Lung cancer is the leading cause of cancer death for men and women in the United States (Siegel, Naishadham, & Jemal, 2013). Although lung cancer is curable in its earliest stages with surgical intervention, most lung cancers are diagnosed when the disease is advanced (30% stage III, 40% stage IV), a factor that contributes to the poor survival statistics (Bach et al., 2012; Wender et al., 2013). Early lung cancer diagnostic methods, most often conducted when patients presented with problematic symptoms, largely relied on chest radiology and sputum cytology, which were unable to detect minute malignant nodules that signal cancer at its earliest stages (Mulshine & Sullivan, 2005; Pastorino, 2010). Although lung cancer screening is not without controversy (Tehranzadeh, 2013), focus on disease screening has intensified with the advent of sophisticated technologies, such as low-dose spiral computed tomography (CT), that are capable of detecting lung cancer nodules during their early growth phases (Wender et al., 2013). Media attention to lung cancer screening has increased, and patient advocacy organizations, such as Lung Cancer Alliance, have taken active roles in promoting screening for individuals at high risk for lung cancer (www.lungcanceralliance.org). The purpose of this article is to present the historical background relative to lung cancer screening, discuss risks and benefits, and review current practice guidelines. Such knowledge is essential for oncology nurses as they provide education and advocacy for patients and their families who will need access to current information to make informed personal healthcare choices.

Background

The American Cancer Society (ACS) recommended lung cancer screening via chest radiography in the 1970s for current and former smokers, an endorsement that was withdrawn in 1980 (Wender et al., 2013). The purpose of screening, a form of secondary prevention, is to diagnose lung cancer at its earliest stages, a period when the illness is asymptomatic. The goal of screening is to provide treatment when the disease is still curable, resulting in fewer deaths, improved quality of life, and longer life expectancy (Smith, Brooks, Cokkinides, Saslow, & Brawley, 2013). Because screening is costly and not without risk, an important goal of population screening is to use selection criteria that accurately identifies who is at high risk to increase the odds that cancer will be detected with screening (Tammemägi et al., 2013).
As such, underlying disease prevalence, the likelihood of benefit that exceeds potential harm, and costs incurred are all important considerations (Smith et al., 2013).

Early screening studies conducted in the 1970s using chest radiology with and without sputum cytology concluded that lung cancer screening was not effective in reducing lung cancer mortality (Pastorino, 2010). However, many of the early screening studies had methodologic flaws that led to continuing research through the 1980s and the National Cancer Institute (NCI)-sponsored Prostate, Lung, Colorectal, and Ovarian (PLCO) cancer screening trial in the early 1990s (Wender et al., 2013). The Cochrane Review group published a meta-analysis that reported findings across nine randomized, controlled trials (RCTs) with more than 400,000 participants evaluating the evidence of the effectiveness of screening in detecting lung cancer and prolonging survival (Manser et al., 2013). The pooled analysis confirmed findings that annual chest x-ray screening did not reduce mortality and that screening for lung cancer with radiology or sputum cytology is not supported (Manser et al., 2013).

The Early Lung Cancer Action Project (ELCAP), a large nonrandomized cohort study involving more than 30,000 participants, published baseline findings that compared chest radiology and the role of CT scanning in early detection of lung cancer (Henschke et al., 1999). The ELCAP study demonstrated that spiral CT scanning could detect very small resectable tumors with an accuracy and sensitivity rate six times higher than chest radiography. This study provided the foundation for several follow-up RCTs to systematically examine the role of CT scanning in early detection of lung cancer in the United States and throughout Europe (Henschke et al., 1999, 2006).

The National Lung Screening Trial (NLST) found that screening with low-dose CT for high-risk patients resulted in a 20% reduction in lung cancer mortality when compared to screening with chest radiography (Aberle et al., 2011). High-risk patients are current or recently former smokers (i.e., quit less than 15 years ago) with greater than a 30 pack-year history (a pack-year is 20 cigarettes per day [one pack] every day for one year) (Aberle et al., 2011). This major study, funded by the NCI, involved more than 50,000 patients from 33 cancer centers across the United States who were randomized to receive either three annual CT screenings or the single-view chest radiograph condition (Aberle et al., 2011). About 43% of the participants were aged from 55–59 years, the sample was 59% male, and the two groups were evenly weighted across demographic and smoking status factors (Aberle et al., 2011). To avoid one cancer death, the NLST data indicated that 320 patients would need to be screened, which means a substantial number of patients would incur the risks associated with screening to obtain the benefits of lowered mortality (Aberle et al., 2011). The NLST trial, which was completed in 2010, identified that the cost effectiveness of low-dose CT screening, the adverse effects of overdiagnosis and positive screening, and considerations of alternative preventive measures, such as smoking cessation, would need to be considered in public policy (Aberle et al., 2011).

