CHAPTER

6

Prevention, Information Technology, and Cancer

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6.1 OVERVIEW

Preventing cancer can serve as a powerful component of a comprehensive effort to decrease the burden of cancer on our society. Increasing cancer prevention efforts in clinical oncology, primary care, and other health care settings provides a substantial and largely untapped potential to reduce morbidity and mortality. This chapter reviews cancer risk factors that are amenable to preventive interventions and outlines how current and future technology-supported protocols can be used to strategically extend and improve cancer prevention efforts.

6.1.1 Cancer Epidemiology

In the United States in 2015, an estimated 1,665,370 people will be diagnosed with cancer, and an estimated 589,430 people will die of it [1]. Cancer of the lung and bronchus and cancer of the colon and rectum were among the top three sites for both men and women across races. Death rates and incidence rates for the four most common cancers (prostate, breast, lung, and colorectal), as well as for all cancers combined, are declining [2]. Despite this progress, much work remains to be done as some cancer incidence rates remain stable and others continue to rise. For example, incidence rates for melanoma are still rising, and lung cancer incidence rates in women also continue to rise. Of significant concern is that many subpopulations demonstrate elevated risk for cancer, and people with low socioeconomic status have the highest rates of both new cancers and cancer deaths. Also worrisome is that younger cancer survivors are smoking more than cancer survivors in the general population (Table 6.1).

6.1.2 Cancer Prevention

Cancer prevention encompasses behavioral risk factor modification, vaccination, chemoprevention, and screening and detection. This chapter focuses on the identification, assessment, documentation, and modification of behavioral factors associated with increased cancer risk, usually referred to as “primary prevention.” Screening and detection (secondary prevention) will be covered in detail in the next chapter, but screening will be touched on here as an opportunity to intervene with cancer risk behaviors.

A recent National Cancer Institute (NCI) report [3] noted that cancer prevention, particularly the prevention of lung cancer that is primarily caused by tobacco use or exposure, has the potential to save more lives than treatment. It has been estimated that most cancer mortality in the United States can be attributed to behaviors such as tobacco use, physical inactivity, excessive alcohol consumption, overexposure to sunlight, and other factors such as obesity and poor nutrition. About 30% of cancer mortality is due to tobacco use [4]. Poor nutrition, sedentary behavior or physical inactivity, and obesity combined account for another 35% of the cancer burden.

6.2 KEY BEHAVIORS OF INTEREST FOR THE PREVENTION OF CANCER

Patterns of behavioral risk factors for cancer illustrate both progress and areas of critical need. Though the decrease in smoking in the last half century has been hailed as a major public health victory, tobacco use remains the largest single preventable cause of cancer [3]. Nutritional and dietary factors are also of concern: alcohol consumption has risen slightly since the mid-1990s; fruit and vegetable intake is not increasing; and red meat and fat consumption is not decreasing. All of these factors have been cited as possible links to increased risk of cancer [2]. As the number of Americans who are becoming either overweight or obese climbs, the connection between cancer and obesity is receiving more attention.

The behavioral risk factors that are the principal focus of this chapter have multiple determinants, from biological to behavioral to economic to social. This has been most extensively reviewed regarding tobacco use, where initiation by youth has been linked to social influences (both family members and peers) as well as to media marketing. Biological factors implicated in tobacco use include differences in uptake and dependence linked to individual variation in nicotine metabolism, which in turn has been linked to gene variation [5]. The influence of economic and policy factors is reflected by the substantial reductions in smoking prevalence rates observed following increases in cigarette excise tax rates and implementation of clean indoor air ordinances.

Similar to tobacco, high caloric and high fat food products that are associated with obesity are heavily marketed in the United States. Moreover, increasing portion sizes, and consumption of high caloric beverages and restaurant meals are contributing to excess weight [6]. Taking a page from health policy efforts designed to reduce tobacco use, there have been initiatives to control trans fats, restrict caloric drink access and size, and tax high fructose beverages.

6.2.1 Challenges of Maintaining Behavioral Change

Sustaining the behavioral change necessary for health risk reduction is challenging both for patients and practitioners. This is generally characterized in the research literature as either maintenance of behavioral change or, alternatively adherence to medical recommendations.
A return to the original behavior, condition, or status is usually described as relapse, slip, or failure.

The relapsing pattern of tobacco use among smokers who try to quit led to the characterization of tobacco use or dependence as a chronic condition or chronic disease. In 2000, the Surgeon General’s report Reducing Tobacco Use [7] concluded that

tobacco dependence is best viewed as a chronic disease with remission and relapse. Even though both minimal and intensive interventions increase smoking cessation, most people who quit smoking with the aid of such interventions will eventually relapse and may require repeated attempts before achieving long-term abstinence.

The US Public Health Service’s (USPHS) Clinical Practice Guideline Treating Tobacco Use and Dependence [8] has consistently framed tobacco use in the same terms, stating in the 2008 update, “Tobacco dependence is a chronic disease that often requires repeated intervention and multiple attempts to quit.” It might be conceptually useful to medical clinicians to similarly characterize weight loss, physical activity, diet, and nutrition as behavioral patterns that fluctuate and vary, and that require sustained effort by the patient and attention and prompting by the medical provider to achieve long-term desired outcomes.

6.2.2 Smoking and Other Tobacco Use

More than 6.5 million Americans have died from smoking-related cancers (and 20 million from all smoking-related diseases) since 1964 [9]. Smoking causes about 30% of all US deaths from cancer. Types of cancer implicated in smoking include those of the lung, esophagus, larynx, mouth, throat, kidney, bladder, pancreas, stomach, and cervix [10]. Though the overall prevalence of smoking among adults is now less than half of what it was in the 1960s, those declines have not been equal across all sociodemographic strata. Smoking-related cancer risk disparities are evident among smokers who are in lower income brackets, are less educated, and have a history of psychiatric and/or substance abuse diagnoses. Avoiding tobacco use is the single most important step Americans can take to reduce the cancer burden in this country [2]. If smoking persists at the current rate among young adults in this country, 5.6 million of today’s Americans younger than 18 years old are projected to die prematurely from a smoking-related illness [9].

Cigar consumption is growing in the United States, and cigar smokers have increased risk for lung, pancreas, and bladder cancers [11]. Smokeless tobacco use is more popular among men than women and is associated with elevated risks of oral, esophageal, and pancreatic cancers [12]. Emerging tobacco products such as e-cigarettes and hookahs are quickly gaining popularity among adolescents [13]. Though the health effects of e-cigarettes remain to be established, there is concern that they will induce youth to try cigarettes and other tobacco products that have established cancer risks.

Comprehensively addressing smoking in clinical practice requires the committed involvement of all staff (eg, medical assistants or roomers, nurses, physicians, and other primary clinicians) as well as modifications in practice workflows. Integrating tobacco use assessment, documenting tobacco use status in electronic...
health records (EHRs), and prompting of the delivery of interventions during all electronic and personal (face-to-face) encounters is critical to increasing treatment delivery, acceptance, and effectiveness. Repeated prompts to quit smoking optimize patient engagement in changing behavior.

