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The Questionable Contribution of Medical Measures to the Decline of Mortality in the United States in the Twentieth Century

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“. . . by the time laboratory medicine came effectively into the picture the job had been carried far toward completion by the humanitarians and social reformers of the nineteenth century. Their doctrine that nature is holy and healthful was scientifically naive but proved highly effective in dealing with the most important health problems of their age. When the tide is receding from the beach it is easy to have the illusion that one can empty the ocean by removing water with a pail.”

*R. Dubos, Mirage of Health,
New York: Perennial Library, 1959, p. 23*

Introducing a Medical Heresy

The modern “heresy” that medical care (as it is traditionally conceived) is generally unrelated to improvements in the health of populations (as distinct from individuals) is still dismissed as unthinkable in much the same way as the so-called heresies of former times. And this is despite a long history of support in popular and scientific writings as well as from able minds in a variety of disciplines. History is replete with examples of how, understandably enough, self-interested individuals and groups denounced popular customs and beliefs which appeared to threaten their own domains of practice, thereby rendering them heresies (for example, physicians’ denunciation of midwives as witches, during the Middle Ages). We also know that vast institutional resources have often been deployed to neutralize challenges to the assumptions upon which everyday organizational activities were founded and legitimated (for example, the Spanish Inquisition). And since it is usually difficult for organizations themselves to directly combat threatening

“heresies,” we often find otherwise credible practitioners, perhaps unwittingly, serving the interests or organizations in this capacity. These historical responses may find a modern parallel in the way the everyday practitioners of medicine, on their own altruistic or “scientific” grounds and still perhaps unwittingly, serve present-day institutions (hospital complexes, university medical centers, pharmaceutical houses, and insurance companies) by spearheading an assault on a most fundamental challenging heresy of our time: *that the introduction of specific medical measures and/or the expansion of medical services are generally not responsible for most of the modern decline in mortality.*

In different historical epochs and cultures, there appear to be characteristic ways of explaining the arrival and departure of natural vicissitudes. For salvation from some plague, it may be that the gods were appeased, good works rewarded, or some imbalance in nature corrected. And there always seems to be some person or group (witch doctors, priests, medicine men) able to persuade others, sometimes on the basis of acceptable evidence for most people at that time, that they have *the* explanation for the phenomenon in question and may even claim responsibility for it. They also seem to benefit most from common acceptance of the explanations they offer. It is not uncommon today for biotechnological knowledge and specific medical interventions to be invoked as *the major reason* for most of the modern (twentieth century) decline in mortality.¹ Responsibility for this decline is often claimed by, or ascribed to, the present-day major beneficiaries of this prevailing explanation. But both in terms of the history of knowledge and on the basis of data presented in this paper, one can reasonably wonder whether the supposedly more sophisticated explanations proffered in our own time (while seemingly distinguishable from those accepted in the past) are really all that different from those of other cultures and earlier times, or any more reliable. Is medicine, the

¹It is obviously important to distinguish between (a) advances in knowledge of the cause and natural course of some condition and (b) improvements in our ability to effectively treat some condition (that is, to alter its natural course). In many instances these two areas are disjoint and appear at different stages of development. There are, on the one hand, disease processes about which considerable knowledge has been accrued, yet this has not resulted (nor necessarily will) in the development of effective treatments. On the other hand, there are conditions for which demonstrably effective treatments have been devised in the absence of knowledge of the disease process and/or its causes.

physician, or the medical profession any more entitled to claim responsibility for the decline in mortality that obviously has occurred in this century than, say, some folk hero or aristocracy of priests sometime in the past?

Aims

Our general intention in this paper is to sustain the ongoing debate on the questionable contribution of specific medical measures and/or the expansion of medical services to the observable decline in mortality in the twentieth century. More specifically, the following three tasks are addressed: (a) selected studies are reviewed which illustrate that, far from being idiosyncratic and/or heretical, the issue addressed in this paper has a long history, is the subject of considerable attention elsewhere, attracts able minds from a variety of disciplines, and remains a timely issue for concern and research; (b) age- and sex-adjusted mortality rates (standardized to the population of 1900) for the United States, 1900–1973, are presented and then considered in relation to a number of specific and supposedly effective medical interventions (both chemotherapeutic and prophylactic). So far as we know, this is the first time such data have been employed for this particular purpose in the United States, although reference will be made to a similar study for England and Wales; and (c) some policy implications are outlined.

Background to the Issue

The beginning of the serious debate on the questionable contribution of medical measures is commonly associated with the appearance, in Britain, of Talbot Griffith's (1967) *Population Problems in the Age of Malthus*. After examining certain medical activities associated with the eighteenth century—particularly the growth of hospital, dispensary, and midwifery services, additions to knowledge of physiology and anatomy, and the introduction of smallpox inoculation—Griffith concluded that they made important contributions to the observable decline in mortality at that time. Since then, in Britain and more recently in the United States, this debate has continued, regularly engaging scholars from economic history, demography, epidemiology, statistics, and other disciplines. Habakkuk

(1953), an economic historian, was probably the first to seriously challenge the prevailing view that the modern increase in population was due to a fall in the death rate attributable to medical interventions. His view was that this rise in population resulted from an increase in the birth rate, which, in turn, was associated with social, economic, and industrial changes in the eighteenth century.

