

## *Successes of Prevention*

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**F**EW PEOPLE argue against the premise that achieving prevention is preferable to attempting cure. A history of common sense would show that every society believed “an ounce of prevention is worth a pound of cure.” Even the medical profession—with roots in Greek, Hebrew, Persian, Arab, and European traditions—has shared this sense of ultimate value. But, from even the most staunch proponents of prevention, there arises an inquietude over whether recent experience provides sufficient substantive evidence to justify continued optimism. This awareness has been growing since Dr. Edward Jarvis over 125 years ago bemoaned that “our education has made our calling exclusively a curative and not a conservative one” (Jarvis, 1853).

The increased divergence between proverbial wisdom and private action has puzzled many. Physicians despair of convincing patients to change how they live in the name of increasing health or extending life. Every internist or family practitioner recalls more than one patient with progressing emphysema caused by smoking who lacked either sufficient desire or will power to desist. And most physicians remember seeing at least one tracheostomized patient smoking via the stoma in the neck. One student of public policy underscores the frustration of the ignored clinician in flatly stating: “Most of the bad things that happen to people are presently beyond the reach of the medical system” (Wildavsky, 1976).

In attempting to examine this divergence between belief and behavior, this paper will: 1) define what prevention means and identify

a framework in which it can operate; 2) examine evidence to date through selected examples that preventive strategies have been effective; and 3) suggest how intervention strategies may be effectively brought to bear on different problems amenable to preventive efforts.

## Prevention: Meaning and Framework

The traditional taxonomy of prevention is along the lines of professional activities and norms, and divides prevention into *primary* (avoidance of clinical manifestation, e.g., through use of air bags, genetic counseling, smoking cessation), *secondary* (early detection and remediation, e.g., through neonatal metabolic screening, Pap smears), and *tertiary* (palliation and diminution of disabling sequelae, e.g., coronary bypass surgery, cancer radiotherapy). This categorization is useful in segregating the potential points of intervention to reduce the incidence and prevalence of illness. For example, reduction of disease due to smoking involves trying to discourage initial acquisition of the habit (*primary* prevention), offering smoking reduction and cessation programs to those who are addicted (*secondary* prevention), and providing medical therapy and surgery for those with diseases of the lung, heart, and other organs attributable to smoking (*tertiary* prevention). This typology, which is simple and widely applied, is used for this discussion.

We should, however, keep in mind that other classifications may coincide better with public expectations of "health" and be employed as popular yardsticks for measuring the success of prevention efforts. This success may be measured by how well the programs: 1) avoid premature death; 2) reduce avoidable morbidity; and 3) minimize disability that interferes with usual functioning. Whether these objectives are being met in our society can be ascertained by answering several questions. Are children born "healthy," i.e., with an absence of physical impediments to survival, growth, and learning? Are children and adults passing through their formative and most productive years unhampered by adverse effects of acquired ill health? Are the disabling effects of existing illness being forestalled and pain (somatic and psychic) minimized?

If we look to history as a guide for ensuring positive answers to these questions, we are drawn away from mechanistic models of clin-

ical medicine. The greatest advances toward these objectives have been byproducts of efforts rarely directed to health problems—better housing, improved sanitation, water purification and sewage disposal, enhanced techniques of food preservation, and changes in reproductive behavior (McKeown, 1976). In most cases, these improvements came into being primarily as a result of economic and social pressures, not because of medical knowledge of disease etiology or mechanism. Were we to adopt the same reformism today, we would not champion a direct attack on morbid conditions shown by laboratory science and statistical inference to be preventable. Rather, we would develop programs aimed at achieving political and social goals, such as guaranteed employment, more affordable housing, improved inner city mass transit systems, and increases in family planning among high birth rate groups. We might expect these policies to produce discernible movement toward our three objectives of health.

To the extent that perinatal mortality, chronic disability, mental illness, and premature death have been associated with (and sometimes causally related to) poverty, unemployment, lack of accessible and effective contraception, and crowded living conditions, some improvement would occur. It is not possible, however, to measure the contribution of each such measure in a scientifically controlled way (so as to determine its *efficacy*), and the *efficiency* (*i.e.*, ratio of outputs to inputs in comparable terms) is bound to be very low from the perspective of health alone. Even more important, these measures are unlikely to be specifically *effective* (*i.e.*, achieve the desired results) in reducing the frequency or degree of impairment that new knowledge of disease etiology and mechanism has made it possible to prevent (primarily, secondarily, or tertiarily). Examples include accidents, heart disease, some types of cancer, diabetes, arthritis, dental caries, poisonings, and genetically determined conditions.

Health professionals have not been content to rely on general economic improvement to achieve major reduction in the incidence, prevalence, severity, and age of onset of major crippling and fatal diseases. Instead, these health workers have employed diverse strategies in targeting resources toward ameliorating both specific diseases and etiological factors common to many diseases. For example, notable successes have been achieved in utilizing simple technology (*e.g.*, screening for phenylketonuria (PKU) and hypo-

thyroidism of the newborn) to detect both inherited and acquired metabolic dysfunction in time to prevent, through simple therapy, irreversible mental retardation. Medical activism has likewise led to high public utilization of screening for early detection of curable neoplasms and controllable hypertension. Some early detection programs have been reinforced or mandated by actions of federal, state, or local government. Government regulations have also required engineering changes that have decreased health hazards albeit without changes in human behavior (e.g., auto safety standards, child proof prescription bottles). In other cases, the government has compelled changes in behavior that have reduced age-specific mortality and serious morbidity (e.g., 55 mph speed limit on highways, immunizations).