The effectiveness of counseling and pharmacologic interventions in increasing smoking cessation rates among patients is supported by extensive research [8]. Brief smoking cessation interventions that are integrated into routine clinical care during a medical visit have been shown to be effective. Tobacco cessation advice and support should be provided by the whole health professional team, including both physicians and other nonphysician clinicians (eg, nurse practitioners, physician’s assistants, nurses, pharmacists, community workers, and social workers). Brief advice appears to work by triggering increased numbers of quit attempts and increasing the chances of success of quit attempts. The USPHS’s Clinical Practice Guideline [8] states that “minimal interventions lasting less than 3 minutes increase overall tobacco abstinence rates.” For those not ready to quit at this time, counseling can boost the motivation to quit by personalizing the costs and risks of the patient’s tobacco use (eg, tying it to the patient’s health, economic status, and family situation). Counseling also provides an opportunity to warn the patient about obstacles or hurdles to quitting and to encourage the patient to use coping strategies to avoid and resist temptations or urges to smoke [14].

Medications such as nicotine replacement therapy (NRT), bupropion, and varenicline have also been found to be effective treatments for smoking cessation. NRT has been shown to be effective in both health care and over-the-counter-like settings without additional counseling [8, 15], but the absolute quit rates are higher when pharmaceutical and behavioral treatments are combined. An international review of the cost-effectiveness of pharmaceutical products for cessation by Cornuz and colleagues found that these therapies compared favorably with other preventive interventions [16]. An excellent resource for the practitioner and the health care system is the previously mentioned USPHS’s Clinical Practice Guideline [8], which was comprehensively updated in 2008.

6.2.3 Overweight and Obesity

Although rates of overweight have stabilized, prevalence of adult obesity is increasing in the United States [2]. In 2009–10, 33% of adults were overweight and 36% were obese. Excess body weight, both overweight and obesity, are implicated in 20–30% of certain cancers, such as colon, postmenopausal breast, uterine, esophageal, and renal cell. Evidence is highly suggestive that obesity also increases risk for cancers of the pancreas, gallbladder, thyroid, ovary, and cervix, and for multiple myeloma, Hodgkin lymphoma, and aggressive prostate cancer [6]. In the United States, excess body weight contributes to 14–20% of all cancer-related mortality. Weight control, physical activity, and nutrition are key factors in cancer prevention and are the most important modifiable cancer risk determinants for Americans who do not smoke.

6.2.4 Physical Inactivity

Approximately one-third of adults report getting no physical activity during their leisure time [2]. Sedentary individuals have higher rates of cancer and poorer cancer outcomes [17]. Physical activity at work or during leisure time is linked to a 30% lower risk for colon cancer. Both vigorous and moderate levels of physical activity appear to reduce cancer risk. Physical activity is also associated with lower risk of breast cancer and possibly lung and endometrial cancers. Studies continue to examine whether physical activity has a role in reducing the risk of other cancers.

Several national groups have recommended that people engage in regular physical activity. The US Department of Health and Human Services’ (HHS) 2008 Physical Activity Guidelines for Americans [18] recommended at least 1 hour of physical activity every day for children and adolescents and 2.5 hours of moderately intense aerobic activity or 1.25 hours of vigorous activity for adults each week. This was a slight departure from former recommendations, which focused on a daily routine rather than a cumulative weekly total for adults, recommending at least 30 minutes per day of moderate physical activity for 5 or more days each week.

6.2.5 Poor Nutrition

Fruit, vegetables, and components of plant foods such as fiber have long been associated with reducing cancer risk. Cancers specifically linked to low rates of fruit and vegetable consumption include cancers of the mouth, pharynx, larynx, esophagus, stomach, and lung [2]. The Greek European Prospective Investigation into Cancer and Nutrition (EPIC) cohort study reported a significant reduction in total cancer risk associated with high consumption of both fruit and vegetables [19]. In the EPIC study from 10 European countries, there was a weak inverse association between high consumption and total cancer risk [20].

High intake of red and processed meat is associated with significant increased risk of colorectal, colon, and rectal cancers. The overall evidence from prospective studies supports limiting red and processed meat consumption as one of the dietary recommendations for the prevention of colorectal cancer [21].
6.2.6 Alcohol Consumption

Drinking alcohol increases the risk of cancers of the mouth, esophagus, pharynx, larynx, and liver in men and women, and of breast cancer in women [4]. In general, these risks increase after about one daily drink for women and two daily drinks for men. These levels of alcohol consumption are defined as “moderate” according to the 2010 Dietary Guidelines for Americans [22]. Alcohol intake limits were exceeded by 22% of men ages 31–50 years, and by 12% of women ages 51–70 years [23].

The chances of getting liver cancer increase markedly with five or more drinks per day [6]. Heavy alcohol use may increase the risk of colorectal cancer and increases the risk for most alcohol-related cancers. The earlier an individual begins heavy, sustained alcohol use, the greater his or her cancer risk. Combining alcohol and tobacco increases the risk of some cancers far more than the independent effects of either drinking or smoking alone. Regular consumption of even a few drinks per week is associated with an increased risk of breast cancer in women—a risk that is particularly high in women who do not ingest enough folate.

6.2.7 Sun Damage

New cases of melanoma skin cancer increased markedly between 1975 and 2009, with a projected number of 76,100 new cases in 2014 [24]. More than 2 million people in the United States were diagnosed in 2006 with basal cell or squamous cell (nonmelanoma) skin cancer, the two most common types of skin cancer in the country, and 40–50% of Americans who live to age 65 will have nonmelanoma skin cancer at least once.

Most skin cancers—including melanoma, the deadliest form of skin cancer—can be prevented. Studies suggest that reducing unprotected exposure to the sun and avoiding artificial ultraviolet (UV) light from indoor tanning beds, tanning booths, and sun lamps can lower the risk of skin cancer [2].

Only about two-thirds of US adults report that they protect themselves from the sun [2]. The percentage of adults who report being sunburned has increased since 2005. Although use of one or more sun protective measures has changed little over the last few decades, the newly defined Healthy People 2020 measure shows some recent promise: during 2005–10, 70% of adults reported that they protected themselves from the sun [25].

6.2.8 Viral Infection

Infection with human papillomavirus (HPV) is the established cause of most cervical cancers [26]. The direct medical costs of HPV in the United States are estimated at $5 billion a year [27]. In the United States, 25% of females ages 14–19, 45% of women ages 20–24, and 27% of women ages 25–29 are infected with HPV [28]. The Centers for Disease Control and Prevention (CDC) recommends that all boys and girls begin the three-shot HPV vaccination regimen at age 11 or 12 [29]. Catch-up vaccinations are also recommended for males through age 21 and for females through age 26, if they did not receive the vaccination when they were younger. However, only 49% of adolescent females have begun the vaccination series, and only 32% have received all three doses required for full immunization [30]. Given that adolescent HPV immunization rates are suboptimal, it has been suggested that EHR systems prompt providers to remind young people to become vaccinated. As vaccines are developed for other viruses related to cancer (eg, Epstein-Barr and Hepatitis C), EHRs can be used to promote adherence to recommended vaccination schedules. A recent study [31], however, failed to demonstrate improved adolescent immunization rates associated with such provider prompts. This suggests that more research is necessary to understand how to improve the effectiveness of provider prompts to address this important cancer prevention objective.