McKeown, without doubt, has pursued the argument more consistently and with greater effect than any other researcher, and the reader is referred to his recent work for more detailed background information. Employing the data and techniques of historical demography, McKeown (a physician by training) has provided a detailed and convincing analysis of the major reasons for the decline of mortality in England and Wales during the eighteenth, nineteenth, and twentieth centuries (McKeown et al., 1955, 1962, 1975). For the eighteenth century, he concludes that the decline was largely attributable to improvements in the environment. His findings for the nineteenth century are summarized as follows:

. . . the decline of mortality in the second half of the nineteenth century was due wholly to a reduction of deaths from infectious diseases; there was no evidence of a decline in other causes of death. Examination of the diseases which contributed to the decline suggested that the main influences were: (a) rising standards of living, of which the most significant feature was a better diet; (b) improvements in hygiene; and (c) a favorable trend in the relationship between some micro-organisms and the human host. *Therapy made no contributions, and the effect of immunization was restricted to smallpox which accounted for only about one-twentieth of the reduction of the death rate.* [Emphasis added. McKeown et al., 1975, p. 391]

While McKeown's interpretation is based on the experience of England and Wales, he has examined its credibility in the light of the very different circumstances which existed in four other European countries: Sweden, France, Ireland, and Hungary (McKeown et al., 1972). His interpretation appears to withstand this cross-examination. As for the twentieth century (1901–1971 is the period actually considered), McKeown argues that about three-quarters of the decline was associated with control of infectious diseases and the remainder with conditions not attributable to micro-organisms. He distinguishes the infections according to their modes of transmission (air- water- or food-borne) and isolates three types of influences which figure during the period considered: medical measures (spe-

cific therapies and immunization), reduced exposure to infection, and improved nutrition. His conclusion is that:

the main influences on the decline in mortality were improved nutrition on air-borne infections, reduced exposure (from better hygiene) on water- and food-borne diseases and, less certainly, immunization and therapy on the large number of conditions included in the miscellaneous group. Since these three classes were responsible respectively for nearly half, one-sixth, and one-tenth of the fall in the death rate, it is probably that the advancement in nutrition was the major influence. [McKeown et al., 1975, p. 422]

More than twenty years of research by McKeown and his colleagues recently culminated in two books—*The Modern Rise of Population* (1976a) and *The Role of Medicine: Dream, Mirage or Nemesis* (1976b)—in which he draws together his many excellent contributions. That the thesis he advances remains highly newsworthy is evidenced by recent editorial reaction in *The Times* of London (1977).

No one in the United States has pursued this thesis with the rigor and consistency which characterize the work by McKeown and his colleagues in Britain. Around 1930, there were several limited discussions of the questionable effect of medical measures on selected infectious diseases like diphtheria (Lee, 1931; Wilson and Miles, 1946; Bolduan, 1930) and pneumonia (Pfizer and Co., 1953). In a presidential address to the American Association of Immunologists in 1954 (frequently referred to by McKeown), Magill (1955) marshalled an assortment of data then available—some from England and Wales—to cast doubt on the plausibility of existing accounts of the decline in mortality for several conditions. Probably the most influential work in the United States is that of Dubos who, principally in *Mirage of Health* (1959), *Man Adapting* (1965), and *Man, Medicine and Environment* (1968), focused on the non-medical reasons for changes in the health of overall populations. In another presidential address, this time to the Infectious Diseases Society of America, Kass (1971), again employing data from England and Wales, argued that most of the decline in mortality for most infectious conditions occurred prior to the discovery of either “the cause” of the disease or some purported “treatment” for it. Before the same society and largely on the basis of clinical experience with infectious diseases and data from a single state (Massachusetts), Weinstein (1974), while conceding there are some effective

treatments which seem to yield a favorable outcome (e.g., for poliomyelitis, tuberculosis, and possibly smallpox), argued that despite the presence of supposedly effective treatments some conditions may have increased (e.g., subacute bacterial endocarditis, streptococcal pharyngitis, pneumococcal pneumonia, gonorrhea, and syphilis) and also that mortality for yet other conditions shows improvement in the absence of any treatment (e.g., chickenpox). With the appearance of his book, *Who Shall Live?* (1974), Fuchs, a health economist, contributed to the resurgence of interest in the relative contribution of medical care to the modern decline in mortality in the United States. He believes there has been an unprecedented improvement in health in the United States since about the middle of the eighteenth century, associated primarily with a rise in real income. While agreeing with much of Fuchs' thesis, we will present evidence which seriously questions his belief that "beginning in the mid '30s, major therapeutic discoveries made significant contributions independently of the rise in real income."

Although neither representative nor exhaustive, this brief and selective background should serve to introduce the analysis which follows. Our intention is to highlight the following: (a) the debate over the questionable contribution of medical measures to the modern decline of mortality has a long history and remains topical; (b) although sometimes popularly associated with dilettantes such as Ivan Illich (1976), the debate continues to preoccupy able scholars from a variety of disciplines and remains a matter of concern to the most learned societies; (c) although of emerging interest in the United States, the issue is already a matter of concern and considerable research elsewhere; (d) to the extent that the subject has been pursued in the United States, there has been a restrictive tendency to focus on a few selected diseases, or to employ only statewide data, or to apply evidence from England and Wales directly to the United States situation.

How Reliable are Mortality Statistics?

We have argued elsewhere that mortality statistics are inadequate and can be misleading as indicators of a nation's overall health status (McKinlay and McKinlay, forthcoming). Unfortunately, these are the only types of data which are readily accessible for the examination of time trends, simply because comparable morbidity

and disability data have not been available. Apart from this overriding problem, several additional caveats in the use of mortality statistics are: (a) difficulties introduced by changes in the registration area in the United States in the early twentieth century; (b) that often no single disease, but a complex of conditions, may be responsible for death (Krueger, 1966); (c) that studies reveal considerable inaccuracies in recording the cause of death (Moriyama et al., 1958); (d) that there are changes over time in what it is fashionable to diagnose (for example, ischaemic heart disease and cerebrovascular disease); (e) that changes in disease classifications (Dunn and Shackley, 1945) make it difficult to compare some conditions over time and between countries (Reid and Rose, 1964); (f) that some conditions result in immediate death while others have an extended period of latency; and (g) that many conditions are severely debilitating and consume vast medical resources but are now generally non-fatal (e.g., arthritis and diabetes). Other obvious limitations could be added to this list.

