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Cancer Screening and Early Detection in the 21st Century

Jennifer Loud and Jeanne Murphy

Objective: *To review the trends in and principles of cancer screening and early detection.*

Data Sources: *Journal articles, United States Preventive Services Task Force (USPSTF) publications, professional organization position statements, and evidence-based summaries.*

Conclusion: *Cancer screening has contributed to decreasing the morbidity and mortality of cancer. Efforts to improve the selection of candidates for cancer screening, to understand the biological basis of carcinogenesis, and the development of new technologies for cancer screening will allow for improvements in cancer screening over time.*

Implications for Nursing Practice: *Nurses are well-positioned to lead the implementation of cancer screening recommendations in the 21st century through their practice, research, educational efforts, and advocacy.*

Key Words: *cancer screening, sensitivity, specificity, screening recommendations, decision-making, early detection.*

The goal of cancer screening and early detection is to cure cancer by detecting the malignancy, or its precursor lesion, at an early stage, before the onset of symptoms, when treatment of cancer is most effective. Indeed, overall cancer mortality has decreased by 25% from 1990 to 2015 in the United States (US), with even greater declines in the mortality rates for colorectal cancer (47% among men and 44% among women) and, breast cancer (39% among women). A portion of this decrease can be attributed to the introduction of high-quality cancer screening for colorectal and breast cancer.[1] The most successful cancer screening programs lead to the identification of precursor lesions (eg, cervical intra-epithelial neoplasia with cervical cancer screening and colonic polyps with colorectal cancer

Jennifer Loud, DNP, CRNP: *Clinical Genetics Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of Health, Rockville, MD*. Jeanne Murphy, PhD, CNM: *Breast and Gynecologic Cancer Research Group, Division of Cancer Prevention, National Cancer Institute, National Institutes of Health, Rockville, MD*.

Address correspondence to Jennifer Loud, DNP, CRNP, Clinical Genetics Branch, DCEG, NCI, NIH, 9609 Medical Center Drive, Rockville, MD 20850-9772. e-mail: LoudJ@mail.nih.gov

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TABLE 1.
Wilson and Jungner Criteria for Disease Screening*

1. The condition of screening should be an important health problem
2. There should be treatment for patients diagnosed with the disease
3. Facilities to diagnose and treat the disease should be available
4. There should be a recognizable latent or early symptomatic stage
5. A suitable test or examination should be available
6. The test should be acceptable to the population
7. The natural history of the condition should be adequately understood
8. There should be agreement in the policy of whom to treat as patients
9. The cost of screening, diagnosis, and treatment should be economically balanced within the total cost of health care spending
10. Screening should be a continuing endeavor to allow for refinement in screening methods, outcomes, and process improvement

*Data from Wilson and Jungner.[2]

screening), where the treatment of the precursor lesion leads to a decrease in the incidence of invasive cancer over time. The guiding principles of screening for disease were proposed in 1968 by Wilson and Jungner[2] of the World Health Organization (Table 1). Not all cancer screening recommendations meet each of these guiding principles; historically there has been a balance between the identification of early or precursor lesions and the avoidance of over diagnosis, which may lead to overtreatment (Table 2).

Application of Cancer Screening Principles

Population screening in the United States for cervical cancer serves as an exemplar of a successfully designed and implemented screening program that has been modified as the biological mechanism of

TABLE 2.
Potential Negative Outcomes of Cancer Screening

Over diagnosis: When tumors are detected that would never become symptomatic or lead to death
Overtreatment: When tumors are detected that would never become symptomatic or lead to death but are treated none-the-less

TABLE 3.
Characteristics of an Accurate Screening Test

The screening test (eg, mammogram, colonoscopy):
Is reliable → delivers same result each time, each instrument, each rater
Has validity → delivers the correct result each time:
  Is sensitive = correctly classify cases (pre-cancer or cancer)
    Sensitivity = cases found/all cases
  Is specific = correctly classify non-cases (things that are not cancer)
    Specificity = non-cases identified/all non-cases

the carcinogenesis of cervical cancer is more clearly elucidated and methods for primary prevention (ie, HPV vaccination) are developed. Cervical cancer screening programs in particular adhere to several of Wilson and Jungner's principles; most importantly, that the natural history of the disease is understood and that it be an important health problem. Chronic HPV infection is the underlying etiologic agent of the carcinogenesis of cervical cancer. Chronic HPV leads to a precancerous lesion (ie, cervical intra-epithelial neoplasia) that can be visualized, after the detection of a positive cytology (through Pap testing), with colposcopy. The removal of the precancerous lesion using colposcopy successfully led to an overall decrease in the incidence of cervical cancers, even though there was overtreatment of some early lesions. Cervical cancer screening represents an example of the use of an accurate screening test (ie, PAP, colposcopy, and now HPV testing) with adequate sensitivity, specificity, and positive and negative predictive value, leading to the identification of a high-risk population, a pre-cancer, or a cancer (Tables 3 and 4). Population screening for colon cancer also conformed many of Wilson and Jungner's principles and led to improvements in overall survival of individuals who adopted screening recommendations.[1] A key feature of both cervical and colon cancer screening is the ability to directly access the tissue of interest and apply an adequate screening test. Population screening for cervical cancer reduced the incidence and mortality rates from cervical cancer and led to enthusiasm that screening programs for other cancers, or pre-cancers, would be equally successful. However, screening, detection, and removal of pre-cancer or early cancer in other cancer types have not always been as successful.