Population-Based Cancer Screening

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Purpose/Objectives: To provide an overview of current issues surrounding the prevention of and screening for lung, breast, cervical, colorectal, ovarian, prostate, and skin cancer.

Data Sources: Original research, review articles, and published guidelines.

Data Synthesis: Although morbidity and mortality rates have decreased for these cancers, prevention and early detection still require increased funding and research.

Conclusions: More behavioral scientists must be trained in prevention and early detection of cancer, and increased research funding is necessary to encourage advances in primary and secondary prevention.

Implications for Nursing: Oncology nurses should incorporate appropriate prevention and early-detection strategies into practice.

Key Points . . .

- Cancer continues to take a high toll on human life in the United States, despite the fact that early detection can decrease morbidity and mortality significantly.
- Research is under way to investigate methods to improve early detection of most cancers. In the absence of a cure, the focus on primary and secondary prevention efforts must continue.
- Future research must focus on cost-effective approaches to increasing screening behavior using advanced technology, such as computers and the Internet. More nurses and public health researchers must be trained as behavioral scientists to devise and test innovative methods to increase primary prevention efforts (e.g., smoking cessation, exercise) and secondary prevention efforts (e.g., screening).

Cancer likely will remain a major health challenge this century. Some cancers are very aggressive and result in death within months of detection; others are indolent and may never surface. Scientists continue to work at the basic and clinical levels, with some successes but overall slow progress. For instance, testicular cancer now is curable with chemotherapy, and the majority of patients survive. However, basic and clinical research have had little impact on mortality for other cancers, such as pancreatic cancer.

Prevention and early detection have a much greater potential to lower morbidity and mortality than treatments such as chemotherapy, surgery, and radiation. Unfortunately, not enough research has been directed at prevention and early detection. Historically, behavioral research in prevention and early detection of cancer has not been funded at the levels necessary for true progress nor is a cadre of scientists prepared to conduct behavioral research. Reimbursement for primary and secondary prevention in the clinical setting generally is lacking. Patients often have an easier time obtaining insurance coverage for late-stage disease treatments than for cancer prevention activities. This article will focus on an important area in the fight against cancer—the use of early-detection methods.

Cancer Prevention and Screening

Screening is a method of secondary prevention, which is defined as the early detection and treatment of disease before signs or symptoms are apparent. In contrast, primary prevention is the prevention of disease through activities such as immunization, smoking cessation, use of sunscreen, diet, and exercise. Tertiary prevention is the management of disease to prevent progression, recurrence, or other complications. Although desirable, good screening tests are not available for every type of cancer. Several conditions must be met before cancer screening makes sense in asymptomatic populations.

First, diseases must have certain characteristics that make screening feasible. Specifically, diseases must have natural histories and biologies that can be predicted, and preclinical phases must have high prevalence and incidence (see Table 1). Prevalence is defined as the number of cancers that exist in a defined population at any given point in time, and incidence is the number of cancers that develop in a population during a defined period of time. If such a preclinical phase exists, healthcare professionals have an opportunity to alter the disease course. This opportunity, though, must be accompanied by effective treatment for early-stage diseases after they are discovered. Detecting early-stage cancer but not being able to stop its progress does little good. Perfect screening

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Digital Object Identifier: 10.1188/02.ONF.853-861

Table 1. Definitions

Term	Definition
Prevalence	The number of cancers that exist in a given population in a given time.
Incidence	The number of cancers that develop in a given population in a given time.
Specificity	The ability of a test to identify people who do not have the disease.
Sensitivity	The ability of a test to identify people who do have the disease.
Lead-time bias	Biased conclusions concerning a test's efficacy related to the fact that it can detect a disease before it becomes clinically apparent.
False positive	An abnormal test result in a person who is free of disease.
False negative	A normal test result in a person who actually has a disease.

tests would incur minimal costs, detect cancer early, allow healthcare professionals to intervene without costly treatments, and be 100% accurate. They also would be acceptable to the populations being screened (Reintgen & Clark, 1996).