Considerable effort has also been devoted to bridging the knowledge-behavior gap by devising strategies to encourage public adoption of healthier personal habits. Although the reasons underlying both successes and failures have been elusive, a significant decrease in age-specific mortality for several conditions (e.g., lung cancer, heart disease) appears to derive, at least in part, from sustained prevention efforts. The diversity of effective preventive strategies is illustrated by seven examples that are discussed below. They are summarized in Table 1, which also lists for each program target the level of proof with respect to etiology and degree of effectiveness of the interventions employed.

### *Examples Involving Primary Prevention*

*Auto Safety.* Auto accidents are the leading cause of death in this country from infancy to early middle age. For many years, the public has been barraged by auto safety educational campaigns designed to instruct people to slow down because "speed kills." For some years, variations on this message virtually monopolized "public service" advertising. Hence, auto safety should have been uppermost in the mind of the public, but the mind seemed far from the heavy foot, which continued to propel the car in excess of every posted speed. Other factors, however, combined to accomplish what education and exhortation had not—a decline of over 42% in the national fatality rate from motor vehicle crashes between 1966 and 1976 (from 5.7 per 100,000,000 passenger miles to 3.4) (Haddon, 1978). An important contribution to this improvement was the

TABLE 1  
Selected Problems and Intervention Strategies in Disease Prevention

Type of Prevention	Problem Example	Etiology	Level of Proof of Etiology*	Selected Intervention Strategies or Natural Changes	Level of Proof of Effectiveness	Active or Passive	Degree of Government Involvement	Public Acceptance of Strategies*
Primary	Auto accident	Excessive speed, alcohol, bad roads	VH	Lowering speed limits Interlock system	H	A	H	H
	Childhood poisoning	Poisonous substances ingested from bottles and cans in home	VH	Safety containers	VH	P	VH	H
	Dental caries	Bacteria, acid acting on enamel	H	Fluoridation	VH	P†	M	VL-H
Secondary	Congenital metabolic disorders, e.g., PKU, hypothyroidism	Genetic	VH	Screening plus special diet	VH	screening=P diet=A	VH L-H	VH
	Cervical cancer mortality	Genetic plus unclear other factor	M-H	Screening plus drug therapy	VH	screening=P drug=A	L-H	VH
		Virus	M	Screening plus surgery	M-H	A	H	H

TABLE 1 (Continued)  
Selected Problems and Intervention Strategies in Disease Prevention

Type of Prevention	Problem Example	Etiology	Level of Proof of Etiology*	Selected Intervention Strategies or Natural Changes	Level of Proof of Effectiveness	Active or Passive	Degree of Government Involvement	Public Acceptance of Strategies*
Combined Primary and Secondary	Heart disease	Lack of exercise	M	Vigorous exercise	M	A	VL	M-H†
		Nutrition habits	M	Altering nutrition	M	A	L	M-H
		Smoking	VH	Preventing smoking	M	A	M	M
Secondary	Stroke	Genetic	H					
		Hypertension	VH	Screening plus drug therapy	VH	A	H	H
Health consequences of smoking:	Stroke	Hypertension	VH	Screening plus cease smoking	VH	A	H	H
			VH	Education including media	M-H	A	M	L-H
			VH		M	P	L-M	M-H
			H					

\*Values assigned are personal judgments of author. VH = very high; H = high; M = moderate; L = low; VL = very low.

†Passive in community water supply, active in school fluoride rinse programs.

‡Two values given suggest clear-cut differences of acceptance among major segments of the population.

reduction of the speed limit to 55 mph coupled with the federal government's pressure on states to enforce this limit. Although motivated by the energy crisis, this change would have been equally defensible as a safety measure.

A second factor in the improved mortality statistics has been the requirement, effective January, 1968, that every car be equipped with lap belts and shoulder harnesses for all passenger positions. Other factors responsible for reducing the U.S. fatality rate include the enforcement of federal motor vehicle safety standards, enactment of motorcycle helmet use laws, improvement of highway design, and provision of emergency medical services. Although seat-belt usage rates of 19% nationally can be construed to indicate public apathy, attention can as easily be focused on the millions of Americans comprising this 19% who routinely wear seat belts and thus reduce their chance of death or serious injury by 35% to 50% (Robertson, 1976). In other countries, particularly Australia, and in some Canadian provinces, belt usage has been required by statute. Where such laws have been mandated, studies show reductions in occupant fatality of 17% to 39%, and in occupant injuries of 15% to 32% (Department of Transportation, 1977).

The failure of traditional auto safety programs suggests that consumer resistance to proven preventive measures is strong enough to render educational programs ineffective in changing behavior. Although some political and social groups advocate compelling individuals to help themselves by using effective measures like seat belts, experience shows that individual freedom is frequently cherished above public good; this is illustrated by the recent congressional repeal of the interlock system that required seat belt buckling before a car would start. For similar reasons, a number of states have recently repealed compulsory crash helmet use by motorcyclists despite clear-cut evidence that helmetless riders run greater risk of fatal injury. By contrast, an approach requiring no behavior change—such as engineering safer cars—has encountered little resistance. Installation of padded dashboards, energy-absorbing steering assemblies, shatter-resistant windshields, and other safety features has been correlated with a reduction in the types of injury they were designed to minimize (Baker, 1973).

*Childhood Poisoning.* A second success of primary prevention has been the decline in mortality and morbidity from childhood poison-

ing in the United States. The largest contribution to this decline is probably the child-resistant container used on bottles containing medicines potentially dangerous to children. In trials of the "Palm-N-Turn" top, the incidence of poisoning by prescription drugs was diminished by 75% to 90% (Breault, 1974). One year after safety packaging became mandatory in the United States, aspirin deaths dropped 50% (Garrettson, 1977).