6.3 CURRENT USE OF INFORMATION TECHNOLOGY FOR CANCER PREVENTION

Information technology (IT) provides new means of informing both patients and the general public about effective cancer prevention strategies. By more efficiently linking individuals and clinicians with cancer prevention opportunities, these new methods hold promise for reducing the more than 500,000 cancer deaths in the United States per year.

In a review of IT and cancer prevention, Jimbo and colleagues [32] defined IT as

any equipment, interconnected system, or subsystem of equipment used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of technology. Information technology includes computers, ancillary equipment, software, firmware and similar procedures, services (including support services), and related resources.

The authors’ review focused on the impact of IT on the delivery of cancer preventive services in primary care offices [32]. Conducted before the wide-scale adoption of certified EHR technology, or meaningful use, the review evaluated 30 studies that assessed cancer prevention and IT. The authors reported that early IT efforts were primarily focused on the prevention of breast, cervical, and colorectal cancers, with about half of the 30 studies focused exclusively on providers and the rest on the

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Closed-loop functionality that can refer patients to

In light of these modest findings, the authors emphasized the importance of moving from the limited early interventions described in their review (primarily computer-generated letters to patients and provider reminders) to more technologically advanced interventions involving computer-generated audits, feedback, and report cards as well as more sophisticated EHR innovations and applications [32]. As a framework for possible IT advances for cancer prevention, Jimbo and colleagues adapted the 2008 USPHS’s Tobacco Use and Dependence treatment algorithm [8], developing a modified “5 A’s” approach that identified potential cancer prevention IT interventions that could be tied to a clinic visit (eg, before the clinic visit “Assess” status regarding cancer screening interventions and “Advise” patient prior to the visit regarding necessary testing) (Fig. 6.1).

6.3.1 Example of IT Use: Skin Cancer Prevention

Skin cancer prevention is a clinical intervention for which a number of IT strategies have been attempted. In one example, Hornung and colleagues [33] developed a multimedia computer program for the primary prevention of skin cancer among children and piloted it in an elementary school in rural North Carolina. Seven months after the intervention, students who received the multimedia training had significantly improved their knowledge and attitudes about skin cancer and sun tanning risks compared with students who received a standard teacher-led training intervention, although the differences in actual behaviors did not reach statistical significance. In another effort to use IT to promote skin cancer prevention, Barysch and colleagues [34] developed an Internet-based campaign against skin cancer in Switzerland that included education, instruction for self-assessment, and evaluation of skin lesions to be conducted online by expert dermatologists (see Chapter 7: “Early Detection in the Age of Information Technology”). The website attracted many users, including middle-aged males, who often participate in such programs. The process led to identification of 494 at-risk lesions. Of these, the team of expert dermatologists determined that 28.5% were “suspicious for skin cancer.” Lastly, Gerbert and colleagues [35] assessed the effectiveness of an Internet-based tutorial in improving the skin cancer triage skills of primary care physicians (PCPs). Physicians who received this training demonstrated significantly better skin cancer diagnosis and evaluation compared to control physicians.

6.4 ELECTRONIC HEALTH RECORDS

Many features of EHR technology make it particularly applicable to cancer prevention and screening interventions, including:

- Prompts that can be programmed to alert clinicians and/or patients to take cancer prevention actions based on established criteria (eg, presence of a risk factor, age, time since last screening test).
- Evidence-based algorithms that assist clinicians in efficiently delivering cancer prevention interventions (eg, smoking cessation counseling and/or medication guides, photos to help discern the pathology of skin lesions).
- Communication tools that share the outcomes of a cancer prevention intervention in a Health Insurance Portability and Accountability Act (HIPAA) compliant way with the patient, selected clinicians, and other individuals within and outside the health care system.
- Closed-loop functionality that can refer patients to outside entities for cancer prevention interventions (eg, a state-based tobacco cessation quitline) and then allow the outcome of that referral to be added to the patient’s EHR while complying with HIPAA rules; for example, for a telephone quitline, a referral that includes the patient’s quit date, as well as information on smoking medication (start and end dates, dose) mailed to the patient from the quitline.
- Patient registries that allow clinics and health systems to sort patients based on risk factors, demographics, and test results for selective cancer prevention interventions.

6.4.1 EHRs and Tobacco Cessation

Among the many uses of EHR technology for cancer screening and prevention, tobacco use intervention may be the application that has received the most research attention. The most recent Cochrane Review on this topic (2014) identified 16 studies that tested the use of an EHR to improve documentation and/or treatment of tobacco use [36]. Most of these studies evaluated the impact of EHR changes on rates of identification of tobacco users
and delivery of cessation treatment such as electronic prescribing of cessation medication, rather than on cessation rates themselves. In most instances, use of EHR was associated with improvements in both identification and delivery of treatment, results that were consistent with the recommendations in the USPHS’s 2008 update of the Clinical Practice Guideline Treating Tobacco Use and Dependence [8].

The 16 studies identified for the Cochrane review [36] included 6 group-randomized trials, 1 patient-randomized study, and 9 nonrandomized observation studies. The review found that these 16 studies were of fair to good quality; none directly assessed patient quit rates. Key findings from the studies addressed some of the “5 A’s” clinical interventions recommended by USPHS’s 2008 update of the Clinical Practice Guideline, as follows [8].

6.4.1.1 Ask Smoker Identification

Two studies [37,38] identified smokers at significantly higher rates when the EHR was used to prompt clinic staff to complete this prevention intervention. However,
Rindal and colleagues [39] found no increase in the already very high levels of smoking status documentation (97.5%) by dental care providers in his study. This high level of documentation is evidence of a cancer prevention success story that resulted, in part, from advances in IT. Tobacco cessation clinical practice guideline recommendations [8], meaningful use requirements, and early calls to include smoking status in vital signs [40] have collectively contributed to a new clinical standard of care: in the United States today, smoking status is obtained and documented for virtually all inpatients and outpatients at the time of their clinic visit or hospital admission [41].

6.4.1.2 Advise All Smokers to Quit and Assess Interest in Quitting

One study [38] reported that clinics where an EHR promoted clinical intervention had higher rates of advising patients to quit smoking and assessing interest in quitting than control clinics (advising patients to quit: 71.6% in intervention clinics vs 52.7% in control clinics; assessing interest in quitting: 65.6% in intervention clinics vs 40.1% in control clinics). Another study [39] reported only postintervention data for 15 dental clinics that were randomly assigned to: (1) an EHR-based dental record intervention that prompted providers to ask about and discuss smoking and interest in quitting; or (2) a usual-care control condition. Measured outcomes included a comparison in rates of asking about tobacco use, discussing quitting, and referring patients who used tobacco to a telephone quitline. Overall, providers in the intervention clinics (relative to those in the control clinics) were more likely to ask about interest in quitting (87% vs 70%), and to discuss strategies for quitting smoking (47% vs 26%).