If a disease has the characteristics necessary for population screening, available tests to detect the specific cancer preclinically must be sought. Two characteristics are essential for good screening tests: specificity and sensitivity. For tests to be sensitive, they must be able to detect individuals within a population who do, in fact, have a particular cancer. The higher the sensitivity is, the better the test will be. If a test detects cancer only 10% of the time, it would not be considered sensitive. Specificity refers to the ability to identify people who do not have a disease, which is very important in terms of patient anxiety and costs for extra medical procedures. If a screening test positively identified 50% of people who did not have cancer, further tests would be needed and those people would experience unnecessary anxiety. Central to sensitivity and specificity are the concepts of false positive and false negative tests. False positives are abnormal results in people who are free of disease. False negatives are normal results in people who actually have a disease. Tests must be able to find cancer if it really is present and correctly identify its absence.

Before organizations recommend population screening, experts must agree that data about the efficacy of screening support the desired outcomes. Most often, scientists look for tests that can demonstrate significantly lower mortality from cancer in populations that are offered screening versus populations that are not offered screening. This type of evidence requires large prospective and randomized trials. By randomizing screened versus nonscreened groups, researchers avoid two important but common problems. The first is lead-time difference, defined as the time by which screening advances diagnosis of disease compared to usual clinical detection. If no randomized longitudinal trial exists, differences in lead times could produce biased conclusions about the effectiveness of screening. For instance, cancer may be detected earlier, but this detection might not have an effect on outcomes if the cancer is progressing rapidly. Patients with rapidly progressing cancer are more likely to die of the disease, and screening is less likely to detect rapidly progressing cancer early enough to affect outcomes. Some argue that benefits to mortality rates should not be the sole consideration for screening measures. Quality of life also could benefit from early detection. In addition, early detection could result in less intrusive treatment options, thus improving quality of life.

Many debates surround this issue. For example, if early detection does not result in decreased mortality, could it actually be harmful? What if individuals discover they have cancer but cures are not possible? Their quality of life actually might decrease because they would have the anxiety of living with cancer and perhaps the side effects of aggressive treatment.

A lack of consensus on many proposed screening tests exists, and many tests cannot detect cancer in its preclinical stages. This article will discuss evidence for and against population screening for breast, cervical, ovarian, colorectal, prostate, lung, and skin cancer; research directions needed to increase screening; and the implications for nursing research.

Breast Cancer

According to estimates, more than 203,500 cases of breast cancer will be diagnosed in 2002, with 39,600 women dying of the disease (Jemal, Thomas, Murray, & Thun, 2002). Risk factors for developing breast cancer include family history, delayed or no childbearing, obesity, early menarche and late menopause, and perhaps a diet high in fat (Madigan, Ziegler, Benichou, Byrne, & Hoover, 1995).

Breast cancer is a good example of a disease appropriate for mass screening. Although its prevalence and incidence are high, mortality has decreased primarily as a result of earlier detection through mammography. Almost two decades of prospective data demonstrate a mortality benefit for screened populations of women ages 50–65. Furthermore, a meta-analysis of prospective data for women ages 40–50 demonstrated significantly lower mortality for screened women (Hendrick, Smith, Rutledge, & Smart, 1997; Smith, 1997; Smith, Osuch, & Linver, 1995). In addition to mammography, breast self-examination and clinical breast examination are recommended because 10%–15% of breast cancers may not be detected by mammography.

Breast cancer screening recommendations are similar across organizations. The American Cancer Society (ACS) and the National Cancer Institute (NCI) recommend routine mammography for women 40 and older. ACS recommends clinical breast examination every three years for women ages 20–39 and annually starting at age 40. Breast self-examination is recommended monthly starting at age 20, although prospective data demonstrating a mortality benefit do not exist (Greenlee, Hill-Harmon, Murray, & Thun, 2001).

Mammography screening has increased significantly in the United States in the past decade, with more than 70% of women age 50 or older receiving mammograms in the past two years. African Americans, who historically have had fewer mammograms, now report a rate of 76% versus 74% among Caucasian women. Hispanics are lowest in mammography adherence, with a rate of 64% (U.S. Centers for Disease Control and Prevention, 2000a). Behavioral research has produced interventions that have increased mammography

screening significantly. These interventions have ranged from postcard reminders to individual counseling to targeted and tailored strategies using print, telephone, and face-to-face interventions (Champion & Huster, 1995; Janz et al., 1997; Rimer, 1994; Skinner, Strecher, & Hospers, 1994). Researchers now are assessing interventions aimed at special populations, such as Hispanics, who have a lower mammography rate, and African Americans, in whom disease often is discovered at later stages. Methods to increase interval screening and implement cost-effective programs, such as physician letters paired with telephone counseling in real clinical settings, also are being explored (Saywell et al., 1999).