The NLST results stimulated development of a consensus panel among the ACS, American College of Chest Physicians, American Society of Clinical Oncology, and National Comprehensive Cancer Network (NCCN) to produce a systematic review of the evidence related to lung cancer screening with low-dose CT (Bach et al., 2012). The systematic review, which included research published since 1996, focused on potential benefits, potential harms, groups who are most likely to achieve benefit, and the setting where screening would most likely be effective (Bach et al., 2012). The search yielded eight RCTs and 13 cohort studies. In addition to the NLST, other major RCTs represented in the review included the Lung Screening Feasibility Study, DEPISCAN (a pilot study to evaluate low-dose spiral CT scanning as a screening method for bronchial carcinoma), Detection and Screening of Early Lung Cancer by Novel Imaging Technology and Molecular Essays (DANTE) trial, NELSON trial (a Dutch-Belgian randomized lung cancer screening trial), Danish Lung Cancer Screening Study (DL CST), and ITALUNG (Bach et al., 2012). Findings from this review concluded that strong evidence existed for low-dose CT screening for high-risk patients as defined by the NLST criteria. The NLST study was very carefully designed, had the largest sample size by a substantial margin of all the RCTs, and was one of three RCTs that provided mortality data (Bach et al., 2012). The other two studies that provided mortality data were DANTE and DL CST.

The NLST targeted a high-risk group in a U.S. population where more than 90 million people are current or past smokers and many individuals have had other risk exposures such as second-hand smoke (Aberle et al., 2011). Another study performed additional statistical modeling analyses on patient selection data from the NLST with data from the PLCO cancer screening trial (Tammemägi et al., 2013). This study found that expanded screening selection criteria that included race (African American), family and personal history of cancer, lower body mass index, less education, smoking intensity, and presence of chronic obstructive pulmonary disease would significantly increase the number of cases of lung cancer diagnosed (Tammemägi et al., 2013). A Cochrane Review, which included a systematic review of RCTs, also concluded that research appears to support the premise that annual low-dose CT screening for high-risk candidates could reduce lung cancer mortality (Manser et al., 2013). However, the Cochrane Review determined that more data on risk, benefits, and cost effectiveness were needed across a broader range of risk groups and practice settings before lung cancer screening could be recommended (Manser et al., 2013).

In 2012 and 2013, respectively, the NCCN and ACS published new guidelines for lung cancer screening that are based on the current body of evidence (Wender et al., 2013; Wood et al., 2012). The NCCN guidelines described lung cancer risk factors; criteria
recommendations for determining high-risk patient selection for screening, evaluation, and follow-up of nodules detected during screening; discussion of low-dose CT screening protocols and imaging modalities; and risks and benefits of screening (Wood et al., 2012). Full algorithms are provided that depict risk assessment, screening modality, and findings; and evaluation and follow-up for specific findings (Wood et al., 2012).

Lung cancer risk assessment includes present and past smoking history, occupational exposure to carcinogens, radon exposure, family history of lung cancer, exposure to secondhand smoke, pulmonary disease (e.g., chronic obstructive pulmonary disease, fibrosis), and absence of signs and symptoms of lung cancer. The current evidence suggests that high-risk patients, defined as men and women in good health aged 55–74 years who are current or past heavy smokers (i.e., 30 pack-year or more history within the past 15 years), may attain benefit from yearly low-dose CT screening for lung cancer (Wender et al., 2013; Wood et al., 2012). In addition, the NCCN guidelines also consider patients who are 50 years or older with 20 pack-year or more smoking history with one other risk factor (other than secondhand smoke) as high risk (based on lower-level evidence—category 2B, NCCN consensus that the intervention is appropriate). Lower-level evidence refers to consensus obtained from findings derived from observational data and nonrandomized studies (Wood et al., 2012). Lung cancer screening is not recommended for patients who are at moderate risk (i.e., 50 years or older with a 20 pack-year or more history or secondhand smoke exposure) or low risk (i.e., younger than age 50 years and less than 20 pack-year history of smoking) (Wood et al., 2012).

