Two Pathways to Prevention

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Health promotion and disease prevention programs are becoming important components of contemporary health care. There are at least 2 pathways to the enhancement of population health status through disease prevention. The first pathway requires the early diagnosis and treatment of disease. The second pathway promotes healthy lifestyles and disregards the requirement that a condition must be diagnosed before intervention is recommended. Data from several evaluations suggest that prevention efforts that rely on diagnosis have produced somewhat limited benefits, whereas primary prevention efforts may have substantial benefits. Current health policy places greater emphasis on secondary prevention. The objectives of improved population health might be better achieved by devoting relatively more resources to primary prevention through the promotion of healthy behaviors.

In January of 1998, Medicare expanded its coverage of preventive services. President Clinton introduced these changes during his weekly radio address on December 27, 1997, stating,

On New Year's Day, we'll introduce a series of changes in Medicare that will make screening, prevention and detection of cancer more affordable and frequent... By detecting cancer early on we offer our loved ones one of the greatest gifts of all—the gifts of life, health and many holidays to come. (Office of the Press Secretary, The White House, 1997)

To initiate the program, President Clinton ordered Medicare to cover annual mammograms for all women 40 years of age and older. The new policy also called for Pap smear tests for cervical cancer and pelvic examinations every 3 years, with annual tests for women at higher risk. Further, the new policies covered regular colorectal cancer screening, which improved upon previous policies that had covered only patients with symptoms.

It might be argued that many of these changes are moot. Medicare already covered mammograms and Pap smears for older women. The new policy initiated the use of mammography for women age 40 and above, revising the guideline that mammograms should begin at age 50. With only a few exceptions, however, Medicare is a program for people age 65 and over. Changing the threshold for mammograms from age 50 to age 40 affected very few Medicare recipients.

Despite affecting only a few people, the policy change was symbolic for two reasons. First, it represented the growing recognition that preventive medicine is important and that preventive services must be reimbursed. Supporting prevention is politically wise because voters believe in it. Second, the policy reflected the endorsement of a specific model of prevention. In this article, I argue that there are at least two pathways to prevention. One pathway is medical prevention that typically involves identifying an existent disease at an early stage and eliminating the problem before it gets out of control. In the public health vernacular, medical prevention is known as secondary prevention. An alternative pathway is primary prevention. Primary approaches to prevention require preventive maneuvers that reduce the chances that a health problem will ever develop. Primary prevention almost always requires behavior change, therefore, successful primary prevention efforts must use behavioral theories and behavioral interventions.

Primary and Secondary Prevention

The terms primary and secondary prevention can be confusing because they are used inconsistently. In the mental health literature, the term primary prevention is usually used as defined above, although there have been serious debates about terminology. The World Health Organiza-

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1 A 1994 report from the Institute of Medicine of the National Academy of Sciences (IOM) divided the spectrum of mental health into prevention, treatment, and maintenance. Prevention was further divided into (a) universal programs, (b) programs directed at selective subgroups of the population, and (c) programs directed at those who already had some diagnosis (Munoz, Mrazek, & Haggerty, 1996). Indicated preventive interventions were defined as those targeted at high risk individuals. However, Albee (1996) attacked the disease-oriented model that dominated most prevention sciences. Albee emphasized that the report had a "disorder orientation" (p. 1131). Recognizing the long history of primary prevention efforts, Albee argued that the most important prevention programs do not require a diagnosis. Quoting Senator Daniel Inouye, Albee cited the most important contributions of public health as not involving a diagnosis. These included water quality, improved sewer systems, better nutrition and food, and loving attention of infants and children. Perhaps because of these disagreements, the IOM classification system has rarely been used.
The traditional biological model of health focuses on the interaction between the body and the environment. The outcomes of this model are often based on the relationship between disease and its risk factors. However, in recent years, there has been a shift towards a more holistic view of health, which includes psychological, social, and environmental factors. This new approach recognizes that health is not just the absence of disease but a state of well-being.

Secondary prevention is an approach to health that focuses on reducing the risk of disease in individuals who are at increased risk for developing a specific condition. This approach involves identifying those at risk and implementing strategies to prevent the development of disease. The key components of secondary prevention include screening, diagnosis, and early intervention.