Cervical Cancer

The projected incidence of cervical and uterine cancer in the United States in 2002 is 52,300 (Jemal et al., 2002). The projected mortality rate in 2002 is 10,700. Invasive cervical cancer has decreased significantly since the 1950s because of use of the Papanicolaou (Pap) test (Adami et al., 1994). Incidence and mortality vary by race, probably at least partly as a result of socioeconomic, environmental, and behavioral factors. The incidence for African American women is about 12.5 per 100,000 versus only 7.3 per 100,000 Caucasian women (NCI, 1999a). Death rates among African American women are about double those of Caucasian women. Vietnamese women have the highest incidence, 43 per 100,000 (NCI, 1999b).

Risk factors for cervical cancer include sexually transmitted diseases, which are related to early age of sexual intercourse and multiple sex partners. Smoking, low socioeconomic status, and poor nutrition also have been linked to cervical cancer. The causative agent for most squamous cell cervical cancer is thought to be the human papilloma virus.

Fortunately, cervical cancer is almost 100% curable with early detection and appropriate follow-up and treatment. The efficacy of the Pap test actually has not been evaluated in prospective clinical trials, but the significant decline in deaths corresponding to its use has provided very strong circumstantial evidence (Eddy, 1990).

Recommendations for cervical cancer screening are consistent among several groups. The American College of Obstetricians and Gynecologists and ACS recommend that women have Pap tests and pelvic examinations when they become sexually active or starting at age 18, whichever comes first. When three consecutive Pap tests are normal, the U.S. Preventive Services Task Force (1996) recommends repeat screening every three years.

Screening for cervical cancer has one of the highest adherence rates of any screening test. The 1997 Behavioral Risk Factor Surveillance System (BRFSS) report indicated that 93% of women older than 18 reported having had at least one Pap test, although rates for low-income women were lower. The number of women who have had a Pap test in the previous two years, however, was 80% (Blackman, Bennett, & Miller, 1999). Although cervical cancer screening rates clearly are high, minority populations, such as Hispanic and Vietnamese American women, still need targeted interventions to increase screening (Chavez, Hubbell, Mishra, & Valdez, 1997; Jenkins et al., 1999). In a summary of cervical cancer screening research, Marcus and Crane (1998) reported on the effectiveness of patient and physician prompts, mass media campaigns, and inpatient and outpatient activation strategies. Research testing within state health departments now is needed to test the efficacy and cost-effectiveness of these interventions.

Ovarian Cancer

Ovarian cancer is the fifth leading cause of female cancer deaths in the United States and has the highest mortality rate of all gynecologic cancers. In 2002, 23,300 women likely will be diagnosed with ovarian cancer and 13,900 will die (Jemal et al., 2002). The five-year survival rate across all stages is 50% (Ries et al., 2001). When ovarian cancer is diagnosed while still localized, the five-year survival rate is 75%–90%; however, only 25% of women are diagnosed at that stage. For women diagnosed with stage III ovarian cancer, the five-year survival rate is less than 20%. The median age at diagnosis is 63 (Reintgen & Clark, 1996). Survival rates would improve significantly if healthcare professionals could identify ovarian cancer at an early stage. Vaginal ultrasounds have been used with symptomatic women but are not sensitive enough for mass screening.

The etiology of ovarian cancer is not known. Risk factors include advancing age; North American or European descent; nulliparity; personal history of breast, colon, or endometrial cancer; and family history of ovarian cancer. Although evidence is inconsistent, an increased risk of ovarian cancer has been associated with the use of fertility drugs (Black, 1999). Factors found to decrease the risk of ovarian cancer relate to the disruption of continuous ovulation, including having more than one full-term pregnancy, breastfeeding, and using oral contraceptives. Having a hysterectomy with ovarian conservation or tubal ligation also decreases risk (Black; Colditz, Rosner, & Speizer, 1996; Hankinson et al., 1993).