However, it would be foolhardy indeed to dismiss all studies based on mortality measures simply because they are possibly beset *with known limitations*. Such data are preferable to those the limitations of which are either unknown or, if known, cannot be estimated. Because of an overawareness of potential inaccuracies, there is a timorous tendency to disregard or devalue studies based on mortality evidence, even though there are innumerable examples of their fruitful use as a basis for planning and informed social action (Alderson, 1976). Sir Austin Bradford Hill (1955) considers one of the most important features of Snow's work on cholera to be his adept use of mortality statistics. A more recent notable example is the study by Inman and Adelstein (1969) of the circumstantial link between the excessive absorption of bronchodilators from pressurized aerosols and the epidemic rise in asthma mortality in children aged ten to fourteen years. Moreover, there is evidence that some of the known inaccuracies of mortality data tend to cancel each other out.² Consequently, while mortality statistics may be unreliable for

²Barker and Rose cite one study which compared the ante-mortem and autopsy diagnoses in 9,501 deaths which occurred in 75 different hospitals. Despite lack of a concurrence on *individual* cases, the *overall* frequency was very similar in diagnoses obtained on either an ante-mortem or a post-mortem basis. As an example they note that clinical diagnoses of carcinoma of the rectum were confirmed at autopsy in only 67 percent of cases, but the incorrect clinical diagnoses were balanced by an almost identical number of lesions diagnosed for the first time at autopsy (Barker and Rose, 1976).

use in individual cases, when pooled for a country and employed in population studies, they can reveal important trends and generate fruitful hypotheses. They have already resulted in informed social action (for example, the use of geographical distributions of mortality in the field of environmental pollution).

Whatever limitations and risks may be associated with the use of mortality statistics, they obviously apply equally to all studies which employ them—both those which attribute the decline in mortality to medical measures and those which argue the converse, or something else entirely. And, if such data constitute acceptable evidence in support of the presence of medicine, then it is not unreasonable, or illogical, to employ them in support of some opposing position. One difficulty is that, depending on the nature of the results, double standards of rigor seem to operate in the evaluation of different studies. Not surprisingly, those which challenge prevailing myths or beliefs are subject to the most stringent methodological and statistical scrutiny, while supportive studies, which frequently employ the flimsiest impressionistic data and inappropriate techniques of analysis, receive general and uncritical acceptance. Even if all possible “ideal” data were available (which they never will be) and if, after appropriate analysis, they happened to support the viewpoint of this paper, we are doubtful that medicine’s protagonists would find our thesis any more acceptable.

The Modern Decline in Mortality

Despite the fact that mortality rates for certain conditions, for selected age and sex categories, continue to fluctuate, or even increase (U.S. Dept. HEW, 1964; Moriyama and Gustavus, 1972; Lilienfeld, 1976), there can be little doubt that a marked decline in overall mortality for the United States has occurred since about 1900 (the earliest point for which reliable national data are available).

Just how dramatic this decline has been in the United States is illustrated in Fig. 1 which shows age-adjusted mortality rates for males and females separately.³ Both sexes experienced a marked

³All age and sex adjustments were made by the “direct” method using the population of 1900 as the standard. For further information on this method of adjustment, see Hill (1971) and Shryock et al. (1971).

