Cancer Prevention Strategies: Use of Cancer Prevention Research Registries

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We present a model to plan a rational strategy for cancer prevention that has two main functions—assessment and intervention. The assessment function includes three main components: to identify populations at high cancer risk, which may be due to their ethnic group, occupational and environmental exposures, family history, cigarette smoking, or other risk factors; to assess exposure to known carcinogens through the general and occupational environments, lifestyle factors, and the home as well as to document known carcinogens using human tissue banks and develop and validate questionnaires to target known risk factors for each of the most common cancers; and to conduct research studies of high-risk populations, including studies on mechanism and genetic testing. The intervention function includes three components: development of population-based intervention programs using the results from the research studies; evaluation of intervention programs; and modification of existing intervention programs and implementation of new ones. The above-proposed prevention strategy depends to a great extent on population-based cancer registries. Existing cancer registries around the United States should be strengthened and other dimensions should be added to their charge to augment their function in prevention research. To convert existing population-based cancer registries, particularly those that serve multicultural and multicultural populations, into Cancer Prevention Research Registries (CPRRs), three types of data in addition to their existing required data complement should be incorporated. These are exposure information including occupational history, host factors, information, and information about family history of cancer and associated conditions. The primary goal of the CPRRs should be to support cancer prevention research in its widest sense. Future research needs must be designed to investigate each of the components of the prevention strategy as well as its integrated performance. Regardless of what we do in the future, we must now promote healthier lifestyles, prevent exposure to known carcinogens, and improve early detection procedures. — Environ Health Perspect 103(Suppl 8):237–239 (1995)

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Introduction

Despite the increasing trends in cancer incidence rates reported by several studies (1,2), particularly for cancers of the breast, prostate, lung, and malignant melanoma, it is clear that the mortality rates for these cancers have not changed significantly over time. The increasing incidence of both breast and prostate cancers is attributed to better screening and early detection, lung cancer to increased cigarette smoking, and malignant melanoma to increased exposure to sunlight. There are many examples of strong associations between preventable causes and specific types of cancer (3–6).

Thus, in addition to seeking better treatment modalities for cancer patients and improving knowledge about biological mechanisms in carcinogenesis, a concerted effort must be devoted to prevention strategies and screening programs. In the long run, this approach will lead to reduction in the incidence of and the mortality due to cancer.

To plan a rational strategy for cancer prevention, one should determine the magnitude of the problem (i.e., the amount of preventable cancer in a population). However, the magnitude of preventable cancer associated with exposure to environmental contaminants in air, soil, water, and the home is difficult to determine. As a part of prevention research, it is imperative that we identify populations at risk and their associated exposures. Models that describe the etiology and mechanism of carcinogenesis will help establish exposure associations and direct prevention research.

Studies of cancer attributed to different environmental carcinogenic factors are complex and require the involvement of several disciplines in science and medicine. One of the main problems in planning and conducting these studies is the selection of study populations, since subjects are highly heterogeneous with respect to their level of cancer risk. In other words, a population included in a study may include groups at high risk for cancer together with groups at much lower risk, which can result in inconclusive outcomes (7).

Strategy for Prevention

We propose the model outlined in Figure 1 as a strategy for cancer prevention. A description of the five components constituting this model is included in the following discussion.

Figure 1. Strategy for prevention.
Identify Populations at High Risk

Groups at high cancer risk may include special occupational groups, those who have heritable cancer syndromes, and, possibly those who because of their cultural–ethnic backgrounds are predisposed to specific cancers due to diet or lifestyle factors. These high-risk groups do not necessarily represent the general population but are ideal for a first-step study in cancer prevention and early detection. Cancer registries, particularly those that capture data on risk factors such as family history, occupation, and industry, are ideal for monitoring incidence and prevalence of cancer in subpopulations to identify groups at high cancer risk.

Exposure Assessment

Several data sources should be generated or, if existing, should be made available to scientists, including: a) monitoring over time the types and levels of known carcinogens in air, water, soil, food, and the home; b) documenting and tracking the types and levels of chemical carcinogens in communities impacted by hazardous waste sites and environmental accidents such as chemical spills; c) documenting existing data on levels of known carcinogens using human tissue banks such as the national adipose tissue repository, and improving the quality of human tissue banks, the accuracy and sensitivity as well as the collection of sufficient tissue, and demographic and medical information on subjects from whom the tissue is collected; and d) developing and validating questionnaires to target known risk factors for each of the most common cancers to be used by investigators in population studies. This will prevent duplication of effort and expense in developing new questionnaires for each study, and will allow comparisons between studies as well as pooling of data if desired and appropriate for reasons such as improving the sample size.

Research Studies of High-Risk Populations

This is one of the most important components of the strategy for cancer prevention. Research findings from these studies will then allow us to: a) estimate the proportion of avoidable cancer; b) identify groups in which prevention can be most effective; c) determine which cancers pose the most significant public health problem; d) evaluate the effectiveness of prevention programs; e) evaluate the acceptability of specific intervention programs—such as gene testing for breast and colorectal cancer—that are candidates to be made available to the population at large; f) determine a possible mechanism for cancer etiology; g) evaluate dose–response relationships for both carcinogenic and protective agents; and h) identify risk factors specific for particular tumors.

