies of how best to evaluate the overall desirability of the basket of mortality, morbidity, and environmental benefits produced by some policy. Most of the workshop group believed that although there were a variety of intellectually stimulating and potentially useful research topics here, this field of inquiry was currently of tertiary importance.

PRIORITY 1: MORE AND BETTER COUNTING OF LIVES AND LIMBS

Rationale

The primary mission of most of the new social regulation agencies—including the Occupational Safety and Health Administration (OSHA), the Consumer Product Safety Commission (CPSC), the National Highway Traffic Safety Administration (NHTSA), the Food and Drug Administration (FDA), and, to a considerable extent, the Environmental Protection Agency (EPA)—is to save lives and limbs, when "limbs" is shorthand for non-fatal illness and accident. The potential is enormous:

- Nearly 2 million people will die this year in the United States, most of them from causes other than "old age": three-fifths of the deaths will be before age seventy-five; and over a third, before age sixty-five. Some 50,000 infants will die, over 40,000 children and teenagers, nearly 50,000 young adults in their twenties, and more than half a million people in those prime and productive years between ages thirty and sixty-five (National Center for Health Statistics 1978).
- The adult population (age seventeen and over), will suffer this year an average of twenty "restricted activity days" per person and spend eight days sick in bed. A quarter will visit a physician at least five times and more than an eighth will be hospitalized at least once.
- Over a full work week will be lost, on average, because of illness among the employed, and more than a tenth of this loss will be due to occupational injury and illness. In total, occupational injury and illness will cost some 35 million work days. Consumer-product-related injuries, caused by falling off stairs, slipping in bathtubs, running into doors, cutting, burning, poisoning, and so on, will result in nearly 9 million people rushing to be treated in hospital emergency rooms.

As a result of various accidents and diseases, more than half a million people currently are blind or so visually impaired that they cannot "carry on major activity" and nearly half a million people are unable to carry on major activity because of paralysis.[1]

How much, however, can be done to reduce the incidence of mortality and morbidity in the United States and thus decrease the staggering social losses and personal tragedies summarized by these macabre statistics? A variety of indirect evidence suggests that substantial progress could indeed be made.[2]

Some of the evidence concerns the large health differentials, both in general and for specific causes of illness and death, between various groups—blacks versus whites, the poor versus the affluent, the poorly-educated versus the well-educated, males versus females, residents of Nevada versus Utah, Japanese Americans and Seventh Day Adventists versus other

Americans, and so on. Although the differentials may be partially due to climate or genetics or other factors largely beyond our control, it does seem plausible that factors—such as health care, hazardous behavior, and pollution levels—that can be affected by public policies play a major role.

Other suggestive evidence involves the long-term downward trends in mortality and morbidity rates. For example, the likelihood of early death—that is, the probability, at prevailing mortality rates, that a new-born would die before age 65—fell from some 61 percent at the turn of the century to under 24 percent in 1979. The rate of progress has been remarkably steady, close to half a percentage point reduction year after year. If this progress could be continued, then in half a century, the likelihood of death before age 65 would be reduced to virtually zero. This is, perhaps, not quite so impossible a goal as it may at first seem: in 1900, almost a quarter of new-borns could be expected to die before age 15, but today the likelihood of death before age 15 has been reduced to under 2 percent.

The most striking evidence that the incidence of mortality and morbidity in the United States might be substantially reduced is given by comparisons with other developed countries. A good summary indicator here, as before, is the likelihood of early death, that is, death before age sixty-five. The United States falls near the bottom of the list of countries for which recent data are available, behind all other major industrialized nations and behind a number of less-developed countries as well. In Sweden, which ranks first, the likelihood of early death is a third less than it is in the United States. If U.S. early death rates could be reduced to Swedish levels, nearly a quarter of a million early deaths could be averted every year. Similar international differentials exist for specific causes or kinds of death or serious illness. For example, Swedish rates of infant mortality, fatal accidents, and fatal cardiovascular disease before age sixty-five are all less than two-thirds of U.S. levels.

The Range of Policy Options

Given the staggering aggregate losses and glaring inequalities caused by illness, disability, and untimely death and given the array of evidence that substantial progress could be made in saving lives and limbs, it is not surprising that enormous efforts are being made to achieve this progress. Our health and safety industry is vast, currently absorbing on the order of one-tenth of the gross national product, or roughly $200 billion. And it is extremely diverse. On the federal level alone, there are scores of agencies concerned with different aspects of health and safety. State, local, and private agencies and organizations can be counted by the hundreds. One compilation (the *Medical and Health Information Directory* 1977) lists 172 federal agencies and 248 federal grants and domestic assistance programs in medicine and health. A second, narrower listing of agencies and organizations involved in the promotion of transportation safety runs on for ten closely printed pages (U.S., Congress 1977).