Screening modalities for ovarian cancer include bimanual pelvic examination, transvaginal ultrasound, and serum levels of CA 125 (NCI, 2001). Transvaginal ultrasound is used to evaluate the ovaries and has been recommended as a screening tool because it can measure ovarian size reliably and detect small masses. CA 125 is a serum tumor marker that routinely is used to monitor patients with epithelial ovarian cancer because it is elevated in 80% of these women. Unfortunately, CA 125 also is elevated in women who have endometriosis, pelvic inflammatory disease, benign ovarian tumors, fibroids, and a host of other benign conditions (Black, 1999). Because of the lack of sensitivity and specificity of each of these individual techniques, the measurement of CA 125 levels in combination with bimanual pelvic examination and transvaginal ultrasound has been proposed as a method for early detection of ovarian cancer. Although studies are under way to establish the efficacy of this combined screening modality, no conclusive evidence exists that these methods should be used for widespread screening to reduce ovarian cancer mortality (Black).

Prostate Cancer

In 2002, the incidence of prostate cancer in the United States is estimated to be 189,000 and about 30,200 men will die from it (Jemal et al., 2002), with the overall incidence and mortality highest for African American men. Internationally, distribution is similar to that of breast and colon cancer. Many developing countries have significantly lower rates of prostate

cancer than North America and northern Europe, although population life expectancy probably influenced data.

Information about risk factors for development of prostate cancer has surfaced from epidemiologic studies. No single factor has been identified to be responsible for prostate cancer, but it appears to be partially linked to diet in developed countries (Kantoff, Wishnow, & Loughlin, 1996). A diet high in fat has been associated with increased rates of prostate cancer.

Screening for prostate cancer is controversial, at best, even though it has a high incidence and, when discovered at an early stage, treatment usually results in better outcomes. Serum prostate-specific antigen (PSA) is the current screening test designed to detect prostate cancer early. Almost all men who do not have prostate cancer will have PSA levels of less than 4 ng/ml. Elevated levels, however, often do not indicate cancer because they may be present in men with benign prostatic hypertrophy or urinary tract infection. Several ongoing studies should provide more definitive information about the mortality benefit of PSA screening. Screening trials at Washington University in St. Louis, MO, have included more than 27,000 men (Catalona et al., 1991, 1994; Catalona, Smith, Ratliff, & Basler, 1993). Combined results showed that about 71% of tumors detected through initial or subsequent PSA screening were confined to the prostate. NCI is funding a prospective prostate trial to determine morbidity from prostate cancer, although results will not be available for at least 10 years. In a workshop convened in May 2000, data were presented from international trials that demonstrate reduction in prostate cancer mortality with PSA testing. Although the trial was not randomized, the data supported recommendations for screening (Ries et al., 2000; Tarone, Chu, & Brawley, 2000).

ACS recommends PSA screening yearly, with digital rectal examination for men who have a life expectancy of at least 10 more years. Men at high risk should begin testing at age 45. High risk is determined by family history and race. Data indicate that about two-thirds of men age 50 or older report knowing about PSA screening and that 50%–60% report having had the test at least once (Steele, Miller, Maylahn, Uhler, & Baker, 2000).

Prostate cancer has a high incidence but the potential for cure is good if it is discovered early. Given the state of knowledge, healthcare professionals would be prudent to offer at least PSA screening to men older than 50 who have a life expectancy of at least 10 more years. Informing men of the possibility of false positives, as well as the uncertainty involving treatment, also is advisable. Future interventions should provide tailored recommendations, as well as information about the potential harm of screening.

Colorectal Cancer

The highest incidence of colorectal cancer is in developed countries. In the United States, incidence and mortality declined 1.6% and 1.8%, respectively, between 1985 and 1997 (Ries et al., 2000). This decline was most evident for the majority Caucasian population. African Americans and men have a higher incidence of colorectal cancer, and African Americans have the highest mortality rate: 23 per 100,000 compared to 17 per 100,000 Caucasians.

Little is known about the etiology of colorectal cancer, but it appears to develop from adenomatous polyps that may take 7–12 years to progress to cancer. Although cancer may occur in the colon or the rectum, staging and disease characteristics for both cancers are similar, and, thus, they often are considered together in the literature (Winawer et al., 1997). Among the risk factors associated with a higher incidence of colorectal cancer are family history, a diet high in fat, inflammatory bowel disease, and lack of exercise or sedentary lifestyle. The use of nonsteroidal anti-inflammatory drugs, estrogen, and physical activity currently are associated with a lower incidence of colorectal cancer (Winawer et al.).