Population-Based Intervention Programs

Using the results from the research studies described above, intervention programs may become feasible and may have high probabilities of success. Such intervention programs may include education and health promotion; control of exposure to known carcinogens in industry, the general environment, and the home; and implementation of population-based chemoprevention, early detection programs, genetic testing, and gene therapy trials.

Evaluation of Intervention Programs

The evaluation phase of the strategy for prevention should focus on two main components: measures of reduction in risk using cancer incidence rates and stage at diagnosis and measures of healthier lifestyles, and prevention and early detection practices in the population.

Modifying of Existing Programs and Implementing New Ones

Based on evaluation results and the close monitoring of population parameters, intervention programs may either continue, be modified to improve performance and results, or be discontinued. This process is also influenced by new scientific findings and the availability of new, perhaps more efficient, less costly or more acceptable programs.

Cancer Prevention Research Registries

The proposed prevention strategy depends to a great extent on population–based cancer registries. These registries must work toward becoming a research resource for epidemiology, molecular genetics, and prevention studies. For example, studies of gene-environment interaction in cancer etiology must include population-based cancer familial and nonfamilial cancer cases. The Cancer Prevention Research Registries (CPRRs) outlined in Figure 2 are ideal for such studies because they contain not only family history information but also data on host factors and environmental exposures as well as linkage to a tissue bank. Existing cancer registries around the United States should be strengthened and other dimensions added to their charge to augment their function in prevention research.

Cancer registries, or the more comprehensive CPRRs, should also develop research methods that analyze data beyond the standard cancer rates by age, sex, race, and ethnicity. These new methods should be able to detect with high specificity and sensitivity slight deviations from normal patterns of disease in a general population and associate such deviations with exogenous exposures, host factors, or familial–genetic predisposition. Thus, the CPRR must register first-degree relatives of the cancer patient, particularly for those cases of familial cancer to facilitate future research.

Figure 2. Components of a Cancer Prevention Research Registry (CPRR) and complementary databases.
on gene–environment interaction. This becomes especially important in the face of the current explosion of knowledge about molecular biology and gene mapping.

As studies of cancer turn increasingly to molecular biology, genetic testing, and the analysis of gene–environment interaction, their psychosocial impact on family members of cancer patients clearly becomes important. Family members of cancer patients who test positive constitute an especially high and readily identifiable risk group. Plans must be formulated now to reduce the adverse effects that family members of cancer patients may suffer as a result of their identification.

The primary goal of the CPRRs should be to support cancer prevention research in its widest sense. A limited number of examples of CPRR functions include a) studies to identify high-risk groups such as population-based familial breast, ovary, and colorectal cancers in relation to patient risk factors and environmental exposures; b) testing of biological markers, including both germline and somatic mutations of known genes to measure genetic and environmental influence on cancer risk; c) monitoring of outcome measures in prevention research studies, including behavioral risk factors, adoption of healthier lifestyles, practicing early detection, and trends in the stage at diagnosis; and d) evaluation of the effectiveness of early detection procedures in the population such as the mammography and Pap smear procedures, particularly in underserved and minority groups.

Future trends in cancer prevention research should also include the understanding and use of information from two sources: first, basic sciences laboratories with regard to molecular biology and cancer gene identification, mapping, and gene characterization for specific tumors and second, agencies setting the standards for environmental exposure levels for carcinogenic agents (both single and mixed exposures) in air, water, soil, and the home. The information from these two sources, together with data from the CPRRs, should be applied in a hypothesis-driven fashion to human populations but with wisdom and with an understanding of the need to protect the confidentiality of the individual.

Although the CPRR, as I have defined it, is a more extensive collection of data about the cancer patient and the family than present population-based cancer registries, it cannot by itself be a sufficient database for prevention research. The CPRR must exist in association with a number of other databases that provide denominator data about the general population in such terms as residential stability, lifestyle characteristics, and cultural/socioeconomic status; information from environmental monitoring networks; information from health and risk factor surveys and data on the availability of tissue banks; input from health education, promotion, and screening programs; and results from population clinical trials.

Because the cause of cancer is most frequently multifactorial, the effect of exposure to multiple carcinogens may be additive or synergistic. Thus, even though the level of environmental exposure to a particular carcinogen may be very small, exposure to multiple small amounts may be important and perhaps causative in individuals already at a somewhat increased risk for cancer because of other factors, including genetic predisposition. In other words, the addition of small amounts of xenobiotic agents may be just sufficient to reach the causative threshold. In a similar fashion and, again, because of cancer’s multifactorial nature, the effect of protective or anti-carcinogenic agents must similarly be additive or synergistic. Further, there must be an equilibrium between the level of genetic susceptibility and the effects of carcinogens on the one hand and protective agents in the external environment and in the human body on the other that regulates cancer outcome. Future research needs to be designed to investigate each of the components of this model as well as its integrated performance to more successfully design and implement prevention. Regardless of what we do in the future, we must now promote healthier lifestyles, prevent exposure to known carcinogens, and improve early detection.

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