A public climate of acceptance facilitated this innovation. Who could oppose a low-cost, easily instituted change that would prevent the serious illness and death of many small children, with minor, if any, inconvenience to the general public? While the ignition interlock system, another engineering advance in the name of prevention, had required active participation and had been considered a major intrusion by government, this anti-poison innovation was a passive measure, greeted with bemused interest. Like most engineering changes, however, child-resistant containers are not without unexpected side effects. Some elderly, poor-sighted, and arthritic people have experienced great difficulty in opening the caps. This unintended problem illustrates that no advance comes without unanticipated secondary ramifications.

*Dental Caries.* Adequate water-supply fluoridation reduces the number of caries in children by about 60% and reduces the per capita cost of restorative dentistry by about one-half (Pelton, Dunbar, McMillan et al., 1969; Cuzacq and Glass, 1972). Approximately 60% of the U. S. population served by community water supplies benefit from fluoride added to the supply, or from a supply naturally high in fluoride (Department of Health, Education, and Welfare, 1977a). Therefore, water-supply fluoridation alone, if maintained only at current levels, is decreasing caries in young Americans by about 35% and is cutting resultant dental bills by about 30%.

Fluoridation might well be considered an ideal preventive technique. It requires no deliberate act on the part of the individual, no will power, and no change in habits. Safe and effective, it has a cost benefit ratio in the range of 1:20 to 1:40. Despite these advantages, fluoridation is slow growing because it has become a rallying point for groups fearing erosion of the individual's freedom to choose. A small but vocal minority has made this the keystone of an attack also directed at pasteurization of milk, and immunization. At least one major anti-fluoridation group also "promotes Laetrile, Krebiozen,



mega-vitamin therapy, naturopathic medicine, and chelation therapy" (Evans and Pickles, 1978). Feelings are so strong on this issue in some communities that state legislatures generally opt out and leave fluoridation decisions to local referenda and advisory ballots. Anti-fluoridationists have also piggy-backed on the public's general disaffection for additives to condemn fluoride as another unwelcome and harmful addition to the human ecosystem.

### *Examples Involving Secondary Prevention*

*Congenital Metabolic Disorders.* Great strides have been made in recent years not only in understanding basic mechanisms of genetic disease but, most important, in developing methods of neonatal diagnosis and treatment for an increasing number of genetically determined abnormalities of amino acid metabolism. Screening for PKU, the most common treatable disorder of amino acid metabolism, is carried out in 45 states. Tests for other inborn errors of metabolism are also performed in a number of states. Massachusetts, for example, has been screening all infants in the state for PKU since 1962 and has added other tests as developed so that screening for 31 inborn errors of metabolism is now performed on three separate filter-paper specimens. From its inception through March, 1978, the Massachusetts program has found 133, or 1:15,000, infants with PKU, and 63 other infants with miscellaneous genetically defined metabolic disorders. If not detected and treated early, these disorders would have led to mental retardation and almost certain institutionalization. Because of early dietary therapy, the affected infants have been able to live normal or near normal lives. One proof of effectiveness is the fact that, since the screening became widespread, and without other policy changes, admission of children with PKU to mental institutions has virtually ended (MacCready, 1974).

Reduction in another important cause of mental retardation was made possible by the development of a laboratory test to screen for congenital hypothyroidism (Klein, Augustin, and Foley, 1974; Dussault, Coulombe, Laberge et al., 1975). The test was first added to the four-state Northwestern Regional Screening Program, based in Oregon (Brandon, 1976). Between January, 1976, when the Massachusetts State Laboratory Institute began screening for congenital hypothyroidism for a five-state New England Regional

Screening Program, and January, 1977, 25 newborns were found to have hypothyroidism (of 129,108 tested), an incidence rate of about 1:5200; this equals the national estimated rate (Fisher, 1977; Mitchell, Larsen, Levy et al., 1978). The interest and cooperation of an advisory group of pediatric endocrinologists in the New England Screening Program have led to rapid confirmatory diagnosis and management of the hypothyroid infants. Researchers stress the importance of early detection of hypothyroidism: if babies with congenital hypothyroidism are detected before three months of age and put on proper medication, about 85% will be normal (Klein, Meltzer, and Kenny, 1972). Investigators, however, estimate that less than one-third of the hypothyroid infants are diagnosed early on clinical grounds alone (Fisher, 1977).

The unit cost of testing for all amino acid metabolism disorders detectable at birth, and for which dietary therapy is available and effective, is estimated at \$2.00. The incremental unit cost of hypothyroidism screening is less than \$1.00 (Van Pelt and Levy, 1974; Committee on Genetics, American Academy of Pediatrics, 1977). Although a rigorous analysis of costs and benefits would have to include cost of treatment, and eventual economic productivity, it seems obvious that the prevention of institutionalization due to these screening and follow-up treatment programs is a sound economic as well as social investment.

Neonatal screening has been installed in most states as a passive measure from the point of view of parents. Blood is routinely taken from the newborn and sent to the laboratory; most parents are not aware that testing for metabolic disorders has been performed. The effectiveness of this type of preventive measure is predicated upon testing all newborns and having sufficient information on them and their parents to reach the latter in the event of a positive test result. As with childproof containers, there is little opposition to this passive approach, which prevents irreversible illness in children and which parents do not perceive as costing anything (the costs are borne through health insurance and general tax revenues).

