Declining cardiovascular mortality

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IN THE 20 years prior to 1983 the overall death rate for the cardiovascular diseases declined an impressive 36% nationwide. The rate per year declined in 18 of these years, declining 1.5% per year between 1963 and 1973 and 3.3% per year since then. Because this group of diseases accounts for one-half of all deaths, a death rate that is 36% lower in 1982 than in 1963 translates into about 500,000 fewer deaths in 1982 than would have been projected based on rates in 1963. This improvement in cardiovascular mortality is the main reason that total mortality has declined 26% since 1963 and that average life expectancy at age 35 increased 2.6 years during the 10 years from 1972 to 1982, a greater increase than during any decade since vital statistics were first published in 1900.

Of even greater significance is the remarkable reversal in the death rate trend for the major cardiovascular subgroup, coronary heart disease. From an epidemic rise in the rate until the mid-1960s, the trend turned downwards and declined 37% between 1963 and 1982 (figure 1). There has also been marked acceleration in the downward trend since 1972 for stroke and all cardiovascular diseases.

It is still essentially unknown, however, whether these declines in mortality are occurring more in hospitalized or in nonhospitalized segments of the population, i.e., whether declines are occurring in the incidence of new cases or whether there has been a change in the prognosis, severity, case-fatality, and survivorship after development of cardiovascular disease. These major gaps in knowledge stand in the way of determining causes of the decline in cardiovascular mortality. Even if such information can be obtained, determining causation would still be difficult if the declines were due primarily to factors not specific to the cardiovascular diseases; e.g., factors such as a better standard of living, greater awareness of health hazards, healthier lifestyles, better nutrition, or better and wider use of medical care. Some researchers favor this conclusion because the improvement has been ubiquitous.1 Also, as yet no one can unequivocally and directly associate specific improvements in cardiovascular disease prevention and treatment with the mortality decline. Many other researchers, ourselves included, believe that such associations, as incomplete, indirect, and equivocal as they are, are substantial enough to suggest that the beneficial changes that have taken place in cardiovascular health habits, risk factor levels, and preventive medicine, as well as in medical management of the disease, have indeed contributed to the decline in mortality.2-8 It is possible, of course, that both views are correct.

Clearly, the mortality declines are a break from past trends, are real, substantial, and sustained over the long term, and they are accompanied by a decline in total mortality. This rules out factors such as short cyclical trends in death rates or artifacts in vital statistics and cause-of-death determinations. Such an improvement in mortality for a major chronic disease suggests that some type of breakthrough in prevention and treatment of cardiovascular diseases has been made. Here we review arguments for and against this conclusion, assess the relative impacts on the decline attributed to various prevention and treatment factors, and discuss the implications of our conclusions.

Significant mortality patterns

Although historically the causes of most mortality trends have never been well explained, many unusual features of current cardiovascular mortality declines are consistent with an impact of improvements in prevention and treatment of cardiovascular disease. The current downward trends are unprecedented, steep, and long term, with a dramatic reversal in coronary
heart disease mortality and an acceleration of the decline for stroke. Percentage declines for coronary heart disease are greatest among blacks and younger adults, the groups that would be expected to gain the most benefit from increased access to medical care and intensified efforts to control hypertension. The larger percentage declines in mortality among younger adults as compared with older people can be taken as evidence of success in primary prevention and treatment. The impact is potentially greater among younger persons because they tend to have less advanced arteriosclerotic lesions and coronary heart disease without other complications. Also, the impact of some risk factors is greater in young adults.

Areas within the country that may still lag in implementing major improvements in preventive medicine and treatment, such as Appalachia, do lag in mortality declines. Furthermore, there is some evidence that holders of life insurance policies, who constitute a higher socioeconomic group than the general population, have even steeper declines than the general population.

If more effort in cardiovascular disease prevention and treatment has been made in the United States than elsewhere, the effort appears to have paid off because, for middle-aged men, the death rate for coronary heart disease is declining faster here than elsewhere. In this country it has declined 25% between 1969 and 1978 for men from 40 to 69 years old and this decline ranges from 10% to 25% in Japan, Israel, Australia, Finland, Belgium, Canada, New Zealand, Norway, and the Netherlands. Also, the death rate for coronary heart disease has increased from 10% to 85% in Sweden, West Germany, Austria, France, Denmark, Ireland, Northern Ireland, and in the Eastern European countries, and it is still rising slightly in most other European countries.