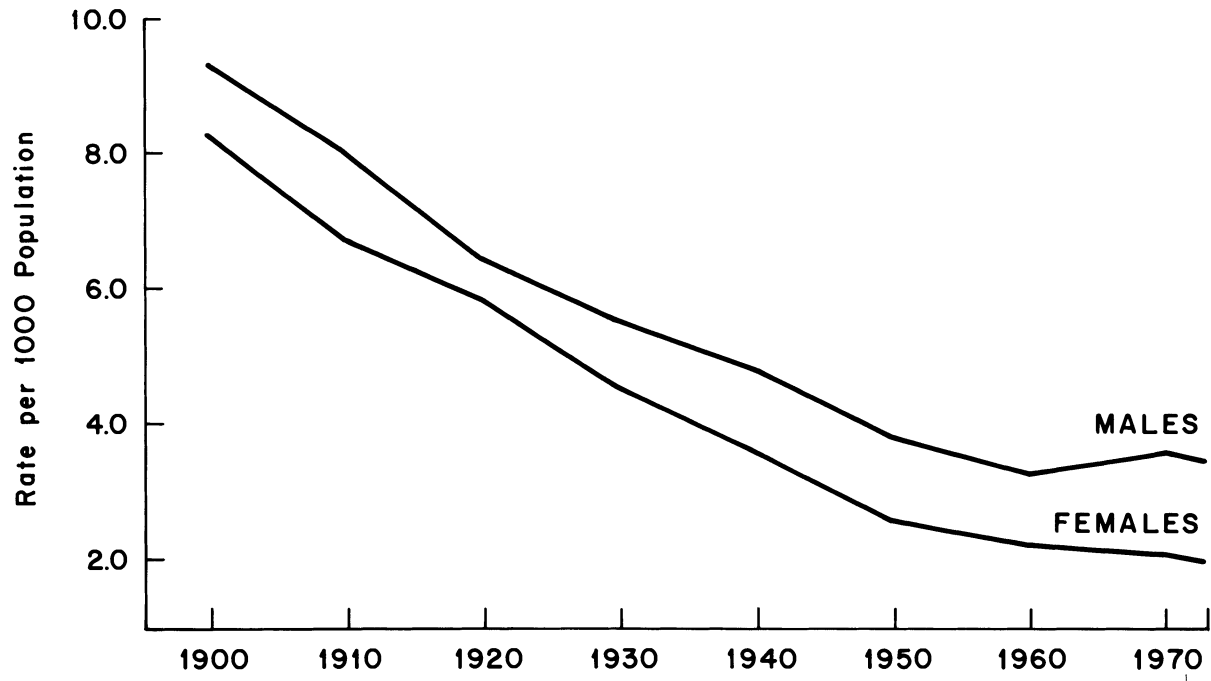


FIG. 1. The Trend in Mortality for Males and Females Separately (Using Age-Adjusted Rates) for the United States, 1900-1973.*

*For these and all other age-and sex-adjusted rates in this paper, the standard population is that of 1900.

decline in mortality since 1900. The female decline began to level off by about 1950, while 1960 witnessed the beginning of a slight increase for males. Figure 1 also reveals a slight but increasing divergence between male and female mortality since about 1920.

Figure 2 depicts the decline in the overall age- and sex-adjusted rate since the beginning of this century. Between 1900 and 1973, there was a 69.2 percent decrease in overall mortality. The average annual rate of decline from 1900 until 1950 was .22 per 1,000, after which it became an almost negligible decline of .04 per 1,000 annually. Of the total fall in the standardized death rate between 1900 and 1973, 92.3 percent occurred prior to 1950. Figure 2 also plots the decline in the standardized death rate *after* the total number of deaths in each age and sex category has been reduced by the number of deaths attributed to the eleven major infectious conditions (typhoid, smallpox, scarlet fever, measles, whooping cough, diphtheria, influenza, tuberculosis, pneumonia, diseases of the digestive system, and poliomyelitis). It should be noted that, although this latter rate also shows a decline (at least until 1960), its slope is much more shallow than that for the overall standardized death rate. A major part of the decline in deaths from these causes since about 1900 may be attributed to the virtual disappearance of these infectious diseases.

An absurdity is reflected in the third broken line in Fig. 2 which also plots the increase in the proportion of the Gross National Product expended annually for medical care. *It is evident that the beginning of the precipitate and still unrestrained rise in medical care expenditures began when nearly all (92 percent) of the modern decline in mortality this century had already occurred.*⁴

Figure 3 illustrates how the proportion of deaths contributed by infectious and chronic conditions has changed in the United States since the beginning of the twentieth century. In 1900, about 40 percent of all deaths were accounted for by eleven major infectious diseases, 16 percent by three chronic conditions, 4 percent by accidents, and the remainder (37 percent) by all other causes. By 1973, only 6 percent of all deaths were due to these eleven infectious

⁴Rutstein (1967), although fervently espousing the traditional view that medical advances have been largely responsible for the decline in mortality, discussed this disjunction and termed it "The Paradox of Modern Medicine." More recently, and from a perspective that is generally consistent with that advanced here, Powles (1973) noted the same phenomenon in England and Wales.

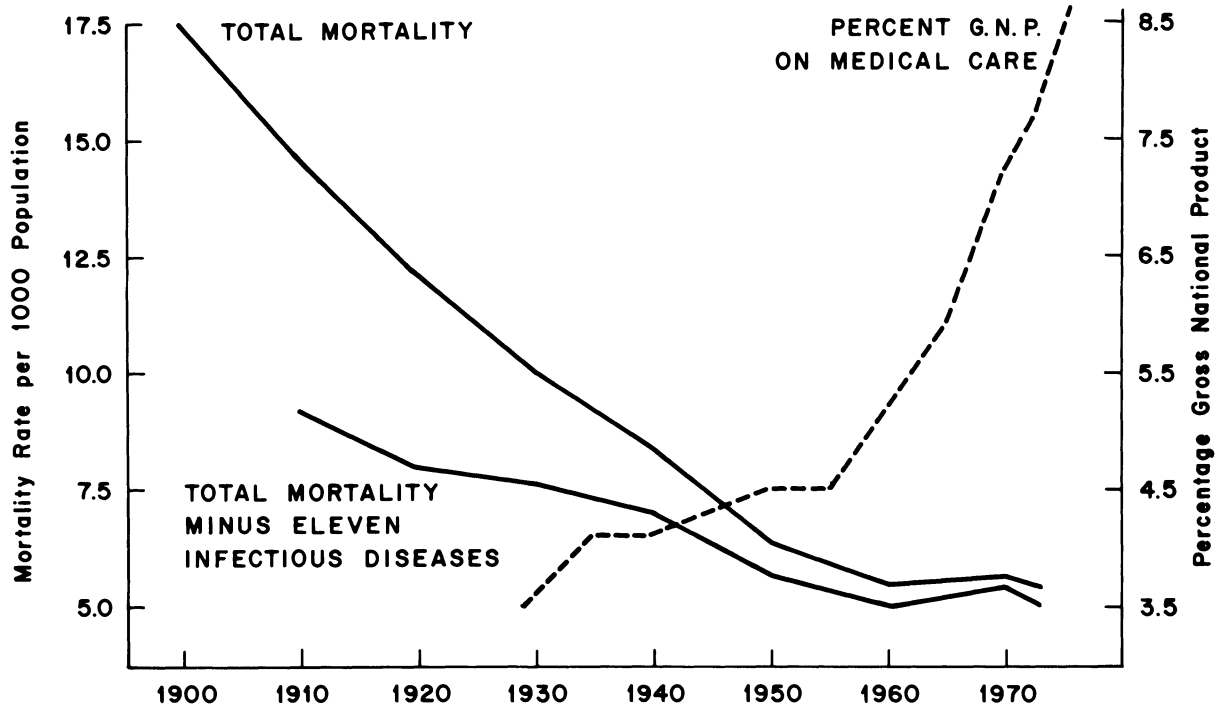


FIG. 2. Age- and Sex-Adjusted Mortality Rates for the United States 1900-1973, Including and Excluding Eleven Major Infectious Diseases, Contrasted with the Proportion of the Gross National Product Expended on Medical Care.