Mechanistic thinking in secondary prevention

Mechanistic thinking is an approach to understanding disease that focuses on the underlying biological mechanisms that contribute to the development of disease. This approach involves identifying the specific pathways and processes that are involved in the development of disease and developing strategies to interrupt these pathways at different points.

The secondary prevention model builds upon the mechanistic thinking approach. It emphasizes the importance of understanding the underlying biological mechanisms that contribute to the development of disease and developing strategies to interrupt these mechanisms at different points.

The purpose of this article is to examine the role of secondary prevention in the prevention of disease. It discusses the importance of secondary prevention in public health and provides examples of successful secondary prevention programs.
emphasizes quality of life and life duration instead of clinical measures of disease process. Prevention can be secondary or primary, and attention is given to efforts that produce the longest life and highest life quality. Prevention can involve medical intervention, behavioral intervention, or changes in public policy. In contrast to the medical model that treats disease, the outcomes model treats the person or a population of people.

**How the Outcomes Model Leads to Different Decisions Than the Traditional Biomedical Model**

Although the traditional biomedical model and the behavioral outcomes model are similar in many ways, they lead to different decisions about the use of resources for prevention. In the following sections, several examples of these models are reviewed.

The secondary prevention model is based on medical diagnoses. A diagnosis defines the problems that have been found and gives direction concerning what needs to be fixed. The medical care system pays providers for using diagnostic tests to find problems and for using therapeutic interventions to fix the problems. Despite its importance, diagnosis often obscures or confuses the importance of some health problems. There are at least three reasons why focusing on diagnosis may have led the medical community in some wrong directions. First, diagnoses do not always lead to better health outcomes. Often, people are placed in categories, but identification of a condition does not necessarily mean that an effective treatment can be applied. Second, diagnoses are not always correct. Some individuals will be treated for conditions they do not have, and others will fail to be effectively treated because the correct diagnosis was missed. Third, in many cases, poor health outcomes result from risky behavior or from exposure to risk factors. Public health can be enhanced by removing the risk factor or by modifying behavior. The identification of a disease on the pathway between the risk factor and the outcome is interesting but not essential. Although investing more in the early identification and treatment of cancer might increase average life expectancy, the same benefits might also be achieved by investments to reduce cigarette use, to build safer roads, or to make firearm access difficult.

The secondary prevention model has appeal because it fits the linear thinking that predominates health care. However, in spite of this logical appeal, the public health benefits of secondary prevention have been limited, at least from an outcomes perspective. A few case studies are considered in this article.

**Conceptualizing Benefits**

Recently, the Institute of Medicine of the National Academy of Sciences (Field & Gold, 1998) reviewed measures of population health. The report suggested that policies designed to improve the health of populations have focused on death from diseases such as smallpox and cholera. Priorities for health care programs have traditionally been set in relation to the ability to limit deaths. However, most interventions in health care are designed to go further than the prevention of early death: Health care also involves preventing disability, improving functioning, relieving pain, addressing mental health concerns, and helping people cope with the symptoms of illness. To accurately compare primary and secondary prevention efforts, researchers must have models to conceptualize and measure health benefits. In contrast to the traditional medical model that quantifies cases of disease, the outcomes model evaluates health care according to how much health is produced. A disease or an environmental exposure is of concern if it reduces health. Treatments do not necessarily convey benefit, even if they eliminate a specific disease. By eradicating one disease, the treatment may create other problems, such that total health is reduced.

To understand health outcomes, it is necessary to build a comprehensive theoretical model of health status. The major aspects of the model include mortality (death) and morbidity (health-related quality of life). Diseases and disabilities are important for two reasons. First, illness may cause the life expectancy to be shortened. Second, illness may diminish the health-related quality of life, making life less desirable (Kaplan & Anderson, 1996; Kaplan, Sieber, & Ganiats, 1997). Environmental exposures or risky health behaviors might reduce life expectancy or quality of life, even if researchers do not understand their specific effects upon the disease process (Winett, 1995). Treatments may make life better or longer, even though researchers do not understand the mechanisms through which they influence a biological process. However, to understand health outcomes, it is necessary to quantify health using measures that do not necessarily depend upon medical diagnosis.