Three screening modalities are recommended for colorectal cancer: fecal occult blood test (FOBT), flexible sigmoidoscopy, and colonoscopy. The sensitivity and specificity of FOBT is affected by the fact that bleeding may be intermittent and is not distributed evenly throughout stool. Sensitivity for the most commonly used FOBT, the hemoccult test, has been reported variously as 26%–98%. Most studies demonstrated sensitivity greater than 65%. Results from randomized trials with FOBT show a decrease in mortality from colorectal cancer ranging from 15%–33% (Kronberg, 1991; Mandel et al., 1993). FOBT detects blood in stool only, which may or may not be related to colorectal cancer. Of those screened by FOBT, 2%–10% will have positive results, but only 5%–10% of those actually will have cancer (Kronberg). In other words, a large majority of those with positive FOBT results actually will have false-positive results for cancer.

A flexible sigmoidoscopy is an invasive procedure in which a lighted, flexible tube is inserted through the rectum to examine the lower third of the colon. It has been shown to decrease mortality, although the majority of studies to date have case-control designs. Three case-control studies on sigmoidoscopy screening have indicated 59%, 70%, and 79% reductions in colorectal cancer mortality (Muller & Sonnenberg, 1995; Newcomb, Norfleet, Storer, Surawicz, & Marcus, 1992; Selby, Friedman, Quesenberry, & Weiss, 1992). One retrospective cohort study found an 85% reduction in mortality (Atkin, Cuzick, Northover, & Whynes, 1993). The only randomized trial reported to date found a 60% decrease in mortality (Friedman, Collen, & Fireman, 1986). Screening with a flexible sigmoidoscope can detect cancers within the visualized segment of the colon (distal colon) with 85% sensitivity (Khullar & DiSario, 1997).

A colonoscopy is an invasive procedure similar to the sigmoidoscopy, but it examines the entire colon. Colonoscopy currently is recommended as a screening tool only for certain high-risk groups (e.g., those with family histories or histories of adenomatous polyps) and as a diagnostic test for those with positive FOBT or sigmoidoscopy. Traditionally, two major arguments oppose using colonoscopy as the screening tool of choice: lack of randomized trial data and cost. Additionally, almost 60% of adenomatous lesions occur in the distal rather than the proximal colon, and they can be detected by flexible sigmoidoscopy. However, new evidence from two studies conducted with asymptomatic patients demonstrates some of the limitations of relying on sigmoidoscopy alone. The studies reported that advanced neoplasms in the proximal colon would have been missed for 32% and 62% of the sample if sigmoidoscopy alone had been performed (Imperiale et al., 2000; Lieberman & Weiss, 2001). However, those studies were not designed to determine the mortality benefits of colonoscopy.

Colorectal cancer presents a unique opportunity for primary and secondary prevention. Regular screening facilitates early

detection, which, in turn, leads to reduced mortality (Winawer et al., 1997). Additionally, the removal of polyps that may develop into cancer decreases the incidence of colorectal cancer itself. Early-stage diagnosis of colorectal cancer through regular screening can lead to survival rates of 90% for colon cancer and 80% for rectal cancer. However, screening rates remain low, indicating the need for research on how to promote screening (Jemal et al., 2002).

Despite the benefits of early detection, colorectal cancer screening with any modality is low and has not increased substantially in recent years. BRFSS survey data of men and women ages 50 and older show that only 21% of those surveyed in 1999 had had FOBT in the preceding year compared with 20% in 1997; in 1999, only 34% had had sigmoidoscopy in the preceding five years compared with 30% in 1997 ("Trends in screening for colorectal cancer," 2001). These rates are well below the goals set in Healthy People 2010: to achieve screening rates of at least 50% for both screening behaviors (U.S. Centers for Disease Control and Prevention, 2000b).

