OBJECTIVES:
To hypothesize on the future of cancer prevention based on past and current progress of the field, as well as possible assimilation of knowledge in other fields that may be applied to cancer prevention.

DATA SOURCES:
Peer-reviewed research and federal government reports.

CONCLUSION:
Cancer prevention will exist in the future as an important public health strategy involving lifestyle and medical approaches that include behavior in relation to risk factors, chemoprevention, biomarker assessment, vaccines, and emerging technologies to better identify individuals at risk for cancer.

IMPLICATIONS FOR NURSING PRACTICE:
In the future nurses will play an enhanced role in cancer prevention through their efforts supporting risk assessment, education, and medical approaches in an expanded role with diagnostic testing, and support for prevention clinical trials.

THE FUTURE OF CANCER PREVENTION

PETER GREENWALD

CANCER prevention, as a public health and research strategy that encompasses both lifestyle and medical approaches, represents the first line of defense in reducing the number of deaths resulting from cancer. The future of cancer prevention will be based on continuing progress in discovering and implementing these approaches. Predicting the future of cancer prevention requires an assessment of the research pathways at the present time, as well as hypothetical suppositions about the future directions of biotechnology and medical, genetic, and behavioral research. This brief look at the future of cancer prevention will focus on how current research in various fields is creating an environment for meeting the challenges identified in systematic cancer prevention research. Although cancer as a disease is unlikely to be completely eliminated in the near future, a realistic goal will be to achieve an understanding of environmental, behavioral, genetic, and metabolic factors that contribute to cancer risk. A tailored cancer prevention strategy based on an individual risk profile can then be developed to include behavioral and nutritional interventions, chemoprevention, and screening, and will complement broader social changes that may impact cancer rates.

LIFESTYLE AND PUBLIC HEALTH APPROACHES

Efforts to promote healthy lifestyle practices such as tobacco control policies, recommendations for dietary modification, and weight control programs have yielded mixed results in reducing cancer risk. The future likely will see a continued effort to increase research—basic biomedicine, animal studies, and clinical trials—that provides new information on the relationships among biology, behavior, and cancer. Recent studies, for example, have described the association of obesity and overweight with approximately 15% to 20% of cancer deaths, as well as significant percentages of deaths from cardiovascular, kidney, and other diseases. Strategies to decrease the number of obese and overweight Americans will demand a creative, multidisciplinary approach that...
includes increased research, disease prevention, and programs to encourage weight loss and increased physical activity. One example of promising future research may be on peroxisome proliferator-activated receptors, which are key regulators of metabolism and energy homeostasis and are associated with the pathogenesis of various tumors. Recent metabolic studies show that peroxisome proliferator-activated receptors play an important role as key regulators of energy balance and insulin signaling that strongly influence obesity.

Successful institutional strategies used in the past against tobacco use, which included policy initiatives such as smoking restrictions and increased taxes on tobacco products, can be encouraged by cancer prevention researchers and public health professionals. To address the challenges of obesity and overweight, future strategies may include advocating city and suburban planning ordinances that encourage a more active living environment in cities and suburbs, such as the urban planning of pedestrian-friendly streets and buildings, active transport policies, increased requirements for physical education in schools, and the promotion of physical activity (e.g., parks, game fields, trails, public transportation, and activity centers) in new housing development ordinances. Cancer prevention researchers will lend critical knowledge of health promotion to this effort.

**MEDICAL APPROACHES**

The primary medical approach for cancer prevention in the future will be an integrated chemoprevention program that combines research findings from basic research, genetics and proteomics, nutritional science, biomarker development and validation, and clinical trials to determine those at risk for cancer and to develop individualized prevention regimens. The use of chemoprevention agents in combination with specific dietary and behavior modifications will provide a level of individualization not currently possible. Our future understanding of bioactive food components and their interactions with genomic, proteomic, and metabolomic factors is key to designing appropriate interventions that target individual risk profiles. Clinical trials will continue to be the gold standard for understanding prevention strategies; in the future, however, prevention trials are likely to have multiple primary endpoints to assess chemoprevention agents for multiple conditions such as cancer, cardiovascular disease, and diabetes. In cancer prevention clinical trials, new chemoprevention agents are being investigated for major cancer sites. Future trials for breast cancer will investigate new generations of selective estrogen receptor modulators, aromatase inhibitors, and nutrition-based agents such as soy and its analogues. As we better understand the differences between hormonally and nonhormonally driven breast tumors, considerable effort will be made to develop newer agents to target those differences. Another priority will be preventing and treating estrogen-receptor negative tumors with various tyrosine kinase inhibitors, retinoid-like compounds, statins, and farnesyl transferase inhibitors, all of which have shown promise in small clinical studies.

A significant public health strategy that includes both lifestyle and medical approaches for future cancer prevention is the development of vaccines that prevent both cancer and cancer recurrence. Recently, efficacy trials have begun to test vaccines directed against two forms of human papillomavirus responsible for approximately 80% of cervical cancers. Vaccines are being used to reduce the risk of liver cancer related to Hepatitis B infection, and it is possible that a vaccine against Hepatitis C will be available in the future. Anti-nicotine vaccines take a different approach from traditional vaccine use; immunization is designed to decrease an activity or behavior (i.e., smoking) that increases cancer risk. In this approach, binding of nicotine by anti-nicotine antibodies raised by immunization reduces or eliminates the effect of nicotine on the brain; thus, most of nicotine's psychoactive affects and rewards are prevented, reducing the drive for continued nicotine consumption. Future anti-nicotine vaccines will be used for cessation for current smokers and for preventing relapses in smokers who have quit recently, as well as for potential use in those who have never smoked, again by eliminating the pleasant effects of nicotine usually experienced by smokers. In addition, advances in molecular biology are making possible the development of therapeutic vaccines that can be used for adjuvant therapy for melanoma and metastatic breast cancer. Animal studies have shown vaccination with virus-like replicon particles containing the HER2/neu gene after conventional chemotherapy increases effectiveness of the chemotherapy.
The success of cancer prevention in the future will require organizational structures that include researchers and professionals from diverse fields of study. Cancer prevention must become multidisciplinary at the earliest planning stage for research initiatives to be most effective. Biometrics and standardized sample collection and storage procedures and procedures and formats for well annotated data sets will gain more attention in the future because there will be a greater amount of information available from future trials through the use of emerging biometric and imaging technologies. Currently there is an emerging relationship between nanotechnology and medical sciences that will take biochemical targeting and imaging into the single-molecule level in living cells. Advances in computer science will afford numerous possibilities for prevention researchers to use ever stronger analytic tools to understand ever smaller impacts of interventions.

The groundwork for investigations of cancer-related nutritional, hormonal, metabolic, genetic, proteomic, metabolomic, and environmental factors are being developed today and should produce enormous benefits in the future. The wealth of information becoming available, along with advances in bioinformatics and pattern recognition algorithms, for example, will allow researchers and clinicians to move away from a “one-size-fits-all” approach to individualized chemoprevention, dietary recommendations, and other cancer prevention strategies.

This brief look at the potential future of cancer prevention is not meant to be comprehensive or to cover all of the scientific advances that will change the course of this field. Decisions made today will become part of the accumulated knowledge used by future cancer prevention scientists to mold strategies for intervention and research. Many areas not covered here—animal models, behavioral strategies, sample repositories, and dissemination strategies—will play major roles in cancer prevention and are not meant to be minimized. The future of cancer prevention is bright and the paradigm of multidisciplinary research coupled with training and cross-training opportunities can secure a future that reduces and manages the risk and consequences of cancer.

REFERENCES