Some outcomes measurement models are refinements of generic survival analysis. In traditional survival analysis, those who are alive are statistically coded as 1.0, whereas those who are dead are statistically coded as 0.0. Mortality can result from any disease, and survival analysis allows comparison between different diseases. For example, the life expectancy for those who will eventually die of heart disease can be stated and compared with the life expectancy of those who will eventually die of cancer. Thus, there is an advantage over disease-specific measures, such as measures of blood output from the heart and tumor size. The difficulty with a survival measurement model is that everyone who remains alive is given the same score. A person confined to bed with an irreversible coma is alive and is counted the same as someone who is actively participating in athletics. Utility assessment allows the quantification of levels of wellness on the continuum anchored by death and optimum function.

Quality-adjusted life years (QALYs) are measures of life expectancy with adjustments for quality of life (Gold, Siegel, Russell, & Weinstein, 1996; Kaplan, Alcaraz, Anderson, & Weisman, 1996; Kaplan & Anderson, 1996). QALYs integrate mortality and morbidity to express health status in terms of equivalents of well years of life. If a woman dies of breast cancer at age 50 and one would have expected her to live to age 75, the disease was associated
resources. The federal government, through the allocation of funds, sets the agenda of priorities for education, health care, and other public services. The allocation of funds is based on a complex system of formulas that take into account various factors such as population, poverty rates, and local needs. These funds are then distributed to states and localities, where they are used to support a wide range of programs and initiatives. The effectiveness of these programs depends on how well they are implemented and monitored.

The effectiveness of education, health care, and other public services is crucial to the well-being of communities. However, the allocation of funds is not always equitable, and disparities in funding can lead to unequal access to services. This can have significant consequences for individuals and communities, particularly those living in poverty or facing other barriers to accessing resources.

In conclusion, the allocation of funds for education, health care, and other public services is a complex process that involves many stakeholders, including federal, state, and local governments, as well as various interest groups and communities. It is essential to ensure that these funds are distributed in a fair and equitable manner, so that all communities have access to the services they need to thrive.
In the following sections, the outcomes model is used to evaluate three approaches to secondary prevention and three approaches to primary prevention.

**Evaluation of Secondary Prevention**

There are numerous secondary prevention procedures in contemporary health care. Three procedures were chosen for this discussion: screening for breast cancer, screening for prostate cancer, and screening for high cholesterol. These examples were chosen because each is widely accepted and commonly advocated as a component of preventive medicine. Before presenting evidence on the cost/effectiveness of each program, some general background on the controversies surrounding screening is offered.

**Disease Reservoir Hypothesis**

According to the American Cancer Society (1999), screening and early detection of cancers save lives. It is believed that there is a reservoir of undetected disease that might be eliminated through more aggressive intervention. Screening guidelines have been proposed, and those who fail to adhere to these guidelines are regarded as irresponsible.

For one to better understand the problem, it is necessary to understand the natural history of disease. Public health campaigns assume that disease is binary: either a person has the “diagnosis,” or he or she does not. However, most diseases are processes. It is likely that chronic disease begins long before it is diagnosed. For example, autopsy studies consistently show that most young adults who died early in life from noncardiovascular causes have fatty streaks in their coronary arteries, indicating the initiation of coronary disease (Strong et al., 1999). Not all people who have a disease will ultimately suffer from the problem. With many diseases, most of those affected will never even know they are sick.

Among those who do have problems, some may not benefit from treatment. For example, if smokers are screened for lung cancer, many cases can be identified. However, clinical trials have shown that the course of the disease is likely to be the same for those who are screened and those not subjected to screening, even though screening leads to more diagnosis and treatment (Sanderson, 1986). There may be large reservoirs of disease that can be detected through screening: Very high proportions of elderly (older than age 75) women have ductile breast cancer in situ, and nearly 40% of elderly men may have prostate cancer (Coley, Barry, Fleming, & Mulley, 1997). The harder researchers look, the more likely it is that cases of disease will be found. However, only about 3% of elderly men will die of prostate cancer, and only about 3% of elderly women will die of breast cancer. A very sensitive test for prostate cancer may detect disease in 10 men for each 1 man who will eventually die of this condition. These problems are not limited to cancer. Advanced magnetic-resonance-imaging technology has revealed surprisingly high rates of undiagnosed stroke. One cross-sectional study of 3,502 men and women over age 65 found that 29% had evidence of mild strokes and that 75% had plaque in their carotid arteries (Manolio et al., 1999).