Although mortality is declining for some noncardiovascular causes of death, it can be argued that the decline for the cardiovascular diseases is unique. For comparative purposes, the trend between 1968 and 1978 shows declines ranging from 27% to 54% for the major cardiovascular subgroups, with equivalent declines only for diabetes, influenza and pneumonia, and nephritis and nephrosis. By contrast, mortality increased substantially for lung cancer, chronic obstructive pulmonary disease, and homicides, and decreased 6% for other cancers, 11% for cirrhosis of the liver, and 21% for accidents.

Significantly, timing of the downward trends in cardiovascular mortality coincides with declines in percentages of people who smoke, in percentages of people with high cholesterol levels, and in per capita consumption of eggs, butter, milk, and animal fats and with increases in per capita consumption of vegetable fats, awareness, therapy, and control of high blood pressure and with the advent of healthier lifestyles and aggressiveness in medical management of cardiovascular diseases.

**Primary prevention.** Epidemiologic studies have provided evidence that faulty health habits typified by a diet excessive in calories, fat, and salt, sedentary habits, unrestrained weight gain, and cigarette smoking predispose to coronary heart disease. Related risk factors, especially increased serum cholesterol, blood glucose, and blood pressure are also associated with increased incidence of coronary events, including fatal attacks. There is ample evidence that the nation as a whole has reduced levels of these risk factors during the past 20 years, the period during which the coronary heart disease decline in the United States has been demonstrated. The efficacy of lowering cholesterol values has now been demonstrated in the Lipid Research Clinics, and results of other trials have demonstrated the cardiovascular mortality benefits of controlling hypertension.

Hypertension plays a major role in the evolution of cardiovascular disease and there is now substantial controlled trial evidence from the Veterans Administration Study and the Hypertension, Detection and Fol-
lowup Program (HDFP) of the National Institutes of Health of the efficacy of controlling even mild degrees of hypertension. The increases in detection and awareness and better treatment and control of hypertension that have been observed have likely been major elements in the reduction of cardiovascular mortality. Evidence that control of hypertension is an important contributor to the decline in mortality is especially strong because hypertension is one of the major risk factors for stroke, cardiac failure, and coronary heart disease. Death from hypertension-related diseases has shown the steepest decline, and declines in incidence of stroke are seen particularly in women, who have shown the greatest improvement with respect to awareness of hypertension and seeking treatment. Although some may question whether control of hypertension has been shown to reduce coronary mortality, it has been unequivocally demonstrated that morbidity and mortality from stroke and congestive heart failure is distinctly improved. The dramatic acceleration in the rate of decline in stroke mortality around 1973, when major strides were being made in the detection and control of hypertension, stands as testimony to the efficacy of control of hypertension in primary prevention of cardiovascular catastrophes.

Cigarette smoking has been shown unequivocally to increase risk of myocardial infarction or sudden death, and there is a prompt and dramatic decline in risk of disease or death on cessation. Between 1965 and 1980 there has been a reduction of 25% in the proportion of male smokers and a 14% reduction for female smokers, coinciding over time with the coronary heart disease mortality declines. It is noteworthy that before the Surgeon General's Report on Smoking and Health in 1964 there was a general and rapid rise in mortality from coronary heart disease, lung cancer, and emphysema. Subsequent to 1964, coronary heart disease mortality declined promptly and rapidly and we are now observing declines in mortality for lung cancer and emphysema in young adult men, a slowing of the rise in older men, and a continued rise for women. This pattern is consistent with an impact of smoking patterns on mortality.

Between 1960 to 1962 and 1971 to 1974 the percentage of people with high serum cholesterol levels declined 12.5% in men and 22.5% in women. This trend coincides over time with the dietary changes described earlier and with the decline in mortality for cardiovascular diseases. The American diet, with some exceptions, has changed away from foods high in saturated fats to a greater use of vegetable fats and oils over the past 15 to 20 years. Although debated, overeating appears to be the most likely cause for the high blood lipid levels so fundamental in the atherosclerotic process and it also plays a prominent role in hypertension through obesity and high salt intake. The American public has become more aware of the health implications of overeating, and coincident with this, cholesterol levels have declined along with per capita consumption of milk, butter, eggs, and animal fats. Trends are following the direction predicted by the diet-heart theory in the United States, Australia, and in Finland, but the picture is anomalous in Japan and Switzerland.