Although the body of research on the behavioral factors that predict screening grows, cost-effective and innovative approaches still are lacking. Tailored print communications have been used to promote a number of different health behaviors but have yet to achieve their full potential for communicating cancer risk and increasing cancer-screening behavior (Rimer et al., 1999). Considering the success of tailored interventions in changing behaviors related to breast cancer screening, nutrition, and smoking, such interventions (e.g., via print, phone, computer) should be tested for their ability to increase colorectal cancer screening among both high- and average-risk populations.

Skin Cancer

Skin cancer comprises basal and squamous cancer and melanoma, which is the most deadly form. ACS estimates that 58,300 new cases of skin cancer, excluding basal and squamous, will be diagnosed in the United States in 2002, 53,600 of which will be melanoma. The estimated number of skin cancer deaths in 2002 is 9,600, of which 7,400 are projected to be from melanoma (Jemal et al., 2002). Melanoma is much less common than basal and squamous skin cancers but much more likely to metastasize. However, it is easily curable if detected at an early stage (Greenlee et al., 2001). Risk factors for melanoma include family history, immune suppression, prolonged exposure to ultraviolet radiation (including sunlight), fair skin, presence of certain kinds of moles, and increasing age (Greenlee et al.). Skin cancer can be detected by visual examination, which usually takes a trained dermatologist only about seven minutes (Wagner, Wagner, Tomich, Wagner, & Grande, 1985). The cost of such an examination is less than $75. Because prognosis is related to tumor thickness, early detection will save lives. Melanoma screening is particularly important in sun-belt states. Behavioral science models, such as the tailored interventions developed for breast and lung cancer, may be beneficial for increasing prevention and early detection.

Lung Cancer

Lung cancer is the leading cause of cancer mortality. An estimated 154,900 deaths will be attributed to it in 2002 (Greenlee et al., 2001). For men, lung cancer has been the leading cause of cancer deaths since the early 1950s, causing 31% of male cancer-related deaths. For women, too, lung cancer has become the leading cause of cancer deaths, surpassing breast cancer in 1987, and is responsible for 25% of female cancer-related deaths. Jemal et al. (2002) estimated that 169,400 new cases of lung cancer (90,200 in men and 77,200 in women) will be diagnosed in 2002. The five-year survival rate for lung cancer across all stages is low, only 15% (Black, 1999). About 50% of patients diagnosed with localized (stage 1) disease are alive after five years, but fewer than 20% of new diagnoses are classified as localized. The strong relationship between stage at diagnosis and survival suggests that screening for lung cancer may be beneficial.

The causal factor responsible for 87% of lung cancer cases is exposure to tobacco smoke (Greenlee et al., 2001). Cigarette smokers have a 10-fold higher risk of developing lung cancer compared to nonsmokers, and risk increases with the intensity and duration of exposure to tobacco smoke (Black, 1999). Although risk declines after smoking cessation, the risk remains elevated for former smokers who have a history of exposure to many packs per year (Peto et al., 2000). Almost half of all American adults have a history of cigarette smoking, and about 25% of the U.S. population currently smoke (Greenlee et al.). Other risk factors include exposure to environmental and occupational carcinogens, such as asbestos and radon gas. Genetics also plays a role in the development of lung cancer (Black).

Chest radiography has been the primary test used for lung cancer screening. The sensitivity of chest x-rays depends on three main factors (Black, 1999).

- Size and anatomic location of a lung tumor
- Technique used to obtain an x-ray
- A radiologist's skill in interpreting an x-ray

According to estimates, 75% of lung cancer's natural progression occurs before lesions are detectable by x-ray. In one study, the mean diameter of missed lung cancers was 1.6 cm, with the largest being 3.4 cm (Austin, Romney, & Goldsmith, 1992). Lesions were missed most often because their anatomic locations were obscured by ribs, hilar structures, blood vessels, or clavicles. Errors in interpretation also are common. Chest radiography is limited as a screening test, especially when compared to technologies that yield images of higher quality, such as spiral computed tomography (CT).

Sputum cytology also has been evaluated as a screening test for lung cancer (Black, 1999; Greenlee et al., 2001). Sputum samples are obtained over three consecutive mornings and microscopically examined for cellular abnormalities. The sensitivity of sputum cytology depends on several factors, including tumor location, tumor cell type, and ability of patients to produce adequate sputum samples. One disadvantage of sputum cytology is that a positive finding must be followed by a systematic visual examination of the upper respiratory tract using bronchoscopy to identify tumor location (Black). Therefore, at this point, sputum cytology is not a viable or sensitive screening modality.