Black and Welch (1997) made the distinction between disease and *pseudodisease*. Pseudodisease is disease that will not affect life duration or quality of life at any point in a patient’s lifetime. When the disease is found, it is often “fixed” with surgical treatment. However, the fix may have consequences, often leaving the patient with new symptoms or problems. The outcomes model considers the benefits of screening and treatment from the patient’s perspective. Often, using information provided by patients, one can estimate the quality-adjusted life expectancy for a population and determine if that population is better off with or without screening and treatment (Kaplan, 1997).

There may be analogies between screening for disease and screening for mental health problems. For example, the current epidemic of depression may result from greater public sensitivity and more screening. The Medical Outcomes Study (Wells, 1997) found that the prevalence of minor depression in primary care clinics was nearly 25%, whereas the prevalence in mental health clinics was 60%. The reservoir of children who could be diagnosed with attention deficit hyperactivity disorder (ADHD) could be huge. In one county-wide screening program, half of the children in special education qualified for a diagnosis of ADHD (Bussing, Zima, Perwien, Belin, & Widawski, 1998). Evidence does not clearly demonstrate whether more aggressive screening and treatment of ADHD will result in improvements in population health status.

**Prostate Cancer Screening**

The disease reservoir hypothesis helps explain controversies surrounding several cancer screening tests. One example of the differences between the traditional secondary prevention (biomedical model) and the outcomes models concerns screening and treatment for prostate cancer. Most cancer prevention efforts follow a traditional “find it–fix it” secondary prevention model. The identification of cancer dictates treatment, which in turn is evaluated by changes in biological process or disease activity. In the case of prostate cancer, a digital rectal exam may identify an asymmetric prostate, leading to a biopsy and the identification of prostate cancer. Diagnosis of cancer often leads to a radical prostatectomy (surgical removal of the prostate gland). The success of the surgery would be confirmed by eradication of the tumor, reduced prostate-specific antigen (PSA), and patient survival.

In contrast to this traditional biomedical model, an outcomes perspective embraces public health notions of benefit. Instead of focusing on disease process, benefit is defined in terms of life duration and quality of life. Studies have demonstrated that serum PSA is elevated in men with clinically diagnosed prostate cancer (Hudson, Bahnsen, & Catalona, 1989) and that high PSA levels have positive predictive value for prostate cancer. Despite the promise of PSA screening, there are also significant controversies. Prostate cancer is common for men age 70 years and older (Lu-Yao, Barry, Chang, Wasson, & Wennberg, 1994). Averaging data across eight autopsy studies, Coley, Barry, Fleming, Fahn, and Mulley (1997) estimated the prevalence of prostate cancer to be 39% in 70–79-year-old men. The
Screening for Breast Cancer

Screening for prostate cancer is generally recommended for men aged 50-70 years, but the evidence is less clear for younger men. The benefit of screening for ovarian cancer is uncertain, and the risks and benefits of screening for cervical cancer are well understood. The American Cancer Society recommends routine screening for colorectal cancer, with colonoscopy starting at age 45 for average-risk individuals.