*Cervical Cancer Mortality.* None of the health problems previously cited is as dreaded as cancer. The Papanicolaou (Pap) smear has become an accepted part of medical practice, and an early diagnosis of precancerous lesions can assure both patient and physician that its progression can be halted by a minor operation. The in-

idence of cervical cancer in the United States declined from 44 per 100,000 women in 1947 to 8.8 per 100,000 in 1970 (Guzick, 1978), and the mortality rate from cervical cancer fell from 9.3 per 100,000 women in the period 1950–54 to 6.2 per 100,000 women during 1965–69. In the absence of clear evidence of any change in the natural history of this disease, it is reasonable to infer that this marked reduction results mainly from earlier treatment indicated by earlier detection through Pap tests. Conservative estimates of the number of Pap smears annually performed today are over 15 million; 75% of the women over age 17 have had at least one Pap test.

Although articles questioning the effectiveness of screening on the reduction of cervical cancer mortality abound, a recent extensive and careful review article concluded: “Therapy based on confirmed positive smears can reduce the incidence and mortality rates of invasive cervical cancer, as shown by declining rates in many centers that had constant or increasing rates before screening began, lower rates for geographic areas and occupational groups having less screening and lower rates among screened women than unscreened women” (Guzick, 1978). One study of the effect of Pap smears estimates that the increase of annual screening from 0% to 30% of the women at risk over a 35-year period has added three years to the life expectancy of women diagnosed as having cervical cancer (Dickinson, Mussey and Kurland, 1972).

The controversy over the effectiveness of cervical screening in reducing cervical cancer mortality illustrates some of the problems of prevention. At first, the Pap smear was hailed as a paradigm of clinical preventive medicine, and a major selling job by the American Cancer Society and the medical profession convinced adult women of its indispensability. Then, researchers reviewing its impact had difficulty in confirming its contribution to the declining cervical cancer mortality rate. Despite some lingering uncertainty of its effectiveness and efficiency in screening programs, most public health professionals feel that cervical cancer screening (followed by treatment when needed) is correctly accounted a prevention success. Few physicians would dare suggest to a woman that she cease having the test performed at regular intervals.

The hard question raised by this example is: How much proof is needed to justify a nationwide campaign for adoption of a preventive measure? Should consensus among a panel of medical experts be the sole criterion? Or should rigorous scientific proof,

accompanied by credible cost-benefit and cost-effectiveness analyses, be required? Should all possible screening tests be compared frequently, and priority assigned to those that are the most worthy candidates for wholesale adoption regardless of accepted medical practice at the time?

If we are to make best use of our limited resources for promotion of health and health care, additional analyses and research are required before definitive decisions can be taken regarding those preventive services that should be routinely integrated into medical practice. On the other hand, the high public concern about some health problems, such as cancer, may militate for a lower threshold for adoption of related screening devices with low attendant risk even though their use is at best considered "prudent" rather than "proven."

### *Combining Primary and Secondary Prevention*

*Heart Disease Prevention.* Overall from 1963 to 1975, a period of increasing attention to coronary risk factors, age-specific coronary mortality decreased for every age group over 55 years; for example, 23.7% for those 55 to 64, and 25.3% for those 65 to 76 (Walker, 1977). This reduction in cardiovascular mortality contributed to an overall increase in longevity and was not offset by a commensurate increase in the mortality for other major diseases. No reason advanced for the decline fulfills Koch's postulates for causality, which state the kind of experimental evidence required to establish the etiologic relationships of a given causal agent to a given disease. It has been difficult to document in a reproducible fashion the effectiveness of medical measures, such as early detection of coronary heart disease, more frequent and beneficial early intervention, and coronary intensive care. Although a number of primary and secondary preventive factors have been implicated in the observed decline, the relative contribution of each factor is conjectural.

*Exercise.* Evidence accumulates that life-style changes may be a major cause of the decline. For example, more Americans are exercising vigorously, as exemplified by a recent estimate of 11 million regular joggers in the United States. Several studies suggest that frequent strenuous exercise, associated with a continuous and significant elevation of the pulse for at least 20 minutes, helps protect

against heart attacks and limit their severity. In one such study, Harvard alumni who exercised casually ran a 64% greater risk of heart attack than their fellow alumni who exercised vigorously and frequently, defined in the study as expending more than 2000 calories per week in vigorous exercise (Paffenbarger, Wing, and Hyde, 1977). Earlier studies of longshoremen (Paffenbarger and Hale, 1975) and of British Civil Service workers (Morris and Crawford, 1958) have shown that those who regularly engage in sustained vigorous exercise face a reduced risk of death from heart disease when compared to control populations.

*Nutrition.* Dietary changes are frequently cited as another contributing factor to the decline in cardiovascular mortality. A recent comparative study of Flemish-speaking and French-speaking populations of Belgium, who have very different dietary habits, displayed differences in the rates of cardiovascular disease that appear to derive primarily from their dietary differences (Jossens, Vuylsteek, Brems-Heynes et al, 1977). In the United States from 1962 to 1975, there was a paired decrease of 57% in per capita consumption of animal fats and oils, and an increase of 44% in vegetable fats and oils, higher in polyunsaturates, lower in calories (Walker, 1977). Per capita consumption of eggs also declined over this period (Chandler and Martson, 1976). In addition, strong evidence supports a fall of about 10% in serum cholesterol over the past 15 to 20 years (Chandler and Marston, 1976; Department of Commerce, 1975; Levy, 1977). It is suspected, although not proven, that these dietary and blood chemistry changes have contributed to reduced cardiovascular mortality.