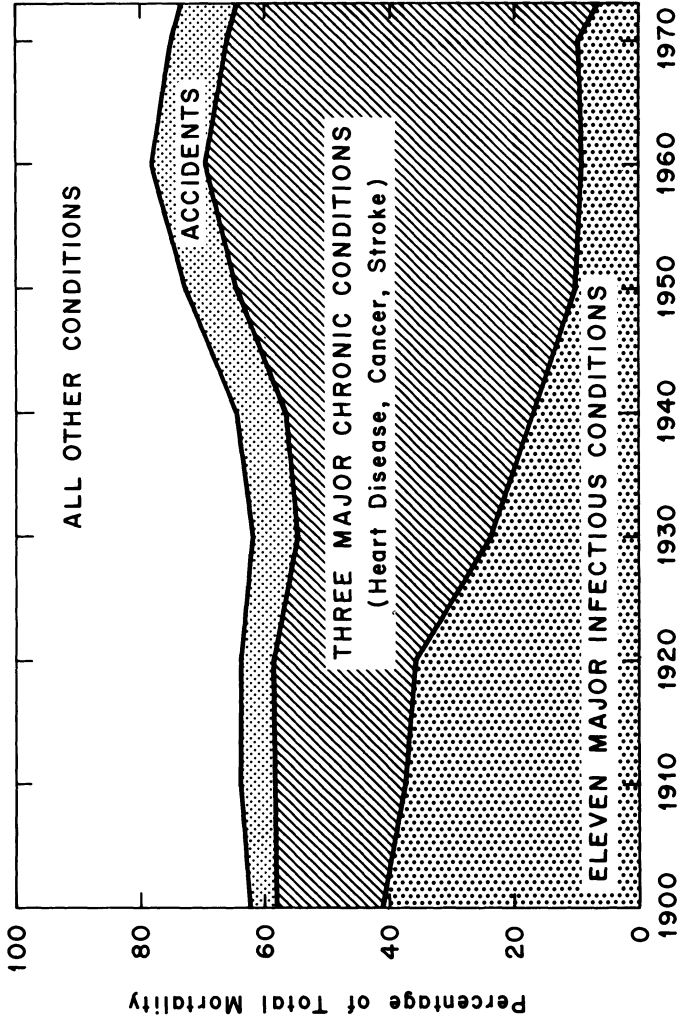


FIG. 3. Pictorial Representation of the Changing Contribution of Chronic and Infectious Conditions to Total Mortality (Age- and Sex-Adjusted), in the United States, 1900-1973.

diseases, 58 percent to the same three chronic conditions, 9 percent to accidents, and 27 percent were contributed by other causes.⁵

Now to what phenomenon, or combination of events, can we attribute this modern decline in overall mortality? Who (if anyone), or what group, can claim to have been instrumental in effecting this reduction? Can anything be gleaned from an analysis of mortality experience to date that will inform health care policy for the future?

It should be reiterated that a major concern of this paper is to determine the effect, if any, of specific medical measures (both chemotherapeutic and prophylactic) on the decline of mortality. It is clear from Figs. 2 and 3 that most of the observable decline is due to the rapid disappearance of some of the major infectious diseases. Since this is where most of the decline has occurred, it is logical to focus a study of the effect of medical measures on this category of conditions. Moreover, for these eleven conditions, there exist clearly identifiable medical interventions to which the decline in mortality has been popularly ascribed. No analogous interventions exist for the major chronic diseases such as heart disease, cancer, and stroke. Therefore, even where a decline in mortality from these chronic conditions may have occurred, this cannot be ascribed to any specific measure.

The Effect of Medical Measures on Ten Infectious Diseases Which Have Declined

Table 1 summarizes data on the effect of major medical interventions (both chemotherapeutic and prophylactic) on the decline in the age- and sex-adjusted death rates in the United States, 1900–1973, for ten of the eleven major infectious diseases listed above. Together, these diseases accounted for approximately 30 percent of all deaths at the turn of the century and nearly 40 percent of the total decline in the mortality rate since then. The ten diseases were selected on the following criteria: (a) some decline in the death rate had occurred in the period 1900–1973; (b) significant decline in the death rate is commonly attributed to some specific medical

⁵Deaths in the category of chronic respiratory diseases (chronic bronchitis, asthma, emphysema, and other chronic obstructive lung diseases) could not be included in the group of chronic conditions because of insurmountable difficulties inherent in the many changes in disease classification and in the tabulation of statistics.