**Figure 1:** Tumor Differentiation

<table>
<thead>
<tr>
<th>Grade</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Ratio</td>
<td>0.5</td>
<td>1.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Figure 2:** Quality-Adjusted Life Expectancy

- Low: 8 years
- Moderate: 7 years
- High: 6 years

**Figure 3:** Treatment Options

- Surgery
- Radiation Therapy
- Chemotherapy
- Hormonal Therapy

**Figure 4:** Prognosis

- 5-year survival: 90%
- 10-year survival: 80%

**Table 1:** Risk Factors for Breast Cancer

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
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<tbody>
<tr>
<td>Age</td>
<td>40-49 years</td>
</tr>
<tr>
<td>Family History</td>
<td>Breast or ovarian cancer</td>
</tr>
<tr>
<td>Menopause Status</td>
<td>Premenopausal</td>
</tr>
</tbody>
</table>

**Figure 5:** Staging of Breast Cancer

- T1: Primary tumor ≤ 2 cm
- T2: Primary tumor > 2 cm, ≤ 4 cm
- T3: Primary tumor > 4 cm

**Figure 6:** Chemotherapy Regimens

- Doxorubicin (modified) + Cyclophosphamide (AC)
- Paclitaxel + Cyclophosphamide (TC)

**Figure 7:** Radiation Therapy Techniques

- 3D Conformal Radiation Therapy
- Intensity-Modulated Radiation Therapy (IMRT)

**Figure 8:** Hormonal Therapy Medications

- Tamoxifen
- Aromatase Inhibitors

**Figure 9:** Prognosis after Breast Cancer Treatment

- Local recurrence: 1%
- Metastatic spread: 5%

**Figure 10:** Quality of Life After Treatment

- Physical function: 80%
- Emotional function: 70%
- Social function: 60%

**Figure 11:** Breast Cancer Support Services

- Oncology nurse specialists
- Support groups
- Clinical trials

**Figure 12:** Lifestyle Modifications

- Healthy diet
- Regular exercise
- Healthy weight
meta-analyses have failed to show a population benefit of screening women in this age group (Fletcher, 1997; Kerlikowske, Grady, Rubin, Sandrock, & Ernster, 1995).

In January of 1997, the National Institutes of Health convened a panel to make recommendations about the use of screening mammography for women 40–50 years of age. In contrast to diagnostic testing used when a woman is in a high risk group or has felt a lump, screening mammography is used to evaluate asymptomatic women. The conclusion of the panel review shocked the American Cancer Society. The headline of USA Today (January 24, 1997) read, “Mammogram Panel Only Adds to Furor.” Commentators on morning talk shows were outraged by the committee’s decision. Richard Klausner, the director of the National Cancer Institute, decided to disregard the report of his own expert panel. Shortly thereafter, the American Cancer Society appointed a panel of experts chosen because each already believed that screening was valuable for 40–50-year-old women. To no one’s surprise, this American Cancer Society panel recommended that 40–50-year-old women be screened (Fletcher, 1997).

The cost/effectiveness of mammography has been estimated in several analyses. These analyses are difficult because most meta-analyses fail to show that screening mammography has any benefit for 40–49-year-old women (there is little debate about the value of screening for women 50–69 years of age). Under the assumption of no benefit, the cost/QALY goes toward infinity because the model would require division by zero. Using studies suggesting some benefit of mammography for women 40–49 years of age, Eddy (1989) estimated the cost to produce a QALY as $240,000. Salzmann, Kerlikowske, and Phillips (1997) used newer data to evaluate the cost/effectiveness of guidelines requiring screening for women 40–49 years of age. They noted that screening women 50–64 years of age produces a QALY at about $21,400. By contrast, the expected benefit of screening women 40–49 years of age increases life expectancy by only 2.5 days at a cost of $676/woman, resulting in an incremental cost utility of $105,000/QALY.

Analyses in all aspects of health care suggest that there is plenty of disease to be discovered and that newer technology will find even more cases. However, are all of these cases clinically important? The disease reservoir hypothesis leads to some controversial predictions concerning breast and prostate cancer screening. One hypothesis is that greater screening for disease will create the false appearance of epidemics. Figure 2 shows increases in breast cancer (left panel) and increases in prostate cancer (right panel) as a function of greater screening. With a reservoir of undetected disease, the more one looks, the more one finds. Figure 2 also shows the mortality from breast cancer and prostate cancer. If these were true epidemics, one would expect increases in deaths from these serious diseases. However, in each case, mortality is relatively stable (Kaplan, 1999).

Stable mortality rates appear to contradict the suggestion that survival from cancer is increasing and is attributable to better screening and treatment (American Cancer Society, 1999). Although there appeared to be a small increase in prostate cancer deaths in the 1980s, the mortality rate has since declined and may have been an artifact.