6.4.1.3 Assist With Cessation

The Cochrane review [36] also identified four observational studies that documented that EHR system changes increase the rate of assistance provided to smokers visiting various health care settings. In one of the larger studies, which examined the hospital records of more than 17,000 patients in a Boston hospital, Koplan and colleagues [44] used a pre–post design to examine the impact of adding a “tobacco order set” (that included orders for a cessation consultation and cessation medications) to the admission screens of a hospital’s computerized order-entry system. After this EHR-based order set was implemented, the authors found a statistically significant increase in the proportion of admitted smokers referred for cessation counseling and in physician orders for cessation medications.

6.4.1.4 Additional Studies

Other studies, not included in the Cochrane report, have assessed the impact of EHR modifications on smoking cessation interventions. For example, Kruse and colleagues [45] studied how PCPs viewed the feasibility and acceptability of a one-click EHR function to refer smokers to a centralized tobacco treatment coordinator who called the smokers, provided brief counseling, connected them to ongoing treatment, and gave feedback to the PCPs. Clinicians were rewarded for participation as part of the pay-for-performance reimbursement that was tied to utilization of the new technology. Over 18 months, involving 36 PCPs and 2894 smokers from two community health centers (CHCs), the authors reported that 81% of the PCPs used the EHR capability more than once, generating 466 referrals. Overall, about 15% of the known smokers visiting the clinics were referred to evidence-based treatment during the study period. While these results were impressive, the Cochrane group elected to exclude this study because the impact of the EHR changes could not be separated from the impact of the pay-for-performance changes.

Finally, EHR modifications have been used to intervene with some populations that have particularly high rates of smoking, including lower-income individuals. For example, the New York City Department of Health and Mental Hygiene established the Health eQuits program [46,47], funded by the CDC. Health eQuits targeted CHCs that had already implemented EHR technology to determine whether they could use that technology to increase the delivery of smoking cessation intervention. Specifically, Health eQuits challenged 19 CHCs with EHR functionality to demonstrate higher rates of smoking status documentation and cessation intervention, providing financial incentives if rates of documentation and intervention exceeded baseline levels. The EHR modifications were extensive and represent a model of the broad capacity of this technology to enhance cancer prevention interventions. These modifications...
included: (1) automated quarterly reports on clinician and clinic performance on the Health eQuit program (reports gave rates of documentation of smoking status, smoking prevalence, and proportion of current smokers who received at least one cessation intervention); (2) a tally of incentive payments earned based on intervention rates with smokers; (3) use of a clinical decision support tool; and (4) a patient registry to identify smokers within the EHR and alert the clinician to address smoking with that patient at that visit.

At baseline, across the 19 New York City CHCs, the mean rate of delivery of at least one cessation intervention to smokers (counseling, cessation medication, or referral to the New York State quitline) was 23% among documented smokers (range across clinics: 0–54%). At the end of the program, 18 months later, the rate of intervention had increased markedly, with 54% of documented smokers having received at least one cessation intervention (range across clinics: 12–91%). During the 18-month intervention, 36,572 smokers received at least one cessation intervention, compared with only 6515 smokers during the 12-month baseline period (Fig. 6.2).

### 6.4.2 Using Lung Cancer Screening Visits to Provide Smoking Cessation Interventions

In a 2013 review of the scientific evidence, the US Preventive Services Task Force (USPSTF) concluded that low-dose computed tomography (LDCT) cancer screening of the lungs can significantly reduce mortality from lung cancer among heavy current and former smokers. Based on this finding, the USPSTF recommended that:

Asymptomatic adults aged 55 to 80 who have a 30 pack-year smoking history and currently smoke or have quit within the last 15 years should be screened annually for lung cancer with low-dose computed tomography, and that screening should continue until the patient has not smoked for 15 years.

This new lung cancer screening recommendation has led insurers, including Medicare, to now pay for LDCT screening, and the availability and use of this test have increased substantially. This increase in LDCT lung cancer screening provides an opportunity for an additional technology-prompted cancer prevention intervention: providing smoking cessation treatment at the time of the LDCT lung cancer screening. One important reason to consider linking these two cancer interventions is the concern that lower smoking cessation rates might result among current smokers who received negative LDCT screening results, as a result of these smokers believing they are no longer at risk (the “health certificate effect”) [48].

To assess this possibility, the USPSTF reviewed studies that assessed this potential unintended consequence. This review yielded mixed results. For example, Ashraf and colleagues [49] examined the effects of LDCT screening for lung cancer on smoking rates in 4104 Danish participants, half of whom received annual LDCT lung
cancer screening tests and half of whom received no screening test. One year after the initial screening period, the biochemically confirmed quit rate among individuals who were smokers at baseline was essentially identical both in the LDCT group (11.9%) and the no-screening control group (11.8%). All participants received minimal (<5 minutes) smoking cessation counseling. Relapse rates also were similar across the two groups—10.0% in the LDCT group and 10.5% in the control group. In another European study [50], 1284 Dutch male smokers were randomized to LDCT lung cancer screening or no screening. Two years after the baseline screening period, prolonged smoking abstinence rates of 13.7% were observed in the LDCT group compared to 14.9% in the no-screening group (p = 0.35). In this study, all participants received a smoking cessation brochure or a questionnaire through which people could ask for tailored, computerized cessation support.

A Minnesota study [51] involving 926 current smokers assessed the impact of three annual LDCT screens for lung cancer on both health outcomes and smoking cessation. Most of the smokers at baseline did not receive smoking cessation assistance, and the study did not include a comparison group that did not undergo LDCT lung cancer screening. A statistically significant increase was found in the likelihood of self-reported smoking cessation among individuals who were told they had abnormal LDCT lung scans. In a similar study, Styn and colleagues [52] assessed quitting behavior among 2094 baseline active smokers who underwent LDCT lung cancer screening, comparing those who received a physician referral for an abnormal CT finding with those who did not. At 1 year, these investigators found a statistically significant increase in smoking cessation rates among individuals who received a referral because of an abnormal CT result.

Lastly, a 2014 study by Tammemagi and colleagues [53] evaluated the impact of lung cancer screening results on short- and long-term smoking cessation rates among the 15,489 baseline current smokers included in the NCI-funded National Lung Screening Trial. These researchers found that for participants who were smokers at baseline, the type of screening result was an important and statistically significant predictor of continued smoking; those with negative lung cancer screening results had lower rates of cessation over 7 years of follow-up compared to individuals with abnormal LDCT screening findings. The authors interpreted their results as suggesting that the “health certificate effect” was not a major effect in their study, but acknowledged that they did not test this effect definitively.