Controlled trials of screening with both chest radiography and sputum cytology have failed to demonstrate a reduction in lung cancer mortality (Black, 1999; Greenlee et al., 2001). Despite the lack of significant data, some evidence exists for a modest relative risk reduction in mortality. In light of the huge burden associated with this disease, even a small relative

risk reduction may make radiographic screening beneficial, especially for those at high risk. Early detection of lung cancer through radiographic screening also may decrease treatment morbidity by resulting in less extensive surgical interventions.

On the other hand, some have argued that screening for lung cancer does more harm than good (Reich, 1995). As many as 10% of people screened for lung cancer using currently available methods receive false-positive results. The invasive procedures required to follow-up on false-positive results can be associated with significant morbidity and mortality (Black, 1999).

Efforts to improve chest imaging and molecular detection of lung cancer are ongoing. One advance in chest imaging involves the development of spiral (or helical) CT, which scans the entire thorax during a single breath hold. In a recent Japanese study of 1,369 smokers, four lung cancers were detected with chest x-ray, whereas 15 were detected with spiral CT (Kaneko et al., 1996). The Early Lung Cancer Action Project reported similarly impressive results, with CT significantly outperforming conventional chest x-ray in identifying small pulmonary tumors (Henschke et al., 1999). Other studies of spiral CT are planned or under way to investigate its efficacy.

Other promising methods for early detection include "virtual bronchoscopy" and screening for molecular mutations in sputum before morphologic changes appear. A virtual bronchoscopy identifies abnormalities in bronchial mucosa by fluorescence bronchoscopes. Normal mucosa differ from atypical mucosa in intensity and wavelength during the procedure. One molecular technique involves immunostaining with monoclonal antibodies that are directed at surface markers of neoplastic cells (Black, 1999).

No organizations currently recommend routine screening for lung cancer among the general population or even for those at high risk (Greenlee et al., 2001). However, the recent dramatic advances in chest imaging and molecular techniques likely will provide opportunities for lung cancer screening in the near future.

Strategies for Increasing Screening

Given the potential of screening to detect several cancers early and, therefore, decrease morbidity and mortality, behavioral research directed at increasing adherence to recommended guidelines is essential. ACS's current screening recommendations for all cancers reviewed in this article are summarized in Table 2. Continued vigilance is needed regarding adherence to breast and cervical cancer screening. Adherence rates for breast and cervical cancer screening are good, but improvement still is needed. Current research with mammography screening adherence has demonstrated that interventions targeting both women and providers have increased screening significantly. New approaches include both targeted and tailored messages using phone counseling and interactive computer counseling.

The importance of involving caregivers and the community has been highlighted in an extensive review (Bonfill, Marzo, Pladevall, Arti, & Emparanza, 2001). The challenge for the future is to provide cost-effective approaches to delivering interventions while incorporating new technology. Particular attention should be given to at-risk groups, older individuals, and adherence to periodic screening.

Colorectal cancer screening rates are extremely low; this must be a major focus of future efforts. Interventions that have been successful in mammography screening must be tested with colorectal cancer screening. Screening adherence in this context involves some barriers that are shared with adherence to mammography, although it also provides unique challenges that will necessitate a great deal of new research.

Future efforts to increase cancer screening require approaches using several principles. First, a transdisciplinary approach is needed: Physicians, nurses, and other healthcare professionals must become involved in promoting asymptomatic screening. Nurses are in a unique position to identify health-maintenance issues, such as screening, that should be promoted. Nurses in general healthcare settings and oncology settings can play active roles in encouraging cancer screening. Nurses should be very familiar with screening recommendations and variations by age and family history. Nurses also should understand the underlying principles on which screening recommendations are based. For instance, a 30-year-old woman asking for a mammogram may not understand that the test is not sensitive for women that age. Nurses also will be asked frequently for advice regarding cancer, such as ovarian, for which screening tests are not effective. Differentiating appropriate screening from inappropriate screening is a significant counseling challenge and an important issue in oncology nursing practice.