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**Figure 2**

*Increases in Breast Cancer and Prostate Cancer: Incident Cases and Mortality*

**Breast Cancer**

**Prostate Cancer**

**Year**

**Year**

*Note.* Data from the Surveillance, Epidemiology, and End Results (SEER) Program registries and National Center for Health Statistics.
Primary Prevention Approaches

Evidence for effective programs exists, in that health promotion campaigns can be effective, but there is a need for further research. The effectiveness of these programs is not yet fully understood, and more research is needed. However, these programs have shown promise in reducing risk factors and improving health outcomes. In conclusion, it is important to continue to invest in these types of programs to promote overall health and well-being.
which corresponds to the proportion that have made a previous attempt to quit. The model assumes that the program would yield 1.7 million new quitters, of whom 40% would have quit on their own and 60% may have been influenced in some way by the program to quit. Further, the model assumed that 9% of smokers would quit with no intervention, 11% would quit with minimal counseling, 12% would quit with brief counseling, and 19% would quit with counseling lasting more than 10 minutes. Use of a nicotine replacement would boost these effects further. The program would cost an estimated $6.3 billion, or about $32 per smoker. Cost per QALY was estimated at $1,915. Considering a variety of assumptions, the cost/QALY ranged from $1,108 to $4,542, placing it well below most programs that have been analyzed (Cromwell, Bartosch, Fiore, Hasselblad, & Baker, 1997).

**Physical Activity**

Research (e.g., Blair et al., 1989; Blair & Brodney, 1999) shows that people who are physically active live significantly longer than those who are sedentary. These studies have documented a relationship between physical activity and mortality from coronary heart disease, diabetes mellitus, cystic fibrosis, and all causes (Sallis & Owen, 1999). In addition to living longer, those who engage in regular physical activity may be better able to perform activities of daily living and enjoy many aspects of life. Further, those who exercise regularly have better insulin sensitivity and less abdominal obesity (Kahn, Tatham, & Heath, 1997; Manson et al., 1992). Regular exercise has been shown to improve psychological well-being for those with mood disorders (Morgan, 1994). Some evidence suggests that the costs of poor health outcomes associated with physical inactivity exceed those attributable to obesity, hypertension, and smoking (Francis, 1996). The Centers for Disease Control estimate that physical inactivity is the most common among risk factors for heart disease and carries a greater population-attributable risk than do high cholesterol or hypertension. Successful programs have been developed to promote exercise for the general population (Dunn et al., 1997). Further, specific interventions have been developed for those diagnosed with particular diseases (Sallis & Owen, 1999).

Despite the benefits of exercise, few people will start an exercise program, and many of those who start do not continue to exercise (Dishman & Buckworth, 1996). Some predictors of failure to exercise regularly include being overweight, low socioeconomic status, female gender, and smoking (Sallis, Zakarian, Hovell, & Hofstetter, 1996). However, the most commonly reported barriers to exercise are lack of time and inaccessibility of facilities. Studies show that exercise patterns change as people age. Physical activity begins to decline by the late teens and early twenties (Physical Activity and Cardiovascular Health, 1995). It appears that Americans are shifting toward less vigorous activity patterns, with walking becoming the most common form of exercise. Physical inactivity is increasing as Americans spend more time watching television, working with computers, or doing both (Sallis & Owen, 1999).
Competition

Competition is a natural part of the market economy. Companies strive to outperform each other to gain a competitive advantage in the marketplace. To achieve this, they invest in research and development, improve their products or services, and innovate to differentiate themselves from the competition.

In the context of the document, the discussion highlights the importance of competition in fostering innovation and efficiency. Companies are encouraged to invest in research and development to improve their products and services, which ultimately benefits consumers.

A competitive market ensures that companies strive to provide the best value to their customers, leading to improved quality and lower prices. It also encourages transparency and accountability, as companies need to be open about their practices and strategies to maintain customer trust.

However, competition can also lead to negative outcomes, such as price wars and unethical practices. Therefore, it is crucial for companies to balance competition with ethical standards and social responsibility.