**Risks and Benefits**

With screening comes drawbacks related to the relatively high rate of benign, noncalcified nodules that are detected with low-dose CT (Bach et al., 2012), which results in an increased prevalence of surgical procedures for benign conditions (Ishell et al., 2011). The incidence of actual malignancy in solitary pulmonary nodules has been shown to range from 10%–68% and is largely dependent on risk factors associated with patient selection, referral, and differences in regional patterns of granulomatous disease caused by fungal infections (Ishell et al., 2011).

Patients may experience anxiety when they receive abnormal findings that require additional diagnostic follow-up, including imaging procedures and invasive biopsies or incidental medical findings that are unrelated to the lung cancer screening (van den Bergh et al., 2011). False-positive tests can incur psychological, physical, and economic costs. Patients who have surgical resection of a lung nodule that is later found to be nonmalignant experience unnecessary financial expenses, lost productivity, stress, physical symptoms, and other risks, including potential for infection (Smith et al., 2006). Patients may receive unnecessary treatment and exposure to radiation from the excessive diagnostic procedures (Wender et al., 2013; Wood et al., 2012).

In the NELSON study, anxiety and distress associated with false-positive tests subsided with time, but psychological effects from screening remain a concern (van den Bergh et al., 2011).

Screening does not ensure that death from lung cancer will not occur. In addition, patients may have comorbid conditions or unexpected events that are unrelated to the lung cancer that may lead to mortality (Bach et al., 2012). A risk is that indolent disease is detected and treated. Indolent disease is a slow-developing disease that, if undetected, would not result in harm to the patient. During the course of screening for early-stage diagnosis, some aggressive lung cancers may be diagnosed that are already advanced. Findings also may be false-negative in which lung cancer is present but not detected by the CT scan (Wood et al., 2012).

Most of the NLST study sites were NCI-designated cancer centers (Aberle et al., 2011). They had well-developed facilities to ensure that proper follow-up and care occurred for patients who were screened. To reduce inadvertent adverse patient risk, lung cancer screening should occur in environments where the medical facilities and expertise can handle the potential adverse events associated with screening.

**Figure 1. Patient Resources for Lung Cancer Screening**

- **American Cancer Society**
  Updated screening recommendations are presented with straightforward answers to frequently asked questions about the guidelines.

- **International Early Lung Cancer Action Program (I-ELCAP)**
  [www.ielcap.org](http://www.ielcap.org)
  I-ELCAP provides information about lung cancer early detection and screening. Links on the website allow users to browse library resources and news releases and find I-ELCAP member screening sites that are closest regionally.

- **JAMA Patient Pages**
  The JAMA Patient Pages are a public service of JAMA. The Lung Cancer Screening Patient Page explains how screening tests for lung cancer work and tells patients where to begin the screening process and where to find more information.

- **Lung Cancer Alliance**
  The Lung Cancer Alliance is the only national nonprofit organization that is focused on advocacy and support for patients and families affected by lung cancer. The site provides a helpline and easy-to-read information about lung cancer risk and screening, insurance coverage, and screening center resources.

- **National Cancer Institute (NCI)**
  The NCI Physician Data Query (PDQ) is a database that provides resources on the latest published information for patients and healthcare professionals. The lung cancer screening PDQ includes a patient version that describes what screening is, general information about lung cancer, tests used in screening, risks, and discussion points for provider interactions.

- **National Comprehensive Cancer Network (NCCN)**
  [www.nccn.org/patients/default.asp](http://www.nccn.org/patients/default.asp)
  The NCCN is an alliance of 25 U.S. cancer centers, most of which are NCI-designated comprehensive sites. The NCCN guidelines for patients provide expert information on lung cancer screening in visually explicit slides. The guidelines were developed to help patients discuss screening and treatment options with their physicians.
proper resources are available should the test suggest an abnormality. The NCCN guidelines recommend that facilities that conduct lung cancer screening have a multidisciplinary approach involving several specialties, including pulmonary and internal medicine, radiology, thoracic oncology, and surgery (Wood et al., 2012). Testing and follow-up require administrative processes in place that ensure proper patient management to avoid potential harm created by excessive or unnecessary testing and associated consequences of invasive procedures (Wood et al., 2012).