These agencies have various focuses, including medical care, preventive medicine, biomedical research, nutrition, health education and health and safety regulation. Scrutiny of any one of these categories yields the same two basic conclusions. First, in each area much is currently being done, but much more could be done. The simple fact that there are so many options provides some additional hope that the incidence of mortality and morbidity could be reduced. Second, exactly what should be done is by no means clear. Very little is known about the desirability and effectiveness of the available options or, indeed, about existing programs. Where careful studies have been made—OSHA, CPSC, FDA, various surgical procedures, or various medical screening tests, for example—the analyst usually concludes that the benefits of what is being done are hardly worth the costs.[3] We have only a vague understanding of why the incidence of mortality and morbidity has been declining, although there is some evidence that most of the decline can be attributed to rising standards of living rather than any particular program aimed at averting deaths or illness. And we have an even vaguer understanding of exactly what we should do to further reduce accidents and disease.

Strong evidence that mortality and morbidity could be substantially reduced, numerous options for doing so, but vast ignorance about particulars—these triple facts imply an adaptive, multipronged learning strategy based on extensive but judicious experimentation and thorough, careful evalua-

tion of costs and benefits. This is essentially the strategy we have been following, except we have done little systematic experimentation and evaluation. We have tried lots of things, but we have not watched carefully what we were doing, and, as a consequence, we have not learned much. Too few controlled experiments have been done; too little painstaking evaluation has been carried out; too many hasty and costly actions, as well as too many inadequate and long-delayed nonactions, have been taken without careful analysis.

Given this state of affairs, it seemed clear to our workshop that the top priority in research on the benefits of health and safety regulation should be given to studies that evaluate how many lives and limbs have been or could be saved by alternative regulations and regulatory strategies. Such research would help the regulatory agencies decide where they could do the most good and help the public and its elected representatives decide which agencies deserve the most support. Regulatory agencies have a tendency to lose sight of their intended goals: consider, for example, the Civil Aeronautics Board before John Robeson and Alfred Kahn, where welfare of existing members of the aviation industry was given the primary consideration, at the expense of the general public. Research that counts lives and limbs will serve to remind the health and safety agencies that their purpose is to save lives and protect health and that they will be judged not only on the goodness of their intentions and on their responsiveness to symbolic politics, but also on how successful they are in significantly reducing the tragically high incidence of mortality and morbidity. Such research is a crucial element of any learning strategy designed to help agencies improve their performance by providing them with feedback and predictions.

Research Topics

Our workshop identified three kinds of research that would be useful here: prospective studies, retrospective studies, and so-called epidemiological studies. Numerous prospective studies have been done by regulatory agencies, their consultants, public interest groups, academics, and industry concerning regulation of such hazards as saccharin, lawn mowers, benzene, and the emissions of coal-burning plants, and such safety devices as air bags and motorcycle helmets.[4] Surprisingly few of these studies have devoted any systematic attention to the central question of how many lives and limbs the regulation in question would save. Most of the studies have been restricted to determining whether some substance or activity can be hazardous, but have largely ignored the question of how hazardous.

Those studies that have made some attempt to estimate health benefits have usually calculated overestimates based on partial analysis. For example, the FDA's estimate that a ban on saccharin would avert 1,200 cases of bladder cancer per year was based on a single rat experiment; previous, less pessimistic experiments were ignored. Furthermore, the estimate was based on the 95 percent confidence bound on the susceptibility of the most sensitive subpopulation (second-generation male rats) in that experiment. The extrapolation to humans assumed that Americans would drink an average of a can of diet soda per day over their entire life spans. Possible beneficial health effects of saccharin for diabetics and the obesity, for example, were not considered (Food and Drug Administration 1977). Thus, although the FDA did calculate an estimate, it was by no means a best-guess estimate, but rather a very "prudent" overestimate. For decisionmaking purposes, such overestimates are less useful than estimates of the mean value of the uncertain quantity of concern, supplemented by some estimates of the spread of the probability distribution.[5]

It clearly is much less difficult to determine that benzene may be a carcinogen or that swimming pool slides may be dangerous than it is to estimate how many deaths would be averted by a ban on benzene or how many injuries would be averted by a manufacturing standard for swimming pool slides. But difficult as estimation of health and safety benefits may be, even order-of-magnitude guesstimates can be informative: it is useful to know whether a standard may save around 1 life per year, 1,000 lives, or 100,000 lives. Research that only very roughly estimates the health and safety benefits of alternative regulatory standards and strategies will help regulatory agencies and the public sort out regulatory priorities. Beyond this,

such studies will give analysts more experience in calculating mortality and morbidity effects and will encourage them to develop better methods for more accurate calculations.