In conclusion, competition is a fundamental aspect of a market economy, driving innovation and efficiency. It is essential for companies to navigate this dynamic environment effectively to maintain a competitive edge and serve the interests of both consumers and shareholders.
arguments are drawn principally from secondary prevention—primary prevention was not discussed or evaluated in any detail.

**Message 2: Primary prevention must be recognized as distinct from health care.** If primary prevention efforts produce health, scientists and researchers should find ways to support them. Some researchers have also suggested there is a need for greater focus on primary prevention. For example, Bailar and Gornik (1997) analyzed progress in the war on cancer that was initiated by President Richard Nixon in 1970. In considering changes in mortality since 1970, Bailar and Gornik concluded that cancer has not been defeated. The find it—fix it model has found and treated significantly more cancer, but the increased treatment has not produced clear public health benefits. Bailar and Gornik argued that it is time to re-evaluate the dominant strategy of the past 40 years that placed most emphasis on improving treatments and secondary prevention and little emphasis on primary prevention. The major increases in cancer have been associated with cigarette smoking (Doll & Peto, 1981). Analysis of trends in U.S. cancer deaths suggests that over the 46 years between 1950 and 1996, changes in all deaths from cancer are attributable largely to variations in lung cancer. Lung cancer death rates are driven to a large extent by smoking rates and are not greatly affected by screening and treatment. Yet, few resources have been devoted to the eradication of tobacco products. Bailar and Gornik (1997) concluded, “A national commitment to prevention of cancer, largely replacing reliance on hopes for universal cures, is now the way to go” (p. 1574).

**Message 3: More resources should be devoted to primary prevention research.** The comparison between primary and secondary prevention is difficult because there have been few experimental trials that evaluate primary prevention interventions. The observational data suggest that behavioral factors, such as physical activity, have strong relationships to health outcome. However, some biological variables, such as high serum cholesterol, were also highly correlated with poor health outcomes. When experimental trials attempted to show that reducing cholesterol would increase life expectancy, the results were unimpressive. It is possible that intervention trials on large-scale behavior change will also fail to fulfill their promise. To date, results of community-wide intervention trials have often produced benefits that were less

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### Table 1
**Comparison of Cost/QALY for Selected Secondary and Primary Prevention Efforts**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Reference</th>
<th>Compared with</th>
<th>Cost/QALY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Secondary prevention programs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mammography</td>
<td>Eddy, 1989</td>
<td>No mammography</td>
<td>$240,000</td>
</tr>
<tr>
<td>Women age 40–49</td>
<td>Salzmann et al., 1997</td>
<td>No mammography</td>
<td>$105,000</td>
</tr>
<tr>
<td>Women age 40–49</td>
<td>Fleming et al., 1993</td>
<td>Watchful waiting</td>
<td>Domated—treatment offers no benefit</td>
</tr>
<tr>
<td>Surgery for prostate cancer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSA screening for men age 60 and 70</td>
<td>Krahn et al., 1994</td>
<td>No screening</td>
<td>Domated—screening causes reductions in QALYs</td>
</tr>
<tr>
<td>Cholesterol screening and treatment with Lovastatin&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For men with cholesterol &gt; 300 mg/dl</td>
<td>Goldman et al., 1991</td>
<td>No screening and treatment</td>
<td>$71,000-$135,000</td>
</tr>
<tr>
<td>For men with cholesterol &gt; 250–299 mg/dl</td>
<td>Goldman et al., 1991</td>
<td>No screening and treatment</td>
<td>$105,000-$270,000</td>
</tr>
<tr>
<td><strong>Primary prevention programs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tobacco taxation of $2/pack</td>
<td>Kaplan et al., 1995</td>
<td>No change in tax</td>
<td>&lt;$0</td>
</tr>
<tr>
<td>Tobacco restriction policy for minors</td>
<td>U.S. Food and Drug</td>
<td>No restrictions</td>
<td>&lt;$1,000</td>
</tr>
<tr>
<td>Administration, 1996; Graham et al., 1998</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking-cessation counseling</td>
<td>Cromwell et al., 1997</td>
<td>No counseling</td>
<td>$1,915</td>
</tr>
<tr>
<td>Regular jogging beginning age 35</td>
<td>Hatziandreou et al., 1988</td>
<td>No change in activity</td>
<td>$11,313</td>
</tr>
<tr>
<td>Daytime use of running lights in automobiles</td>
<td>Williams &amp; Lancaster, 1995</td>
<td>No use of lights</td>
<td>&lt;$0</td>
</tr>
<tr>
<td>Law requiring lap and shoulder belts in automobiles&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Graham et al., 1998</td>
<td>No restraints</td>
<td>&lt;$0</td>
</tr>
</tbody>
</table>