Collectively, these studies highlight the potential of the lung cancer screening test as an opportunity for smoking cessation intervention, and the potential for EHR-based technology to link these two interventions and prompt tobacco cessation treatment.

6.4.3 Linking Patients to Their State Tobacco Quitlines and Closed-Loop Functionality

Among its many capabilities, the EHR can refer patients with cancer risk factors to external entities that can provide cancer prevention interventions. Specifically, the ability to refer smokers visiting primary care settings to a state-based telephone tobacco cessation quitline has been extensively evaluated. Vidrine and colleagues [42] randomly assigned 10 family practice clinics in Houston to two conditions. In the intervention clinics, smokers were linked electronically to their state tobacco cessation quitline using an expanded EHR capacity. In the control clinics, smokers were given a quitline referral card and encouraged to call the quitline on their own. Among smokers connected electronically to the quitline via the EHR, 7.8% enrolled in quitline treatment, compared to 0.6% of those given a referral card and encouraged to call—a 13-fold increase in the proportion of smokers enrolled in treatment.

In an expansion of referral functionality, Adsit and colleagues [54] evaluated the potential of an EHR’s “closed-loop” capability. In this study, the authors assessed the ability of the EHR to electronically refer smokers to a telephone tobacco cessation quitline. Then, in a significant innovation, the quitline and EHR vendors (two independent entities) developed coordinated technical programming to allow for the results of the quitline referral to be electronically inputted into the patient’s EHR. In this demonstration project, 14% of smokers visiting two primary care clinics were referred to the state quitline using the new EHR functionality versus only 0.3% using the previous method of referral (paper fax). The closed-loop component of this new functionality worked effectively; for every referred patient, the quitline was able to send back outcome data on whether the patient was successfully contacted, if the patient set a tobacco cessation quit date, and what medications were prescribed by the quitline (typically over-the-counter nicotine replacement medications), directly populating the individual patient’s EHR in a HIPAA-compliant way.

6.4.4 Engaging Physicians to Improve Patients’ Health

EHR technology can be utilized in a number of ways to engage clinicians in interventions that can reduce cancer risk. One means of achieving this outcome is to use the EHR in a surveillance function and to communicate to clinicians findings regarding that surveillance. Cowburn and colleagues [55] used this EHR functionality when they assessed the association between insurance status and cervical cancer screening in community health settings in Oregon and California. They showed that the absence of insurance coverage was negatively associated
with the likelihood of receiving a Pap test, identifying a high-risk population for intervention within these settings. White and Kenton [56] used the EHR for a training function, developing three EHR-based tools to educate providers on cervical cancer screening guidelines. Implementing the training program with additional electronic medical record prompts improved compliance with cervical cytology guidelines, including improved targeting of the screening test toward high-risk individuals.

6.4.5 Patient Registries as a Means of Promoting Cancer Prevention

One EHR feature that can be applied to cancer prevention interventions is the patient registry capability: EHR technology that can systematically sort patients based on a variety of clinical, demographic, and physiologic parameters. One of the most common clinical applications of this feature has been the development of a diabetes registry that sorts patients based on a variety of possible parameters: prior elevated blood glucose or hemoglobin A1C level; body mass index; use of a diabetes medication in the last 1–5 years; and/or the inclusion of a diagnosis of diabetes in the problem list. Use of such criteria can help select patients with either a diagnosis or a risk of diabetes. Then, by targeting such selected patients, EHR technology can prompt the patient, clinician, or health care system to undertake certain preventive, diagnostic, or treatment interventions. For example, the EHR might scan the records of each diabetic patient and prompt him or her to schedule and complete a podiatry exam if warranted. Similarly, if a diabetic patient has not undergone a check of his or her hemoglobin A1C in the past 6 months (a test that should be completed every 3 months), a series of escalating prompts may signal to the patient the importance of regularly undergoing this test [57].

Similarly, patient registries may be used for cancer prevention activities. In one innovative application of patient registries, Womble and colleagues [58] used EHR technology to establish a registry of males with newly diagnosed, but low-risk, prostate cancer, in an effort to manage these patients with active surveillance—periodic Prostate-Specific Antigen (PSA) testing. The authors used EHR technology to ensure that these PSA tests took place on schedule as needed; 49% of the patients fulfilled criteria and could be followed successfully under this active surveillance model. This cancer prevention innovation successfully helped prevent overtreatment of indolent prostate cancer and the unnecessary surgery, radiation, and hormonal therapy that expose these individuals to substantial risks and high costs. In an accompanying editorial, Cooperberg [59] highlighted the power of this patient registry as an innovative tool to provide quality care to these individuals, stating “the registry truly serves as the surging tide raising all boats.”

EHR-based patient registries have also been used to identify and target tobacco users for intervention. In one such study, Sherman and colleagues [60] established a system to sort smokers in 10 primary care clinics and target them for referral to telephone-based cessation counseling. These results were compared to findings from eight comparison clinics. Over a 1-year intervention period, almost 3000 smokers were identified from the intervention clinics; almost one-half of them were then successfully connected to a telephone cessation quitline, and 11% of them had quit smoking 6 months later. The authors concluded that the use of such EHR-based patient registries for targeted tobacco cessation intervention can have substantial impact on clinic-wide smoking rates.

6.4.6 Challenges of EHRs

The widespread adoption of EHR technology in health care settings offers tremendous opportunity to coordinate cancer prevention treatment in a manner that is consistent, efficient, and sustained over time. Although the use of EHR and IT offers extraordinary potential for cancer prevention, the response to these innovations by clinicians, health systems, and the public has been mixed. That mixed response has resulted in large part from concerns about clinical workflow, added burden, and efficiency.

In an effort to better understand challenges to the adoption of EHR and meaningful use, Heisey-Grove and colleagues [61] assessed more than 140,000 providers in 2012. The authors conceptualized these challenges as falling into four categories: (1) practice issues (eg, workflow adoption, provider engagement, training, vendor selection); (2) vendor issues (eg, upgrade needs; delays in implementation, installation, certification; inadequate training or support materials); (3) attestation process issues (eg, calculating patient volume, lack of an operational Medicaid program, Medicaid or Medicare technical or administrative challenges); and (4) meaningful use measures (eg, achieving core quality measures). Their surveillance highlighted the myriad of organizational and implementation challenges to widespread EHR adoption.

Pizziferri and colleagues [62] performed a time-motion study in five primary care clinics involving 20 physicians to assess physician time utilization before and after implementation of EHRs as well as physicians’ perceptions of EHR. Postimplementation, the mean overall time spent per patient during clinic sessions decreased by 0.5 minutes (from 27.55 to 27.05 minutes per patient). A majority of survey respondents believed that EHR use resulted in quality improvements, yet only 29% reported
that EHR documentation took the same amount of time or less compared to paper-based health record systems. While the EHR did not require more time for physicians during a clinic session, the authors recommended further studies to assess the EHR’s potential impact on nonclinic time.