The relative contributions of these primary prevention measures are unknown. Also not known is why so many Americans have recently adopted more healthful habits. Exercise has always been considered "healthy" in folk wisdom; even professional sanction by the President's Council on Physical Fitness, Dr. Paul Dudley White, and the American Heart Association strongly encouraged exercise as contributing to health and well-being. Still, a relatively small proportion of Americans routinely engage in sustained physical activity throughout the year. School sports programs have focused on the competitive aspect of sports, failing to impress upon youth that physical exercise is an important lifetime activity.

Over a very few years, regular exercise has been embraced by millions of adults as contributing to personal health. Was it a reaction to sedentary lifestyle, to overindulgent eating and epidemic obesity, an attempt to stay young and avoid the mid-life crises described by Gail Sheehy's *Passages* (1976), or a way to steal some personal time for reflection? Most certainly it did not derive from a concerted campaign on behalf of the government or from an all-out thrust by voluntary health agencies. Some prominent physicians have imparted to the public their considered opinion that regular strenuous exercise may reduce the risk of heart attack. This information may have been the spur for the pioneers. Since these professionals were the best educated and included many opinion shapers, their statements and personal examples may have catalyzed the geometric growth characteristic of every epidemic.

Nutritional habits have changed more slowly. In 1961 the American Heart Association began cautioning Americans that their diet was contributing to atherosclerotic heart disease, and recommended the kinds of changes that have occurred over the past decade. "Save Your Heart" cookbooks began to appear in profusion. Raised consciousness of risks related to cholesterol led to margarine use instead of butter and fewer eggs on the breakfast table. Marketing experts, sensing more than a short-lived fad, introduced products both to satisfy and stimulate altered consumer desires: egg substitutes, low-fat milk, artificial (low calorie) margarine, meat substitutes made of soybean, and cooking oils with polyunsaturates. Moreover, the experts began to market these products as healthful and low in calories, thus attracting not only heart-conscious buyers but weight-conscious ones. Salubrity and vanity are good commercial partners. Thus the power of advertising was harnessed to modify the American diet, not because of feelings of social responsibility, or government intervention, but because a new market had been created for which food processors were competing, knowing full well that brand loyalty relates to market share.

Reduction in smoking and untreated hypertension in the United States of America, important risk factors for heart disease, are discussed separately below.

*Hypertension-Induced Diseases.* One success in expanding efforts in clinical practice to reduce risk factors for heart disease and stroke is widespread screening for, and improved treatment of, hyper-

tension. Now accepted as part of good medical practice, high blood pressure control has been advanced as a way of defusing an internal time bomb rather than as an essential component of preventive medicine. Although hypertension is an important risk factor for heart disease and its control probably contributes to decreased cardiac mortality, assessing the extent of its contribution is difficult because of concomitant changes in other risk factors. More clear-cut indices of effectiveness of high blood pressure screening and control efforts are reductions in hypertensive disease deaths and stroke deaths. In both these disease groups, hypertension is known to be the principal cause. United States death rates for hypertensive disease (excluding stroke) decreased 35.4% from 1970 to 1975. The national fatality rate for stroke decreased 9% from mid-1968 to mid-1970, and 21% from mid-1972 to mid-1976 (Department of Health, Education, and Welfare, 1978). The number of deaths from hypertension-related diseases declined from 919,000 in 1972 to 843,000 in 1976.

Representative national surveys in 1971-1972 and 1972-1974 showed that the percentage of hypertensive persons aware of their condition had increased from 51% to 56%, and that the total visits and first visits to physicians for hypertension-related reasons had increased 50% from 1971 through 1976 (Ward, 1978). Unlike cervical cancer screening, the effectiveness of this program, measured by the reduction of mortality through controlling hypertension, has not been contested by even a minority of preventive medicine experts.

In 1972 the National High Blood Pressure Education program was launched by the National Institutes of Health to educate the public on the need for blood pressure screening and treatment and to improve physician interest and competence in dealing effectively with hypertension as a chronic disease. Although the effectiveness of both this governmental initiative and the voluntary sector efforts with similar objectives is clear-cut, major problems remain in convincing hypertensive patients to adhere to the prescribed medical regimens. At least one-half of the known hypertensives are still not adequately controlled. Taking pills, many with undesirable side effects, for the rest of one's life to treat a disease frequently without symptoms requires commitment, future orientation, understanding, and fear of the disease to a greater extent than many people are capable. The availability of inexpensive and simple screening programs, coupled with relatively inexpensive, effective treatment and medical community support, does not mean, however, that the

overwhelming majority of those detected with the problem will have their blood pressure adequately controlled.

Of particular note is the clear-cut progress recorded in increasing hypertension detection and control among blacks, who have a hypertension prevalence rate of 2 to 4.5 that of whites, depending on the age group. Data on mortality from hypertension and cardiovascular diseases for the period 1968–1976 show that rates for both whites and non-whites have declined markedly. The decline has been proportionately greater for non-whites (blacks and others) than for whites (Table 2). A little over a decade ago, blacks were less likely to know they had hypertension. Moreover, they were less likely to have continuing medical care, and adequate control of their hypertension. (McDonough, Garrison, and Hames, 1964; Department of Health, Education, and Welfare, 1964; Wilbur, 1967).

A large-scale hypertension detection and follow-up program (1973–1974), and the blood pressure measurements taken as part of the National Health and Nutrition Examination survey during the period 1971–1974, reveal that among males and females found to be hypertensive, there was no race-related difference in awareness of their hypertension at the time of screening (Hypertension Detection and Follow-up Program, 1977; Department of Health, Education, and Welfare, 1976c).