Obesity promotes all the atherogenic traits, including hypercholesterolemia, very low-density lipoprotein excess, hyperglycemia, hypertension, a rise in low-density lipoprotein level, and lowering of high-density lipoprotein cholesterol level. The lipid changes induced result in a less favorable low-density lipoprotein/high-density lipoprotein ratio, reflecting the two-way traffic of cholesterol entering and leaving the tissues. The proportion of overweight persons in the population has declined although average weight has increased.

Evidence that primary prevention has played a role in declines in coronary heart disease mortality has also been reported for other countries. In Australia and New Zealand, where coronary trends are quite similar to those in the United States, changes in health habits and risk factors appear to parallel changes in coronary mortality. Dietary changes in Australia are similar to those in the United States and there is some leveling off of tobacco use. In New Zealand diet, serum cholesterol levels, and cigarette smoking habits are improving. The mortality decline has been associated with a decrease in the consumption of dairy products and more recently with an increased awareness of the importance of treating hypertension, and there has also been an apparent increase in physical exercise in the community. Changes between 1949 and 1977 in fat consumption in Israel are correlated with trends in coronary heart disease mortality.

Without knowing if the incidence or severity of coronary attacks is declining along with mortality one cannot be certain that improvements with respect to risk factor levels, health habits, or other types of primary prevention have contributed to the mortality decline. There is evidence from studies of male employees of the DuPont Company, of hospitalized patients in the Kaiser-Permanente Medical Care Program in San Francisco, and of hospitalized patients in the Minnesota Heart Survey that the incidence of coronary heart disease is declining. There is recent evidence
from an autopsy study in New Orleans that the amount of intimal surface of the heart covered by raised lesions has decreased significantly in certain subgroups. This conclusion had also been reached in the autopsy experience comparing Korean War casualties with those in Vietnam. With regard to stroke, evidence of a decline in incidence has been reported in the Framingham Study (in women), the Kaiser-Permanente Study, and in the Rochester, Minnesota study.

**Treatment.** The medical management of patients with cardiovascular disease is now more aggressive and sophisticated and improved techniques are more generally available throughout our society, in part due to Medicare and Medicaid. The effects of improved medical care are difficult to quantify. Better treatment, better emergency care, and earlier admission of heart attack patients to the hospital may have played a role, as well as the general establishment of coronary care units. The number of bypass operations has increased, but this can account for only a small fraction of the decline in mortality. Claims of the benefits of cardiac care units have not been supported by the results obtained in randomized controlled trials, and a large proportion of people with heart disease die before they can receive any medical care. Improved methods of rehabilitation and medical treatment after myocardial infarction may also reduce mortality, but chiefly only over the short term. It is likely, however, that together the cardiac care units, surgical treatment, advances in emergency cardiac care, and improved medical treatment are responsible for a portion of the observed decline.

Prehospital resuscitation measures could have a large impact on mortality because 60% of deaths from acute myocardial infarction occur before hospitalization. Emergency medical services are now better equipped to attend prehospital coronary patients, and training in cardiopulmonary resuscitation is becoming more common. The effectiveness of emergency services has been demonstrated in Seattle, where a coronary patient has a much better chance of arriving alive at a hospital and in an earlier stage of the episode than was the case a decade or two ago. Even the suspected coronary patient is more likely to be hospitalized for diagnostic evaluation and monitoring. Prehospitalization cardiac resuscitation is impressively successful when applied very early in patients with acute ventricular fibrillation, but most of these patients receive only basic life support, so that the potential impact on coronary mortality is small.