Retrospective evaluations of the mortality and morbidity reductions achieved by regulatory standards would also be useful. What, for example, has been the effect of the 55 mile-per-hour speed limit? What has been the effect of OSHA's highly criticized standards concerning the construction and use of ladders? If a prospective analysis of some standard were done, a retrospective study could compare the prediction with the results to draw lessons about how to better forecast health and safety benefits.

Epidemiological studies analyze patterns of mortality and morbidity and thus are useful in identifying promising opportunities for saving lives and limbs. Why, for instance, do blacks suffer a much higher death rate than whites? Why does Sweden have a far lower death rate than the United States? Why do workers in some industries have much higher death rates than in other industries?

So many hazardous substances and activities have been identified—from eating eggs to living in brick buildings—that there would seem to be little payoff in identifying additional minor hazards to worry about. A more pressing research priority is to sort through what people die from and are injured by—and, in particular, what some people die from and are injured by a lot more often than from other sources—in order to identify the areas where the greatest potential exists for saving lives and limbs. It was comparative epidemiological research of this kind that suggested that air pollution may be a major killer (Lave and Seskin 1977). Other epidemiological research has uncovered the importance of poverty and poor education as a correlate of illness and early death. Perhaps the most effective way to save lives and limbs would be through economic growth, redistribution of income, or reorganization of the medical system, rather than health and safety regulation.[6]

Unfortunately, the kind of large and detailed data base required for many kinds of epidemiological research—on, for example, the effects of a variety of toxic substances—is often very costly and time-consuming to assemble. Furthermore, relatively few researchers are well trained in the appropriate

methods of epidemiology. On the other hand, enormous, if limited, files of health-related data do exist, assembled by the Bureau of the Census, the Public Health Service, the CPSC, and other agencies. And the methods of epidemiology are relatively easily mastered (and improved on) by people trained in quantitative economics, demography, mathematical statistics, or applied mathematics. Indeed, it is economists who are doing some of the most pathbreaking epidemiological research today. (Fuchs 1975; Kneese 1981; Lave and Seskin 1977).

What to Count

Since the principal purpose of health and safety regulation is to save lives and limbs, the thrust of these prospective, retrospective, and epidemiological studies should be to count, as accurately as the incomplete data permits, the number of lives saved and the number of injuries and illnesses of varying degrees of severity averted. The consequences of death are so much more severe than the consequences of most illnesses and injuries that the emphasis in most of these studies should be on lives saved.

Some refinements may be useful here (see Zeckhauser and Shepard 1976). Lives are never really saved; they are extended. Consequently, it may be informative to measure life years saved or to measure change in life expectancy. Dose-response curves that estimate the number of deaths at different degrees of exposure may be helpful in determining how many additional lives could be saved by lowering exposure levels. Since predictions of health and safety effects are almost always uncertain, it will usually be informative to provide estimates of the range of uncertainty. Finally, if mortality and morbidity effects are delayed, it will be useful to describe the nature and length of the delay.

Participants in our workshop suggested a rich variety of other effects that may be of some interest. These include various unintended and spillover effects; distributional impacts; synergistic effects; effects on productivity and innovation; changes in advertising behavior, strength of brand names, and degree of competition; effects on the quality of business and

personal decisionmaking; degree of compliance; and esthetic effects.

Such staggering lists of considerations are useful reminders of how difficult it is to do a comprehensive analysis. Such lists, however, should not paralyze analysts. Although many kinds of effects may in some cases be worth estimating, they should in no case be given undue emphasis or be allowed to detract from the primary goal of research in this area, namely, to estimate the number of lives and limbs that health and safety regulations have saved or could save.

Simple and direct calculations that can be done are superior to comprehensive analyses that are too hard to do. This, of course, is not to say that comprehensive analyses are not highly desirable when practicable. In coping, however, with the buzzing confusion of risks we face, some straightforward counting of lives and limbs can go a long way in helping us to uncover problem areas, to set priorities, and to gain a sense of perspective.