While many have evaluated the response of physicians to the widespread implementation of EHR technology, little is known about patients’ response to this technological innovation. Kim and colleagues [63] attempted to evaluate challenges to using an electronic personal health record (ePHR) by a low-income elderly population. While 70 individuals were initially identified for the evaluation, only 44 used the technology, and only 14 of these completed the survey. While their data available for interpretation were limited, the authors found that use of the ePHR was hindered by the participants’ poor computer and Internet skills, technophobia, low health literacy, and limited physical and/or cognitive abilities. They concluded that “those who can benefit most from an ePHR system may be the least able to use it” and that “disparities in access to and use of computers, the Internet, and ePHRs may exacerbate health care inequality in the future” [63]. An in-depth discussion of user-centered design can be found in Chapter 11: “Data Visualization Tools for Investigating Health Services Utilization Among Cancer Patients” in this book.

6.4.7 The Changing Regulatory and Policy Environment

The regulatory and policy environment has evolved markedly to encourage and/or mandate that health systems use EHR technology more broadly and more effectively. While these regulatory and policy changes create a powerful incentive to adopt such technology, the science base regarding how to most effectively utilize EHR technology to promote cancer prevention interventions is both new and modest.

6.4.7.1 Meaningful Use: A Federal Incentive Program to Encourage Adoption and Use of EHR Technology

In 2009, the Health Information Technology for Economic and Clinical Health (HITECH) Act [64] was passed and signed into law. HITECH is designed to encourage clinicians and health systems to adopt EHR technology and use it to achieve certain benchmarks on a variety of evidence-based health care goals (“meaningful use” requirements). The HITECH Act provides financial incentives to both physicians and hospitals that adopt and demonstrate the meaningful use of EHR systems.

HITECH has been a remarkably powerful piece of legislation because it is not just an investment in technology but was designed to reward the meaningful use of that technology. As described by the first director of the Office of the National Coordinator for Health Information Technology (ONC), David Blumenthal, “By focusing on the efficient use of EHRs with certain capabilities, the HITECH Act makes clear that the adoption of records is not a sufficient purpose: it is the use of EHRs to achieve health and efficiency goals that matters” [64]. He described the four goals of HITECH as: “define meaningful use, encourage and support the attainment of meaningful use through incentives and grant programs, bolster public trust in electronic information systems by ensuring their privacy and security, and foster continued health information technology (HIT) innovation” [64]. Blumenthal highlighted the importance of these goals: “Information is the lifeblood of modern medicine. HIT is destined to be its circulatory system” [64].

The impact of this legislation was remarkable, rapidly transforming health records in the United States from paper records to electronic health (eHealth) systems. From 2008 to 2013, the proportion of US physicians who report using EHRs increased from 17% to 78% [65]. By June of 2014, more than 400,000 clinicians (75% of the nation’s eligible clinicians) and more than 4500 hospitals (92% of eligible hospitals) had adopted EHR systems required for meaningful use payments (Fig. 6.3).

6.4.7.2 The Affordable Care Act and Guidance on Treating Tobacco Dependence

A core component of the Affordable Care Act (ACA, or “Obamacare”) was its provisions regarding clinical preventive services. Specifically, the ACA mandates that health insurers must cover, without cost-sharing requirements, clinical preventive health services that have an A or B rating in the current recommendations of the USPSTF, including smoking cessation treatment that has a USPSTF A rating. While providing such general guidance, the ACA legislative language did not specify what constitutes ACA-compliant smoking cessation treatment.

In May 2014, a guidance document describing in detail what constitutes ACA-compatible cessation coverage was released by the HHS, the US Department of the Treasury, and the US Department of Labor. This guidance specified that all covered individuals are eligible for two courses of smoking cessation treatment per year with each course of treatment including:

- four tobacco-cessation counseling sessions (telephone, group, or individual) with each session lasting a minimum of 10 minutes; and
- a 90-day course of any tobacco-cessation medications approved by the US Food and Drug Administration (FDA) (prescription or over-the-counter) that are prescribed by a health care provider [66].
Today HIT has the potential to reach almost 3 billion Internet users and 7 billion people with mobile-cellular subscriptions worldwide [67]. Because of technological advances and widespread adoption of new technologies, eHealth has expanded into mobile health, or mHealth, which harnesses the power of portable technology to efficiently transmit and receive data and information to enhance health outcomes. mHealth can operate through numerous devices, including smartphones, personal digital assistants (PDAs), tablets, standard cellphones, wearable devices, game consoles, and more. These devices’ capabilities for short message service (SMS), multimedia message service (MMS), Internet access, direct calls, and other mobile applications (apps) are widely used and studied for health and medical purposes [68].

SMS, MMS, and other mobile applications partially account for the ease and utility of mobile devices. SMS allows for brief interactions or exchanges of text information; MMS performs a similar function for video and images; and apps are used with or without the Internet as a platform for data collection and information sharing. Each media tool can produce customized messages for patients, which can lead to improved health outcomes. Personalization is enhanced by the real-time continuous data collection that is made possible by device mobility. With greater quantities of accurate data, mHealth can lead to better health management and reduced burden of disease.

The widespread use of mobile devices opens mHealth projects to numerous target populations, such as patients, doctors, nurses, underserved or low-income populations, and the general public. mHealth is particularly beneficial in improving the process of care in low-resource areas [69]. mHealth also has the potential to reduce health disparities and health care costs because of the widespread penetration of mobile devices across sociodemographic strata and the extraordinarily low costs associated with providing health information, including cancer prevention information, on a large scale.

Along with the ubiquity of smartphones and other mobile devices, there has been a multitude of mobile applications that take medical readings, monitor health, and prompt health behavior change. These include calorie counters, wearable sensors that monitor heart rate or track physical activity, and apps to help people lose weight, stop smoking, and sleep better. As of 2012, roughly 19% of smartphone owners had downloaded at least one app to manage or track their health, the most commonly downloaded apps being exercise, diet, and weight management apps [70]. The FDA notes that 500 million smartphone users worldwide will be using a health care application by 2015, and by 2018, 50% of the more than 3.4 billion smartphone and tablet users will have downloaded mHealth applications [71].

There is a growing body of mHealth research addressing health behavior interventions, including: smoking cessation and tobacco use, physical activity, diet, alcohol consumption, and sun protection. While there is limited research on the effectiveness of smartphone apps in promoting behavior change, research utilizing SMS is widespread among clinical trials, pilot studies, and new study designs.

### 6.5.1 mHealth and Cancer Prevention

Research has shown that using mHealth tools significantly improves adherence to medicine regimens and affects sunscreen use and smoking quit rates [72]. SMS, MMS, automated voice services, and the Internet have been the main vehicles used in successful eHealth and mHealth cancer prevention projects.
Although mHealth has the capacity to promote primary cancer prevention, little research has studied the efficacy of most of the apps that are currently available. Bender and colleagues [73] found 295 smartphone apps related to cancer, yet no research addressing their effectiveness and impact exists. A total of 46% of the available apps pertained to cancer in general, while other apps focused on awareness, educational information, early detection, fundraising, and social support. While these apps might facilitate cancer prevention, research findings are currently lacking to estimate their effects.