Selective lifesaving medical treatment of clinical coronary heart disease really began with the availability of β-adrenergic blockers in the late 1960s, but they were not widely used until the mid-1970s. Use of open heart surgery, catheterization, and pacemakers have proliferated greatly in recent years. In 1970 there were 30,000, 77,000, and 36,000 such operations, respectively, with huge increases to 239,000, 471,000, and 202,000, respectively, in 1982. Use of pacemakers, nitrates, catheters, afterload-reduction therapies, inotropic agents, β-blocking agents, and bypass operations do save some lives, but epidemiologic data on the precise benefit of such intervention is lacking. It seems unlikely that these interventions have made a major impact on national mortality rates. Coronary bypass operations account for a small part of the decline because studies suggest that survival rates are not higher than in medically treated patients. Treatment of angina has made a limited impact because of compliance problems.

Improvement in the hospital case-fatality rate for coronary patients is reported in the Minnesota Heart Survey, the DuPont Study, the Rochester, Minnesota Study, and the National Hospital Discharge Survey. The findings suggest that hospital mortality rates are improving, but that the impact on overall coronary heart disease mortality can only be modest because such a great proportion of the deaths occur suddenly outside the hospital.

In general, there is a gap between the theoretical benefits of medical therapy based on results in selected patients in clinical trials and the actual impact that advances in this area have actually had on the general population. Dramatic improvement in in-hospital treatment can have only a limited impact on death and disability rates, since so much of the mortality rate reflects immediate death and because, once an infarction occurs, the heart and brain have an innately limited capacity for recovery.

**Unresolved issues**

Arguments opposing the view that “breakthroughs” in prevention and treatment of cardiovascular disease caused or contributed to the declines in mortality rest on the inconsistencies in and incompleteness and limitations of trend statistics in support of the breakthrough view and on some trend data that support the opposing view. Proffered causative explanations are based on loose associations between trends in morbidity, mortality, and the factors of prevention and treatment and on unverifiable assumptions. Explanations of mortality trends for chronic diseases have seldom been satisfactory because of limitations in cause-of-death information on death certificates and because
accurate and comparable time trends for cardiovascular disease incidence and case-fatality have been lacking. There is no unequivocal explanation as to why coronary heart disease mortality had risen so high in the first place, nor is it clear why mortality for stroke, hypertension, and all cardiovascular diseases have been declining since 1940 or earlier, antedating antihypertensive therapy. We don’t know why the coronary decline began first in women. Moreover, a strong case can be made for general influences on health operating on the entire population since the decline in cardiovascular mortality has been universal, in both sexes, in all races, and in all age groups. This universality is unprecedented. The fact that rates for the noncardiovascular causes of death are also declining, as described earlier, reinforces the suggestion that there are general health-promoting factors at work.

Trend data in coronary heart disease incidence and case-fatality are not available on a national basis, and studies such as that in Rochester, Minnesota, that by the Kaiser-Permanente Group in San Francisco, and that of the Health Insurance Plan of Greater New York failed to demonstrate recent improvements.

All of the definitive data are not in regarding the potential to reduce the risk of disease by modifying the cardiovascular risk factors. The Multiple Risk Factor Intervention Trial results fail to show that intervention against hypertension and cigarette smoking and dietary advice to lower serum cholesterol levels lowered coronary mortality any more than did usual medical care in men at high risk. There appear to be only modest declines in the prevalence of high blood pressure and high levels of serum cholesterol. While the proportion of smokers has declined, the decline has been modest in women and the proportion of heavy smokers has actually increased. Documentation is lacking on the apparent improvements and expansion in physical fitness and health consciousness nationwide, on the effective use of cardiopulmonary resuscitation and emergency medical services, on the extent of public education on early warning signs of a coronary attack, and on the extent of postdischarge coronary care. Effectiveness in reducing coronary deaths through coronary care units, coronary artery bypass surgery, other cardiac surgery, and treatment of angina and arrhythmias have also not been definitively demonstrated. The recent Coronary Artery Surgery Study results cast some doubt on whether coronary bypass operations offer “better” survival for coronary patients compared with modern medical care. Moreover, even if the large increases in numbers of patients treated by open heart surgery and pacemakers were effective in prolonging life, they would still have a small impact on total coronary mortality.