There is strong evidence that federal financing programs, coupled with government efforts at improving health care in the inner city and rural areas of this country, brought a disproportionately large number of blacks to medical evaluation and treatment (Brunswick and Collette, 1977; Eckenfels, Frate, Logan et al. 1977; Hypertension Detection and Follow-up Program, 1977; Apostolides, Entwisle, Ouellet et al., 1978). These programs led to the integration of preventive medicine approaches toward hypertension with the accepted medical model of therapeutic personal health care. With access to continuing care a reality for more blacks and other economically disadvantaged groups, a national program to control hypertension could move its emphasis from detection and initial treatment to adherence and continuity of care.

*Smoking.* The problem of smoking is inherently different from the few previous examples of habits whose alteration improve health. Smoking distinguishes itself by its innate lack of utility. Switching to a more healthful diet, a less sedentary existence, driving slowly, and



TABLE 2  
Age-Adjusted Death Rate for Specified Causes by Color, 1968-1976\*

Year	Hypertension†		Cerebrovascular Diseases‡		Cardiovascular Diseases§		All Causes			
	White	Non-White Ratio	White	Non-White Ratio	White	Non-White Ratio	White	Non-White Ratio		
1968	2.6	10.6	4.08	1.88	351.6	481.1	1.37	708.6	1077.3	1.52
1969	2.4	9.5	3.96	1.84	341.4	457.9	1.34	694.4	1046.2	1.51
1970	2.2	8.6	3.91	1.73	330.3	421.7	1.28	679.6	983.4	1.45
1971	2.1	8.4	4.00	1.76	327.9	431.1	1.32	668.5	1003.0	1.50
1972	2.0	7.5	3.75	1.66	324.7	409.1	1.26	667.6	965.4	1.45
1973	1.9	6.4	3.37	1.67	317.9	402.0	1.27	659.3	953.1	1.45
1974	1.7	5.6	3.29	1.61	302.9	374.8	1.24	635.4	901.3	1.42
1975	1.5	5.0	3.33	1.60	284.6	346.4	1.22	609.8	852.4	1.40
1976	1.4	4.7	3.36	1.59	277.8	337.2	1.21	599.9	833.7	1.39

\* Rates per 100,000 estimated population.

† Hypertension, ICDA (8th Revision) 400, 401, 403.

‡ Cerebrovascular Diseases, ICDA (8th Revision), 430-438.

§ Major Cardiovascular Diseases, ICDA (8th Revision), 390-448.

|| Non-White to White Ratio.

Sources: *Vital Statistics of the United States, 1968-1976*. Department of Health, Education, and Welfare, National Center for Health Statistics

avoiding children's engorgement of poisonous but useful household products and medicines, all involve making safer the intrinsic and necessary activities of daily living. By contrast, smoking is a very harmful addiction. Its marketing preys on human weakness. Its rationales for continued existence are not lack of demonstrated harm but consumer demand in a free society, significant tax revenues to states and the federal government, and employment for a significant percentage of the work force in several states.

The federal government has made only sporadic and limited attempts to reduce smoking (*e.g.*, the 1964 Surgeon General's Report and its updates, and the general health warning on the side of cigarette packets)—despite the well-established fact that smoking remains the greatest preventable cause of premature death and disability in Americans. Lack of federal action has been attributed to vehement opposition by powerful congressional leaders from tobacco-growing states, a well-organized and financed cigarette lobbying organization, and a civil libertarian attitude that adults have a right to adopt foolish and even harmful habits, as long as others are not harmed. The health professionals' protestations against marketing tactics aimed at attracting children to cigarette smoking, and their estimates of \$27.5 billion for the direct and indirect costs of smoking nation-wide (Luce and Schweitzer, 1978), have elicited minimal response. A Secretary of Health, Education, and Welfare who brands smoking the nation's number one health problem has been unable to secure funds for a mass media anti-smoking campaign targeted at preadolescents. Nor has he been able to garner Presidential support for strong remedial legislation or to effect a rethinking of the Department of Agriculture's tobacco subsidies.

Nonetheless, a reduction in adult smoking *has* occurred and justly qualifies the government's preventive effort as a success. Since the original Surgeon General's Report in 1964, the proportion of adult American men who smoke has decreased from 52% to 39% and of women, from 32% to 29%, with 29 million Americans having stopped between 1964 and 1975. Of physicians, dentists, and pharmacists who ever smoked, 64%, 61%, and 55%, respectively, have quit, and the proportion who now smoke is down to 21%, 30%, and 28% (Department of Health, Education, and Welfare, 1977b).

Analysis of smoking trends suggests, in retrospect, that the first Surgeon General's Report on Smoking and the anti-smoking advertising that followed on the electronic media produced significant an-

nual declines in cigarette consumption (Warner, 1977). Per capita tobacco consumption during 1960–1970 declined 10.5% in the United States compared to increases of 4.2% for Canada, 11.9% for Belgium, 17.1% for Finland, and 19.6% for West Germany. Since smoking cessation reduces individual risk for coronary heart disease with almost no time lag, the fact that mortality from coronary heart disease, the leading cause of death in the United States, began its pattern of decline the same year as the Surgeon General's Report is at least partially attributable to changing smoking habits (Walker, 1977).