Benefits to lung cancer screening include the potential for reduced lung cancer mortality (Bach et al., 2012). Quality-of-life benefits may be incurred when patients experience reductions in illness and treatment-related morbidity as a result of being diagnosed with less advanced disease (Wood et al., 2012). In a comprehensive screening program that includes behavioral counseling and smoking cessation programs, patients may incur improvements in quality of life by adopting a healthy lifestyle and may experience reductions in anxiety and psychosocial distress (Wood et al., 2012). Cost effectiveness also could be improved because the cost of treatment of lung cancer may increase with an advanced stage (Villanti, Jiang, Abrams, & Pyenson, 2013). Although more research on the cost effectiveness of lung cancer screening is required (Wood et al., 2012), a study by Villanti et al. (2013) indicated that lung cancer screening combined with smoking cessation programs for high-risk patients is highly cost effective.

Role of the Nurse in Patient Education and Patient Advocacy

People who are concerned about their risk for lung cancer deserve access to information that is timely, accurate, balanced in terms of pros and cons of screening, and easy to understand. Armed with such knowledge, they can then make informed decisions about whether to pursue screening or can understand why it is recommended if they meet the established high-risk criteria. The ACS recommends that clinicians at healthcare sites that have access to high-volume, high-quality lung cancer screening and treatment centers have discussions about preventive screening with those who are at high risk for lung cancer (Wender et al., 2013). If someone who meets the high-risk criteria desires screening but is at an institution that lacks expertise in screening and proper follow-up with a multidisciplinary team, then he or she should be referred to sites that have those capabilities (Wender et al., 2013). Screening for lung cancer at sites that lack appropriate training and resources for follow-up is not recommended (Wender et al., 2013).

Screening for lung cancer can be costly from an economic standpoint (Bach et al., 2012). Some insurance companies may not reimburse for lung cancer screening (Wood et al., 2012). Eligible patients who desire screening may need a referral to social workers to assist with financial issues associated with reimbursement (Wood et al., 2012). As evidence of the cost effectiveness of screening for lung cancer to reduce mortality becomes established, coverage to include screening services may become more common (Villanti et al., 2013).

Discussions with people who are not at high risk as defined by the NCCN criteria should not be initiated. However, if information about lung cancer screening is requested by someone who does not meet the high-risk criteria, they can be informed that the risk/benefit balance is uncertain for anyone younger or older than the 55–74 year age range with less exposure to tobacco smoke.

Developing competency in identification of high-risk individuals who are eligible for lung cancer screening and guiding them through the decision-making process are essential obligations of health professionals. Information is available about lung cancer screening at cancer websites (see Figure 1).

Oncology nurses need to be cognizant of concerns and be prepared to answer questions about lung cancer screening. Such preparation should include the potential benefits, limitations, and risks associated with lung cancer screening with low-dose CT for individuals who are at high risk. By being knowledgeable about the screening criteria, appropriate settings for such screening to occur, and appropriate follow-up, clinicians will be in a strong position to provide high-quality patient care and advocacy. Figure 2 provides resources that clinicians can use to gain more information about lung cancer screening. In addition, patients who are active smokers can be encouraged to quit and can be provided smoking cessation resources such as counseling and medications.

Conclusion

An important future research priority will be to examine data from ongoing RCTs in meta-analyses so that the best recommendations are available for people at risk for lung cancer.

FIGURE 2. Clinician Resources for Lung Cancer Screening

- American Cancer Society
  Updated screening recommendations are presented with straightforward answers to frequently asked questions about the guidelines.
- American Society of Clinical Oncology (ASCO)
  ASCO provides resources for oncology professionals to promote quality care. The site provides access to ASCO's evidence-based guidelines related to lung cancer screening and a panel discussion about lung cancer screening.
- National Comprehensive Cancer Network (NCCN)
  www.nccn.org/professionals/physician_gls/f_guidelines.asp
  The NCCN clinical practice guidelines in oncology are the most widely used resources in oncology practice. Each guideline is developed by oncologist teams from a review of the best scientific evidence available from clinical trials.
- Treating Tobacco Use and Dependence Quick Reference Guide for Clinicians
  www.ahrq.gov/legacy/clinic/tobacco/tobaqrg.htm
  This guideline provides a description of the development process, discussion of available research, critical evaluation of assumptions and knowledge, and information for healthcare decision making regarding tobacco cessation.

References