TABLE I
The Contribution of Medical Measures (Both Chemotherapeutic and Prophylactic) to the Fall in the Age and Sex-Adjusted Death Rates (S.D.R.) of Ten Common Infectious Diseases, and to the Overall Decline in the S.D.R., for the United States, 1900-1973

<i>Disease</i>	<i>Fall in S.D.R. per 1,000 Population, 1900-1973</i> (a)	<i>Fall in S.D.R. as % of the Total Fall in S.D.R.</i> (b)=(a)×100% 12.14	<i>Year of Medical Intervention (Either Chemotherapy or Prophylaxis)</i>	<i>Fall in S.D.R. per 1,000 Population After Year of Intervention</i> (c)	<i>Fall in S.D.R. After Intervention as % of Total Fall for the Disease</i> (d)=(c)×100% (a)	<i>Fall in S.D.R. After Intervention as % of Total Fall in S.D.R. for All Causes</i> (e)=(b)(c)% (a)
Tuberculosis	2.00	16.48	Isoniazid/ Streptomycin, 1950	0.17	8.36	1.38
Scarlet Fever	0.10	0.84	Penicillin, 1946	0.00	1.75	0.01
Influenza	0.22	1.78	Vaccine, 1943	0.05	25.33	0.45
Pneumonia	1.42	11.74	Sulphonamide, 1935	0.24	17.19	2.02
Diphtheria	0.43	3.57	Toxoid, 1930	0.06	13.49	0.48
Whooping Cough	0.12	1.00	Vaccine, 1930	0.06	51.00	0.51
Measles	0.12	1.04	Vaccine, 1963	0.00	1.38	0.01
Smallpox	0.02	0.16	Vaccine, 1800	0.02	100.00	0.16
Typhoid	0.36	2.95	Chloramphenicol, 1948	0.00	0.29	0.01
Poliomyelitis	0.03	0.23	Vaccine, Salk / Sabin, 1955	0.01	25.87	0.06

TABLE 2
Pair-Wise Correlation Matrix for 44 Countries, Between Four Measures of
Health Status and Three Measures of Medical Care Input

Variable	Matrix of Coefficients								
1. Infant Mortality Rate (1972)									
2. Crude Mortality Rate (1970-1972)	-0.14								
3.(a) Life Expectancy (Males) at 25 Years	-0.14	-0.12							
3.(b) Life Expectancy (Females) at 25 Years	-0.12	0.04	0.75						
4.(a) Life Expectancy (Males) at 55 Years	-0.01	0.10	0.74	0.93					
4.(b) Life Expectancy (Females) at 55 Years	-0.13	0.01	0.75	0.98	0.95				
5. Population per Hospital Bed (1971-1973)	0.64	-0.30	0.05	-0.02	0.17	0.0			
6. Population per Physician (1971-1973)	0.36	-0.30	0.11	0.04	0.16	0.07	0.70		
7. Per Capita Gross National Product: In \$U.S. Equivalent (1972)	-0.66	0.26	0.16	0.18	0.07	0.22	-0.56	-0.46	
Variable (by number)	1	2	3a	3b	4a	4b	5	6	6

Sources:

1. *United Nations Demographic Yearbook: 1974*, New York, United Nations Publications, 1975. (For the Crude and Infant Mortality Rates).
2. *World Health Statistics Annual: 1972*, Vol. 1, Geneva, World Health Organization, 1975, pp. 780-783. (For the Life Expectancy Figures).
3. *United Nations Statistical Yearbook, 1973 and 1975*. New York, United Nations Publications, 25th and 27th issues, 1974 and 1976. (For the Population bed/physician ratios).
4. *The World Bank Atlas*. Washington, D.C., World Bank, 1975. (For the per capita Gross National Product).

measure for the disease; and (c) adequate data for the disease over the period 1900–1973 are available. The diseases of the digestive system were omitted primarily because of lack of clarity in diagnosis of specific diseases such as gastritis and enteritis.

Some additional points of explanation should be noted in relation to Table 1. First, the year of medical intervention coincides (as nearly as can be determined) with the first year of widespread or commercial use of the appropriate drug or vaccine.⁶ This date does *not* necessarily coincide with the date the measure was either first discovered, or subject to clinical trial. Second, the decline in the death rate for smallpox was calculated using the death rate for 1902 as being the earliest year for which this statistic is readily available (U.S. Bureau of the Census, 1906). For the same reasons, the decline in the death rate from poliomyelitis was calculated from 1910. Third, the table shows the contribution of the decline in each disease to the total decline in mortality over the period 1900–1973 (column b). The overall decline during this period was 12.14 per 1,000 population (17.54 in 1900 to 5.39 in 1973). Fourth, in order to place the experience for each disease in some perspective, Table 1 also shows the contribution of the relative fall in mortality after the intervention to the overall fall in mortality since 1900 (column e). In other words, the figures in this last column represent the percentage of the total fall in mortality contributed by each disease after the date of medical intervention.