With the advent of genetic testing and chemoprevention trials, more knowledge is needed to help patients and first-degree relatives with prevention and early-detection issues. For instance, women with significant history of familial breast cancer may be appropriate candidates for tamoxifen or genetic counseling. When dealing with a 45-year-old woman whose mother has died of breast cancer, genetic counseling and chemoprevention must be considered.

Both individuals' and healthcare providers' behaviors are important for increasing screening. Research has demonstrated that recommendations from healthcare providers have a significant impact on screening behavior. Reminder systems for providers can help increase recommendations during routine healthcare visits.

Insurance and access barriers must be addressed through community involvement. Programs provide free or inexpensive screening for breast and cervical cancers, but screening for prostate and colorectal cancers still may be too expensive for many people. Colonoscopy, which is the preferred screening test for colorectal cancer, may cost as much as $2,000 when facility and provider costs are included.

Behavioral research that addresses preventive behaviors and adherence to screening guidelines is essential. Interventions must be tested in real-world settings and with a focus on cost-effectiveness. Future efforts also must take advantage of the technology now available, such as interactive computer applications. Web-based programs that use tailored approaches to target individual behaviors hold great promise. Prevention and early detection of cancer offer tremendous potential and, for now, the greatest hope for decreasing the morbidity and mortality associated with the disease.

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Table 2. American Cancer Society Recommendations

Cancer Type	Population	Test or Procedure	Frequency
Breast	Women ages 20 and older	Breast self-examination	Monthly, starting at age 20
		Clinical breast examination	Every three years, ages 20–39 Annually, starting at age 40[a]
		Mammography	Annually, starting at age 40
Cervical	Women ages 18 and older	Papanicolaou (Pap) test and pelvic examination	All women who are or have been sexually active or those who are 18 or older should have annual Pap tests and pelvic examinations. After three or more consecutive normal annual examinations, Pap tests may be performed less frequently at the discretion of a physician.
Ovarian	Women ages 18 and older	Bimanual pelvic examination	All women who are or have been sexually active or those who who are 18 or older should have an annual pelvic examinations.
		Transvaginal ultrasound and serum levels of CA-125	No recommendations for population screening with these two diagnostic tests
Prostate	Men ages 50 and older	Digital rectal examination and prostate-specific antigen test	Both should be offered annually to men who have a life expectancy of at least 10 more years, starting at age 50[b].
Colorectal	Men and women ages 50 and older	Fecal occult blood test (FOBT) and flexible sigmoidoscopy[c]	FOBT annually and flexible sigmoidoscopy every five years, starting at age 50
		or	
		Flexible sigmoidoscopy	Every five years, starting at age 50
		or	
		FOBT	Annually, starting at age 50
		or	
		Colonoscopy	Every 10 years, starting at age 50
		or	
		Double contrast barium enema	Every five years, starting at age 50
Lung	–	Chest x-ray	No organizations recommend routine screening of general populations or those at elevated risk. Physicians and at-risk patients may decide to use these screening tests on an individual basis.
		Sputum cytology	
		Spiral or helical computed tomography	
		Molecular examination of bronchial epithelial cells with fluorescence bronchoscopy	
Skin	Men and women ages 20 and older	Self-examination of all skin surfaces	Monthly, starting at age 20
		Skin examination by qualified health-care professional	See cancer-related checkup below.
Cancer-related checkup	Men and women ages 20 and older	Every three years for people ages 20–39 and annually after age 40. It should include examination for cancers of the thyroid, testicles, ovaries, lymph nodes, oral cavity, and skin, as well as health counseling about tobacco, sun exposure, diet and nutrition, risk factors, sexual practices, and environmental and occupational exposures.	

[a] Beginning at age 40, annual clinical breast examination should be performed prior to mammography.

[b] Information should be provided to men about the benefits and limitations of testing.

[c] Flexible sigmoidoscopy with fecal occult blood test (FOBT) is preferred compared with FOBT or flexible sigmoidoscopy alone.

Note. From "American Cancer Society Guidelines for the Early Detection of Cancer," by R.A. Smith, A.C. von Eschenbach, R. Wender, B. Levin,T. Byers, D. Rothenberger, et al., 2001, *CA: A Cancer Journal for Clinicians, 51,* p. 40. Copyright 2001 by the American Cancer Society. Adapted with permission.

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