6.5.2 Tobacco and Smoking Behaviors

There is growing research support of the efficacy and utility of mHealth applications for smoking cessation. A recent Cochrane review [74] acknowledged the benefit of mobile phone-based smoking cessation interventions but noted that positive outcomes tended to be associated with text messaging applications. The Community Preventive Task Force [75] concluded that there was sufficient evidence to support recommending mobile phone-based interventions for tobacco cessation. In the years following up to the recommendation and since then, numerous meta-analyses have been conducted to determine the effectiveness of mHealth interventions.

A review by Whittaker and colleagues [74] found that SMS, Internet programs, and interactive voice response service (IVRS) all showed positive effects for self-reported, short-term quitting. IVRS provided voice recordings with time-specific information on the health effects of cessation. It ensured user engagement by motivating participants to seek more information and visit the web page of the day. A subsequent review by Whittaker and colleagues [76] found that SMS, Internet programs, and video messaging had positive effects, leading to cessation that lasted at least 6 months (relative risk (RR) = 1.71, 95% confidence interval (CI) = [1.49, 1.99]).

Spohr and colleagues [77] found that SMS interventions were associated with an increase in smoking cessation rates at the 3- and 6-month follow-ups when compared to the control condition (odds ratio (OR) = 1.35, 95% CI = [1.23, 1.48]). Similarly, Free and colleagues [78] found short-term, self-reported abstinence rates were significantly higher for pooled SMS programs (RR = 2.18, 95% CI = [1.80, 2.70]). In both studies, automated SMS interventions varied in design, but often contained messages providing quit advice, motivational messages, interactive polls and quizzes, information on NRT, links to helplines, and information about social support. These results were affirmed for long-term, self-reported, and biochemically tested quit rates using mHealth strategies.

Analogous to previous research, Stop Smoking with Mobile Phones (STOMP) used SMS to provide cessation tips, trivia, polls, quizzes, buddies, and on-demand help. The success of the STOMP trials led to its implementation nationally in New Zealand, and expansion to studies in the United Kingdom. In initial trials, cessation success was noted at 6 weeks, and verified cessation abstinence at 6 months was significantly increased among participants who received the text messaging intervention (RR 2.20, 95% CI = [1.80–2.68]) [79]. Based on the available evidence for SMS interventions on smoking cessation, these techniques may offer benefits when incorporated into standard health care services.

Given the enormous penetrance and reach of web and mobile devices, it is important to evaluate the real-world effectiveness of such interventions and to widely disseminate interventions found to be effective at the population level. The NCI smokefree.gov represents one of the world’s largest smoking cessation and health behavior change mHealth-based intervention services. Initially launched as a single website in 2003, the program now encompasses 5 websites, 15 text message programs, 4 smartphone apps, and a dozen social media platforms targeted to a variety of populations. In 2013, more than 5 million users interacted with smokefree.gov resources. The smokefree.gov website and related mHealth platforms include resources designed to motivate people to quit; they provide information and behavioral skills training to smokers to improve quit success and help sustain abstinence. Additional intervention support is also provided for related health behaviors such as mood management, diet, and physical activity. In a test of five different population-based treatments, the NCI smokefree.gov website was shown to be an effective population-based smoking cessation intervention [80].

While findings are promising for SMS and MMS-based interventions for tobacco cessation, less research has been published concerning mobile apps for smoking (and other tobacco) cessation. Abroms [81] reviewed 47 publicly available iPhone apps related to smoking cessation and found that only 11% of these aligned with one of the USPHS’s 2008 Clinical Practice Guideline for treating tobacco dependence [8]. Few of these 47 apps provided smokers with proven tobacco cessation treatments: only 4.3% connected smokers to quitlines, and 8.5% provided intratreatment social support. As with the research on apps related to cancer, findings on tobacco cessation apps suggest that more research is necessary before recommending these as evidence-based interventions.

6.5.3 Nutrition and Physical Activity

To address the increased cancer risk and rising health costs associated with obesity and overweight, mHealth technologies have been developed to encourage patients to reach and maintain a healthy weight, increase physical activity, and improve diet. Systematic reviews have
addressed the topic of mHealth as it relates to diet, nutrition, and physical activity. These reviews include numerous studies that used a range of technologies. Results have been mixed, and these results have been influenced by the type of technology used and the healthy weight behavior targeted.

6.5.3.1 Support for Weight Loss

Research suggests that self-monitoring and social support are effective contributors to successful weight loss. mHealth makes it possible for people to track their behavior related to losing weight using either an online journal or mobile diary application, and provides social support via the Internet or mobile phone. Three studies have assessed the use of PDAs, mobile apps, and websites to support weight loss compared with traditional paper-and-pencil tracking methods. All studies found that greater adherence to self-monitoring helped participants achieve greater weight loss [82–84]. Khaylis and colleagues [85], reviewing the use of online journals, pedometers, and PDAs, also found that when participants were held accountable, the technology was effective in improving weight loss.

6.5.3.2 Increased Physical Activity for Weight Loss

mHealth interventions provide a system for individuals to be held accountable for their physical activity. Systematic reviews looked at web-based interventions [86], pedometer usage [87], PDAs, mobile phone applications [87,88], and SMS technology [89]. Findings for using these tools to increase physical activity and lose weight are mixed. Pedometer usage and mobile phone apps were consistently successful in increasing activity, while PDAs had inconsistent results and require more research [87,88]. Web-based interventions had a less significant impact on increased physical activity than other methods, and again, findings were mixed.

Wearable devices such as Fitbit, classified as accelerometers, are becoming increasingly popular [89]. Researchers have not evaluated the effectiveness of accelerometers with online data access to assess and increase physical activity.

6.5.4 Alcohol Consumption

Mobile technology may be a successful strategy for reaching the 85% of problem drinkers who never come into contact with professional help [90]. A large number of mobile applications focus on alcohol use, but few have been scientifically reviewed. A needs assessment by Cohn and colleagues [90] found 567 alcohol-related mobile apps, but only 29% were related to alcohol cessation. Of those, 90% used empirically based treatment methods: motivational counseling, self-control training, and social support. Weaver and colleagues [91] conducted a similar review of the top 250 alcohol-related apps from iTunes and Google Play. Only 11% of those studied were related to health promotion or reduced consumption. Both of these reviews noted that the majority of alcohol-related apps facilitate alcohol use and are for entertainment purposes only. Although there are apps focused on controlling alcohol use, to date no research has been conducted to determine their efficacy.

Web-based interventions have been studied but were found to have limited effectiveness. Bewick and colleagues [92] reviewed the literature and found that participants had positive attitudes toward web-based interventions, but results were inconsistent, with some interventions increasing alcohol consumption instead of reducing it.