Concern by smokers over the health effects of their habit has led to an increase in the use of filter cigarettes; by 1974 they were smoked by 61% of the male and 54% of the female smokers (Department of Health, Education, and Welfare, 1975). Health concerns have also fostered the development and successful marketing of low-tar and low-nicotine brands (15 mg or less tar, 1.5 mg or less nicotine) whose sales increased from 11% of the total sales in 1975 to an estimated 25% in 1977, with 40% projected for 1980 (*The Wall Street Journal*, 1978).

Smoking cessation clinics have achieved a 12- to 18-month success rate of 13% to 37%, and an approximately 20% success rate in four- to five-year follow-up studies (West, Graham, Swanson et al., 1977). New techniques promise to push one-year success rates to 40% to 60% (Danaher, 1977; Landow, 1977).

Why smoking has experienced such a marked decline is unknown. Persistent warnings plus teaching by example on the part of health professionals and an overwhelming fear of cancer on the part of smokers and their loved ones are frequently proposed reasons, but the answer probably has at least as much to do with changing social pressures and increased interest in *feeling* healthy. Opinion makers have more recently abandoned smoking, and their quitting has been told as a success story. Family pressures, including those from children, to quit or not start have intensified. The millions starting to exercise strenuously and regularly find it difficult if not impossible to do so if they smoke. Smoking is no longer chic or socially required. In fact, it is increasingly regarded, at least by most adults, as a socially unacceptable habit, in much the same way as spitting was several generations ago. (Part of the early campaign to control tuberculosis involved reducing spread of the bacillus by portraying spitting as ill mannered. A public not well versed in disease etiology

came to view spitting as anti-social and abandoned it primarily for that reason.) Non-smokers have also become more militant; smoking is legally restricted in more and more public places, and non-smokers are demanding enforcement. Courts are starting to declare that workers are entitled to a smoke-free environment. The silent majority has become vocal. In addition, a recent widely publicized study showing that non-smoking patients with angina pectoris experienced reduced exercise tolerance after several hours' exposure to second-hand cigarette smoke may intensify pressures for government and industry action to discourage and restrict smoking (Aronow, 1978).

Despite general progress in smoking cessation, however, smoking among some groups has actually increased. For example, a careful cohort study found that the percentage of regular smokers among girls 15 to 16 years old had risen from 9.6% in 1968 to 20.2% in 1974, and among girls 17-18, from 18.6% to 25.9% (Department of Health, Education, and Welfare, 1976b). Although a generation ago smoking among women was much higher in groups with the greatest formal education and highest income, this trend is being reversed. Cessation is now preferentially occurring among the best educated, whereas habit acquisition is highest among the least educated and poorest. The trickle down (from highest to lowest social class) phenomenon of smoking cessation observed in the male population is less true among women, perhaps because women may be striving for greater independence and may consider smoking a symbol of new freedom. These trends suggest that preventive efforts may have differential success according to social class, educational background, age, and sex. Smoking among teen-age girls may be more affected by *social* warnings that smoking stinks and reduces sex appeal than by more *scientific* evidence of longer term health risks. Prevention efforts may have to sacrifice homogeneity of approach to all smokers if they are to achieve effectiveness in some high risk groups.

## Multiple Risk Factor Intervention

Of special interest are two community projects designed to attack multiple cardiac risk factors simultaneously: the North Karelia Project and the Stanford Heart Disease Prevention Program. The North Karelia Project in Finland has shown that community support and

interest, plus careful planning, can reduce cardiac risk factors in a defined population, in this case, 180,000 (Puska, 1977). Evaluation after 4½ years of intervention has shown that, among middle-aged males, the percentage of current smokers decreased from 54% to 43%, users of low fat milk increased from 17% to 50%, and users of butter decreased from 86% to 69%. If it is assumed that a change in either incidence or prevalence of hypertensive disease occurred during this period, it is important to note that the percentage of persons under anti-hypertension treatment increased from 3% to 11% among men and from 9% to 13% among women. The incidence rate of stroke dropped from 3.6 per 1000 in 1972 to 1.9 in 1975 in males aged 30–74 years, and from 2.8 to 1.8 for females in the same age group; both the acute myocardial infarction mortality and overall mortality rates also declined for this middle-aged population.

The Stanford Heart Disease Prevention Program has demonstrated the success of intervention on cardiac risk factors in three Northern California communities (Farquhar, Maccoby, Wood et al., 1977). Community health education and face-to-face counseling led to a difference in total cardiovascular risk between control and treatment communities of 23% to 28%. The program demonstrated the effectiveness of using mass media to influence some personal behaviors, especially smoking.

## Levels of Evidence

Most of us subscribe to the thesis that the stronger the evidence that a product, practice, or behavior causes disease, the stronger the rationale for intervention by government and other social and health agencies. Yet whether this approach can be adopted depends on the public's perception of the relative strength of various interventions and its relative fear of different ills. For example, preventive medicine specialists generally feel that the benefits of cervical cancer screening exceed those of routine mammography in reducing cancer mortality when applied to all adult women. However, if the public believes that mammography is a more effective way to avoid cancer death than Pap smears, and if its fear of breast cancer outweighs its fear of cervical cancer, it will be difficult to advance policies or budgets that allocate a disproportionate number of dollars toward the latter procedure and related follow-up.

Public perceptions of the appropriateness of investment in alternative intervention strategies may also be influenced by the nature of the proposed interventions. Strongly embedded is the passive notion that the medical care system and its evolving technology can contribute more to protection from dread diseases than can active modification of personal habits. Public support may be behind routine chest X-rays and sputum examination for early lung cancer detection yet be lacking for concerted efforts to assist smokers to quit, despite the much lower cost effectiveness of the former techniques in lowering lung cancer mortality rates.