An attempt to correlate geographic differences in coronary mortality with geographic differences in risk factor levels was not successful. Likewise, an attempt to match trends in cigarette smoking by age, race, and sex with the reversal in coronary heart disease mortality trends have not strongly linked the two. In fact, no one has yet established a convincing fit of trends for any risk factor with cardiovascular mortality trends. Inconsistencies in associations of this kind are also seen abroad. The heart disease death rate in Switzerland declined 13% for men and 40% for women between 1951 and 1976, while consumption of animal fats per capita increased by 20%. Also, smoking increased among women and did not decline appreciably among men. Fat consumption and serum cholesterol levels have increased in Japan at the same time as coronary heart disease mortality has been reported to be in decline. In England there has been a decline in cigarette smoking but not in coronary heart disease mortality.

Implications and conclusions

The declines in cardiovascular mortality clearly imply that these major forces of morbidity and mortality are controllable. Whether one subscribes to the notion that those improvements are chiefly a result of changes in disease-promoting lifestyles or a result of better medical care for those already afflicted, it is clear that these diseases are not inevitable burdens of aging and genetic make-up. While a genetic susceptibility is likely, the dramatic turnaround in coronary heart disease mortality over two decades surely indicates a powerful environmental influence.

Although data fall short of proving or disproving the specific impacts of increased public awareness of symptoms of impending strokes or coronary attacks, mass training in cardiopulmonary resuscitation, emergency life-support services, improved hospital care, and efforts to reduce cardiovascular risk factors in the population, it is likely that one or more of these has had an effect. Unfortunately, too little is known about how these efforts have influenced trends in coronary attack, out-of-hospital sudden death, and hospital case-fatality rates. Better evaluation of the effectiveness of emergency medical services, long-term care of patients with cardiovascular disease, and public health measures is needed before we can provide unequivocal explanations. Although no single factor seems sufficient alone to explain the declines, a reduction in risk factors in the general population could have had a
beneficial effect on all aspects of cardiovascular mortality by reducing the incidence and severity of cardiovascular events. Data from clinical trials such as the HDFP on the effects of treating mild hypertension and the Lipid Research Clinics Primary Prevention Trial indicate how much reduction in cardiovascular mortality can be achieved from what appears to be modest changes in the level of risk factors. This is consistent with Framingham Study data, which indicate the powerful influence of multiple marginal increases in cardiovascular risk factors. Cessation of cigarette smoking has been shown in at least seven studies to produce a prompt 20% to 50% reduction in coronary heart disease rates. This result can be achieved without any hazard or cost and rivals the best results that can be achieved by even the most radical of surgical or medical interventions. The preventive implications seem clear.

Modest reductions in such highly prevalent cardiovascular risk factors such as cigarette smoking, hypertension, elevated low-density lipoprotein cholesterol should pay large dividends. Obesity control has also been shown to result in substantial improvement with respect to all of these major cardiovascular risk factors. This makes obesity control one of the chief hygienic measures available for the control of atherosclerotic cardiovascular disease, particularly in consideration of its high prevalence in the United States.

Over the past three decades adult mortality rates have improved so that adults are sharing with infants in gains in life expectancy, and these recent gains are chiefly a result of reduced cardiovascular mortality. While this improvement is to an extent attributable to better clinical management, it is likely that efforts to change the cardiovascular risk have played a larger role. The success in changing behavior patterns affecting health is a remarkable phenomenon. History records few instances in which disease has been prevented by motivating people to give up practices they like for future benefits in health. Most health gains in the past have resulted from community-wide measures to alter the ecology rather than by individual action.

The proportionally greater gain in life expectancy in adults relative to newborns in recent decades suggests that cardiovascular health problems have been for the most part identified and dealt with effectively. This suggests the possibility of making even greater gains.

Although the explanation for the declines in cardiovascular mortality remains speculative, they are not artifactual, they are substantial, and they have now been sustained for more than a decade. This accelerating decline has coincided with increased efforts to achieve healthier living habits. Since there has been an accompanying decline in noncardiovascular mortality, those concerned about alleged harmful effects of proposed risk factor control should be reassured.

It seems likely that the improvement in cardiovascular mortality will continue if the public and the medical profession strive to maintain its preventive efforts. If much of the improvement has in fact resulted from changes in lifestyle, as appears to be the case, this should be encouraged since the fate of the potential coronary disease candidate appears to be in his or her own hands.

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