Note. QALY = quality-adjusted life year; PSA = prostate-specific antigen. <sup>a</sup> 20 mg/day. <sup>b</sup> Assumes only 50% compliance.
no effect on the intermediate step of the reaction, thus affecting the final outcome of the process. This is why the correct answer is C.

Q. What is the main purpose of the study described in the research paper?

A. To investigate the role of a particular enzyme in a metabolic pathway.

Q. Which of the following statements is supported by the evidence provided in the article?

A. The enzyme in question is essential for the survival of the organisms studied.

Q. What is the significance of the results reported in the study?

A. They provide new insights into the mechanisms of cellular metabolism.

Q. In the context of the research described, what is the potential clinical relevance of this study?

A. The findings may lead to the development of new therapeutic strategies.

Q. How does this research contribute to our understanding of the biological processes involved?

A. It enhances our understanding of the complex interactions within biological systems.

Q. What are the potential implications of the results for future research?

A. They provide a solid foundation for further investigations into related phenomena.

Q. What is the role of an enzyme in the process of protein synthesis?

A. Enzymes catalyze the chemical reactions that build amino acids into proteins.

Q. Which of the following statements accurately describes a characteristic of an enzyme?

A. It increases the rate of a chemical reaction by lowering the activation energy.

Q. What is the function of a catalyst in a chemical reaction?

A. A catalyst increases the rate of the reaction by providing an alternative pathway.

Q. Which statement best describes the relationship between enzymes and substrates in a reaction?

A. Enzymes bind to substrates, lowering the energy barrier for the reaction to occur.

Q. How do the findings of this study challenge existing theories about the role of enzymes?

A. They suggest a new mechanism for enzyme action that was previously unknown.

Q. In the light of the research findings, what is a potential avenue for further investigation?

A. Investigating the effect of different environmental factors on the enzyme's activity.

Q. What is the primary objective of the research described in the article?

A. To explore the role of enzymes in cellular processes.

Q. Which of the following statements is not directly supported by the data presented in the study?

A. Enzymes do not change the exothermic or endothermic nature of the reaction.

Q. Why is the study important for advancing scientific knowledge?

A. It contributes new data and insights that can guide future research.

Q. What is the significance of the research findings for pharmaceutical development?

A. They may lead to the discovery of new drug targets.

Q. How does the study advance our understanding of enzyme function?

A. It reveals novel aspects of enzyme-substrate interactions.

Q. Which of the following is not a characteristic of enzymes?

A. They are not affected by changes in temperature or pH.

Q. What is the role of enzymes in the regulation of metabolic pathways?

A. Enzymes catalyze specific reactions, thus controlling the flow of metabolic pathways.
Conclusion

It is not known whether primary prevention programs will produce large public health benefit because few experimental trials have been completed. However, there are many reasons to believe that primary prevention will pay substantial dividends. Primary prevention is about the prevention of disease. Primary prevention does not necessarily follow the dictates of the traditional biomedicai model. It does not depend on diagnosing problems nor does it depend on therapy. Secondary prevention involves detecting and treating disease that already exists. Current policy favors secondary prevention in health care, even though the payoff from secondary prevention appears to be quite limited. Conversely, primary prevention still remains outside the core of health care and public policies to improve health. Although the traditional biomedicai model emphasizes secondary prevention, there are at least two pathways to prevention. Although evidence is still incomplete, the primary prevention pathway may offer the most health at the lowest cost. There are two paths to prevention, and as a rich country, the United States can afford to follow both during the extended time it will take to evaluate the value of primary prevention.

REFERENCES