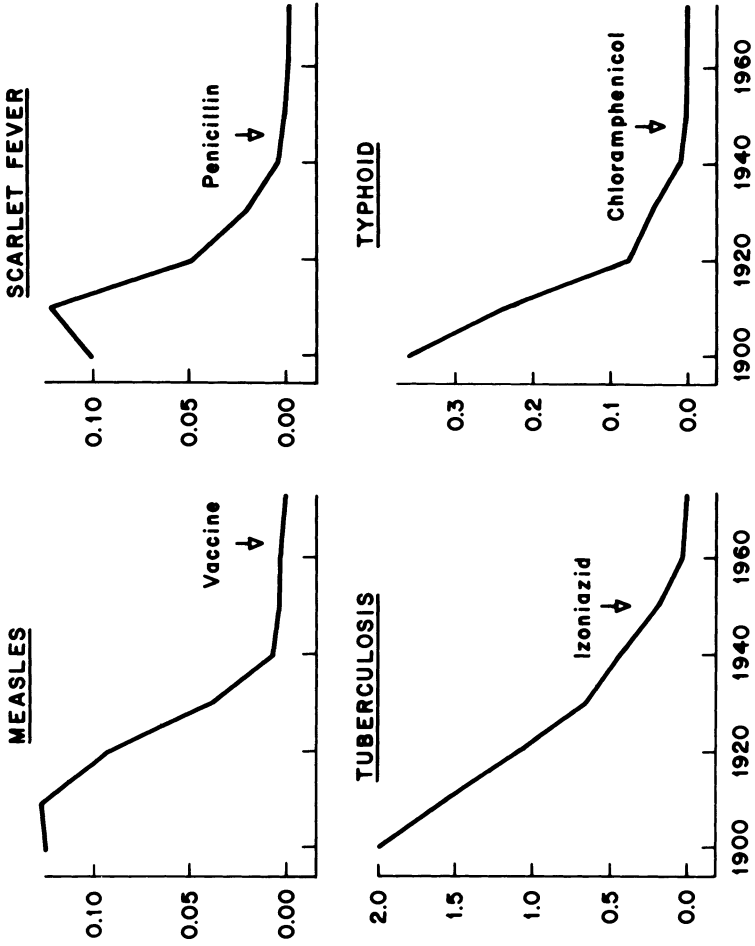
It is clear from column b that only reductions in mortality from tuberculosis and pneumonia contributed substantially to the decline in total mortality between 1900 and 1973 (16.5 percent and 11.7 percent, respectively). The remaining eight conditions *together* accounted for less than 12 percent of the total decline over this period. Disregarding smallpox (for which the only effective measure had been introduced about 1800), only influenza, whooping cough, and poliomyelitis show what could be considered substantial declines of 25 percent or more after the date of medical intervention. However, even under the somewhat unrealistic assumption of a constant (linear) rate of decline in the mortality rates, only whooping cough and poliomyelitis even approach the percentage which would have been expected. The remaining six conditions (tuberculosis, scarlet

⁶In determining the dates of intervention we relied upon: (a) standard epidemiology and public health texts; (b) the recollections of authorities in the field of infectious diseases; and (c) recent publications on the same subject.

fever, pneumonia, diphtheria, measles, and typhoid) showed negligible declines in their mortality rates subsequent to the date of medical intervention. The seemingly quite large percentages for pneumonia and diphtheria (17.2 and 13.5, respectively) must of course be viewed in the context of relatively early interventions—1935 and 1930.

In order to examine more closely the relation of mortality trends for these diseases to the medical interventions, graphs are presented for each disease in Fig. 4. Clearly, for tuberculosis, typhoid, measles, and scarlet fever, the medical measures considered were introduced at the point when the death rate for each of these diseases was already negligible. Any change in the rates of decline which may have occurred subsequent to the interventions could only be minute. Of the remaining five diseases (excluding smallpox with its negligible contribution), it is only for poliomyelitis that the medical measure appears to have produced any noticeable change in the trends. Given peaks in the death rate for 1930, 1950 (and possibly for 1910), a comparable peak could have been expected in 1970. Instead, the death rate dropped to the point of disappearance after 1950 and has remained negligible. The four other diseases (pneumonia, influenza, whooping cough, and diphtheria) exhibit relatively smooth mortality trends which are unaffected by the medical measures, even though these were introduced relatively early, when the death rates were still notable.

It may be useful at this point to briefly consider the common but dubious practice of projecting estimated mortality trends (Witte and Axnick, 1975). In order to show the beneficial (or even detrimental) effect of some medical measure, a line, estimated on a set of points observed prior to the introduction of the measure, is projected over the period subsequent to the point of intervention. Any resulting discrepancy between the projected line and the observed trend is then used as some kind of "evidence" of an effective or beneficial intervention. According to statistical theory on least squares estimation, an estimated line can serve as a useful predictor, but the prediction is only valid, and its error calculable, within the range of the points used to estimate the line. Moreover, those predicted values which lie at the extremes of the range are subject to much larger errors than those nearer the center. It is, therefore, probable that, even if the projected line was a reasonable estimate of the trend after the intervention (which, of course, it is not), the



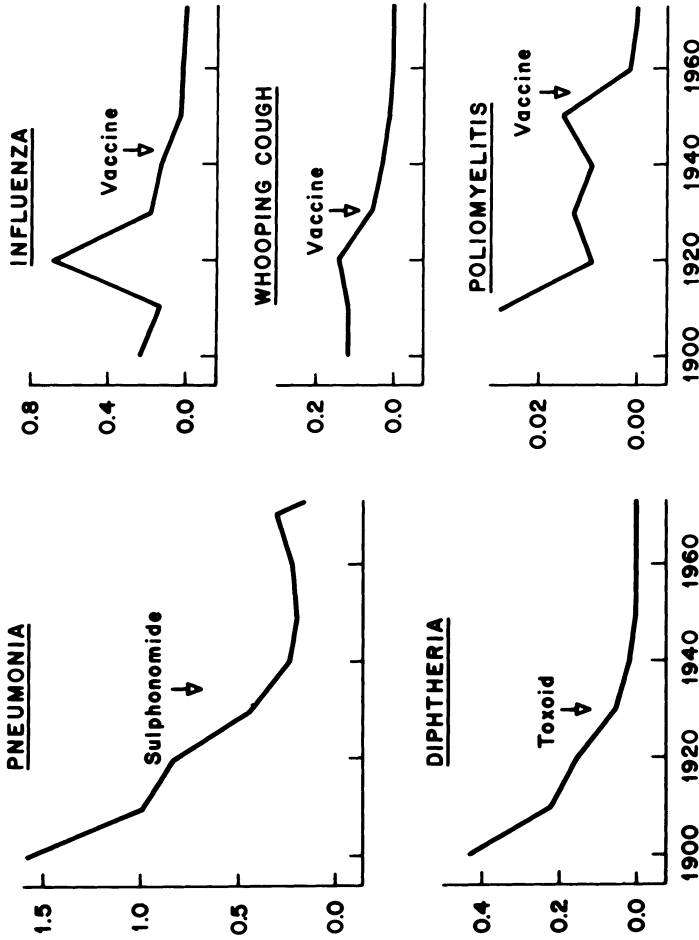


FIG. 4. The Fall in the Standardized Death Rate (per 1,000 Population) for Nine Common Infectious Diseases in Relation to Specific Medical Measures, for the United States, 1900-1973.

divergent observed trend is probably well within reasonable error limits of the estimated line (assuming the error could be calculated), as the error will be relatively large. In other words, this technique is of dubious value as no valid conclusions are possible from its application, and a relatively large prediction error cannot be estimated, which is required in order to objectively judge the extent of divergence of an observed trend.