6.5.5 Sun Protection

While most people know the benefits of sunscreen and reducing UV light exposure, this knowledge often does not translate to behavior change. Few SMS programs and apps have been developed to promote and reinforce the necessary behavior change. One study found that individuals who received daily SMS reminders to apply sunscreen and notices about the daily local weather applied sunscreen 56% of the time compared to the control group who applied sunscreen only 30% of the time [93]. Other mHealth methods to reduce UV exposure include phone applications, but as of 2012, there were only 19 sun behavior health apps [94].

The results of UV reduction and sunscreen application apps are mixed. One study found that individuals using the SolarCell app in the United States spent more time in the shade, but application of sunscreen decreased compared to those in control groups [95]. The SunSmart app, a component of a larger public health campaign in Australia to reduce UV exposure, has also had mixed results. The app had been downloaded more than 80,000 times, but only 40% of adults reported using UV alerts or sun protection information to make decisions about time spent in the sun. Of individuals who used the app, 90% stated that it was important to them and recommended the app to others [68]. The efficacy of mHealth tools for promoting healthy sun behavior needs further evaluation.

6.5.6 mHealth Research Gaps and Opportunities

mHealth applications have clearly engaged consumers. As a result, they offer great promise for reducing behavioral cancer risk factors. A key concern and research imperative is the empirical demonstration of treatment effectiveness among application users. This is especially true about demonstrating acceptability and
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impact in low- and middle-income countries, since the majority of studies have been conducted in high-income countries. Future research development should address the need for grounding in strong health behavior theory. Results of a systematic review of Internet interventions promoting health behavior change indicated that interventions varied in their use of theory, but those with a stronger theory base were generally associated with a larger effect size [96].

Research concerning mHealth may be enhanced by utilizing optimized study designs, data capture and analysis methods, and infrastructure. One methodological approach to consider before beginning mHealth trials is the use of a multiphase optimization strategy (MOST), a highly efficient application of engineering principals to prescreen and detect potentially viable intervention components [97]. MOST methods allow for the efficient identification of “active” intervention components. Randomized control trials are generally viewed as a best research practice, but because of their long lag time that often includes lumping of a number of intervention components, they might be less effective for the evaluation of quickly evolving technology [98,99].

Other innovative designs, incorporating the continuous evaluation of evolving interventions (CEEI), can take technological upgrades into account and thereby serve as a more efficient evaluation approach than other study designs. As a trial progresses, CEEI makes it possible to assess new versions of the interventions against previous versions. For data aggregation, statistical analysis, and sophisticated algorithms, researchers recommend drawing techniques from computer and engineering science because of the real-time data and within-person variance that is captured by mHealth tools. Lastly, it is important that the proper infrastructure is in place within clinics and hospitals, specifically for use of common measures and public sharing [100]. For this field to thrive, health care settings must promote innovation and encourage collaboration among professionals with differing expertise.

With the surge of medical mobile apps, the FDA has mapped out guidelines regarding its intentions for monitoring and regulating mobile device apps. The FDA’s approach aligns with the risk-based approach the agency uses to ensure safety and effectiveness for other medical devices. The FDA plans to provide general guidance for apps that make decisions or behavioral suggestions or that individuals will use to log, record, track, or evaluate information related to developing or maintaining general fitness, health, or wellness [71].

Use of mHealth is a relatively novel practice, which calls for unique considerations apart from assessments of effectiveness. Confidentiality, privacy, and legal and ethical issues are highly sensitive topics because of the virtual network of mHealth data. This is particularly true if mobile devices are lost or stolen, as they can contain highly personal health and lifestyle information [100].

6.6 SUMMARY AND FUTURE DIRECTIONS

IT innovations that focus on cancer prevention represent an enormous opportunity to reduce cancer morbidity and mortality in the United States. While the reduction in smoking prevalence over the last half century has been appropriately heralded as a great public health accomplishment, half of physicians in the United States still neglect to advise smokers to quit during routine medical visits. High rates of physical inactivity and excess body weight represent other important modifiable cancer risk factors that could be integrated into regular clinical care practice protocols. In addition to targeting clinicians and their patients in the health care setting, applications of cancer prevention IT (eg, mHealth) can directly target the patient or consumer, thereby expanding the reach, and potential impact, of such innovations.

There is growing empirical literature that can guide adoption of such cancer prevention interventions. The successful implementation of these interventions by health care systems, however, will require a great degree of sensitivity to critical front line clinical issues including: workflow, an increasingly complex regulatory environment, and overburdened providers already dealing with frequent technology advances. The way forward may lie in strategically leveraging IT-supported protocols. EHR systems offer the possibility of practice surveillance, provider prompts and order sets that potentially can integrate and streamline assessing patient risk factors and engaging them in behavioral change action plans designed to reduce cancer risk. In addition, mHealth applications via tablets and smartphones that already have the advantage of near universal adoption, can facilitate education and support and can provide targeted guidance that is portable and available 100% of the time.

Though the pace of technology has accelerated far ahead of empirical evidence on efficacy and effectiveness, it is clear that the potential impact of these changes is enormous and, perhaps will be transformative in terms of reducing the burden of cancer illness and death. In addition to science documenting efficacy, the most urgent research and development needs are to advance EHRs beyond their current limited role serving as data repositories and providing clinician reminders to the richer potential of turning outward, targeting patients, clinicians, and possibly others to engage them in evidence-based cancer prevention activities. This evolution may be facilitated by EHR developers and vendors engaging patients in
early design activities. Moving from automating cancer prevention interventions that use generic interventions based on outcome algorithms, to individualized interventions based on patient characteristics may have the added advantage of increasing patient satisfaction and heightening the likelihood that they will engage in cancer prevention behaviors. Development of organized, efficient, evidence-based IT innovations holds great potential for enhancing cancer prevention.

LIST OF ACRONYMS AND ABBREVIATIONS

ACCA Affordable Care Act
APP Application
CDC Centers for Disease Control and Prevention
CEEI Continuous evaluation of evolving interventions
CHCs Community health centers
eHealth Electronic health
EHR Electronic health record
ePHR Electronic personal health record
EPIC European Prospective Investigation into Cancer and Nutrition
FDA US Food and Drug Administration
HHIS US Department of Health and Human Services
HIPAA Health Insurance Portability and Accountability Act
HIT Health information technology
HITECH Health Information Technology for Economic and Clinical Health
HPV Human papillomavirus
IT Information technology
IVRS Interactive voice response service
LDCT Low-dose computed tomography
mHealth Mobile health
MMS Multimedia message service
NCI National Cancer Institute
NRT Nicotine replacement therapy
PCPs Primary care physicians
FDA Personal digital assistant
PSA Prostate-specific antigen
SMS Short message service
STOPM Stop Smoking with Mobile Phones
USPSTF US Preventive Services Task Force
UV Ultraviolet

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II. SUPPORT ACROSS THE CONTINUUM


A. Mobile phone-based interventions for smoking cessation.


B. The effectiveness of web-based interventions designed to reduce smoking.


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