Causality can be more believable if described in mechanical terms. That a virus frequently found inside cells in the cervix can induce certain of these cells to grow in strange and uncontrolled ways does not strain credibility. That smoking cigarettes contributes to coronary heart disease or bladder cancer is more difficult to explain in mechanical terms and may, as a result, appear less believable as a danger and less worthy of public investment.

Availability of potentially efficacious, effective, and efficient interventions does not guarantee success. Although a large proportion of severe genetic diseases can be prevented through a combination of genetic counseling, amniocentesis, and elective abortion, implementation of these approaches is limited by difficulty in identifying those individuals at increased risk, in effectively communicating notions of genetic risk, and in dealing with the conviction of many providers, patients, and taxpayers that abortion is wrong.

In our examples, the degree of public acceptance of an intervention correlates less well with the level of proof of etiology than with whether the intervention is active or passive (Table 1). *Passive* interventions (e.g., metabolic screening, engineering safer cars, child-proof medicine containers, reducing cigarette tar and nicotine) in general achieve higher acceptance than do *active* interventions (e.g., smoking cessation, adherence to anti-hypertensive drug regimens, driving more slowly), except when a vocal segment of the public perceives that the passive intervention in turn subjects people involuntarily to health risks (e.g., fluoridation). In the only example in Table 1 featuring strong governmental involvement in an active strategy, the ignition interlock system, the public's elected representatives removed the administrative branch's ability to act.

A recurring issue in intervention strategies is how far should the government intervene in the lives of minors. As an example, some

persons would justify intervention in helping to prevent teen-agers from acquiring the smoking habit on the basis of the *parens patriae* doctrine that the state can act to protect those who are not able to protect themselves. Such a posture, however, would probably outrage new left libertarians, who might question whether the intervention was not directed at a social goal rather than at the alleviation of a clear and present danger. Invocation of *parens patriae* is justified more easily in the case of metabolic screening where failure to screen and follow up some infants after birth leads unequivocally to permanent severe damage. Although advocates of universal fluoridation can use the same *parens patriae* argument, the lesser disability resulting from inaction and the only partial effect of intervention weaken the weight of the argument.

### Diseases, Organs, Problems, or Technologies

In our rush to prevent what we can, we have not employed a uniform set of goals. Sometimes we focus on a particular disease, such as coronary artery disease, and measure the worth of efforts by reduction in natural age-adjusted mortality rates. Attacking diseases with multifactorial etiology requires developing programs of many different types (*e.g.*, diet, exercise, smoking, and hypertension). On the other hand, should a single causal factor predominate (*e.g.*, smoking as the major cause of lung cancer) most resources can be directed at one habit or problem, with the potential of greater impact. Many voluntary agencies derive their *raison d'être* from the maladies of a particular organ (The Kidney Foundation, The Lung Association, The American Heart Association, etc.). This approach also requires diverse programming frequently directed at different target groups with disparate objectives. The American Heart Association is concerned with congenital heart disease in addition to acquired coronary artery disease. Congenital heart disease prevention entails educating young prospective parents (*e.g.*, on the risks of rubella infection during the first trimester) and providing genetic counseling to parents of a child affected with congenital heart disease that shows familial aggregation. Such an effort has almost nothing in common with the prevention of acquired disease that can possibly be prevented by attention to personal habits during early middle life and beyond. Nor does this focus have much in common with a campaign

designed to convince persons on penicillin prophylaxis following a first case of rheumatic fever to continue this regimen to avoid subsequent attacks or their sequelae.

A third approach is to classify targets for prevention by problem, like smoking or obesity, each not a disease in itself but a contributor to many. These problems are not listed as the immediate cause of death on death certificates; many are man-made, their cause and effect separated by many years. The assignment of their contributions to disease involves epidemiology and application of probability theory, not tangible enough to incite people to join together to vanquish the common foe. Although not the object of eleemosynary zeal, a number of these problem have been the subject of entrepreneurial schemes (*e.g.*, Weight Watchers, and Smokenders) that have been, at least momentarily, quite successful. Unfortunately, the short-run results of success are, at best, inferential; truer relationships may be discernible only across long time spans.

A final prevention strategy that has been employed is to work for the development and application of a successful technology. The success of natural fluoridation helped coalesce those interested in better teeth for their families and preventive medicine efforts to push fluoridation of community water supplies. The efficacy of the seat belt and of the child restraint was important in the genesis of Physicians for Automotive Safety. In other cases, a particular technology has become the means to an objective already established by a well-organized group: the Pap smear for the American Cancer Society, amniocentesis for the National Tay Sachs and Allied Diseases Association, and polio immunization for the March of Dimes.

The importance of this diversity of approaches stems from the need to compare alternative methods of preventing a particular problem for efficacy, efficiency, and effectiveness. In the same manner, the need exists to compare the impacts of choosing alternative categories of targets (*e.g.*, smoking vs. coronary heart disease) in terms of levels of evidence, chances of support by other health groups and the media, and secondary effects on health status viewed from an economic perspective. As a general rule, investments in strategies with the primary impact on morbidity (*e.g.*, fluoridation, metabolic screening) have obvious benefits that outweigh costs. Examination of effective prevention of premature mortality, however,



requires careful assessment of many secondary economic effects, among them an older population using more health care services, more pension dollars, and more publicly-supported social services for the elderly. If these are not offset by increased earnings and enhanced tax contributions, human benefits in terms of increased longevity and possible improvements in the quality of some years of life must be considered against a backdrop of increased taxes and a possible decrement in the standard of living (Gori and Richter, 1978).

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