PRIORITY 2: BETTER UNDERSTANDING OF PUBLIC CONCERNS AND PERCEPTIONS

Public perceptions of various health, safety, and environmental risks often differ substantially from the true, actuarial risks. Most people seem resigned to tolerate certain risks such as drunken driving or cigarette smoking, although they seem (at least to some analysts) to be "paranoid" about the far smaller risks of, say, flying in an airplane.

Public perceptions are clearly an important influence, and often the dominant influence, on regulatory decisions. Some members of our workshop felt that this was no bad thing. Just as the bulk of our medical care system is devoted to comforting and reassuring the public, to caring for people rather than to curing diseases, so it may be the case that our health and safety regulatory agencies provide valuable benefits by reassuring people and responding to their fears, even if the actual number of lives and limbs saved is small. To the extent that this is true, however, it would be useful to better understand the nature of people's worries about health and safety hazards. Given this knowledge, agencies could respond more directly and effectively to public desires. Furthermore, it might be possible to develop more efficient strategies for government action, involving perhaps some alternatives to regulation such as education and the provision of information (Kleindorfer and Kunreuther 1981; Chapter 2). The workshop group concurred that research on public perceptions should not be given as high a priority as research on estimating actual mortality and morbidity effects. But most members of the group felt that research here should be given almost as high a priority.

An Array of Research Questions

A variety of research topics were suggested,[7] including studies of:

- Perceived versus actual risks
- The kinds of risks people are particularly concerned about
- How people decide to avoid or accommodate different kinds of risks
- When liberty matters and, more generally, how people feel about being constrained from taking various kinds of risks
- How people feel about labeling, including the costs of having too many warnings
- The importance to people of symbols such as the "priceless-ness of life" and the fact that society will not abandon you
- How people feel about voluntary versus involuntary risks and known versus unknown risks
- What kinds of risks are considered to be reasonable and acceptable
- How people acquire or lose confidence in products, companies, industries, and governmental agencies
- How perceptions about risks, including the perceptions of children, semiliterates, and the gullible, are influenced by various kinds of information, including advertisements

One question that seemed especially interesting was: Does the public's perception of risk depend on how the risk is expressed (Tversky and Kahneman, unpublished). Research on

this question would be useful in deciding how to communicate information about hazards. Consider, for example, the hazardousness of eggs. Egg yolks contain cholesterol, and there is some evidence that eating cholesterol increases the risk of heart disease. Vaupel and Graham (1980) calculated the following "prudent overestimates":

- "Each egg that the average American cuts out of his or her weekly consumption of eggs may reduce the yearly chances of dying from coronary heart disease by about one-third of one percent.
- "Totally eliminating eggs from our diet might increase life expectancy by twenty days.
- "Each egg consumed may reduce average life expectancy by . . . about one minute.
- "Halving current egg consumption of five eggs per week might save 5,000 lives per year; eliminating eggs, some 10,000 lives per year.
- "Eating ten dozen eggs is less hazardous than smoking a single pack of cigarettes.
- "One death occurs for every six million eggs eaten."

All of these "prudent overestimates" are calculated on the basis of the same data sources: the figures are all consistent with each other. To most people, however, the hazardousness of eggs seems quite different depending on how that hazardousness is measured.

Research Approaches

The participants in the workshop felt that a number of approaches would be useful in investigating questions about people's concerns and perceptions. These approaches included:

- Small-group experiments. (see Chapter 6)
- Large-scale surveys.
- Studies of preferences revealed by actual behavior.
- Studies of the perceptions and concerns of small groups of decisionmakers and opinion leaders in government, industry, unions, public interest groups, and news media. One interesting group to study would be the five commissioners of the CPSC.

PRIORITY 3: WEIGHING AND MAKING TRADEOFFS AMONG COMPETING OBJECTIVES

Any particular health or safety regulation produces a number of consequences along different dimensions. This often makes it hard to determine whether the overall benefits of one regulatory standard are better than those of another. Is it better to save the lives of ten twenty year olds or fifty eighty year olds? Is it better to save ten lives now or twenty lives fifty years from now? Is it better to save one life or to avert 500 sprained ankles? Is it worth spending an extra $100 on a lawn mower if the risk of injury is cut in half? Is it worthwhile to restrict people's liberty—by requiring drivers to fasten their seatbelts, say, or to drive less than 55 miles per hour—if 10,000 lives per year could be saved?