With regard to the ten infectious diseases considered in this paper, when lines were fitted to the nine or ten points available over the entire period (1900–1973), four exhibited a reasonably good fit to a straight line (scarlet fever, measles, whooping cough, and poliomyelitis), while another four (typhoid, diphtheria, tuberculosis, and pneumonia) showed a very good quadratic fit (to a curved line). Of the remaining two diseases, smallpox showed a negligible decline, as it was already a minor cause of death in 1900 (only 0.1 percent), and influenza showed a poor fit because of the extremely high death rate in 1920. From Fig. 4 it is clear, however, that the rate of decline slowed in more recent years for most of the diseases considered—a trend which could be anticipated as rates approach zero.⁷

Now it is possible to argue that, given the few data points available, the fit is somewhat crude and may be insensitive to any changes subsequent to a point of intervention. However, this can be countered with the observation that, given the relatively low death rates for these diseases, any change would have to be extremely marked in order to be detected in the overall mortality experience. Certainly, from the evidence considered here, only poliomyelitis appears to have had a noticeably changed death rate subsequent to intervention. Even if it were assumed that this change was entirely due to the vaccines, then only about one percent of the decline following interventions for the diseases considered here (column d of Table 1) could be attributed to medical measures. Rather more conservatively, if we attribute some of the subsequent fall in the death rates for pneumonia, influenza, whooping cough, and diphtheria to medical measures, then perhaps 3.5 percent of the fall in the overall death rate can be explained through medical interven-

⁷For this reason, a negative exponential model is sometimes used to fit a curved line to such data. This was not presented here as the number of points available was small and the difference between a simple quadratic and negative exponential fit was not, upon investigation, able to be detected.

tion in the major infectious diseases considered here. Indeed, given that it is precisely for these diseases that medicine claims most success in lowering mortality, 3.5 percent probably represents a reasonable upper-limit estimate of the total contribution of medical measures to the decline in mortality in the United States since 1900.

Conclusions

Without claiming they are definitive findings, and eschewing pretensions to an analysis as sophisticated as McKeown's for England and Wales, one can reasonably draw the following conclusions from the analysis presented in this paper:

In general, medical measures (both chemotherapeutic and prophylactic) appear to have contributed little to the overall decline in mortality in the United States since about 1900—having in many instances been introduced several decades after a marked decline had already set in and having no detectable influence in most instances. More specifically, with reference to those five conditions (influenza, pneumonia, diphtheria, whooping cough, and poliomyelitis) for which the decline in mortality appears substantial after the point of intervention—and on the unlikely assumption that all of this decline is attributable to the intervention—it is estimated that at most 3.5 percent of the total decline in mortality since 1900 could be ascribed to medical measures introduced for the diseases considered here.

These conclusions, in support of the thesis introduced earlier, suggest issues of the most strategic significance for researchers and health care legislators. Profound policy implications follow from either a confirmation or a rejection of the thesis. If one subscribes to the view that we are slowly but surely eliminating one disease after another because of medical interventions, then there may be little commitment to social change and even resistance to some reordering of priorities in medical expenditures. If a disease *X* is disappearing primarily because of the presence of a particular intervention or service *Y*, then clearly *Y* should be left intact, or, more preferably, be expanded. Its demonstrable contribution justifies its presence. But, if it can be shown convincingly, and on commonly accepted grounds, that the major part of the decline in mortality is unrelated to medical care activities, then some commitment to social change

and a reordering of priorities may ensue. For, if the disappearance of *X* is largely unrelated to the presence of *Y*, or even occurs in the absence of *Y*, then clearly the expansion and even the continuance of *Y* can be reasonably questioned. Its demonstrable ineffectiveness justifies some reappraisal of its significance and the wisdom of expanding it in its existing form.

In this paper we have attempted to dispel the myth that medical measures and the presence of medical services were primarily responsible for the modern decline in mortality. The question now remains: if they were not primarily responsible for it, then how is it to be explained? An adequate answer to this further question would require a more substantial research effort than that reported here, but is likely to be along the lines suggested by McKeown which were referred to early in this paper. Hopefully, this paper will serve as a catalyst for such research, incorporating adequate data and appropriate methods of analysis, in an effort to arrive at a more viable alternative explanation.

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In his 1976 *The Modern Rise in Population*, Thomas McKeown focused on the other half of the equation: changes that improved the resistance of humans to infectious diseases. In particular, his argument centered on improved "nutrition." To McKeown, this meant not an improvement in food quality but an improvement in food quantity. "The Questionable Contribution of Medical Measures to the Decline of Mortality in the United States in the Twentieth Century." *The Millbank Memorial Fund Quarterly. Health and Society*. 1977;55(3):405-428. While it would be overkill to conclude from this that cod liver oil must be the sole explanation for the historical decline in measles mortality, it would be rather foolhardy to ignore its probable contribution.