The answers to these questions are by no means clear. Some controversial, partial answers have been developed by researchers in the field of study commonly known as "cost-benefit analysis." Our workshop devoted considerable time to discussing the value of further research in this area. The discussion revealed a sharp division of opinion on the benefits of cost-benefit analysis. Cost-benefit analysis excites passionate loyalties and animosities. One interesting set of research questions would thus appear to be: Why is cost-benefit analysis so controversial? Can it be modified somehow so it will be better received and more widely used? Are there alternative methods, such as the methods of multiattribute utility theory developed by decision analysts (Keeney and Raiffa 1972), that would be more useful to regulatory decisionmakers?

A second set of research questions raised in the discussion concerned whether wider use of cost-benefit analysis would make any difference. That is, if more cost-benefit analysis were done as part of the complex deliberatory process for making health, safety, and environmental decisions, would the decisions be significantly different, and socially more beneficial?

A third and final set of research questions concerned the further development of the methods of cost-benefit analysis. Among the topics suggested were:

- How should incommensurables, such as lives, environmental quality, and productivity, be weighted against each other? What are the alternatives to costing out incommensurables in monetary equivalents (Keeney and Raiffa 1972)?
- When it is useful to do so, how should benefits be translated into dollar equivalents to enable comparison with dollar costs? More specifically, what is the monetary value of life-saving programs (Acton 1976)?
- What weight should be placed on distant benefits accruing to future generations? More specifically, what discount rate should be applied to health and safety benefits?
- How can more useful and acceptable quality-of-life and health status indexes be developed?
- What weight should be placed on the health and safety of vulnerable or disadvantaged groups, such as children, the elderly, the handicapped, blacks, or migrant workers?
- How should uncertain uncertainties be handled, especially health and safety risks that are probably small but might be large?

The workshop group felt that questions of this sort were of considerable intellectual interest and of some practical significance. The consensus, however, was that research on the methods of cost-benefit analysis or on the more general topic of how best to weigh and make tradeoffs among competing objectives would probably prove to be far less useful at the present time than research on predicting and evaluating the mortality and morbidity effects of health and safety policies or research on public concerns and perceptions.

There were two arguments for this view. First, the conceptual difficulties and ideological disputes concerning cost-benefit analysis are so great that the likelihood that additional research would produce significant and widely acceptable breakthroughs seemed small. Second, given accurate and comprehensible estimates of the mortality and morbidity effects of various policy options, it seemed unlikely to most members of the workshop that different schemes for weighting and adding up the benefits of these effects would substantially alter decisions about the relative desirability of the options.

There was some dispute about this. An interesting research project would be whether wider use of cost-benefit analysis could significantly improve the performance of health and safety regulators. The consensus of the group, however, was that at least over the next decade the greatest potential for helping the health and safety regulators to learn how to improve their performance lay in research that counted lives and limbs saved, and to a somewhat lesser extent, in research that analyzed public concerns and perceptions.

NOTES

1. The statistics in these paragraphs are from Public Health Service (1977).
2. See Vaupel (1978) for references to this literature.
3. See Vaupel (1978: 73–118) for a survey.
4. For samples of these studies see Food and Drug Administration (1977) on saccharin; Stanford Research Institute (1977) on lawnmowers; Environmental Protection Agency (1979) on benzene; Lave and Seskin (1977) on air pollutants; and National Highway Traffic Safety Administration (1980a, 1980b) on air bags and motorcycle helmets. For a general discussion of several of these hazards see Wilson and Crouch (In Press) and Green and Waitzman (1979).
5. The standard introduction to division analyses is Raiffa (1968)
6. See Vaupel (1978) for further discussion. Interesting epidemiological work includes Kneese (1981), Kitagawa and Hauser (1973), and Fuchs (1975).
7. Baruch Fischhoff, Paul Slovic, and Sarah Lichtenstein at Decision Research in Eugene, Oregon have done a variety of studies on some of these research topics. Fischhoff, Baruch, Paul Slovic, and Sarah Lichtenstein. In Press. "Lay Foibles and Expert Fables in Judgments About Risk." In *Progress in Resource Management and Environmental Planning*, vol. 3, edited by T. O'Riordan and R.K. Turner. Chichester: Wiley. This study includes references to earlier studies by the authors.
8. The best survey of these issues can be found in Acton (1976).

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